

# Resilience – The New Research Frontier

Proceedings of the  
20<sup>th</sup> Annual International Sustainable  
Development Research Conference

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# Welcome Message—Conference Chair

## Welcome to the 20<sup>th</sup> Annual International Sustainable Development Research Conference

We are thrilled to convene, in partnership with the International Sustainable Development Research Society, the 20<sup>th</sup> International Sustainable Development Research Conference. Following the long tradition of the International Sustainable Development Research Society, we once again bring together the academic community with stakeholders, including decision makers, policy makers, private sector participants, and NGOs. We will discuss opportunities for a sustainable future given the challenges of continued human development with this year's theme: "Resilience – the new research frontier."

The conference in 2014 is dedicated to research contributing the human efforts for securing well-being and a decent life for all while maintaining the planets ecological capacity for future generations. The main aim of the conference is to provide an interdisciplinary forum for discussion on the complex issue of sustainability and its relations to resilience in nature and society. We hope that this conference will create scientific debate that will continue in existing and newly formed networks for years to come.

We are grateful to all of you for the wonderful range of presentations and posters, demonstrating the healthy state of sustainability research. Many thanks also to the track chairs for their work, preparing the calls for papers and reviewing abstracts, to the organization committee, the scientific committee, the student assistants and last but not least our sponsors. All of you are contributing greatly to making this conference a memorable event.

Dr. Martina Maria Keitsch, Chair ISDRC 2014  
Associate Professor, PhD Program Leader,  
Department of Product Design  
Norwegian University of Science and Technology

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# SUSTAINABLE UNIVERSITIES IN AUSTRIA. BUILDING ALLIANCES AND CLARIFYING THE CONCEPT

**Lisa BOHUNOVSKY<sup>1</sup>, Friedrich M. ZIMMERMANN<sup>3</sup>, Thomas WEIGER<sup>2</sup>, Fred LUKS<sup>4</sup>  
Thomas LINDENTHAL<sup>1</sup> and Helga KROMP-KOLB<sup>1</sup>**

<sup>1</sup> Centre for Global Change and Sustainability, BOKU University of Natural Resources and Life Sciences, Vienna; [lisa.bohunovsky@boku.ac.at](mailto:lisa.bohunovsky@boku.ac.at)

<sup>2</sup> University of Salzburg, Department of Cell Biology

<sup>3</sup> University of Graz

<sup>4</sup> Vienna University of Economics and Business

## ABSTRACT

Universities have different roles in promoting sustainability: as institutions for higher education, universities influence future decision makers; as research institutions they provide new models and knowledge; and as organisations they have a significant impact through their environmental and social performances. There evidently is a trend for universities to become a “sustainable university”, but the ideas behind this concept differ in regard to the scope and concepts. The paper contributes to this issue by presenting a Handbook for the Development of Sustainability Concepts at Universities that attempts to clarify the notion of sustainable universities. Moreover, the paper introduces the Alliance of Sustainable Universities in Austria and presents drivers and barriers found by participating universities when implementing concepts of sustainability.

*Keywords: green campus, network, sustainability in higher education, sustainable university, sustainability strategy, alliance, sustainability research;*

## 1 INTRODUCTION

Within the next decades, universities will have to deal with massively changing societal, environmental and economic environments themselves. In order to sustain their key functions they will have to find concepts to remain resilient towards these global challenges: starting the transformation towards sustainability can help increasing universities’ resilience. Moreover, universities play a leading role in the development of society, and they have a moral and ethical obligation to promote sustainable development. Based on this, it is the responsibility of universities to take a holistic approach to integrating sustainability issues into all levels of their activities.

In the past decade, more and more universities have become aware of the corporate responsibility to raise awareness of sustainable development among their students, researchers, lecturers and other staff members. This has been accompanied by a number of declarations such as the Talloires Declaration (1990) [1], the Agenda 21 (1992) [2], the CRE-COPERNICUS Charta (1993) [3], the Ubuntu Declaration (2002) [4], and global initiatives such as the Johannesburg World Summit for Sustainable Development and the Global Higher Education for Sustainability Partnership (WSSD & GHESP, 2002). In December 2002, the United Nations General Assembly adopted a resolution declaring a 'United Nations Decade of Education for Sustainable Development' (UN DESD)[5] from 2005 to 2014. This Decade should call for action all over the world to initiate programmes of sustainability at all levels of education, and to raise awareness about sustainability among people of all ages, groups and countries [6].

Within the last years, several universities have started to publish their efforts in regard to sustainability in sustainability reports. In Austria e.g. the University of Natural Resources and Life Sciences, Vienna [7] or the University of Graz [8, 9], in Germany e.g. the Hamburg University and Medical University [10] or Leuphana University in Lüneburg [11]. But also in other parts of the world universities are becoming active and reporting their efforts, e.g. the UCLA which already started in 1989 [12].

These reporting activities show that principles of sustainable development are becoming increasingly important for universities and that they are challenged to act as important agents in promoting these principles within society. Traditionally, since the first efforts following the Stockholm Declaration on the Human Environment in 1972, the integration of sustainability into higher education has been mostly understood as so-called 'Greening Campus' initiatives, which concentrate on environmental activities on university campuses. With the dawn of the new millennium, sustainability issues have also been integrated into education, research and management of universities. Universities develop new knowledge in regard to sustainability and they have an important multiplier effect that carries knowledge and innovation outside the universities. Thus, research, teaching and knowledge transfer are also central fields of transformation and key issues of a university [13, 14]. These core tasks of universities indeed have a much bigger impact on society and therefore universities must succeed in promoting sustainability in these fields in order to further the societal transition towards sustainability. In regard to Education for Sustainable Development (ESD) the question is how to integrate sustainability in the curricula and which key competences students should acquire in regard to sustainability. A main challenge of ESD is to find ways of teaching new competences. ESD is not just about teaching sustainability topics, but it includes inter- and transdisciplinary approaches or teaching on how to prioritize actions after assessing benefits in all three sustainability dimensions [15]. Lecturers need to assess, how their field of expertise can contribute to train students accordingly and with whom they should collaborate in their teaching [15]. Barth et al. [16] stress the importance of formal and informal learning settings to promote key competences for sustainability in Higher Education.

Besides education, universities are primarily places of research and innovation. Research for sustainability can be seen as problem-oriented research for the grand societal challenges. Many research areas contribute with their findings to sustainable solutions and thus deal with sustainability – even when the term is not directly used in their context, e.g. projects that deal with the improvement of any renewable energy technology or with possibilities to reduce the use of synthetic fertilizers. Other research projects deal with sustainability as such or explicitly take into account the interrelations between ecological, economic and social aspects. Moreover, research itself can be performed in more or less sustainable ways, e.g. by flying thousands of miles by airplane in order to meet project partners versus virtual meetings. Application of strategies to enforce sustainability, e.g. by integrating a sustainability view in existing research (institutes), promoting sustainability related funding, need to be pushed in this area – to name a few examples how to encourage scientists to pay more attention to sustainable research.

The links between universities and sustainability in the fields of operations, teaching and research are manifold and diverse. But there is no generally accepted definition or criteria of what defines a “sustainable university”, which roles and fields of action should be taken into account and to what degree sustainability should be a holistic concept, covering all fields of university-activities.

Not everybody at universities will be interested in promoting sustainability at universities. Different people or groups may be involved in the implementation of sustainability activities at their institution or simply may have the power to enforce this process by the power of their office. This might be: the president or his/her deputies of a university, sustainability managers, regular staff members appointed to this task, study commissioners, department and institute directors, or student representatives. Students have an ambiguous role in this transformation. Lukman et al. [14] (page 112) state that they are “*difficult to organize, but easier to motivate*”. Nevertheless, many important initiatives at universities were driven by student initiatives, e.g. [17]. In this regard, the international students initiative oikos ("oikos", the ancient greek word for house and the root for both "ecology" and "economy"), a global network to enrich students' curriculum at their respective universities with sustainability topics – with so-called local chapters in Vienna and Graz is particularly worth mentioning [18].

Experiences so far show that collaboration between universities support individual efforts by e.g. allowing for an easier start although each university needs to find its own position and strategy in order to take advantage of common projects [19] Moreover networking is an essential aspect of sustainable universities and other higher education institutions, for the scientific community but also for the global-local-interplay [20, 21].

In 2012 the Alliance of Sustainable Universities in Austria was founded, with the aim to bundle strengths, enforce synergies and cooperate in regard to sustainability at Austrian universities. This

paper describes the Alliance's objectives, approaches and efforts. Among other activities, the Alliance compiled a handbook for the Development of Sustainability Concepts at Universities that helps to overcome the shortcoming of missing definitions of a "sustainable university" by proposing criteria, objectives and measures. Below the individual paths of four universities to achieve comprehensive and considerable steps towards sustainability are described. Finally, the authors discuss drivers and barriers they encountered and how efforts for sustainability can increase universities resilience.

## 2 THE ALLIANCE OF SUSTAINABLE UNIVERSITIES IN AUSTRIA

The Alliance of Sustainable Universities in Austria was funded in 2012 as an informal network of universities that aims at promoting sustainability issues in Austrian universities and thus to contribute to a more sustainable society. Currently nine Austrian universities are members of the network: BOKU University of Natural Resources and Life Sciences (Vienna), Karl-Franzens-University of Graz, Graz University of Technology, Medical University of Graz, University of Music and Performing Arts Graz, Vienna University of Economics and Business, Alpen-Adria-Universität Klagenfurt, University of Salzburg and University of Innsbruck [22].

The Alliance strengthens sustainability issues through its common appearance and thus motivates its members – and especially those people within a given university who are/feel responsible to promote issues of sustainability within their organizations.

The main objectives of the Alliance are to exchange good practice-experiences and to start joint activities in the fields of

- research
- education
- operations
- society/knowledge transfer
- identity;

On a superordinate level, it generally aims at anchoring sustainability issues at universities and thus to contribute to a sustainable society.

A main success of the Alliance was that each participating university committed to developing a sustainability strategy. This aim was defined in the performance agreements for 2013-2015 that each university negotiates with the Austrian ministry for science and research. These strategies must include specific objectives and measures to promote sustainability within research, education and operations. A working group of the Alliance then elaborated a handbook for the development of sustainability concepts at universities – which is described in detail below (chapter 3).

Further working groups take care of a variety of issues related to sustainability at universities:

- The Working Group "Climate Friendly Climate Research" tackles the issue of carbon intensity of climate research. The 'climate-friendly climate research' project of the Alliance in cooperation with the CCCA (Climate Chance Centre Austria) is financially supported by the Austrian ministry for science and aims at reducing the carbon footprint of climate (and other) research, and thus increasing its credibility [23, 24]. From November 11-15, 2013 the JPI CLIMATE Online Conference – Climate-Friendly Climate Research was held to discuss and test climate friendly exchange. For further information go to: <http://ccca.boku.ac.at>.
- In 2013 the working group on environmental management won a large 5-year grant that will allow all participating universities to implement - or if they already have one, to extend - the EMAS program. EMAS is the European Eco-Management and Audit Scheme that aims at improving environmental performance of companies and organisations. BOKU established EMAS in 2006 and will implement further steps under the project; the universities of Graz (KFU), Klagenfurt, Salzburg and the Vienna University of Economics and Business will establish the EMAS management system within the next 5 years.
- The working group for sustainable mobility is built upon experiences at the Universities in Graz which are based upon a research driven concept including four phases to achieve sustainable mobility: (1) the project "alternative mobility at the University of Graz" focused on an improvement of the modal split of staff and students towards biking and walking, including a catalog of improvement measures. (2) this project was widened to all four universities in Graz under the label „UniMobil4U“. (3) S. Janschitz [25] extended the concept of sustainable mobility by the aspect of barrier-free accessibility and the concept „Design for All“, with a strong focus on

awareness raising and using a geographic information system for planning and application. 4) Finally a mobility concept was elaborated for the University of Graz and a „traffic avoidance strategy“ was implemented where University members can „trade“ their parking lot at the University for funded public transportation tickets (year, half year) or for a high quality city bike with the University logo, again funded by the University and therefore for a very low price.

- The working group for sustainable procurement which elaborated a guideline for sustainable procurement for the University of Graz and held a workshop on the issue.
- The Viennese universities collaborate within the Working Group Sustainability Entrepreneurship. They exchange information in regard to Social Entrepreneurship in Austria in general and how it can be incorporated in teaching activities. Their aim is to enlarge “spaces” for social entrepreneurship at universities.

### 3 THE HANDBOOK FOR THE DEVELOPMENT OF SUSTAINABILITY CONCEPTS AT UNIVERSITIES

In order to support the development of sustainability concepts at the Alliance-universities, a working group created a handbook in 2013. The handbook intends to help persons in charge to develop, accompany and evaluate sustainability concepts. It is designed as a "living document" that will grow with the universities' experiences.

While the main part of the handbook is intended as a set of proposals that should assist the respective universities to choose their priorities, several quality criteria are spelt out in the beginning, that are considered essential for the success and acceptance of university sustainability processes by the Alliance's experts. The quality criteria for sustainability concepts at universities embrace the following points:

1. Consideration of all three pillars of sustainability (ecological, economic and social), i.e. for each column corresponding objectives and measures should be defined.
2. Smart, measurable, accepted, realistic and terminated (smart) goals should be defined for the short (1-3 years), medium (3-5 years) and long-term (> 5 years) and corresponding measures should be formulated.
3. Verifiability in terms of target achievement, i.e. defined objectives and qualitative or quantitative indicators;
4. Clear timetable for the introduction and implementation of the measures;
5. Institutionalized monitoring process that captures who or which bodies are responsible for the creation, monitoring, quality control and implementation, as well as for any necessary adjustments;
6. In terms of operations either the points raised in the handbook must be observed or a recognized environmental management system has to be implemented (e.g. EMAS [eco management and audit scheme]).

Moreover, the handbook describes an ideal form of a participatory process of all members of a university (students as well as employees) in order to develop a sustainability concept. A sustainability process should include the creation of structures, the development of binding goals and objectives, the implementation of a project team and an expert group, annual programs and monitoring of the process. This monitoring can be university-internal, but the Alliance also offers support.

The hand book also names several criteria that should be considered for sustainable universities. By listing these criteria it also clarifies the notion of sustainability in the context of universities. Sustainability means considering general criteria for sustainable development, like resilience, biodiversity, justice, participation, or ecological and social fairness of financial and commercial politics. In the case of education and research, the handbook also adds didactic or methodological criteria, respectively. It claims that for sustainable education it is not sufficient to teach sustainability as content, but to ask if the didactic methods are appropriate to teach critical reflection, to raise awareness of the strong interrelations between the topics or to demonstrate the high complexity of the challenges as well as possible solutions. Sustainability in the context of higher education and research includes criteria such as giving system-oriented, holistic pictures; inter- and transdisciplinarity, problem- and project-oriented; allow for reflection on values, attitudes, non-sustainable paradigms; etc. (based on [26-33]).

The main body of the handbook lists examples of specific goals and measures along seven thematic areas (see table 1). These proposals can be adapted according to the universities' needs, specific strengths and possibilities.

Table 1. Exemplary objectives and measures from the handbook for seven thematic areas

Exemplary objectives	Exemplary Measures
<i>Thematic area: Education</i>	
More students dealing with sustainability issues	Establishing general sustainability courses
Cooperation between alliance members in regard to teaching	Establishment of a curriculum for complementary sustainability studies for students of all faculties
<i>Thematic area: Research</i>	
More sustainability in the implementation of research projects	Lobbying activities in funding agencies for sustainability research (national and European)
More research projects on sustainability issues	Measures for evaluating the social and sustainability relevance of research
<i>Thematic area: Operations</i>	
Reduced energy and resource consumption on campus	Internet platform for the collection of internal environmental innovations
Consideration of environmental and social sustainability into business decisions	Environmental report, sustainability report and certification
<i>Thematic area: Strategic development</i>	
Clear strategic orientation of the university towards sustainability and institutionalization of sustainability	Participatory development of a vision of a "sustainable university"
Intensification of cooperation within universities	Measures to significantly increase the participation of stakeholders
<i>Thematic area: Public relations / societal impact</i>	
Make reports and information for sustainability activities more accessible and transparent	Identification of internal and external stakeholders
Internal and external awareness raising for sustainability	Measures to strengthen networking (especially with and among students) in the field of sustainability
<i>Thematic area: Financial management</i>	
Identifying opportunities for emphasizing the selection of ecological financial instruments	Check opportunities to collaborate with eco-banks
Clarify possibilities how to integrate social standards in the selection criteria of financial instruments	Develop decision-making basis for eco-investment, preparation of first implementation steps
<i>Thematic area: Organizational culture and, if appropriate, social responsibility</i>	
Common responsibility of all university members for the university and its sustainable development	Reflection on implicit or explicit core values within the university and its departments/institutes/facilities
More transparency and participation in decision-making	Sustainability orientation / awareness raising through events and training for all university members

#### 4 FOUR DIFFERENT APPROACHES TOWARDS REALISATION

##### 4.1 BOKU University of Natural Resources and Life Sciences, Vienna

The BOKU was founded in 1872 and traditionally is a University of Forestry and Agriculture. Nowadays its focus is on providing the scientific basis for the security and the sustainable management of natural and renewable resources, for a secure supply of the population with food and water, for the development of rural and urban areas and for innovative solutions in the field of

biotechnology. Currently, the BOKU comprises about 1500 staff members and 11.000 students. As the “University of Life” is has a strong historical bias towards sustainability issues.

Sustainability initiatives have a long tradition at BOKU. In 2002, the university started reporting on its initiatives, since 2006 the sustainability report is compiled according to the Global Reporting Initiative (GRI)-standard. Moreover, sustainability is within the focus of many institutes and research projects. And it offers a bachelor and master program “Environment and Bio-Resources Management” that has a strong focus on sustainability. Also, the doctoral program on sustainability (dokNE) has to be mentioned.

Although sustainability projects have been supported by the university administration in principle, no binding strategy for implementation has been readily identifiable.

In 2013, in order to strengthen sustainability issues, the BOKU started a university-wide process to develop a sustainability strategy (<http://bit.ly/1jjqBoc>). The development of the strategy started in June 2013 with a kick-off workshop and was followed by four topic-specific workshops between October and December 2013 covering research, education, identity and society (organisational culture, strategy and interactions with society), as well as operations (environmental management and social responsibility).

Individual – subjective – appraisals of the status quo by the workshop participants were the starting point for further discussions that focused on objectives and measures that the BOKU could accomplish to reach the desired situation. The participatory process resulted in 39 objectives in regard to sustainability, which were consolidated from the results of the thematic workshops and ranked according to their importance and relevance by the participants of a synthesis workshop. Each objective has one or more corresponding measures (70 in total). A decision-making group then selected those measures that will be realized in the short, middle and long term. A sustainability core group and a reflection group coordinate the process and the realization of the measures.

*Table 2. Exemplary results from the BOKU process*

<b>Exemplary BOKU Objectives</b>	<b>Exemplary BOKU Measures</b>
<i>Thematic area: Society</i>	
Change of mind-set to emphasise the relevance of public communication of sustainability issues	Development of an incentive scheme
<i>Thematic area: Research</i>	
Increase visibility of / assess to sustainability related research at BOKU	Develop sustainability and social impact as alternative evaluation criteria
<i>Thematic area: Operations</i>	
Improve nutritional situation at BOKU in regard to sustainability	Intensify regional, seasonal and organic food supply at BOKU locations

## 4.2 Karl Franzens University of Graz

The Karl Franzens University of Graz pursues an integrative process of sustainable development with a responsible university management serving as a role model for students, staff and the society. Social networks for knowledge transfer as well as the involvement and participation of committed students and staff in the sustainability process guarantees high-quality in education and training for future decision makers and lifelong learners. The research is characterized by its social relevance and the wide application of transdisciplinary approaches.

*Table 3. Selected sustainability milestones of the University of Graz*

1991	Development of an interdisciplinary curriculum “Environmental Systems Sciences”
1993	Signing of the COPERNICUS Charta
2002	Foundation of oikos Graz Chapter at the University of Graz
	Starting Point of the Sustainability Library
2004	Integration of “Sustainability” into the University’s strategies and goals
2006	Sustainability Reporting” started - as one of the first Universities in Austria
2008	The 4 universities in Graz connected to “Sustainability4U” (potential of approx. 10,000 employees and 60,000 students)

2009	Foundation of the COPERNICUS Alliance, the European Network on Higher Education for Sustainable Development – initiated and chaired by the University of Graz
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Currently the University of Graz offers several Master programs focused on Sustainability, e.g. Environmental Systems Sciences (with specialisation options on Economy, Geography, Physics, Chemistry and Natural Sciences), Sustainable Urban and Regional Development, Gender Studies, Global Studies, Joint Degree Sustainable Development and Erasmus Mundus Master in Industrial Ecology etc. And there are numerous international research projects with a strong focus on sustainability like: ConSus - Connecting Science-Society Collaborations for Sustainability Innovations, UE4SD - University Educators for Sustainable Development, SUSTAINICUM Collection - Teaching materials for education for sustainable development; (details on: <http://rce.uni-graz.at/en/research/projekte-partner/>)

With regard to the future, the development plan of the University of Graz 2013 - 2018 defines the following projects:

- The ecological sustainable University: „Sustainability and climate neutrality“. Specifically targeted measures include the use of energy saving instruments, the thermal optimization of buildings and the use of roof spaces to implement solar energy facilities for heating and cooling. The University will publish a sustainability report and a climate protection report on a regular basis in order to evaluate and communicate the effect of the above mentioned measures and to plan further steps. Furthermore the University of Graz started to implement “EMAS III” in September 2013 at all levels with the goal to reduce environmental impacts of the university, to increase the environmental performance and to guarantee legal compliance concerning environmental issues. Based on the environmental review the university’s environmental policy and goals will be set and finally the environmental management system will be implemented and validated in fall 2015.
- The economic sustainable University: „Facility Management, green office and energy management“; pilot projects and pilot units are implemented.
- The social sustainable University: „Strengthening sustainable education, training and life-long learning“.
- Improvement and coordination of all activities at the University dealing with sustainability issues.

#### 4.3 University of Salzburg

In June 2011 Heinrich Schmidinger, president of the University of Salzburg, invoked the sustainability program named PLUS Green Campus. PLUS stands for the name of the university “Paris Lodron University Salzburg” but also implies that this movement wants more than just to fulfil environmental legal requirements. From the very beginning students were involved in the development of the program.

The name PLUS Green Campus was developed as a brand name with its own logo marking all sustainability related activities of the university and as such, guaranteeing high recognisability. Furthermore the University uses the official webpage of the university [www.uni-salzburg.at/plusgreencampus](http://www.uni-salzburg.at/plusgreencampus) as well as a monthly electronic newsletter during the semester to update and inform employees as well as students about the latest developments or events of PLUS Green Campus. This again helps to get the message out and remind people – on a monthly basis – that sustainability is an important issue not only for the operations of the university but also for the daily life of all of us at the work or study place.

While the start of PLUS Green Campus was marked by unrelated actions and events it soon turned out that a management structure and strategy was needed. For this reason a sustainability core group was formed including all stakeholders of the university who define aims, plan, act, evaluate and push forward sustainability measures. This group reports to the president of the university on one hand and hands over the operational agenda to a group of so called coordinators for areas like mobility, sustainability, operations and facility management, green meetings, health, or public relations on the other. At the level of departments sustainability appointee’s connect the coordinators with all members of the university.

The University of Salzburg quickly recognized the need for a strategic instrument which would help to organize and manage its sustainability program. EMAS was chosen as the guideline to: a) manage the sustainability agenda professionally, b) progress constantly and c) most important to do this in close

communication with the members of the university as required by EMAS. The university aims to be EMAS certified by 2015.

The next step at the University of Salzburg is to implement a further strategic component adding research and education to its already existing operational strategies. Thus, EMAS helped us to set up a basic environmental strategy, which will be extended to the areas of research and education to cover these main duties of a university in close cooperation with the Alliance of sustainable universities in Austria.

#### **4.4 Vienna University of Economics and Business (WU)**

The Vienna University of Economics and Business (WU) has, in its current development plan, committed itself to the goal of sustainability. Following several initial workshops and the formation of a Competence Center for Sustainability in the summer of 2013, WU's sustainability process continues with a focus on participation of faculty, staff, and students. Workshops focused on issues such as "quality of work and social issues", "environmental protection and green operations". "Research in the area of sustainability at WU" brought together many members of the WU from a wide array of fields. It was easy to see and feel the huge interest in this issue. The workshops provided a good introduction to and overview of the sustainability related research already underway at WU. All the workshops generated many ideas for how the role of sustainability could be strengthened in the different fields. An electronic consultation process will take place to give as many university members as possible an opportunity to take part and so to expand the support base for the process.

Besides the idea-generating process, there are already concrete measures under way. The Competence Center for Sustainability is active in the areas of research, teaching, university management and stakeholder dialogues. It supports scientists, provides information on sustainability topics, co-operates closely with the campus management and several student organizations. It is also actively networking with other institutions, for example in the context of the "Principles of Responsible Management Education" and the aforementioned Alliance of Sustainable Universities in Austria.

## **5 DISCUSSION**

The four universities have found different, albeit similar, ways to introduce or strengthen sustainability efforts in their institutions. First, success factors and barriers in regard to the process development will be discussed; second, the discussion will focus on the three roles of university: research, teaching and operations.

The University of Salzburg has mainly focused on environmental issues to date, but aims to develop a broader approach. Besides efforts in regard to environmental issues, BOKU and the Graz University introduced several educational programs that highlight sustainability several years ago and also follow an approach that aims at widening their efforts. The WU has just recently made a shift towards sustainability – following a holistic approach from the very beginning. The pathways of the four universities differ, according to the historical background, the thematic focus of the university and are also very dependent on the initiators of the process, but each of the four universities follows a sustainability pathway in a holistic way. The pathways described above, show that the decision of a university to become sustainable need not be a 180° turn, but it can be an evolving process by accepting challenges step by step and gaining one stakeholder after the other for the sustainability goal. Such pathways keep resistance low and allow for flexibility and openness for new ideas.

All four universities show that it is important to have a "sustainability core group" that feels responsible for the further development of sustainability on a strategic and practical level. This group can have different compositions and status within the university. Its central responsibility is to observe, accompany, coordinate and initiate the process and to make sure, that goals that are set out in strategic papers are realized (monitoring, self-reflection and evaluation). Sharp [13] (page 132) states that *"Universities are multi-structured, complex organization that exists without any single observation point or any single control center from which university wide changes can be programmed and implemented."* This complex structure of universities poses specific problems at those who are interested to promote sustainability in universities and makes a top-down approach difficult. It calls for a successful cooperation of the management, (scientific and administrative) staff as well as students. This stakeholder management also needs to be coordinated and steered by a core group in order to ensure that all main groups are represented:

First, students' participation is a key factor for the success of any sustainability program at a university for many reasons like the fact that students are the vast majority of persons at any university outnumbering employees and most important they will be the future opinion leaders who have to make decisions which may in one way or another affect our environment more or less substantially. Nevertheless, the high turnover of students makes it difficult to start continuous processes. All four universities aim to integrate students in projects, whereas the students clearly act more or less proactively. This might have to do with their disciplinary background (e.g. students who chose to study at the BOKU often have a strong affinity to the environment, and thus to sustainability), but also on the individual interest of students or how active the official students representation at a particular university is in this area.

Second, the commitment of university decision makers guarantees the (financial, but also the "ideological") support and empowers the staff and the students to take action. The presence of and contribution by the university's management in the participatory process at the BOKU was recognized and appreciated very much by the participants of the workshops and made sure that their contributions were heard by the management. Third, the support of the administrative staff is needed to realize objectives and measures, set out in a sustainability plan or strategy. Operational issues are mainly carried out within this group. Last but not least, the scientific staff encompasses those persons who can make a change in universities research and teaching activities. Since academic freedom is a very important value also for sustainability, changing the focus of research or teaching relies on inspiring people and supporting those interested integrating sustainability in their work. The dialog with these groups needs to take into account the different attitudes and (disciplinary) backgrounds of the partners in order to be successful ([34].

Those, who support the idea of sustainable development and who are willing to take responsibility can be found at each university and in each of the groups mentioned above. A participatory process can help to turn followers into leaders, by giving them the opportunity to participate, join forces with others or simply by getting information about initiatives that are going on. Nevertheless, participatory processes can fail if no success stories can be seen by those who invested their time and energy. Therefore, the communication of activities is a central issue [34]. Among the universities described here, the BOKU and the WU have already started participatory processes that include staff and students and are supported by the rectorate – the next months will show in how far the positive spirit that was started by these processes will be kept alive.

Another issue, observed at all four universities is the fact that time investments for sustainability at the university are hardly rewarded and there is little recognition for those who participate. There is hardly additional budget available and most activities are based on voluntary engagement. This can lead to the situation that those people who are very enthusiastic and motivated in the beginning lose their motivation over time or that people, who would be interested in sustainability in general, cannot participate despite their wish to contribute. As a person responsible for the sustainability process it helps to recognize that it is not necessarily a lack of a sense of responsibility if university members do not support one's efforts, but due to other restrictions in regard to time or different priorities of staff (high pressure of teaching load and research needs...).

The Alliance of sustainable universities in Austria is another structure that proved helpful, by being an excellent forum for mutual support as well as an exchange platform for good practice examples. Regular meetings were used to exchange on current activities and possibilities to overcome barriers. The participatory processes at the WU and BOKU may now serve as models for other alliance universities that want to start such a process.

Moreover, the chance to apply for public reward and recognition through (international) institutions through prizes or press releases fuels the support within the university.

The experiences at the four universities have shown that the operational part is easier to tackle, while the core agenda of a university – research and education – are more difficult to define as sustainable and/or to organize in sustainable ways. EMAS is an accepted standard of environmental reporting and is or will be followed by all four universities. This measure meets with very little resistance. In contrast, it is much more complicated to support changes in the fields of education and research.

Moreover, alternative ways have to be found to integrate sustainability topics into teaching and research. Rusinko [35] presents a matrix of options to integrate sustainability in higher education. She distinguishes between (I) the integration into existing courses or programs, (II) the creation of new, discipline-specific sustainability courses or programs (III) the integration into common core

requirements and (IV) the creation of new, cross-disciplinary sustainability courses or programs. While the creation of specific programs might arouse resistance, the integration into existing courses might be easier if lecturers can be motivated who are interested in the topic of sustainability. Moreover, the approaches differ in regard to the share of students who can be reached. BOKU, for example, follows a multiple strategy, by assessing possibilities to develop (blocks of) elective courses accessible for all students or to introduce a basic sustainability course for all students regardless of the program they follow.

Education should have the biggest weight in this respect since it allows for the greatest indirect environmental effects, as it influences the actions of its graduates for the rest of their lives and the decisions they make later as opinion leaders or CEO's in respect to a better environment. Here universities have a great responsibility to educate and teach students how to live and act in agreement with a sustainable environment. In other words universities need to convey sustainability values to their students so they are in a position to shape the future in a responsible and sustainable manner.

## 6 CONCLUSION

The Alliance of Sustainable Universities in Austria helps to strengthen, develop and push forward sustainability within university policy, public perception, and promotes several intense collaborations. The jointly developed *Handbook for the Development of Sustainability Concepts at Universities* supports the process of introducing sustainability concepts at universities, by presenting quality criteria, sustainability criteria and various exemplary measures for implementation. By providing a broad approach towards the guiding principle of a sustainable university it ensures the implementation of sustainability programs within universities' key roles of, namely education, research, operations, and knowledge transfer. The experiences so far show that these efforts are very fruitful as well as gainful despite low/no extra budgets or timely limitations of university sustainability stakeholders.

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# EKOTEKNIK (ECOTECHNICS/ECOTECHNOLOGY) – 30 YEARS OF EXPERIENCE IN INTERDISCIPLINARY EDUCATION

**Erik GRÖNLUND<sup>1</sup>, Mats BARTHELSON<sup>1</sup>, Andreas ENGLUND<sup>1</sup>, Inga CARLMAN<sup>1</sup>,  
Morgan FRÖLING<sup>1</sup>, Anders JONSSON<sup>1</sup> and Paul VAN DEN BRINK<sup>1</sup>**

<sup>1</sup> Ecotechnology and Sustainable Building Engineering, Mid Sweden University, Östersund, Sweden

## **ABSTRACT (250 WORDS MAX)**

An important part of a society's resilience is how prepared it is to cope with the changing conditions during the alpha and omega phases according to resilience theory. Lars Thofelt, an academic from the mid Sweden region, early recognized this need for students to develop skills needed for a societal change, and devoted his life to pedagogy suitable for this. The main outcome of his achievement was the interdisciplinary university program in Ecotechnics/Ecotechnology (Ekoteknik in Swedish), at Mid Sweden University. Ecology, economy and technology in cooperation for sustainable development were the original approach, and still are.

Thofelt's ideas had a main focus of helping students develop their inherent capabilities of solving problems and overcome obstacles. After Thofelt's 12 years at the program his ideas were carried on by former colleagues and students, and the teaching further developed with a mix of the Thofelt tradition and other experiences brought in by new employees. This paper describes this interdisciplinary teaching approach with special focus on development of resilience capacity in students.

It was concluded that 1) a key element to develop resilience skills in students is to push them to a self-propelled learning behavior rather than traditional teaching, 2) not too easily provide the students with answers will develop their problem solving skills, 3) doing-before-reading teaching is more time consuming but seem to give deeper knowledge, 4) interdisciplinary teaching will in the long run benefit from having the interdisciplinary team within the department, rather than as a conglomerate of several departments.

*Keywords: Resilience, social change, problem solving, self-propelled*

## 1 INTRODUCTION

Resilience theory includes the important phases of change in the development of systems, and even labels them "creative destruction" [1]. These are the added alfa and omega phases to the traditional r and K phases, see for example figure 2-1 in Holling and Gunderson [2]. For systems including humans these phases of change are of course connected to ethical dilemmas as resource division and sharing, poverty and even questions of life and death. An important part of the resilience of a society is how prepared it is to cope with the changing conditions during the alpha and omega phases. Lars Thofelt, an academic from the mid Sweden region, early recognized this need for students to develop skills needed for a societal change, and devoted his life to pedagogy suitable for this [3-6]. The main outcome of his achievement was the university program in Ecotechnics/Ecotechnology (Ekoteknik in Swedish), which started in 1983 at the University college in Östersund, later merged into Mid Sweden University.

Thofelt's ideas had a main focus of helping the student develop the student's inherent capabilities of problem solving and to overcome obstacles. In his memoirs about a life with teaching, Thofelt [5] describe how he struggled with this since the mid-70s at different levels in the Swedish school system.

Thofelt left Ecotechnics in 1995 but his tradition was carried on by former colleagues and students. The teaching was further developed with a mix of the Thofelt tradition and other experiences brought in by new employees.

### 1.1 Purpose

Sustainability science is difficult to achieve since it demands an interdisciplinary approach over the traditional faculty division of natural, social, and engineering sciences. At Mid Sweden University all these three have been integrated in education for 30 years. The purpose of this paper is to describe the interdisciplinary teaching with special focus on development of resilience capacity in students.

### 1.2 Method

The paper has a phenomenological approach in its aim to describe the experiences from the 30 years of interdisciplinary teaching.

## 2 EXPERIENCES OF INTERDISCIPLINARY TEACHING

### 2.1 The creation of independent, problem solving students.

It is a common feedback from both former students and employers that compared to competing groups, which has mainly been biologist, “biogeo”-ists, environmental health inspectors, etc., the Ecotechnics/Ecotechnology students had a higher degree of problem solving capacity. During the period when the Ecotechnics/Ecotechnology was a 2-year education program one employer even said: “These Ecotechnics students, they don’t know much, but they always solve the problem you give them!”. The students they were compared with most of the time had a 3-year education with focus on detailed knowledge instead of problem solving. After 10 years the Ecotechnics education was upgraded to also include 3 years. Today it is also complemented with an International Master’s program in Ecotechnology and Sustainable Development.

It is interesting to see that Lars Thofelt was successful with his ideas of producing adaptive problem solving students. And that the focus on this skill had a trade-off regarding the amount of facts the students were able to gather. During the early years this “fact underdog” situation of course was explained partly by the 2-year length of the education. But this is the experience also from later teachers that ‘skill learning’ takes more time than ‘fact learning’. The skill focus is of course not unique in education; it is the focus of the engineering tradition. But since the Ecotechnics/Ecotechnology students competed mainly with natural science students the engineering approach showed results. Another saying of Ecotechnics/Ecotechnology is that it is a natural science based education with engineering attitude. This makes sense in that ecology was not at that time (and still is not to any recognizable extent) part of any engineering education, but was part of the natural science tradition. The experience from today is that this tradition has been possible to preserve to some extent. The opinion is that Ecotechnics/Ecotechnology students still have an advantage compared to competing groups regarding projects work and problem solving capacity. However, other educations have reduced the gap, probably partly because of the increased popularity of problem based education, and partly because lower education in Sweden in general seems to have taken a large step toward project based education, especially in the upper comprehensive school.

### 2.2 “Don’t answer questions”

Probably most striking for new teachers coming into Thofelt’s teaching group was to absorb the habit of not answering questions. Thofelt [3] writes:

”The teacher is to be a guide in the project, never to have any answers but to help the students find their own answers and thus their true capacity. The teacher has to, by listening and discussing, clarify the student’s mind and thus deepen a holistic understanding...”.

This can be illustrated by the exercise “The green square meter” which students met as their first exercises at the Ecotechnics/Ecotechnology program the first 15 years. It was a very simple exercise but “...a shock to the students” [5]. Immediately after the roll call the very first day of the course the students were taken to a grass lawn or similar place with low vegetation, at a first glance appearing to be homogenous. The students worked in pair of two, and had the assignment to find “What, and how

much? (meaning what plants and how big biomass)” [5]. At first the students could not find anywhere to start. But when the teacher gave no further instructions the student started to find some structure in the square meter. Some blades were sharp, some were round. Small parts were bare ground. The square meter started to get some character. The next step was for the student to find tools to analyze the square meter. Either a new method was developed or a standard was used. Now the teacher had a clear role as a guide. However, it was important that the student himself/herself made the choice of method. Now it was possible to work the way through the square meter. The student had now had the first lesson in being the driver of the project, finding a method that can solve the problem, and structure the result in a way that can be presented. From the teachers perspective it is important not to lead the student, but rather “mirror” their questions and help them reformulate questions. Thofelt [5] writes: “For example you could ask the question back with a little addition of a different angle.” This will help the student through the challenge. A problem can be that the teacher feels that he/she has to teach the student for reasons like: “I get paid for this. I must perform to live up to my salary”. Or, that the teacher has a need to show to the student that he/she knows more than the student, and can transfer knowledge to the student. This is not what the student needs according to Thofelt, and several times he had to take new teachers away from the student group, hissing in their ear “Come here, you destroy the whole teaching!”. Rather the student benefits most from learning how to be self-propelled.

### 2.3 Doing before reading

The example above of the green square meter shows also another feature in Ecotechnics/Ecotechnology teaching: the doing before reading. The principle is to let students try to solve a problem without any prior teaching. After a period of trial some lectures are introduced. This is more time consuming than teaching the theory first, and then let the students test the theory in some experiment. The experience is that the knowledge goes deeper and will last better with the doing before reading. It is like the minds of the students are prepared by the trial and the motivation to learn when the theory comes is much higher. Another explanation may be that the student put up many more hypotheses, conscious or unconscious, if they have fewer instructions what to expect from the exercise. They practice the skill of finding patterns in the unknown. Another example is the approach in the chemistry lab. Very rarely the teacher has prepared the equipment needed for the experiment. Rather the students have to find the equipment in the chemistry lab. In their search they add a lot of “grey zone” information what other stuff is available in the chemistry lab, which gives them means to later set up experiments created in their own mind, or when facing another problem in a totally different context.

### 2.4 Group dynamics

Over the years we have observed a lot of group dynamics in the Ecotechnics/Ecotechnology classes. Here we will present some patterns that have repeated themselves, even if we don't have a clear explanation of the pattern.

During a period we had what was called the October or November revolution. First year students were really angry with the teaching and complained more and more. This was the perfect time to talk to them about what the program was about, why this setup of courses were chosen, why we used the pedagogies we did, and more. Coming with the right speech at this time really flipped the class from anger and disappointment to strong motivation. We have no clear explanation for this behavior but probably important factors were (the phenomenon was discussed to a large extent among teachers during the coffee breaks and staff meetings):

- the students realized that this was a reality situation. Many of them being young and so far just have followed the "flow" of life; they realized that it was up to them if the education would be successful. The degree of taking responsibility in the class rose from low to very high before and after the motivation speech.
- the students realized that the teachers really cared for the class and the teaching. That we actually had a plan for them and were discussing the pedagogic aspects of teaching very much outside class. A large part of their displeasure was based on that bureaucratic things didn't work as well as they expected. They did not get the service level they expected from the teachers. They didn't learn as much as they expected, and this was the teachers fault. The teaching had low quality in the eyes of the students. However, realizing that they themselves were the key element to their learning changed

everything. Motivation was suddenly there, to a much higher degree than before. We experimented a little with this and tried to give the students this information earlier during the semester, but that had very little impact on the class level. The storm had to build up before teacher speeches could make any difference. October or November revolutions gave those classes a strong motivation boost, and many of us teachers had the experience that those classes with October or November revolutions in general produced better thesis' at the end of the program, than classes that did not go through this revolutionary behavior.

## **2.5 Working in teams**

At Ecotechnics/Ecotechnology there have always been a lot of group works. During the period when the teacher resources were more abundant the normal situation was that the students group work reports were returned multiple times. Every time problematic parts were pointed out but no solutions were given. This was probably the most fruitful part of the group work, since it forced the students to have a discussion how to act on (or handle) the criticism. In the first report many groups divided the work and wrote different parts. No group process developed during this phase. Later with cut down teaching resources there is still a lot of group works, however, not so many returned reports. We are currently struggling with new solutions for this, where student peer review is one path tested.

## **2.6 Synthesis courses**

The last year of the program has always consisted of different types of synthesis courses. During ten or 15 weeks the students work with for example business ideas in the course Environmental Driven Innovation, creating a brand new environmentally friendly city on the same spot as Trondheim in the Visionary course, or make a development plan for the bioresources in a Swedish or European municipality. The full course will focus on the same project. The students take most of the contacts needed themselves, which strengthens their feeling of sitting in the driver's seat of the project. If not before this is also the time when the students see that their previous gained knowledge and skills can be put into action in a realistic and holistic context. Our latest experiment here is to create three different tracks of students, all of them interdisciplinary but with a little different focus in their courses. The first year they study most of the courses together and learn to know each other, the second year they are more separated, and the third year they come together again in the synthesis courses. The Ecoengineers have the traditional engineering math in their courses, and more environmental engineering courses; the Ecoentrepreneurs have less chemistry and math, but more social entrepreneur and green procurement courses, and the Ecotechnology students are standing in between as the most interdisciplinary students. In addition a group of international students are accepted to the Ecotechnology program every year to increase the "melting pot" of different backgrounds and experiences in the synthesis courses.

## **2.7 Being in the context of engineering or natural science**

Interdisciplinary teaching and research always have problems to fit into the traditional faculty division of social, natural and engineering sciences. During the 30 years Ecotechnics/Ecotechnology have been placed both in natural science and engineering departments (so far never in a social science department). The experience is that in engineering departments there has been an understanding that we need to bring in interdisciplinary competence to the group to fulfill our mission. There is a respect for the integrity of the group. In natural science departments on the contrary, during the periods we have been placed within them, there seemed to be a prevailing view that the subjects of chemistry and biology should be the pillars of the program and that these departments should take responsibility for these parts of the education program. We have seen this pattern also from other universities in Sweden. The benefit of having an interdisciplinary team on its own is that the members are then given the chance to transcend from their old subjects to become more interdisciplinary oriented teachers and researchers. Belonging to the biology or chemistry group seems to keep you tied to that subject for good and bad. The experience from earlier periods was also that the natural science department sooner or later will try to cut up the program into more traditional pieces of biology and chemistry, and a pedagogic idea of the Thofelt type will be very difficult to maintain. It is our belief that interdisciplinary teaching will in the long run benefit from having the interdisciplinary team within the department, rather than as a conglomerate of several departments. However, this should of course not be an excluding approach. Cooperation is always potentially good.

## 2.8 Teachers are individuals

Using the ideas of Lars Thofelt highlights that teachers are individuals, although Thofelt's aim was to make the teacher obsolete. For example Thofelt's habit of pushing the student to the limit of their capacity, can be a dangerous road to walk if the teacher doesn't have the skill to do it properly. Pushing the student over the limit can be long term harmful for the student. Thofelt himself was highly skilled in knowing how far it was possible to push a student, and still see the recovery occurring within the course. However, most of us followers don't have that skill to the extent Thofelt had (hopefully we have other skills though!). Nowadays there are also larger classes with more students to handle. Obviously, it is important to know your capacity regarding this as a teacher. Many of the examples Thofelt gives in his books, and the stories told about his teaching from former students, seems a little bit extreme to many of us. It must be remembered that Thofelt could teach far out on the edge, since he had that skill, but you should not follow that far if you don't have the same experience and skill.

## 3 CONCLUSIONS

A key element in resilience theory is the ability of systems to cope with the change that occurs between the four phases r, K, alfa, and omega. The conclusions of this paper from this perspective – although not based on a systematic evaluation but rather on accumulated phenomenological observations during the 30-year period—are the following:

- 1) a key element to develop resilience skills in students is to push them to a self-propelled learning behavior rather than traditional teaching.
- 2) to not too easily provide the students with answers will develop the problem solving skills,
- 3) doing-before-reading teaching is more time consuming but give a deeper knowledge, since it stimulates students motivation.
- 4) interdisciplinary teaching will in the long run benefit from having the interdisciplinary team within the department, rather than as a conglomerate of several departments.
- 5) when performing problem based teaching where an important part is challenging the students inherent capabilities, it is important to also focus on the teachers inherent capabilities. It is important to realize that teachers too are individuals.

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# COMPENSATING FOR THE INTERNATIONAL AVIATION CARBON EMISSIONS OF STAFF AND INTERNATIONAL STUDENTS AT UNIVERSITIES. CAN CARBON COMPENSATION SCHEMES CONTRIBUTE TO THE DEVELOPMENT OF SUSTAINABILITY IN HIGHER EDUCATION?

**Jonathan DAVIES<sup>1</sup>, Paul HOOPER<sup>1</sup>, Chris PALING<sup>1</sup>, Holly PRESTON<sup>1</sup> and Callum THOMAS<sup>1</sup>**

<sup>1</sup>Centre for Aviation, Transport and the Environment, Manchester Metropolitan University

## **ABSTRACT**

Higher education institutions are seen as key in helping to facilitate the transition to a more sustainable society and many are taking measures to ensure sustainable practices are embedded within their institution. One area of higher education institutions that has received less attention is carbon emissions generated from staff and international student air travel. This research has identified a gap in university actions to mitigate/compensate for these emissions. Using a project at Manchester Metropolitan University as a case study to demonstrate how projects could be used in academia to mitigate a significant carbon impact; this paper describes pragmatic and innovative ways to compensate for the carbon emissions generated by staff and international student air travel at higher education institutions, and the pros and cons of various alternatives. UK Higher Education Institutions provide the perfect opportunity to further the sustainability agenda. By going above and beyond their current mandate to account for their aviation emissions from staff business travel and international students, they will be able to compensate for some of the ecological damage that is caused by these flights, through projects that themselves could engender social change. Furthermore, by compensating for these activities, it will build resilience in the sector, enabling the continuation of their vital teaching and research but in a more ethical, equal and fair way.

*Keywords: Carbon compensation, International Aviation, Higher Education, Sustainability*

## **1 INTRODUCTION**

The issue of sustainability has become a hot topic for UK Higher Education Institutions (HEIs) in recent years, with many HEIs taking measures to ensure sustainable practices are embedded within their institution. HEIs can be seen as key in helping to make the transition to a more sustainable and low carbon society. Every UK HEI has committed to making carbon reductions in line with sector targets yet despite this push for greater sustainability in the sector (including a focus upon the carbon emissions generated by institutions), an area that has received less attention is the carbon emissions generated by international student and staff air travel. Emissions generated through travel are categorised under the Greenhouse Gas Protocol as Scope III emissions [1] and at present, it is not mandatory for UK HEIs to reduce or compensate for Scope 3 carbon emissions. However, these emissions could significantly contribute to the carbon liability footprint of a university. This research has identified a gap in HEI action to compensate/mitigate for these emissions, which in doing so, can contribute to improving the sustainability agenda. Such research is particularly relevant given that firstly the demand for UK higher education will continue to increase as developing countries like Brazil, China, India and the Gulf region in particular change to more knowledge based economic growth and most HEIs are aiming to increase both international student numbers and the internationalisation of the university. Secondly, institutions are trying to increase internationalisation by forging teaching and research partnerships globally, leading to increased staff travel to partner institutions, conferences etc. This paper describes pragmatic, innovative ways to compensate for the carbon emissions generated by staff and international student air travel at HEIs, and the pros and cons

of various alternatives. If the HE sector is to be at the leading edge of the sustainability agenda, then they must be seen engaging with challenging issues like international student/staff air travel emissions. However, the topic is not a straightforward one as international air travel from both staff and international students is essential to the development of HEIs. International travel by university staff helps to contribute to the establishment of new networks and relationships that are vitally beneficial to not only the career of the academic in question, but also the development and prestige of the university in terms of research, expertise, and international standing. Furthermore, with high profile research contracts such as the European Horizon-2020 funding sources which in particular has an emphasis on international collaboration; participation in such projects will require some amount of international air travel. Of course, some substitution of flights can come about through the use of video/teleconferencing and a modal shift to rail where possible, but they cannot fully take the place of face-to-face meetings and attending of events which is often required for a truly successful partnership and collaboration.

International students are vital to HEIs in that they engender a multicultural society and promote international relationships, as well as increasing the recruitment potential of the institution and increasing revenue. From the student's point of view, the ability to study in another country provides benefits including experiencing new cultures and a wide choice of universities and courses. HEFCE guidelines state that two return flights per calendar year should be attributed to EU national students, and one return flight a year to non-EU students [2]. These flights would be hard to avoid when encouraging international students to study at your university, and when studying on a course, video/teleconferencing is not appropriate in many cases. This paper uses a project at Manchester Metropolitan University (MMU), as a case study to demonstrate how carbon compensation projects could be used in academia to mitigate the carbon impact from international aviation emissions from staff and international students.

## 2 CASE STUDY: MANCHESTER METROPOLITAN UNIVERSITY CARBON COMPENSATION PROJECT

MMU is located in the North West of England and has approximately 33,500 students and employs 4,400 staff [3]. Over the last few years, MMU has been making significant efforts to reduce its environmental impacts and carbon footprint, embedding sustainability within every area of the University; and MMU's Environmental Sustainability Agenda, states "MMU is committed to reducing its carbon footprint, and educating future decision makers, business leaders and citizens" [4]. Focusing efforts on those activities under Scope I and II (Scope I emissions being direct emissions, and Scope II being indirect emissions from the consumption of electricity, heat, etc.), MMU has achieved its emissions reductions targets, been awarded the Carbon Trust Standard (an external independent verification), and in June 2013 was named People and Planet's No.1 greenest university across the whole of the UK. Despite these tremendous efforts, there are still areas of the University where the carbon footprint is growing and therefore MMU has begun to expand its carbon management strategies to include Scope III activities (including those from travel, waste, water and procurement). An area of travel which is experiencing increasing carbon emissions are those from air travel from (1) staff travel and (2) international students. MMU has a considerable international student body: in the academic year of 2012/2013 over 3,000 international students were studying at MMU (44% of students from EU countries, and 56% from non-EU countries) [5]. This equates to over 4,300 international flights a year attributable to international students (according the HEFCE guidelines stated earlier). Between 2007 and 2012, staff at MMU travelled approximately 7,500 km (per full time (FT) employee) by air on business travel, with 2012 having the largest distances travelled with an average total distance of 1,943 km per employee [6]. When the carbon emissions of staff and international students' flights are totalled, this represents a considerable carbon liability due to MMU. Therefore, under the Scope III commitments, a carbon compensation scheme that aimed to mitigate these emissions could help in achieving MMU's carbon management goals. This case study highlights the keys points evaluated in a scoping study currently being undertaken at MMU to calculate the carbon liability associated with the international flights taken by FT staff and international students; and details the proposal of a variety of compensation schemes through which MMU can account for those emissions, and thus contribute to MMU's environmental and sustainability efforts.

## 2.2 Important considerations when calculating carbon liability of staff and international student aviation travel

When considering carbon compensation, carbon offsetting is often the first port of call for many organisations. Carbon offsetting is a mechanism for compensating for greenhouse gas emissions generated by a particular activity by paying for equivalent emissions savings or reductions to be made elsewhere in the economy [7]. Whilst carbon offsetting is one of the measures considered in this study, the term carbon compensation is used as the schemes proposed also focus on additional ways in which to account for the emissions generated by staff and international student air travel. Within this carbon compensation, there are a number of elements that need to be considered. These include:

1. **The carbon calculation:** There are a variety of carbon calculators available which calculate the carbon liability of a particular activity. When calculating aviation emissions, there are a number of assumptions (which can vary between calculator) used within the methodology of the calculator including uplift and load factors, seat band, weight of cargo, aircraft type and the non-CO<sub>2</sub> emissions. Whilst most of the aviation carbon calculators have some level of commonality, even small variations in the assumptions could lead to differing carbon calculations (and essentially, cost). The International Civil Aviation Organisation (ICAO) has produced its own calculator [8], which is a good one to use as it has a transparent methodology, is based upon complex assumptions, and is provided by a reputable organisation.
2. **The cost of each tonne of carbon:** The price of each tonne of carbon is an important aspect of carbon compensation as it ultimately decides the overall cost of compensating a particular activity. There are a number of ways in which a carbon price could be determined; in this scoping project the pricing options evaluated include:
  - *The cost on the voluntary carbon market:* The voluntary offset market refers to all voluntary sales and purchases of carbon credits (mostly project-based emissions reductions credits) [9]. An average from some carbon offset providers in the UK, determined that the average price is around £8 per tonne of CO<sub>2</sub>.
  - *The Carbon Reduction Commitment (CRC) price of carbon:* Established in 2010, the CRC was designed “to encourage large public and private sector organisations to reduce their carbon dioxide (CO<sub>2</sub>) emissions through energy efficiency” [10]. The current price of a tonne of CO<sub>2</sub> under the CRC is £12 [11].
  - *The Carbon Price Floor (CPF):* The CPF is a tax set by the UK Government on fossil fuels used to generate energy. The cost per tonne of CO<sub>2</sub> is £18 (capped until 2020) [12].
3. **General principles for carbon compensation:** There are a number of fundamental principles that need to be considered for an effective carbon compensation scheme:
  - *Quality of offset:* There are a variety of different projects that can be used to compensate aviation emissions; however, they vary in their quality. For example, sequestration projects can vary in the effectiveness of capturing CO<sub>2</sub>, and there may be a risk to permanence if there is future land-use change, which could compromise the CO<sub>2</sub> captured in the past. There is also a risk of leakage where projects simply cause the original emissions generated to be moved elsewhere.
  - *Adequate monitoring and verification:* This is vital in ensuring the credibility of the compensation scheme, as well as tracking the progress and success of the project, and providing external reporting.
  - *Transparency:* Transparency is important in assisting in internal and external reporting on aspects such as what emissions savings are being made, how they are being made, how the revenue is being generated and how it is being spent.
  - *Ensuring additionality:* It is important that the carbon compensation schemes are additional to any projects or carbon reductions that are already planned or in place within the institution.
  - *Avoiding double counting:* Double counting refers to when carbon emissions savings are counted more than once. A carbon compensation scheme must provide new savings which are only counted the once, and are additional.

## 3 POTENTIAL CARBON COMPENSATION SCHEMES AT MMU

In this scoping study, 5 potential carbon compensation schemes were investigated which could be developed by MMU and are outlined below:

### 3.1 Carbon offsetting through an established provider

'Offsetting' is a term used to describe a range of approaches to compensate the climate impacts associated with GHG generation of a specific activity [13]. The principle is to pay for someone else's project to deliver the reductions needed. There are a variety of companies on the voluntary carbon market who sell carbon offsets through a process whereby carbon from a range of activities can be calculated and then mitigated, often with a choice of offset projects. Many of the early issues of accountability, transparency and effectiveness of the offset projects and companies have been resolved, with a variety of certification schemes and standards put in place to monitor and assess the providers. Purchasing carbon offsets through an established provider is one form of compensation that could be used by MMU to account for the emissions for its staff and international student aviation travel. It would be important, however, for MMU to ensure that it carefully selects a provider that subscribes to a reputable certification scheme (such as The Gold Standard), has a history of excellence, and provides a quality offset.

### 3.2 Carbon reduction projects within MMU

MMU could account for the aviation emissions generated through making carbon reductions within the institution. Examples of such activities include improving energy efficiency of buildings, plant and equipment; zero or low-carbon energy generation; and carbon sequestration through planting on the University estate. This type of scheme is tangible, easily implemented and monitored internally. However, as MMU already has an extensive and wide reaching carbon reduction plan, there may be little room left for reductions to be made to compensate for the aviation emissions generated. Furthermore, additional policies would have to be put into place to ensure the longevity of the projects, for example, if MMU used the funds to support biodiversity and sequestration projects on MMU estates, then policies would have to be implemented to ensure that redevelopment of those areas did not compromise the carbon savings being made.

### 3.3 Funding environmental and sustainability courses online for international students

This compensation scheme would provide a carbon compensation fund to be used to develop environmental and sustainable courses online for international students. Such a scheme could have the potential to limit or prevent flights taken by international students as they would not need to attend classes in the UK, whilst simultaneously maintaining the valuable international student body enrolled at MMU (albeit in a virtual capacity). Through the development and promotion of online courses that have a significant environmental sustainability emphasis and content, it would be expected that graduates from the course would have the skills, knowledge and values which would help shape a more sustainable future.

### 3.4 Funding for poor students on environmental and sustainability related courses

Similar to the previous compensation scheme, this scheme would aim to compensate for the emissions generated by staff and international student flights through the funding of grants to poor students on environmental and sustainability related courses. Whilst technically this scheme does not mitigate emissions from staff and international student's flights in a way that is quantifiable, it could however engender change through education.

### 3.5 Carbon efficiency support to areas local to MMU

A scheme whereby MMU provided carbon efficiency support to its local areas could include advice, training and carbon literacy workshops to provide locals with education and support on all areas of carbon efficiency, and fuel management. A project like this would have strong community and environmental co-benefits. However, as with the previous scheme, the impact could be difficult to quantify unless MMU maintain a strong connection to the communities and projects.

Figure 1 highlights the pros and cons associated with each of the schemes.

When considering how the revenues may be generated for the carbon compensation projects, 3 revenue generators are considered:

1. *MMU central budget*: MMU could ring-fence funds from the central budget to go towards the chosen compensation scheme.

2. *Research Bids*: Revenue could be generated through adding the compensation cost into research bids.
3. *Tuition fees*: When compensating for international students air travel, a small fee could be added onto the international student's tuition fees.

## 6 BENCHMARKING WITH OTHER UNIVERSITIES

To identify what compensation activities are taking place at other UK HEIs, the top 10 universities listed under the People and Planet's Green League [14] were used to identify what actions were currently taking place. Any policies and reports made available by the universities were read and actions noted. The main headline findings were that whilst most of the universities were making efforts to calculate and publish their Scope III emissions, and in particular the aviation emissions, actions were mainly limited to the following:

1. Producing travel plans (although often without specific reference to staff and international student flights)
2. Reducing the need for business travel and encouraging the use of trains where possible
3. Increase the availability of video/teleconferencing.
4. Identifying measures to reduce air travel.
5. Policies to explore options for carbon offsetting

Aside from the top 10 universities, Loughborough University has a scheme, Trees for Loughborough, where a donation is given for air travel and the monies used to plant trees to offset the travel related carbon emission [15]. Notable action from a HEI outside the UK has been demonstrated at Duke University, in the US. Duke University has undertaken the following: an emissions inventory dating back to 1990; calculated its carbon emissions from air travel [16]; has a climate neutrality goal by 2024; established its own Carbon Offset Initiative [17]; and has a system in place (and an offset calculator using the Clean Air – Cool Planet calculator assumptions for air travel) for offsets to be purchased by individuals, for meetings and special events, and for University departments at a flat rate of \$10 per offset or tonne of CO<sub>2</sub>e reflecting the average price of the offsets in the portfolio [18] [19]. The portfolio of initiatives that the Carbon Offset Initiative has includes, methane capture projects from North Carolina swine farms; community based energy efficiency projects (being piloted by Duke University staff and students); the potential for carbon sequestration through forestry and land-conservation projects; and the purchase of external offsets to meet the University's demand [18] [19].

## 7. CONCLUSIONS AND THE ROLE OF ACADEMIA IN SUSTAINABILITY SCIENCE, ADVOCACY AND EDUCATION

Some aviation emissions in HEI are vital and unavoidable. There is a clear lack of action across the HE sector in the UK in addressing the international emissions beyond monitoring, reporting and a few standard policies (such as encouraging the use of video-conferencing). There are a number of projects that could help to compensate these emissions, including ones which could provide local community support and education and aid in improving HEIs sustainability. The actions undertaken at Duke University demonstrate clearly that there is considerable potential to compensate for an institutions emissions through a suite of projects spanning emissions capture, energy efficiency, sequestration and offsetting, as well as getting both the university community, and local community involved. HEIs provide the perfect opportunity to further the sustainability agenda. This research demonstrates an opportunity for the development of sustainability within higher education through accounting for aviation emissions from staff business travel and international student travel. HEIs will be able to compensate for some of the ecological damage that is caused by these flights, through projects that themselves have the potential to improve the sustainability performance of the institution and could engender wider social change. Furthermore, by compensating for these activities, it will build resilience in the sector, enabling the continuation of their vital teaching and research but in a more ethical, equal and fair way.

<b>Compensation Project</b>	<b>Pros</b>	<b>Cons</b>
<b>Carbon offsetting</b>	<ul style="list-style-type: none"> <li>• Emissions reductions quantifiable, auditable and transparent ensuring a clear paper/carbon trail and makes reporting easier.</li> <li>• Projects are monitored and verified to ensure actual savings are made.</li> <li>• Offsetting is easy to implement as there are a number of providers available and it is easy to calculate emissions using the provider's carbon calculators.</li> <li>• Costs are easily calculated in advance.</li> </ul>	<ul style="list-style-type: none"> <li>• Can have a negative public perception if projects do not provide results promised and are often considered to be 'buying a way out' rather than addressing the problem.</li> <li>• No intrinsic connection to MMU as many of the projects take place in countries outside the UK.</li> <li>• Depending on the provider, allocation of funds may mean that not all of the offset fee paid for will go directly to the offset project, with some for-profit companies allocating a proportion of the cost to areas such as administration.</li> <li>• Risk of lack of permanence with projects being outside MMU's sphere of influence.</li> </ul>
<b>Carbon reduction efforts within MMU</b>	<ul style="list-style-type: none"> <li>• Keeps reductions within MMU assisting with internal environmental and sustainability strategies and improving energy efficiency.</li> <li>• Allows for internal monitoring which could be cheaper and could prove timelier and in-keeping with internal frameworks.</li> <li>• Tangible reductions with benefits which are easily observed.</li> <li>• In-house carbon reduction efforts would be easy to implement.</li> </ul>	<ul style="list-style-type: none"> <li>• Risk of double counting carbon reductions and could prove difficult to ensure additionality.</li> <li>• Limited scope for reductions within MMU as it is already making concerted efforts to reduce its carbon emissions.</li> <li>• There may be a risk of a lack of permanence of any carbon savings made unless the projects were safe-guarded through University policies and future planning.</li> </ul>
<b>Environmental &amp; sustainability courses online for international students</b>	<ul style="list-style-type: none"> <li>• Reduction of carbon emissions through reducing the need for international aviation travel to MMU from international students whilst maintaining the international student body.</li> <li>• Keeps focus upon education – particularly pertinent for a HEI.</li> </ul>	<ul style="list-style-type: none"> <li>• Would require the creation or adaptation of course materials which could be costly and time consuming in an already time constrained sector.</li> <li>• Could potentially reduce income for MMU (aside from tuition fees).</li> </ul>
<b>Funding for poor students on environmental &amp; sustainability related courses</b>	<ul style="list-style-type: none"> <li>• The scheme is novel and unique, and maintains an emphasis on education.</li> <li>• The scheme promotes environmental and sustainability education and values.</li> </ul>	<ul style="list-style-type: none"> <li>• The scheme does not provide verifiable carbon reductions that could be monitored or reported upon.</li> <li>• It would prove almost impossible to quantify the impact of such a scheme.</li> </ul>
<b>Carbon efficiency support to local areas</b>	<ul style="list-style-type: none"> <li>• Such a scheme would promote engagement with the local communities, promoting a positive community opinion of the institution and aiding with building local connections.</li> <li>• The project has an emphasis on education.</li> </ul>	<ul style="list-style-type: none"> <li>• It would be difficult to quantify the carbon reductions and impact of such a project.</li> </ul>

Figure 1: Pros and Cons of the carbon compensation schemes proposed to address MMU's staff and international student aviation emissions.

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# A DYNAMIC, INTEGRATED STAKEHOLDER FRAMEWORK FOR COHERENT SUSTAINABILITY POLICYMAKING FROM AN INDUSTRIAL ECOLOGICAL, SOCIOLOGICAL AND BEHAVIORAL SCIENCE PERSPECTIVE

Harn Wei Kua<sup>1</sup>

<sup>1</sup> Department of Building, School of Design & Environment, National University of Singapore;  
[bdgkuahw@nus.edu.sg](mailto:bdgkuahw@nus.edu.sg)

## ABSTRACT

The importance of involving stakeholders in sustainability policymaking is widely recognized. Current strategic management theories on stakeholders are not appropriate for different aspects of involving stakeholders in sustainability policymaking. To fill this gap, we proposed a novel integrated framework for stakeholder identification, understanding, engagement and role management. This is based on extensive review and application of principles on industrial ecology, sociological and behavioral science, creative governance, integrated sustainability policymaking and the widely utilized methodology of action research. Although there is not a real world example in which this comprehensive framework is applied, a case study on how it has been partially applied was given. This was a household energy intervention program in the southwest district of Singapore that reduced electricity consumption by 15.8% for one of the treatment groups, at a greenhouse gas reduction price comparable to that under the EU Emission Trading System.

*Keywords: Stakeholder identification, stakeholder engagement, integrated policy, sustainability policy*

## 1 INTRODUCTION

It is a widely accepted that stakeholder involvement and participation is an important element in public policymaking. This is especially true for sustainability policymaking where the issues involved have complex implications in multiple aspects of policies and policymaking. Ironically, studies on stakeholders in public policy are not as extensive as those in strategic management. The main objective of this paper is to fill this gap by constructing a framework for stakeholder involvement. The assumption is that to meaningfully involve stakeholders, several key steps must be in place: stakeholder identification, understanding of the identified stakeholders, and finally, using the knowledge of these stakeholders to customize the ways they are engaged and manage their roles in the engagement process to maximize the chance of success. Our review of existing theories on stakeholders in the strategic management literature lays the foundation of a stakeholder framework appropriate for public policy can be constructed.

## 2 STAKEHOLDER CONCEPTS AND DISCOURSE IN STRATEGIC MANAGEMENT AND PUBLIC POLICY

In studying the dynamics of stakeholder, Mitchell et al. [1] proposed that stakeholders can be sub-divided into classes depending on the power, legitimacy and urgency they have. However, this method of classification does not help in identifying who the stakeholders are, or should be, in the first place. Works such as those by Donald and Preston [2] highlighted three aspects of alternate theories of stakeholders – descriptive/empirical, instrumental and normative. These aspects are more focused on identifying and engaging stakeholders, but less on understanding them from the more fundamental level. Similarly, Freeman [3] proposed a framework that consists of three levels of stakeholder analysis; as a whole, it helps to identify the stakeholders and determine ways of engaging each of them

meaningfully. However, this framework pays little attention to understanding them from a more fundamental behavioral perspective, which was advocated by Donaldson [4].

In development and environmental studies, scholars have attempted to apply stakeholder theories with roots from strategic management to analyze public policies. However, there is evidence that such attempts inherited some of the aforementioned limitations of the strategic management-based concepts. For example, Mikalsen and Jentoft [5] and Buanes et al. [6] applied Mitchell et al.'s concepts of urgency, power and legitimacy for searching the “correct” stakeholders to engage in public discourse in fishery management in Norway. Although they applied the concept in a different and innovative way, it is unclear how such a categorization of stakeholders can help policymakers determine meaningful and effective ways of engaging and managing the diverse roles played by these stakeholders. Banerjee et al. [7] applied Freeman's theory to define the environmental stakeholders that should be involved to exert environmental pressures on the wine industry to adopt environmental measures. Similar applications were made in the works of Gallagher [8], Henriques and Sadorsky [9], Marshall et al. [10], Vellinga [11] and Squires et al. [12]. In these applications, the inherent limitations of Freeman's theory were not aptly resolved and thus the understanding of the identified stakeholders was not made from a more fundamental social psychological and behavioral science level.

Why is understanding stakeholders at such a fundamental level important? Lafreniere et al. [13] observed that the stakeholder management literature predominantly focused on how management or authorities perceive stakeholders, and much less on understanding stakeholder perspectives on the issues concerned. Hence, in extending stakeholder theory to promote resource management initiatives to key stakeholders in the case study on water transfer in Alberta, Canada, they proposed an audience-centric perspective. Their findings suggested that the nature of the marketing campaign conducted by management on identified stakeholders caused changes to the dynamics of the stakeholder-management relationships, and these changes can only be fully appreciated by understanding the psychological responses of the stakeholders to the campaign. This is one of the studies that directly hint on the need to understand stakeholders from a fundamental psychological level.

There are also ongoing discussions on augmenting stakeholder analysis with concepts that explain the collective actions or behavior of stakeholder groups. An example is the comparison of stakeholder analysis with cultural theory by Billgren and Holmen [14]. Cultural theory was first developed by Douglas [15] and it has been revised several times over time. As highlighted by Thompson et al. [16], Cultural Theory essentially claimed that there are five ways of life (also known as “solidarities”) that can be defined by group and grid dimensions. For example, there is a group – individualists – who believe that they are in control in their lives and the decisions they make reflect that belief. However, in testing this theory for natural resource management in Naivasha, Kenya, Billgren and Holmen found that these “solidarities” lack the flexibility to describe many of the categories of stakeholders in their case study.

### 3 STAKEHOLDER FRAMEWORK FOR SUSTAINABILITY POLICYMAKING

We proposed an Integrated Framework for Stakeholder Identification, Understanding, Engagement and Role Management (IFSUIER). As shown in figure 1, this framework is composed of a clear sequence of activities that systematically identify, understand, engage and manage the roles of stakeholders. These various stages are illustrated as follow.

#### 3.1 Identification of stakeholders – the life cycle and bottom line-based nested approach

Industrial ecology (IE) is a concept about converting linear flows of energy and materials in industrial processes to circular closed-loop flows that are similar to many processes in nature. Nitrogen cycle is an example of circular flow of nitrogen in the natural environment. An important methodology of IE is life cycle assessment (LCA), in which a product or process is “broken” down into its constituent stages known as life cycle stages, and the inputs/outputs and impacts of every life cycle stage is summed up to yield the total impacts due that product or process. For a building, the design and construction phases are two examples of its life cycle stages. Since it is technically possible to break any product or process down into its life cycle stages, we propose applying this concept of life cycle as a guide to comprehensively identify and classify stakeholders. That is, using the example

above, the people and groups involved in the design and construction stages of buildings should be engaged in sustainability policymaking process.

After the life cycle stages of a product or process are identified, how can we decide who to engage in each of these life cycle stages? Figure 2 illustrates a bottom line-based framework for identifying stakeholders in each selected life cycle stage. There are three types of such stakeholders:

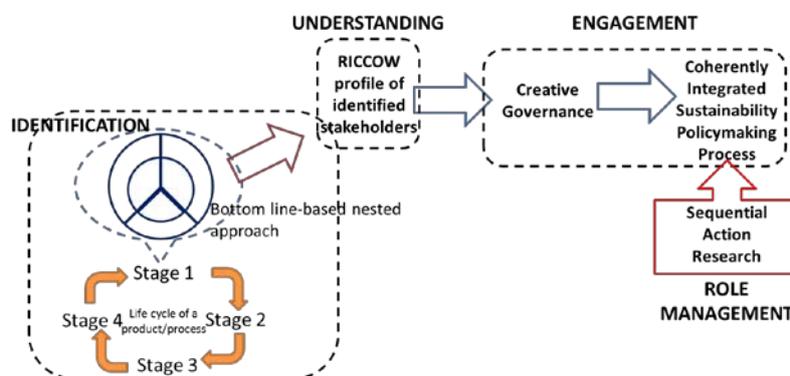


Figure 1. The IFSIUER. Details of the bottom line-based nested approach are shown in Figure 2. Note that although the bottom line-based nested approach applies to every life cycle stage, only the approach for one life cycle stage (stage 1) is shown for brevity.

- Those who are affected by or affect the environmental, economic or social aspects (also known as the triple bottom lines of development) of the processes in the life cycle stage (denoted as the LA and GA in Figure 2).
- Those who are affected by or affect two out of the three bottom lines of the life cycle stage (denoted by LB and GB in Figure 2).
- Those who are affected by or affect all three bottom lines of the life cycle stage (denoted by LC and GC in Figure 2).

In every life cycle stage, the stakeholders may represent organizations, thus interest, at different levels. For example, at the production stage of cement, the concern of the plant management (which can be considered as the “local” stakeholders and represented “LA”, “LB” or “LC” in Figure 2) will be to maximize profits whereas the concern of the municipal government (which can be considered as the “global” stakeholders and represented “GA”, “GB” or “GC” in Figure 2) would be to reduce the pollutions caused by the cement plant. Given the multiple levels of stakeholders considered in this model, it can be called a bottom line-based nested approach to identifying stakeholders in each life cycle stage.

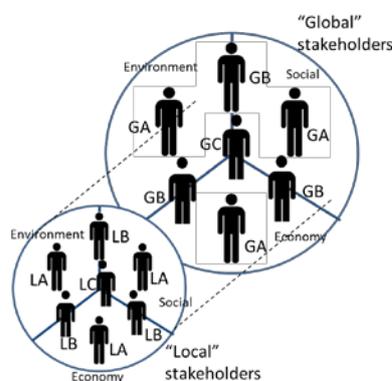


Figure 2. Bottom line-based nested stakeholder identification framework for every life cycle stage. The “local” stakeholders are nested within the “global” ones but they are shown separated from each other for clarity.

After the stakeholders at the different life cycle stages have been identified, the next step is to understand them so that they can be effectively engaged in the policymaking process.

### 3.2 Understanding of stakeholders

We propose that stakeholders can be understood by studying their RICCOW profile (refer to figure 1), which also points to possible ways of changing their attitude and/or behavior. RICCOW refers to Responsibility, Incentive, Capacity, Capability, Opportunity and Willingness. More specifically:

- Responsibility refers to an individual's sense of purpose towards the cause of an action and his/her ability to control the outcome related to this cause with his/her actions.
- Incentive refers to the presence of appropriate motivations that are given to an individual to create a certain attitude or action.
- Capability refers to an individual's ease in access to resources, such as money, for a certain attitude or action to occur.
- Capacity refers to an individual's cognitive and skill-related abilities to create a certain attitude or action.
- Opportunity refers to situational factors, including getting the required information or necessary assistance at the right time, for creating a certain attitude or action.
- Willingness refers to the internal state of mind that consciously makes the decision to create a certain action.

Specifically, understanding stakeholders' RICCOW profile means knowing

- a) Their sense of responsibility over the issues in question and how to increase this altruism,
- b) What kind of incentives will encourage them to be more willing to practice pro-environmental behavior (PEBs),
- c) How to increase the appropriate capabilities, so that they are more willing to practice PEBs,
- d) Their existing capacity and how to increase it, so that their capabilities can be improved and they become more willing to practice PEBs, and
- e) Provide an opportunity for all the above to happen, so that intention leads to PEBs as much as possible.

The significance of each of the 6 RICCOW factors in affecting PEBs is well studied in the social psychology literature (for example, Saphores et al. [17] and Zhang et al. [18]). A thorough review of these works revealed underlying relationships among these 6 factors and elements of Theory of Planned Behavior. This resulted in the RICCOW model diagram shown in figure 3.

### 3.3 Engagement and Role Management of stakeholders

#### 3.3.1 Concept of Creative Governance and Coherently Integrated Sustainability Policymaking (CISP)

After the stakeholders have been identified and understood, the next step involves devising platforms to bring some or all of these stakeholders together to come out with creative solutions to the problems at hand. Kua [19] proposed the concept of creative governance (refer to figure 1), which refers to a concept in which stakeholders who do not normally work together are brought together for common objectives and create innovative solutions to certain sustainability-related problems. Creative governance has applied to two case studies (Kua [19]; He and Kua [20]).

Finally, when different stakeholders from different levels are engaged to address certain issues, it is very important that their objectives and outcomes of their actions do not contradict one another. In other words, it is important to ensure coherence in their efforts. Kua [21] observed that for sustainability policies to avoid negative and unintended consequences, they must address a range of sustainability indicators at once; identify, understand, engage and involve a range of different governmental and non-governmental stakeholders; employ a reasonable range of different policy instrument or tools to implement, monitor and modify policies; and systematically analyze how the different components of a sustainability policies may react with one another to give rise to possible negative unintended consequences. Figure 4 is an adaptation of the CISP model proposed in Kua [21]. The main part of the model is 4 types of feedback loops, involving either "local" or "global"

stakeholders. By “global”, we mean a relatively larger geographical or jurisdictional boundary, such as that of a country; a “local” scale refers to a smaller boundary that may be, for example, a municipality. In short, figure 3 outlines a process through which, as far as possible, all local sustainability policies should be coherent with global sustainability goals, and that any problem-shifting across local regions or countries be prevented as much as possible. Further, the actual policy outcomes must be closely monitored and any incoherence between outcomes and objectives be addressed.

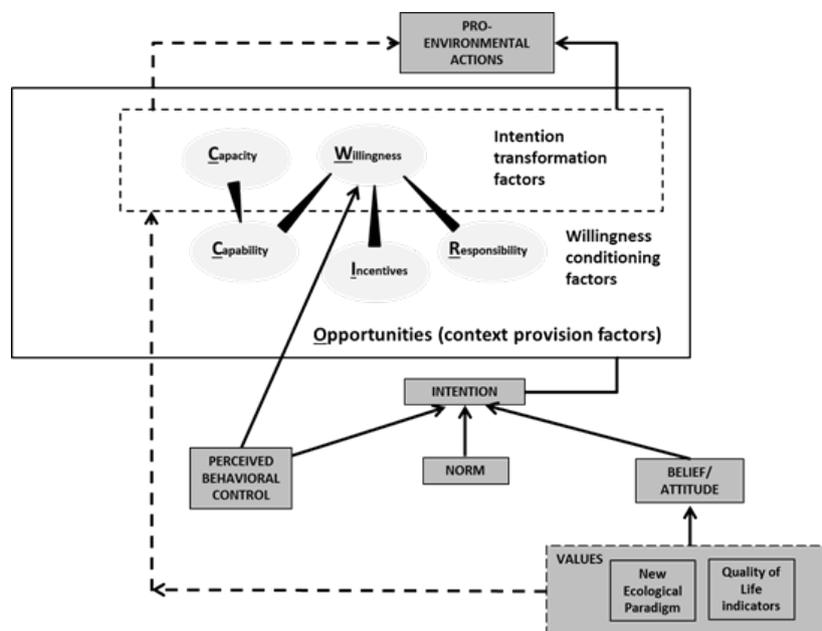


Figure 3. The RICCOW model for understanding the psychological profile of an identified stakeholder. The shaded boxes refer to the stages and elements in the Theory of Planned Behavior.

### 3.3.2 Sequential Action Research

In any stakeholder engagement situation, the roles played by facilitators and how they complement the roles of the other stakeholders are instrumental to the success of the engagement. The roles played by these different participants depend on the nature of the “platforms” on which the stakeholders are been engaged. One of the possible platform is an action research, which is a social science research methodology that involves researchers engaging or/and collaborating with members of an organization, community or network (that is, a certain stakeholder group) with an aim to improve certain pre-determined conditions relevant to this particular stakeholder group (Greenwood & Levin [22]). Greenwood and Levin proposed a co-generative model that traces the different steps in an action research. This model can be adapted and integrated into Kua’s CISP model to create a more holistic model on how action researchers and stakeholders can engage one another sequentially in each of the 4 feedback loops, with the aim of creating coherently integrated sustainability policies. Within IFSIUER model, this can be viewed as an option of applying sequential action research on the CISP model as a method of defining and managing the roles of the different stakeholders.

## 4 CASE STUDY – ECO-living Program @Southwest

To our knowledge, a complete version of the IFSIUER has not been implemented anywhere yet. Here, an example of how the IFSIUER has been partially applied for a local energy intervention program was provided. He and Kua [20] initiated the ECO-living Program@Southwest, which was collaboration among several local stakeholders. The main objective was to find out what outreach mechanism (or, treatment method) was the most effective in encouraging household to reduce their energy consumption. We used a FUTE (From-Understanding-To-Engagement) matrix (table 1) to analyze the RICCOW profile of the main stakeholders (but only those for the four main stakeholders are shown).

In summary, these four stakeholders were all related to the “use” stage of energy (electricity) life cycle. The Mayor’s office is considered a “GC” stakeholder (refer to figure 2) because the programs it supports concern the three bottom lines of sustainable development. Analyzing MO1 to MO12 of table 1 revealed that the Mayor’s office’s RICCOV was conducive for implementing and funding the ECO-living program. The university research team played the role of a “LB (environmental-social)” stakeholder because the project, which was designed by it, was primarily concerned with improving energy efficiency and promoting students’ community involvement. Analyzing UR1 to UR12 of table 1 revealed that the research team was strong in responsibility and capacity to design and implement the project. With the Mayor’s office providing the funding to source for human resource – student volunteers – to run the project (capability) and allowing the data to be used for academic publication (incentive), the research team’s willingness was considerably increased. The student volunteers were engaged as “energy ambassadors” who helped the research team visit the households and implement the different treatment methods. They were considered “LA (environmental)” stakeholder, because they were from their school’s environmental club. Their school was keen to capitalize on the opportunity offered by the Mayor’s office to involve their students in a meaningful community project. To increase the students’ willingness, the Mayor’s office provided refreshments and free transportation (capability) and the schools provided activity endorsement points as incentives; the researchers also provided free coaching sessions for the students to increase their capacity.

Households were considered “LA (social or environmental or economy)” or “LB (environmental-economy or social-economy)” stakeholders; these characteristics were further confirmed from the surveys conducted on them. They were divided into three groups – one that received monthly visitation “energy use counselling” by student volunteers; one that received instructions only from leaflets and stickers, and a control group. Analyzing H1 to H12 of table 1 revealed that the willingness to participate in the program was increased by providing the capability (easy-to-do PEBs). Student volunteers’ counselling and demonstrations also increased their capacity in understanding the implications of saving energy and the range of PEBs. However, the effectiveness of the incentive – the prospect of saving money – was one of the variables tested in the study.

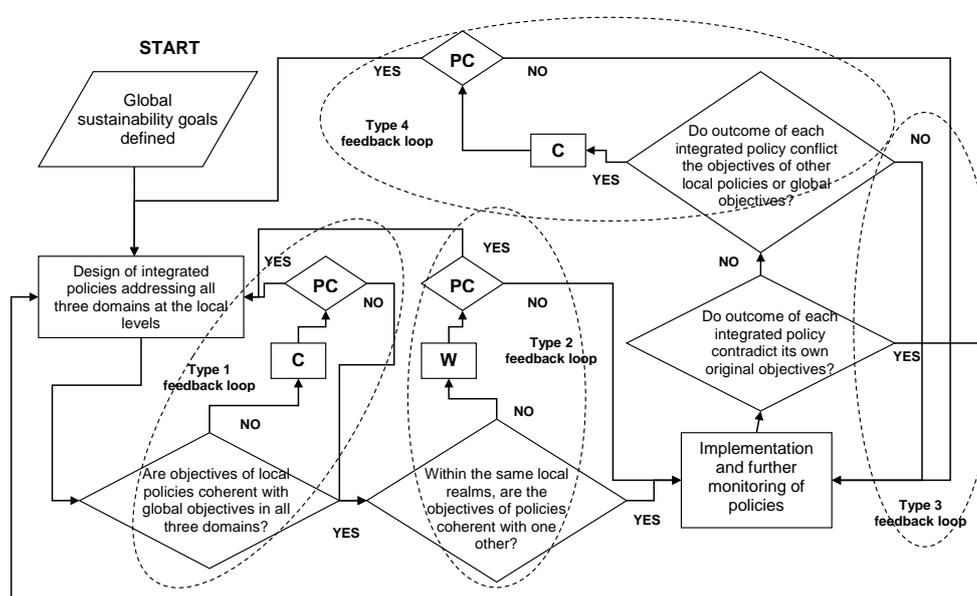


Figure 4. The proposed coherently integrated sustainability policymaking. The “C” block represents cross-level interaction of stakeholders to address any contradictions or conflicts, as well as mobilization of new resources to address any problem-shifting. The “W” block represents within-level interaction of stakeholders. The “PC” condition means that there are changes to the policymaking process as a result of such cross-level or within-level stakeholder interaction (adapted from Kua [21])

It was found that a combined use of leaflets and stickers resulted in highest (that is, 15.8%) reduction in average consumption over the 6-month duration of the program. The local government spent an estimate SGD 900 on this project (as the outreach and intervention effort is purely on a voluntary basis). It was estimated that the equivalent carbon dioxide (CO<sub>2</sub>) reduction cost of this project was around SGD 56 (or, USD 44) per ton of CO<sub>2</sub> avoided, which can be seen as a cost

effective method when compared to the price of greenhouse gas emission under the EU Emission Trading System that was started in 2005 (Ekvist et al. [22]) – between USD 9.40 and USD 48.60 per ton of CO<sub>2</sub>.

As a partial implementation of the CISP model (under engagement stage), the Mayor's office and university researchers examined ways to expand this program in the future without reducing allocations of funds to the other related programs in the district that are supported by these student volunteers. Due to the short duration of this project, role management was not practiced but we expect this to be an important stage if the project was to be extended.

## 5 CONCLUSION

Conventional stakeholder theories that are created for management studies are shown to be inappropriate for describing the stakeholder involvement in sustainability policymaking. A holistic framework for identifying, understanding, engaging and managing the role of different stakeholders was proposed. There are likely to be other factors that can be added to the IFSIUER model; the aim of this paper is to propose IFSIUER as a starting point to trigger more extensive discourse on how an appropriate stakeholder involvement model can be created for sustainability policymaking. It is hoped that this model will help to clarify and optimize stakeholders' role in the collaborative process of creating policies that will positively contribute toward sustainability.

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IDENTIFIED STAKEHOLDER	OPPORTUNITY		CAPACITY		WILLINGNESS		CAPABILITY		INCENTIVE		RESPONSIBILITY	
	Status quo	Target	Status quo	Target	Status quo	Target	Status quo	Target	Status quo	Target	Status quo	Target
	Does the stakeholder think that he/she has the opportunity to practice the pro-environmental behavior (PEB)?	How can opportunity be provided?	What is needed to practice the PEB? Does he/she have the required capacity?	What can be done to provide or increase the capacity?	Is he/she willing to practice the PEB?	What can be done to increase his/her willingness?	What are the capabilities needed for this PEB? Does he/she have these capabilities? Can these capabilities lead to more willingness to practice the PEB?	What can be done to increase his/her capabilities in order to increase his/her willingness to practice the PEB?	What are the incentives needed to increase his/her willingness to practice the PEB? Does he/she have enough of such incentives?	How can sufficient incentives be given to increase his/her willingness to practice the PEB?	Does he/she feel responsible over the issue in questions? Why?	What can be done to increase his/her sense of responsibility over the issue in question?
Mayor office	MO1	MO2	MO3	MO4	MO5	MO6	MO7	MO8	MO9	MO10	MO11	MO12
University researchers	UR1	UR2	UR3	UR4	UR5	UR6	UR7	UR8	UR9	UR10	UR11	UR12
Student volunteers	SV1	SV2	SV3	SV4	SV5	SV6	SV7	SV8	SV9	SV10	SV11	SV12
Households	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12

Table 1. The FUTE matrix applied to the four main stakeholders in the household energy intervention program.

# SUSTAINABILITY AND PUBLIC SPACE – A STAKEHOLDER COLLABORATION APPROACH

**Bijay Singh<sup>1</sup>, Martina Maria Keitsch<sup>2</sup>**

<sup>1</sup>MSc in Urban Ecological Planning, Tribhuvan University and Norwegian University of Science and Technology Trondheim, bjlals@hotmail.com

<sup>2</sup> Department of Product Design, Norwegian University of Science and Technology,

## ABSTRACT

One of the major challenges today is to learn how to share spaces that have been made for all. This is not just relating to the use of old public space, it is also about creating new common space. Apparently cultural, social and economic activities of certain societal groups influence access to public space, but these activities do not necessarily include all users or contribute to its overall sustainability. The aim of this article is to analyse how stakeholders negotiate and conduct activities, how these form and change, how they permit and confine access to public space for different users, in which ways they allow to negotiate access and how they relate to sustainability with focus on a case study of the Akash Bhairabnath temple on Indrachowk Square, Kathmandu. Results of the study show that understanding the interdependency of stakeholders and their activities is imperative for sustainable development and, it is, to a certain degree, possible to create more awareness on stakeholder communication and activities.

*Keywords: Urban conservation, stakeholder-driven change, sustainability, cultural practices*

## 1 INTRODUCTION

A major challenge for any urban society lies in facilitating adequate relationships between the built environment, ecology and peoples' activities. Economic opportunities influence urban development to a great deal, but perhaps the greatest challenge in introducing sustainable planning strategies lies in their acceptance by local stakeholders. Access to urban public space is accompanied and influenced by cultural, social and economic activities of certain societal groups. This puts focus to a greater recognition and empowerment of local actors, addressing their needs more fully along with national and global priorities and including them in decision-making processes [1]. Methodologically but also normatively this means to be actor- and action-research oriented and strive for a mutual trust building, initiative taking and ownership. McCoy [2] emphasizes: "People want to be part of community ... and to make progress on the issues that are important to them... They need opportunities that allow them to make the best use of their skills and time. They need to be invited to participate by those they know and trust."

This article analyses how stakeholders coordinate and negotiate activities and how involvement in public space issues can be stimulated. We look at a case study on the renovation of Akash Bhairabnath temple on Indrachowk Square, Kathmandu, Nepal. Following the introduction, we examine which stakeholders were involved in section two and what and how the phases of the renovation process took place in section three. Section four analyses the stakeholder inclusion process in terms of dialogue, deliberation and engagement. The analysis is based on observations and semi-structured interviews with local stakeholders. Results and implications for further research on stakeholder involvement in the sustainable design of public spaces are discussed in section five. One discovery is that triple-bottom line sustainability is profoundly influenced by cultural activities. Further, on a stakeholder level and considering the acceptability of sustainable development, there must be access opportunities for the various users of space. However, access to space comes not as equal right for all per se, but it has to be recognized as dynamic possibility for competition and negotiation to use it. Third, in order to get and maintain access, competence development of stakeholders related to knowledge, values, and

cultural beliefs connected with the space play an important role, and getting this competence can, in turn, be encouraged by fostering specific cultural and sustainability related activities.

## 2 KEY STAKEHOLDERS: ACQUIRING POWER AND NEGOTIATING THE ACCESS TO SPACE

Historically, Indrachowk was one of the important nodal points of Indo-Tibet trade route from the mid seventh century until the end of 19<sup>th</sup> century. Apart from the vibrant economic environment, the square as a public space still has religious importance with temples like Kantishwor Mahadev, Bansheswor Mahadev, Betal, *Ganesha* and most importantly Akash Bhairab Temple. The square is also part of one of the famous chariot festivals of Kathmandu, called *Indrajatra*. Disordered, heterogeneous traffic streams, increased building heights, and a growing number of shops are the characteristics of today's Indrachowk. The streets once used for pedestrian and chariots are congested with vehicular traffic and parking in haphazard manner resulting damaged roads and heavy traffic jams. The encroachment and overcrowding of streets by the wayside informal vendors limits the use of these spaces for leisure and recreations. The Shree Akash Bhairab Indrachowk Club, a local social group in the area, has established a feasible solution by imposing a schedule mechanism<sup>1</sup> to balance the claims from different groups to use Indrachowk. There is also a *pashmina*<sup>2</sup> *shawl group* who is privileged to use the plinth of *Bansheswor Mahadev Temple* for selling *pashmina shawls* mainly because of their strong bondages with the local groups through participation in various cultural activities related to Indrachowk. Creating strong social networks with the Shree Akash Bhairabnath Bhajan Khala and the Shree Akash Bhairabnath Indrachowk Club has helped them not only to maintain their position in the market but even to establish long-term user rights compared to the other street vendors.

The current appearance and management of the Indrachowk square can be seen as the outcome of the negotiations of space and power relations managed by some of the key local groups (see below) often through informal activities. The local groups themselves recognize their common cultural background as the primary reason for engagement and strength. They are mostly dominated by Newars<sup>1</sup>, who are considered as the original inhabitants of Kathmandu valley and popular for their cultural heritage. The cultural beliefs and values of Newars are directly linked with the activities in the public space. For Newars public space is not only the intersection point of people, physical settings and social interactions. The Newar civilization is built around outdoor community living [3]. So, through cultural beliefs and values, these local groups dominated by Newars are inherited with the information, experiences and sense of attachment to Indrachowk. Considering culture as 'the way of life' [4], they are attached to the public space in every aspect of the life, and contribute with great strength and commitment to the development process of this space, which has made them the primary users with greater control, commitment, motives and responsibility. However there is still an argument if these local stakeholders could hold the majority of the managerial power within the local context.

The Indrachowk square space is managed by the following key local groups:

### ***Akash Bhairab Guthi***

The history of traditional *guthi* goes back to rule of Lichchhavi period, around fifteen hundred years ago. The *guthi* successively institutionalized management, operation, and maintenance of city space, of secular and religious artefacts, of activities, and festivals and of other urban services on the community level by setting up norms for rituals. These activities link the *guthi* to land, spaces and acts of assembly and socialisation. The *guthi* has a tacit interest in preserving the norms and values of community. It binds the people at different levels: caste, patrilineal (hereditary through father in patriarchal society) lineage and territory [5] [6]. So, it is an exclusive institution bound by rituals and culture similarly. Akash Bhairab *guthi* is also an exclusive Newar<sup>3</sup> society of *Jyapus*<sup>4</sup> with the place

<sup>1</sup> The street market vendors are allowed in the morning till 9:00 AM. The club charges Rs 20 per day for the sweepers and guards from the vendors.

<sup>2</sup> A fine cashmere wool material for textiles.

<sup>3</sup> Newar is a homogeneous community of a number of former ethnic groups, formed through centuries with a common Tibeto-Burmese language and other traditions [5]. They can be both Hindu and Buddhist, divided into

bound to Indrachowk territory and the patronage linked to the Akash Bahirab Temple. Currently the institution consists of fiftyseven members. This guthi used to have land gifted for performing various activities. However, it has lost its land due to haphazard privatisation. Moreover, the institution is mainly bound to perform the rituals, festivals and other activities bound to Akash Bhairab Temple and do lack financial resources.

### ***Shree Akash Bhairab Indrachowk Club***

The club initially started as a sport club by youths and was registered in 1977. It is important to note that most of the founding members were related to Akash Bhairab guthi, as the sons of the *guthi* members. Today the members comprise of different users including women, retired people, shop owners, youths from the area. The club has diversified social and environmental activities such as solid-waste management, garbage collection and is organizing various social events like blood donation programs, managing street vendors. Shree Akash Bhairab Indrachowk Club is acting voluntarily in various feasts and chariot festival and works as the mediator for any kinds of conflicts. One of the interviewees claimed that the diversification of the activities is mainly due to the inefficiency of the local institutional body and the decreasing trust of the people in local governmental authorities. The lacunae in the relationship between local people and local government have urged local social groups such as the club to take social actions and act as mediator.

### ***Shree Akash Bhairab Bhajan Khala***

Shree Akash Bhairab Bhajan Khala is a group mainly focused on continuing the tradition of religious activities of hymn singing. With the growing economic claims from trader, hymn singing lost its ground and even identity. So, the group started with the funds from donations in 2000 and has successively captured interest of other users, especially younger people from different parts of Kathmandu, transgressing the local boundaries of Indrachowk. A major contribution of the Shree Akash Bhairab Bhajan Khala group are activities during the *Indrajatra* festival when they prepare a setting for singing hymns for eight days and invite groups from other places for the performance. The groups itself has undergone changes in its internal structure by opening up to other ethnic groups as well based on Hindu-Buddhist religious practices.

Regarding the role of these stakeholders, the question might arise how far they realized their role as gatekeepers [7]<sup>5</sup> to providing use opportunities for other users, such as e.g. the *pashmina shawl group*. The informal regulations deployed by the local groups, irrespective to the government regulation, control opportunities for street vendors and others to use the space and regulations often entail the variations in the user rights. Clearly, the eleven-pashmina shawl shops have greater control for the use of space that can use the space whole day by excluding the other economic users<sup>6</sup>. Moreover, the shop keepers do not pay rent but rather give donations to the *Shree Akashbhairabnath bhajan khala* for organizing various religious activities. The control of the shop keepers is thus based on their profound information on the local groups' values, feelings and experiences related to the place. It is interesting to note that most of pashmina shawl shop keepers are not local residents but has this information due to their prolonged involvement in various activities with the local groups. The experience and the respect for local values have established trust between these groups. The other street vendors and users lack that information and trust which puts them in lower rank in terms of control of the use of space.<sup>7</sup> Clearly, the better informed have better control user rights in case of Indrachowk square.

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different castes (*jaat*) on the basis of hereditary occupation, marriage circles and ceremonial purity and have to follow specific rules based on the social practices. Each Newar is associated with a *Guthi* - the institutionalized body to manage, operate and maintain secular and religious artifacts and activities with the hidden interest of preserving the norms and values of community [3,5].

<sup>4</sup> Farmer castes in Newar society.

<sup>5</sup> The main stakeholders are here conceived as gatekeeper i.e. holders of knowledge and information. They set the agenda, control the boundaries of the discourse, the process and the available actions for other stakeholders.

<sup>6</sup> The other users can use the plinth of *Bansheswor Mahadev temple* can use the space only if the current users of the plinth don't put their merchandise there and give consensus for other user to use that space.

<sup>7</sup> In an interview with one of the members of *Shree Akashbhairabnath bhajan khala*, he stressed that the pashmina shawl shops are there for very long time and they don't know them and the group know every activities

### 3 THE RENOVATION PROCESS OF AKASH BHAIKARNATH TEMPLE

The renovation of Akash Bhairabnath temple illustrates how the local groups above developed determination, motives and commitment and how they managed to engage other stakeholders in the process. In the socio-cultural context, the managerial power is inherited by *Akash Bhairab Guthi*. An understandable rational approach to the renovation of Akash Bhairab temple would have been hiring a technical expert or designer by the Guthi, who would also lead the overall project and give the technological solutions as per the available financial resources and his/her expertise with the final decision power to the Guthi. The majority of time was spent on making major decisions on whom and how to include various stakeholders. Within twenty years of development, fund collection, design and construction period took only the final four years. The whole renovation project can be categorized into four phases: First phase (1983-1993), second phase (1994-2000) third phase (2000-2003).

#### ***First Phase (1983-1993) - The Learning Phase***

While the concept for renovation for certain parts of temple was conceptualized in 1983, the *Guthi* only got approval on 1985 from Department of Archaeology to replace the existing roof with a brass roof. During the whole period, the *Guthi* was learning to identify the stakeholders, who would commit to the process. Being a popular temple, there were many religious followers, who believe that worshipping the temple brings prosperity in life, including business people (especially from the *Marwadi*<sup>8</sup> community) who informally had promised to support the project financially. The *Guthi* believed that with many of worshippers and the temple's charismatic cultural image, they would be able to collect the enough funds. The active involvement of the local youth club, *Shree Akash Bhairabnath Indrachowk club* have in the locality and its influence on the local people had in fact encouraged the *Guthi* to identify them as one of the stakeholders.

The project also needed the government interest and support, which was however encumbered by the chaotic political environment in this period. There was political turnover with the dissolution of existing Panchayat system in 1990. The dawn of democracy soon saw the rise of political parties, which also accelerated the dialogues between *Guthi* members and local political leaders. The enthusiasms from the worshippers, businessmen and others might have induced these political leaders to participate in the whole process making them probable stakeholders. So at the end of this period, there were continuous dialogues among them informally during the learning period. However, the *Guthi* was still waiting for the right context to carry on the inclusion process. The greater challenge for them was to overcome the bureaucratic barrier and work coherently with different potential future stakeholders. The *Guthi* had also difficulties carrying out the inclusion process, deciding how much stake would various stakeholders have during the whole process, and most importantly who could be the right, charismatic person or group to lead the whole process of coherent inclusion and the overall objective of renovation.

#### ***Second Phase (1993-2000) – The Inclusion Period***

The right moment came after the local government election in 1993. In 1993, the renovation committee was finally established under the elected ward<sup>9</sup> representative president that included representatives from business groups, local government and local political leaders. The *Guthi* formally handed over the responsibility to this committee in 1994 and also selected the technical advisor. The committee soon got expanded with proper division of works. While the committee was busy in developing the strategies related to bureaucratic, financial and technical barriers, the *Guthi* also was involved in organizing the groups based on the cultural activities; *Akash Bhairab bhajan khala* was founded to continue hymn singing activities while *Akash Bhairab Guthi* youth group was founded for the youths of Guthi in order to encourage the active participation of the youths to carry out the activities related to *Akash*

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related to place and even participate. The street vendors could not be trusted on this as they frequently move out for the place and at the time of participation of activities, they would turn their back.

<sup>8</sup> *Marwadi* is one of the Indian ethnic community and their traders have the migratory habit.

<sup>9</sup> Ward is the smallest unit of local government

*Bhairab*. The *bhajan khala* was inclusive in nature while youth group was exclusive with members only the male descendants of guthi members. Even though these groups were not founded for the renovation project, they played crucial role in spreading the message and also encouraging others to get involved. The local groups; *Indrachowk club* and *bhjana khala* did have mutual understanding with the other users of the public. The growing inclusion process through dialogues and deliberation had even brought the government interest with the involvement of municipality and parliament members. The final two years also saw the selection of the design of the temple which was also put for public discussion. The design was also amended after recommendation.

Along with the finalization of design, the renovation executive committee was also reshuffled after the mass meeting<sup>10</sup>. The final executive committee and advisory committee consisted of the following representatives:

- Three members from guthi
- One member from guthi youth group
- One from bhajan khala
- One from Indrachowk club
- One from renters of the old temple building
- Two member of parliaments from different political parties
- Two from businessmen community

Leading the executive committee is the elected local government executive president. The final year also saw the formation of a technical committee with one of the member being an overseer as well as member of the guthi.

### ***Third Phase (2000-2003) – The Implementation Period***

The implementation period comprised the construction of temple and even an annex. Much of the minor details and construction details were decided by the technical committee. However, some of the major decisions e.g. selection of construction technology, and building materials were discussed with the executive committee (For). Before the construction was implemented, the decision was made by the technical team and executive committee of using traditional building construction technology (traditional *Newari* architecture style with brick, wood and mud mortar) the decision was not made on the annex part which was to be added to the temple. So, the designer wanted to imply the traditional technology while the executive committee wanted to construct with modern technology (RCC structure) with traditional façade. Due to conflict on the technology, the designer left the technical team and the remaining members of the committee finish the project as per the executive committee's decision. During the construction period, there were regular instances when people participated in unskilled works irrespective of their degree of stakes. The common cultural belief to the temple has instigated many people participate even in the works that they are not experts of. The period also saw the fund collection for the renovation project. The mobilization of various local stakeholders and networks of the representatives in the executive committee has seen the overwhelming participation of people from various sectors<sup>11</sup>.

### ***Fourth Phase (2003-present) – Post renovation Period***

The post renovation period saw an unexpected outcome. Recently the executive committee has celebrated its decade anniversary of completion. While it was expected to dissolve the executive committee after the completion of project, the executive committee was not able to come into consensus on what to do with the surplus fund collected. There were actually two possibilities that have been put

<sup>10</sup> On November 20, 1999, a public notice was issued to announce an open larger mass gathering with the aim to enlarge the steering committee and informing as many people as possible. After the mass meeting, the committee was reshuffled with new advisory committee under presidency of Bikash Bhakta Shrestha on November 27, 1999.

<sup>11</sup> At the beginning the committee had merely Rs 2,000,000. By the end of the period, the total fund raised was around Rs 197,000,000, in which the fund from general populace was Rs 120,000,000 more than the half of the total money raised. The project ended with the surplus amount of Rs 6,000,000 (approx.) which has compounded to Rs 10,000,000 within 10 year span. Note: - Rs 70=1 \$ (approx. at the time of renovation. The current rate is Rs 100=1\$ (approx.)

forward with regard to the surplus fund and the executive committee. The first possibility is to hand over the surplus fund to *Akash Bhairab Guthi* who can use the money to perform various religious activities related to Akash Bhairab temple and also maintenance of it. Another alternative could be to register the current executive committee as a user group that will be used to renovation of other culturally important monuments within the locality. Currently, the executive renovation committee is still running and the money is being used for maintenance of temple and performing various cultural activities in festivals (like Indrajatra festival).

#### 4 STAKEHOLDER INCLUSION: DIALOGUE, DELIBERATION AND ENGAGEMENT

The completion of the renovation project was mainly possible because of deliberate stakeholders' inclusion. However, there was a query on whom to include. A simple answer for whom to include would be 'everyone'. Yet, there was a big challenge for the *Guthi* to identify the 'everyone' who could contribute and commit in the whole process. Apart, the challenge is also on the ways to integrate various stakeholders. The renovation process answered these three simple questions:

##### ***Why other stakeholders anyway?***

When the *Guthi* started to develop the concept, it was their internal affair and they initiated the project as the *Guthi*'s goal. However, they soon face three barriers; financial, technical and most importantly the bureaucratic barrier. Financially, the *Guthi* alone didn't have enough funding to carry out the big project. Being culturally bounded group, the *Guthi* was not competent enough to overcome all those barriers and did realize the need for including other stakeholders in the whole process. Since the *Guthi* is an exclusive group bounded by the cultural obligations a strong counter argument was that the inclusion could bring the cultural infiltration which could endanger the group's identity and integrity. Eventually, continuous deliberative-dialogue brought consensus among the *Guthi* members to include other stakeholders in the renovation process in a way that would not obstruct the normal cultural and religious activities. However, the *Guthi* could not come up with the strategies that could obtain both the objectives and waited for that perfect time.

##### ***Who were the stakeholders?***

While the *Guthi* group did agree on the inclusion process, the challenge remained identifying stakeholders that could not only help to overcome barriers but would also understand the socio-cultural obligations. For the *Guthi* the first period was about convincing oneself and identifying the potential stakeholders, who could commit to and respect the whole renovation project. The approach by the *Guthi* was based on the kinds of barriers they have to overcome. Their informal dialogues with *Marwadis* and other actors in the business community were especially for raising the funds. The dialogues with the members of clubs were basically for the social mobilization that was needed for the mass information flow and the public attention. The dialogues with local political leaders and other socialites were basically to ease bureaucratic barriers that might come on the way during the process. The learning process for the *Guthi* consisted of knowledge sharing and in developing understanding for possible ways to include stakeholders even though their initial approach was rational and normative. The inclusion of other stakeholders was necessity rather than obligation. The commitment and enthusiasm on of *Guthi* renovation was reasonable as they would be getting a new building, but a reason for the business community or political leaders or the local youth club participation sounded like a riddle. Also, at glance all these stakeholders looked random with everybody is coming from different fields. However, while identifying the stakeholders, the *Guthi* was looking for the commitment and responsibility and trustworthy. In that perspective, the *Guthi* looked for the persons or groups, who had knowledge and respect of the local value towards *Akash Bhairab Temple* and its cultural practices. In other words, the knowledge and respect for cultural practices played a crucial role in developing the mutual trust and commitment. Like there are variations in the stake, it would also be unrealistic to expect same degree of commitment from every stakeholder and *Guthi* has accepted that reality. The

*guthi* had chosen stakeholders from whom they could expect the commitment<sup>12</sup> as their starting point of stakeholder inclusion.

### ***How to include the stakeholders?***

The approach to initially include stakeholders with similar cultural practices can be criticized as ‘*favoritism*’ of the *guthi* and their motifs were guided by pragmatic rather than democratic considerations. However, their inclusion approach turned out to be successful for the majority of stakeholders involved. Sustained as an exclusive group for around 1500 years, the *guthi* had in fact also undertaken an innovation process, a self-change, to initiate an inclusive process due to the necessity to overhaul the barriers. Their approach to include stakeholders with similarities in their cultural practices can be interpreted as first step towards inclusion and as a starting point for carrying out an inclusion process. The continuous dialogues and deliberations within the groups as well as with other groups were in fact a learning process for *guthi*. The timely decision when to create the executive committee and accomplish the project is a positive and successful outcome of the lessons the *guthi* learned through informal dialogues and conversations.

The stakeholder inclusion process was realized here as a series of strategies of learning, and knowledge sharing. Starting from the dialogues with the particular stakeholders to the formation of the final executive committee after the mass meeting, the committee underwent a series of reshuffling and expansion. The process of reshuffling and expansion comprised adding new stakeholders in every new executive committee was an attempt to include every possible stakeholder during the process. It would be idealistic to have representatives from each and every possible stakeholder. However it was made sure that all stakeholders would be well aware of the decisions through the public notice and through the mass meeting, the interested person was given the opportunity to share and comment his/her arguments. The final executive committee is an example of this and consisted of representatives from other local groups as well<sup>13</sup>. The disclosure of the final design for public discussion and making amendments<sup>14</sup> as per the suggestions was a further step of inclusion. While everybody would expect the member from the *guthi* to lead the project, it was a local elected ward president who had the responsibility to progress the matter in a coherent manner. The decision came as the *guthi*'s self-realization of their incompetence to overcome barriers<sup>15</sup>. On the other hand through this decision, the *guthi* also made the impression to other stakeholders that this was indeed an inclusive process.

## 5 RESULTS AND IMPLCATIONS

A primary concern for any individual or group is having spatial rights and control to perform social, economic, or cultural/religious activities and having a say in any development project of concern. However, a realistic scenario where each individual or group has the same control rights is unlikely, there are *defacto* variations of control and they are dynamic in nature and shift among different users. A control system requires information of values, feelings and experiences, additionally facts and techniques. Increased power or stake comes with increased responsibility and commitment and the local groups in our cases have come in fore to take that responsibility. The completion of the renovation of *Akash Bhairab Temple* is an example of the commitment shown by the local groups.

In any cases, a critical component before starting any engagement plan is stakeholders' identification [8]. Many users have accepted these local groups as *de facto* forces, but may also feel vulnerable un-

<sup>12</sup> In the interview with one of the *guthi* member and member in executive committee argued that we could not expect same kind of commitment from everybody. He questioned if it would be the same response to approach business people, other than the *Marwadis*.

<sup>13</sup> In seven years the executive committee was formed three times. The final executive committee also consisted of the representatives from Shree Akash Bhairabnath Indrachowk Club, Shree Akash Bhairabnath bhajan Khala and the renters of the temple.

<sup>14</sup> Mr. Amit Bajracharya from Jhwa bha suggested for example that the tiles of balcony should be removed.

<sup>15</sup> In an interview with the *guthi* member as well executive committee member, Bajracharya admitted that if it had been a *guthi* member leading the overall team, it would never have been raised so much funds and make necessary decisions. At that time, Bajracharya was the perfect leader with his position in local government, political background, relationships with business people and cultural and emotional attachment to the Temple.

der their management and control system. The local groups have the power to impose mechanisms or decisions, which has a great impact on the control and management systems as in case of Indrachowk. However, a question remains if these local groups are competent enough to manage and make decisions, considering various opportunities for different kinds of potential users. Critically, there is every possibility that giving the managerial power to local groups without any monitoring can lead to exclusion of users, especially of those who are in the lower hierarchy. These local groups also tend to be conservative and they may argue that how they can trust future users whom they don't know as e.g. in case of the street vendors. The present users might thus not feel emotional obligation for those who are to come<sup>16</sup>. The vulnerability also increases the higher trust gap between the local groups and the potential stakeholders. Therefore, one might consider establishing a control mechanism for local groups. One way of doing this is through the internal alteration of the groups, which tend to be quite static, and then establishing a local control system through stakeholder's inclusion that could attempt to provide basic opportunities for the potential future users or stakeholders irrespective of the variations in their stakes. The competence of the local stakeholder might be questionable in having a complete managerial and control system. However, a good local stakeholder is competent enough in identifying potential future stakeholders with his/her vast experience and knowledge on the local values and beliefs<sup>17</sup>. He or she can be motivated to envision the necessity to change according to the changing context and on the other hand contribute to maintain beliefs, values and identity. And probably it is the local stakeholder, who best understands the need to include potential stakeholders in any kind of managerial systems.

With environmental change, local groups also undergo internal alteration in order to adapt to changes. Planners, designers and local groups are however not only challenged to adapt to changes, but to couple innovation with the responsibility of protecting the local values, beliefs and identity. For, one of the major challenges is identifying whom to include, a simple answer would be 'everyone'. However with the reality of variations in stakes and commitment, the expectations of pure inclusiveness and commitment are idealistic. Merely including various stakeholders does not bring coherence in the performance. Further, a 'black and white' description of 'Stakeholder inclusion' is missing out Trust among the stakeholders. Only those stakeholders who trust each other work coherently and common participation of diverse users in various cultural activities seems to be a promising way to create mutual trust. Probably the involvement in such activities presents also an opportunity for potential users to gain some stakes<sup>18</sup>. Moreover, local stakeholders may open up for opportunities for other stakeholders to have some stakes in the local context and while those understand the local values and beliefs<sup>19</sup>. Trust building is the two way process and in the case analyzed here common cultural practice was a starting point to establish trust.

Conclusively, a stakeholder collaboration approach comprises a process of creating an environment of mutual trust through various *grey zones* of cultural practices, participation, conflict, dialogues, deliberation, and consensus. Sharing cultural practices within a context of indigenous knowledge and heritage can be a motor of common activities, and is thus not just a driver of inclusion, social mobility and economic competitiveness, but can play a key role in creating sustainable environments [9]. The goal of stakeholder collaboration is however making stakeholders work together in a coherent manner. The fifteen years that the *guthi* has spent for a twenty-year project of renovation of Akash Bhairab Temple illustrates another important aspect of stakeholder collaboration, namely the importance of some sort of managerial and control mechanism system. Changes can and should be monitored to reveal unde-

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<sup>16</sup> The way the local groups interact with *pashmina shawl shops* differs from the way they do with other street vendors.

<sup>17</sup> For example, the Akash Bhiarab *guthi* has opted for the inclusive process which by far has sustained for 1500 years as an exclusive cultural entity. The *guthi* also self realized in incompetency in leading the renovation project but identified the future stakeholders who could lead the project into completion.

<sup>18</sup> The *Marwadi* community is the trusted one due to their long involvement with Akash Bhairab Temple from generations. The *pashmina shawl* group also seems to be on the way of it, but the trust building is a long process and might take generations to build.

<sup>19</sup> The *Akash Bhirabnath bhjana khala* could be considered as an such opportunity provided by the local group or the mass meeting during the renovation project where every person can give his/her opinion on the overall project

sirable shifts like growing inequity, incongruence, and rising exclusion. Sometimes local level control may lead to the self-destructive pathways, misusing the space, and asserting social injustice and even environmental decay. These kinds of instabilities and conflict do require interventions as ultimate regulation mechanisms to provide the future sustainability of space for all users.

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# WASTE MANAGEMENT AND THE ROLE OF STAKEHOLDERS - A CASE FROM TWO URBAN COMMUNITIES OF MADHYAPUR THIMI MUNICIPALITY, NEPAL

Udhab Nepal<sup>1</sup> - presenting, Martina Keitsch<sup>2</sup>

<sup>1</sup> MSc in Urban Ecological Planning, Norwegian University of Science and Technology, Trondheim, udhab73@gmail.com Author TWO<sup>2</sup>

<sup>2</sup> Department of Product Design, Norwegian University of Science and Technology, martina.keitsch@ntnu.no

## ABSTRACT

Challenges of wastewater management are increasing with rapid population growth in urban areas. In Nepal, rivers are increasingly polluted as more than 90 percent of wastewater is being discharged directly without any treatment, which constitutes a particular problem in urban settings. This paper present and analyses a case study on wastewater treatment in the Madhyapur Thimi municipality. The case study is a pilot and demonstration project that was initiated as a community-based DEWATS (decentralized wastewater treatment system) by an NGO in Madhyapur Thimi municipality to tackle the worsening wastewater situation in urban areas of Nepal. After construction had started in Siddhikali, local people objected the construction saying that it would pollute the local environment. Efforts were made to convince the local people but were in vain. Sunga people, nearby of Siddhikali, requested for the construction of the system in their vicinity. Based on this case study, the paper analyses social acceptance and its role in implementation of community based DEWATS.

*Keywords: Decentralized wastewater treatment system, social acceptance, stakeholder involvement*

## 1 INTRODUCTION

One of the great challenges to implement and operate sustainable solutions over a longer period more efficiently lies in their socio-political acceptance by local stakeholders. Socio-political acceptance is social acceptance on the broadest, most general level. Both, policies and technologies can be subject to social acceptance (or lack thereof). At a general level socio-political acceptance also concerns the acceptance by key stakeholders and policy actors for effective policies. The concept of social acceptance is applied as theoretical basis to analyse this case study. After discussing the settings for the case study in the first section and introducing the project in section two, we present factors affecting social acceptance in a modified form to suit community-based DEWATS in section three. These factors are grouped into four broad categories namely project specific factors, project external environment, community factors and technology related factors. Some practical implications are conclusively presented in section four.

In Nepal, challenges of wastewater management are increasing with rapid population growth in urban areas. Rivers get increasingly polluted as more than 90 percent of wastewater with human excreta is being discharged directly into the rivers without any treatment which constitutes a particular problem in urban settings. Due to rampant discharge of wastes, during the dry season rivers seems like open sewer within urban areas, especially in Kathmandu valley.

This paper discusses a case of community-based decentralized wastewater treatment system (DEWATS) based on simple plants- reed plants to treat households sewage, which faced first rejection and then acceptance from neighbouring communities. It is an NGO initiated project funded by Asian Development Bank initially started in Siddhikali in Madhyapur Thimi municipality to tackle the worsening wastewater situation. After the plant construction had begun, local people object it by saying that it would pollute the local environment. The implementing agency Environment and Public

Health Organization (ENPHO), an NGO, made a lot of effort to convince the local people. They were asked for observation visits to existing treatment plants, but they refused to proceed with the construction (ENPHO, 2005).

Geographically, the former construction site was situated unfortunate on the way and near the vicinity of Siddhikali temple. Siddhikali is the main temple of Prajapati community of Thimi. Prajapati is a caste among an ethnic community Newars. Prajapatis are potters by caste who make clay products as family enterprises, and are, according to the caste hierarchy system, prevalent in Nepalese society, placed in a lower status than Shresthas though all restrictions regarding castes have lost their legal ground. Religious people of the community frequently use the way while visiting the temple. Relating to the socio-cultural environment there are many religious and cultural events taking place in Thimi. One of the most important cultural events is Bisket Jatra (chariots festival). Many people gather to observe the famous Bisket Jatra which is observed from the open space of Siddhikali where community-based DEWATS was initiated to construct.

Sunga people, nearby of Siddhikali, then requested the construction of the system in their vicinity. The Sunga settlement is located on a higher elevation and the treatment plant is located on the lower level in a remote area. The site is isolated and there are no ways for public access, the place was formerly used for open defecation and waste dumping. Landslides were frequently observed on this site. The treatment system is designed and built on a steep terrain, which is now in operation. The system is treating wastewater from 84 households.



Figure 1 Location of case study

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|-----|---------------|---|
| 1.  | 2001          | With support from Dutch INGO SIMAVI, ENPHO carried out a feasibility study for a community-based wastewater treatment system based on RBTS (Reed Bed Treatment System)                                  |
| 2.  | Oct., 2002    | ENPHO requested a fund of US\$ 50,000.00 to ADB for operational research on decentralized wastewater management & its dissemination which consists of pilot and demonstration activity (PDA).           |
| 3.  | May, 2003     | ADB (Asian Development Bank) approved grant for the proposal  |
| 4.  | Jun., 2004    | PDA program for water in Nepal was launched (With an implementation period of 12 months) by grant from ADB with an additional support from UN-HABITAT and Water Aid Nepal.                              |
| 5.  | Jul., 2004    | Project inception report sent to ADB by ENPHO.  |
| 6.  | Dec., 2004    | RBTS construction started in Siddhikali by clearing the site including procurement of materials but locals interrupted (US\$ 10,960.45 spent out of which materials costing US\$ 7200.95 was procured). |
| 7.  | May 28, 2005  | Management committee (MC) formed in Sunga.  |
| 8.  | Jun. 19, 2005 | MC formed a Construction Sub-committee of 7 members.  |
| 9.  | Jun. 25, 2005 | Laying of foundation stone of the community-based DEWATS.   |
| 10. | Jun. 27, 2005 | Time extension granted by ADB up to September, 2005.  |
| 11. | Jun. 28, 2005 | MOU signed between MC, Municipality and ENPHO regarding construction of the system in Sunga.  |
| 12. | Oct., 2005    | Construction of the system was completed (in a tight work schedule of four and half months in US\$ 44,000 and PDA completed with an investment of US \$ 70,850).  |
| 13. | Jan. 14, 2006 | Treatment plant operation started.  |

Table 1 Time line events of community-based DEWATS in MadhyapurThimi

## 2 STAKEHOLDER INVOLVEMENT IN PLANNING COMMUNITY-BASED DEWATS

The 'outcome' dimension was overemphasized in the planning of this community-based DEWATS while the 'process' dimension was neglected. Mobilizing local people at grass root level to identify their needs and seek their concern for the solution to solve the wastewater management problems seemed absent as well and while selective participation was achieved while forming the management committee in the former site Siddhikali. The usefulness of the project was determined by the initiating NGO.

There were some fundamental challenges in employing a community-based approach for planning DEWATS in Thimi, which should rely on decentralized and collective decision-making that seeks locally appropriate solutions. For example, the focus on 'outcome' dimension, which can be conceived, planned and operated by NGOs and local institutions should have direct benefit for the local community either in terms of creating job opportunities or resources use that can be linked in a way at households' income level. These direct benefits should be realized by the local community people, but not by the project developer. In Siddhikali, ENPHO hired heavy equipment for excavation work to level the ground. Materials were procured by ENPHO staffs. A contractor was mobilized for construction work but the role of Management Committee (MC) was not clear. The economic authority was not handed over to the MC. Here, the approach taken by ENPHO to initiate construction can be questioned from a transparency viewpoint. Local political leaders agreed to initiate the construction but local inhabitants were disagreeing, some wanted to initiate the project while others were objecting it.

There were various reasons that led to rejection of community based DEWATS in the former site Siddhikali. The main reasons were lack of community involvement from the outset of project planning and selective participation made in the decision-making process ignoring local political dynamics that focus only in product rather than in process among other various reasons. Local people were worried about the impact of possible foul odour to the religious environment. Traditional uses of the place while selecting the site were ignored. Further, literacy among Siddhikali's prajapati people was less than municipal average and there were still significant number of households without toilet facilities among them. Environmental awareness was also limited among local Prajapati people. Moreover, there was lacking political commitment from municipality i.e. established supporting mechanism for future operation and maintenance of the system.

In the later ~~second~~ site Sunga, NGO and local leaders interact to a greater extent for example through stakeholders' gatherings to discuss pros and cons of DEWATS. Mass gatherings for community interactions were organized three times before making the decision to initiate the construction. The first time gathering was to explain and describe functioning of DEWATS. The second time was to show a documentary to visualize how the system works and the last time was to make an inspection visit of existing DEWATS sites. Sunga's Shrestha people were more educated, politically more active and the numbers of households having toilet facilities were almost cent percent in Sunga. It was the management committee to initiate and manage the construction work. Local labours were hired to carry out the construction works and local construction materials procured. MC members supervise the works. The construction expenses were reimbursed by ENPHO to the MC. The main cause for the acceptance of community based DEWATS in Sunga was to protect the land from landslides. Further, community preparedness and mobilization that were carried out for selecting the site and forming the management committee including political commitment i.e. tri-party MOU for future operation and maintenance were among other reasons. These changed strategies employed by ENPHO might be the lessons learnt from the rejection of community-based DEWATS from Siddhikali.

## 3 SOCIAL ACCEPTANCE

The concept of social acceptance can be characterized by three dimensions: socio-political acceptance, community acceptance and market acceptance (Van der Horst, 2007 cit. in Wüstenhagen et al., 2007).

Often a project, necessary to improve environmental conditions from a national perspective, also faces local objections as a disturbing nuisance to the local residents. Some authors also stress that moving from global to local, and from general support for technologies and policies to effective positive investment and siting decisions, requires the acknowledgement that there is indeed a problem (Bell et al., 2005 cit. in Wüstenhagen et al., 2007). Other factors influencing community acceptance include distributional justice (how are costs and benefits shared?), procedural justice (is there fair decision-making process giving all relevant stakeholders an opportunity to participate?) and trust (Gross, 2007: in Wüstenhagen 2007). As Figure 2 illustrates Wüstenhagen's concept has to be slightly modified for community-based DEWATS based on the findings of this study.

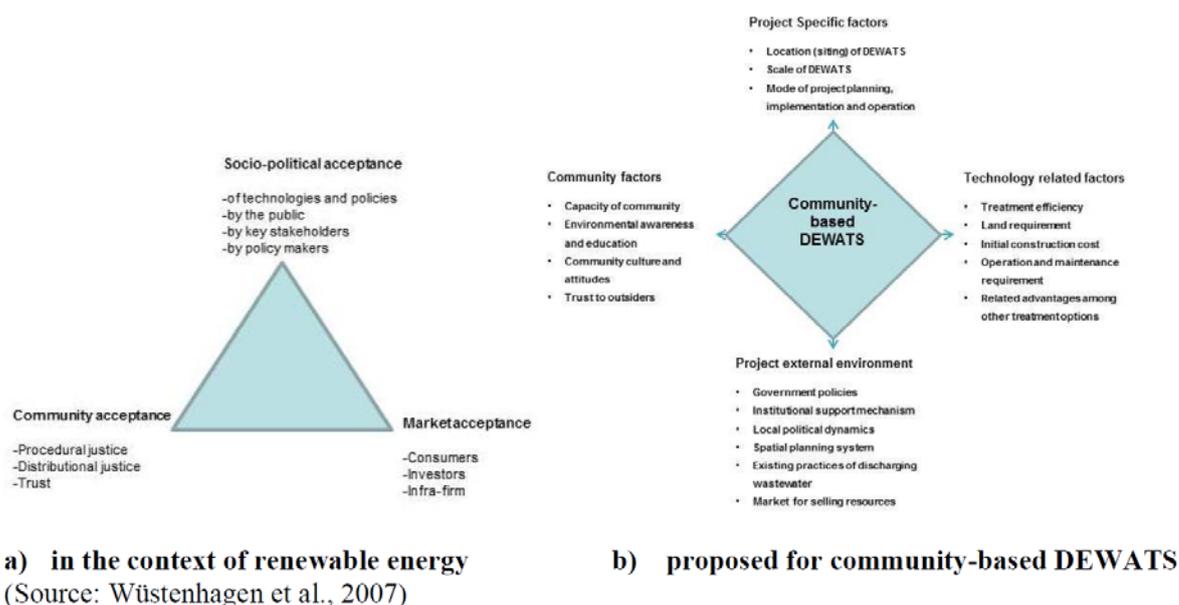


Figure 2 Social Acceptance

The aim of this modified version is to contribute to a new understanding on social acceptance of community-based DEWATS. Social acceptance of community-based DEWATS is low, mainly due to matters of handling wastes and associated foul odour problem, among various other factors.

These factors can be grouped into four broad categories namely project specific factors, project external environment, community factors and technology related factors (see Figure 2 section b). Project specific factors include location (siting), scale of DEWATS i.e. size of settlement, mode of project planning, implementation and operation (room for local people participation). Focus on 'process' dimension is vital in planning DEWATS as installing the system within a community do not directly benefit the community. Project external environmental factors are government policies, institutional support mechanisms, local political dynamics, spatial planning system, existing practices of discharging wastewater, market for the resources obtained from DEWATS. Community factors include capacity of the community to own, operate and manage the system; level of environmental awareness and education, community culture and attitudes, trust to the intention of outsiders. Technology related factors are treatment efficiency of the system, land requirement, initial construction cost, operation and maintenance requirement, relative advantages of the selected technology among other treatment options. Among the above envisioned factors sometime one or some of the factors may be decisive than rest others to contribute social acceptance of community-based DEWATS.

#### 4 PRACTICAL IMPLICATIONS AND REFLECTION

In the following section, we present some practical implications on social acceptance of community-based DEWATS as results of this study and reflections on how to reach a better establishment of the plants in the future.

##### *Walk the talk*

First, the government agencies should be pioneer for implementing discharging treated wastewater according to their policy premises. Further, enforcing existing rules and regulations against rampant discharge of wastewater from organized sectors viz. the factories, industries, institutions (hospitals, offices, and schools), apartment buildings, and organized housing colonies is the next necessary step. These efforts can provide the general public with convincing examples towards sustainable wastewater management. Political stability and will power of the government play here a significant role for long-term strategic action.

##### *Locational preferences for community-based DEWATS*

People naturally want to remain at a distance from wastes. A close-by wastewater treatment plant creates some nuisance for example because of bad odour. Siting community-based DEWATS can be a contested decision and local residents might be reluctant to initiate it in their vicinity. Thus, a system should be installed in a somehow remote location having limited access such as wastelands, wetlands near the bank of rivers. Traditional use and practice of the local people to use the place can support or obstruct the siting decisions for the system.

##### *City-wide campaign to clean rivers*

Community-based DEWATS can be sustained if they are included as a part of a larger comprehensive plan such as citywide campaigns for depolluting rivers. Making rivers pollution free is a common responsibility of all inhabitants, institutions and communities, who are residing at the watershed (a river basin). A single community cannot take full responsibility to depollute the river. Even if it does, this does not make any significant de-facto difference. Further, a community cannot feel the necessity of establishing community-based DEWATS if industries and private institutions are discharging polluted wastewater directly into rivers.

##### *'Healthy city standard'*

There are fragmented laws and rules against river pollution in Nepal. The National Central Government can develop a 'healthy city standard' regarding the cleanliness of cities that can also address all the issues against river pollution in a single document. The standard can also be tied-up with government funds flow mechanism with reward and punishment provision. 'Clean cities' will get additional grants while 'non-clean cities' will lose grants and get penance.

##### *Environmental awareness and education*

Level of environmental awareness among the local people plays a significant role to establish community-based DEWATS. Many people in Nepal are uneducated. The level of environmental awareness among many people is limited. There is a need of persistent environmental awareness programme to motivate, educate and raise environmental awareness among people. NGOs (Non-governmental organizations), CBOs (Community-based Organizations), and public organizations can play an active role in awareness creation and advocacy for environment conservation. The impact of a clean environment should be linked to the individual benefits in a way that local people can understand and realize the importance of community-based DEWATS. More research is needed to explore direct benefits such as savings at medical expenses from good health or saving productive time at household level from a clean environment especially sanitation.

##### *Institutional support mechanism*

Wastewater treatment requires a significant amount of investment. Not only initial investment, it requires some recurrent expenditure for operation and maintenance although DEWATS is based on low maintenance principle. Community-based DEWATS cannot exist without a support of external institutions and organizations as there are no direct benefits to the local community by installing community-based DEWATS within their vicinity but for overall surroundings spanning over many

communities. Assured operation and maintenance support is also needed for resource constrained communities.

Conclusively, one can say that the level of environmental awareness among the local people plays a significant role to implement community-based DEWATS. Many people in Nepal are however uneducated, which also restrict the level of environmental awareness. There is a need of continuous environmental education and awareness programs to motivate educate and raise public interest in sustainability issues. NGOs, CBOs, and civic organizations can play an active role in awareness creation and advocacy for sustainable development. The goal of a clean environment should be linked to the individual benefits in a way that local people can understand and realize e.g. the importance of community-based DEWATS.

More research is needed to explore such direct benefits e.g. saving medical expenses or saving productive time at a household level from a clean environment, especially sanitation. Also citywide campaigns to make polluted rivers clean should be launched simultaneously mobilizing different stakeholders. These suggestions set focus on a greater interaction between different stakeholders, addressing local needs more fully along with national and global priorities and including individuals and groups systematically in planning and decision-making processes. Concerning local stakeholders, they can provide basis information on an existing situation and they might have knowledge and professional expertise, which is particular valuable for the design and implementation of sustainable solutions. Finally, synergies between stakeholders create dialogues that acknowledge the importance of collective action and shared work, an acknowledgment that ideally contributes to generate discussions and strong civic movements and that democracy needs.

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# ENVIRONMENTAL CONSIDERATION IN LOCAL DEVELOPMENT PLAN OF NEPAL

**Sigdel E.R<sup>1</sup>**

<sup>1</sup>Environment Specialist, Local Governance and Community Development Program, Nepal  
ekrajsigdel@hotmail.com

## **ABSTRACT**

Around one third of Nepal's economy depends on natural resources. Environment degradation impacts negatively to poor, women and marginalised communities. The government of Nepal has promulgated various tools such as policies, manuals and directives for mainstreaming environment into local developmental plan and budgets. The local development plan and budgets in environment and climate change adaptation has been considered as the reflection of compliance of the various policies, manuals and directives of the Central Government. However, there is no reliable baseline information in place about how effectively the environmental policies, manuals and directives are translated into local development plans and programs. To fulfil this knowledge gap, the study was carried out in 2014. The study has assessed to what extent the local bodies have complied with national policies, manuals and directives. The study was primarily undertaken following a desk review and interaction with policy makers as the approach is cost effective, appropriate and reliable too [1].

*Key words: Poverty and environment, sustainable development, energy demands, decision making factors*

## **INTRODUCTION**

To initiate and expedite the mainstreaming process the government of Nepal has promulgated various policies, manuals and directives in different time intervals. The following sections highlights key features of the mainstreaming tools and their implementation effectiveness.

## **Legal Framework**

Interim Constitution of Nepal, 2007 mentions that environmental protection and promotion will be given emphasis in all kinds of development, construction and service processes to be operated in public and private sector. The Local Self Governance Act (LSGA), 1999 and LSGA Regulation, 1999 necessitates formulating district and municipality periodic plan. While planning District Development Committee (DDC) should take longer term vision and goals of sustainable development. The legal instrument has identified 16 different fields for the development including natural resources management and sustainable development. The government of Nepal promulgated Environmental Protection Act (EPA), 1997 and Environmental Protection Rules (EPR), 1997 for promoting environment friendly sustainable development activities.

In line with creating enabling environment to address the emerging issue of climate change, the government of Nepal has prepared The Nepal's Climate Change Policy (2011) and National Adaptation Programme of Action (NAPA). Similarly, Ministry of Federal Affairs and Local Development (MoFALD) together with the Ministry of Home Affairs (MoHA) has supported local bodies with preparing and implementing Local Disaster Risk Management Guidelines (LDRMP), 2012 and District Disaster Risk Management Plan (DDRMP), 2013. In addition, environment, climate change and disaster criteria are incorporated into various guidelines such as Minimum Condition and Performance Measure (MCPM), Resource Mobilization and Management and Environment Friendly Local Governance Framework (EFLG). In 2010 MoFALD issued circular to all 75 districts to carry out Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) while mining sand, gravels and boulders.

### ***Minimum Condition and Performance Measure Guidelines***

Minimum Condition and Performance Measure (MCPM) system has been practiced as an integral part of the overall governance reform in Nepal. According to this system, the Government of Nepal annually adjusts the grants to be provided to local bodies (LB) based on their scoring in the MCPM assessment. LB refers to DDC, VDC and Municipalities. LBs that meet the MC and score high in PM are provided with an additional amount in the form of capital grants and vice versa. LSGR 1999 requires assessment of LB and permits subsidies to them to be expanded or reduced after having obtained recommendations from the Local Body Fiscal Commission and taking MCPM into considerations.

There are four environmental performance indicators with a total of 12% marks in Municipality MCPM Guidelines 2012 [2]. The indicators include i) Sanitation and solid waste management following 3R principles ii) Environmental management - As per need IEE/EIA implemented, road side plantation, environment awareness program, climate change adaptation activities, environment unit/section established, focal point with ToR identified, environment management fund developed and budget mobilized management and iii) Emergency service/disaster management. Likewise, there are four environmental performance indicators with a total of 8 marks in DDC MCPM Guidelines, 2013[3]. The indicators, among other includes Energy and Environment management plan prepared for infrastructure development activities, micro hydro and energy development project formulated and implemented, local adaptation program planned and implemented, policy formulated from DDC council to use heavy equipment etc.

### ***Capacity Enhancement Trainings***

To pilot the mainstreaming process in the ground, MoFALD has prepared Training Manual on Mainstreaming Poverty and Environment for Social Mobilisers, Village Technicians and Village Development Committee Secretaries (MoFALD, 20112). Similarly, Annual District Development Plan of Dhading, one of the Midhill Districts of Nepal that was approved by the DDC Council in 2012 includes three important policy and programs regarding to environmental conservation. First, pre-feasibility, Initial Environment Examination (IEE) and survey design shall be carried out while implementing infrastructure Project. Infrastructure projects shall be guided by Environment Protection Act and Regulation and DDC Block Grant Mobilization Guidelines. Second, at least 10% budget of every road project shall be set aside for maintenance fund for the rural road. Third, budget for environmental conservation and climate change and adaptation (IEE, Local adaptation and improved cooking stoves) though small grant amounting - Rs. 43, 25,000, amounting 4% of the total budget has been included in the plan.

### ***Climate Change Public Institutional Review***

Nepal studied Climate Change Public Expenditure Institutional Review (CPEIR) in 2012 to assess the status of climate public expenditure in the national development programmes. The study provided a baseline to initiate developing criteria and methods for climate budget code, which led to development and introduction of climate budget code to track climate public expenditure. National Planning Commission's (NPC) planning guidelines have incorporated the directives to conduct coding, which makes coding each development programme for climate relevance mandatory in development planning process. The review showed that the coding tool is quite effective in tracking climate financing, particularly in each sector and in the field, where 80% of climate budget is supposed to go. Climate budget code has been introduced in the annual budget in 2012/13 and was reviewed to understand how does the information generated explain climate financing and help track public expenditure on climate activities. Climate budget code is fully institutionalized from coding of the development activities at the ministries and departments to bringing summery of allocated climate budget as Annex 16 – a new annex with climate budget information - in the annual budget book known as the red book. Climate budget allocation increased from 6.74% of the annual budget in 2012 to 10.3% in 2013.

### ***Municipality Annual Planning Guidelines – 2067***

There are 10 steps in annual planning process in Municipality starting from data collection and analysis and forwarding the approved plan from the Municipality Council to the DDC [4]. In connection with preparing the annual development plans, all municipalities need to prepare resource

map. According to the Guidelines, the resource map should include climate change vulnerable areas, landslides prone areas, and river cutting and flood and erosion prone settlements. Similarly, Agriculture, Forest and Environment Committee, and Integrated Planning Formulation Committees (IPFC) should screen the sub projects whether the ward forwarded activities includes climate change and environment disaster risk reduction activities or not. The IPFC should review the activities whether they are in line with climate change adaptation and environment or not. Ward level planning workshop aims at prioritizing activities that have been forwarded from settlement level. Similarly, while undertaking feasibility study environmental and climate change effect analysis should be undertaken.

#### ***District Development Annual Planning Guidelines – 2068***

The guidelines also include environment and climate change resilience consideration while preparing annual development plans of DDCs. According to the guideline, the District Development Annual Plan (DDAP) should include pro-poor, inclusive, environment friendly and effective activities by undergoing participatory process [5].

#### ***Local Body Resource Mobilization and Management Operation Guidelines 2069***

With an objective of helping local bodies on preparation and implementation of annual development plans and programs following the principle of good governance, the government of Nepal has promulgated Local Body Resource Mobilization and Management Operation Guidelines 2069. The guidelines acknowledge the importance of environment friendly local governance for sustainable development. To this end various provisions are included in the guidelines.

According to the guidelines, local government shall spend the capital grant received from the central government in forest, environment conservation, biodiversity, parks, and open and green zones, climate change, renewable energy, environment conservation and climate change. Funding shall not be done in programmes or projects that are selected in contravention of the provisions of the Environment Protection Act, Environment Protection Regulations, and Social and Environmental Safeguard Framework 2008.

#### ***Environment Friendly Local Governance Guideline, 2013***

The concept has been evolved with the notion that environment conservation should begun from household level. In this regard, the household can be judged whether it is complied with environment friendly through attaching indicators in various livelihood components such as natural capital, financial capital, and social capital, physical and human capitals. The indicators have been developed with the premises that it helps expedite the process of environment and climate change mainstreaming into local development planning and budgeting process. In addition, the indicators will help strengthening result based monitoring mechanism. To institutionalize the concept, the government shall embed the environmental consideration in the existing 14 step local bodies integrated planning, monitoring and reporting mechanism.

Under this concept, capacity of District Environment Energy and Climate Change Section needs further strengthening. To ensure sustainable financings to environmental component of the sustainable development activities, Environment Management Special Fund shall be established and mobilized under District Development Fund. The "volunteer incentive based approach" will be applied to encourage each and every household towards adopting environment friendly criteria. In recognition of the environment friendly household, settlement, VDC/Ward and DDC, special arrangement will be made such as discount on land taxes, special facilities for official work, attaching various colour tags and availing hoarding boards to name few would be in place.

## **THEORETICAL FRAMEWORK**

National policies and directives explicitly state that the local bodies should have appropriate resource allocation for environmental consideration in local development program/project. The study examined local level development plans of three consecutive fiscal years 2011, 2012 and 2013 to assess how much resources they have allocated for the environmental activities to address the local demand. The study was undertaken under the premises that effectiveness of all the efforts made by the central government towards mainstreaming environment and climate change adaptation into local

development planning and budgeting can best be reflected to what extent the local bodies have include programs and budgets for climate change and environmental activities.

### RESULT AND DISCUSSION

While reviewing 15 selected District and five Municipal Annual Development Plans, it was revealed that 95% local bodies have considered environment as a major program. The environment program

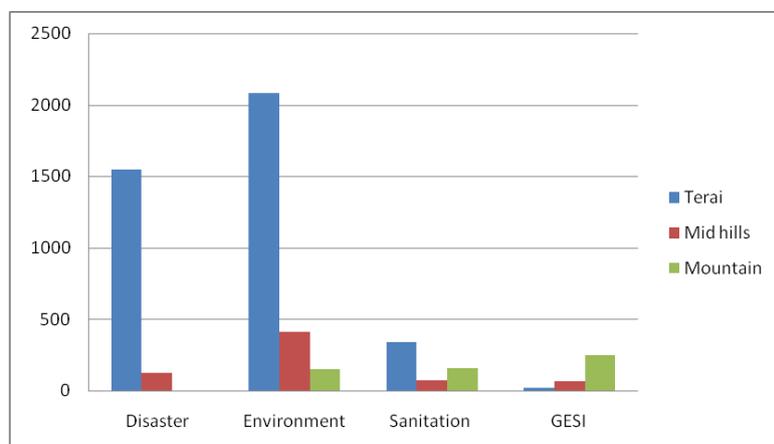


Figure 1 Budget in sector and geographic region, in million (RS.)

includes various activities such as establishing and strengthening of environment energy and climate change sections, environment management special fund, and alternative energy programs. The other activities under environment headings comprises of agriculture, biodiversity conservation, forest management, climate change adaptation, repair and maintenance fund for rural roads and soil conservation and watershed management. While assessing, consistency between approved

programs and activities, it was found that 95% activities under environment programs are kept under funding category. Similarly, 70%, 80% and 45% activities under disaster, sanitation and social

inclusion respectively are being placed under dedicated funding headings.

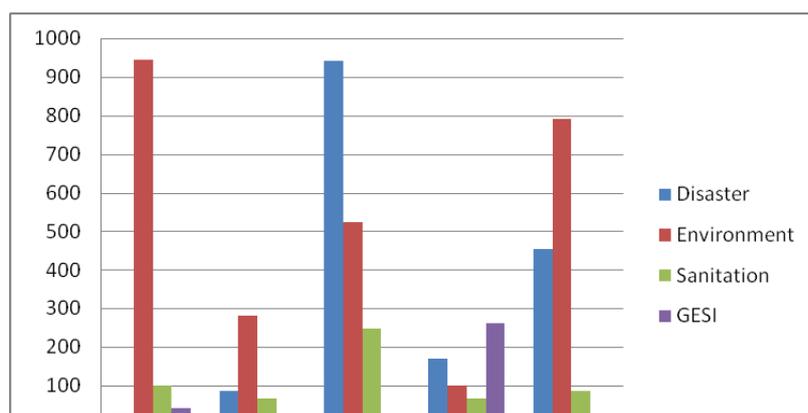


Figure 2 Development region wise sectoral programs in million (Rs.)

While analyzing the budgeted activities in the annual development plans, of the total approved budget US\$ 6,98,599,646 for the selected districts and municipalities only 4.1% budget is allocated for environmental management activities, mainly for plantation, alternative energy,

climate change adaptation and disaster risk management. This figure is in decreasing order from Terai to Mid Hills and Mountain areas (Fig.1). But reverse is true for Gender Equality and Social Inclusion (GESI).

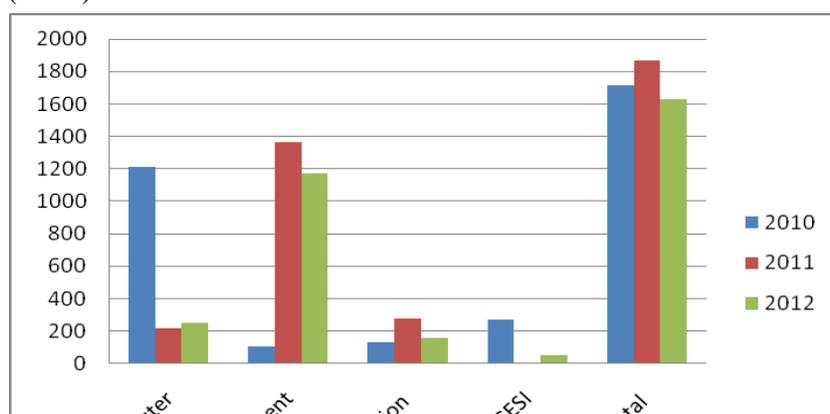


Figure 3 Sector wise expenditure over the years, budget in million (Rs.)

According to the figure 1, environmental as well as disaster related activities are being budgeted in Terai regions, while the expenditure in Mid Hills and Mountain regions for those activities are being decreased. Activities related to sanitation are implemented across the country while the gender and

social inclusion activities are confined only in Mid Hills and Mountains. Good amount of budgets are allocated in environment and disaster activities in West and Far Western Development Region. Over and above, there is no specific pattern of expenditure in terms of geographic region.

As shown in figure 2, environment and disaster programs are being designed across the country with higher proportion in Western and Far Western Development Regions.

According to figure 3, in an average budget allocated for over all pro-poor environmental activities was around 8% of the total. Budgets allocated in different sub-activities are not consistent. For instance, budget for disaster was highest in 2010. However in the ensuing years it was more than five times lower. Similarly, budget for environmental activities was in fluctuation. Having heavy rainfall followed by flood in Terai in 2009, local bodies might have allocated more budgets for disaster risk management in 2010.

Though 75% local bodies under study have included disaster programs in their annual development plans, budget has been allocated only for 20% of the total. In total, 50% and 60% local bodies have included program of alternative energy and disaster respectively in their annual development plans. Only 35% local bodies under study (15 DDC and five Municipalities) have included programs of climate change adaptation in their annual development plan of which only Lekhnath Municipality has got funding for climate change adaptation activity in the study period.

## RESEARCH GAPS

Successful mainstreaming can be achieved only when the pro-poor environmental linked renewable energy program and activities are adequately incorporated in socio-economic development plan, programs and budgets of local bodies (GoN, NPC; 2013). Some questions are being raised among other include: i) are the planned budget of 4% by local bodies in environment management is adequate or what is the figure that local bodies should allocate to ensure sustainable development? Why only a fraction of total budgets of local bodies are appropriated for this sub sector? What are the key factors that influence decision making process?

## CONCLUSION AND RECOMMENDATION

Formulation of various policies, manuals and directives by central government and allocation of a total 4% budget, though small for environment and climate change adaptation activities by local bodies is a reflection of the Government of Nepal's commitment towards environment friendly sustainable development. The study will be an eye opening for policy makers and also act as baseline data in the front of environment mainstreaming sector. Some questions are being raised among other include: i) are the planned budget of 4% by local bodies in environment management is adequate or what is the figure that local bodies should allocate to ensure sustainable development? Why only a fraction of total budgets of local bodies are appropriated for this sub sector? What are the key factors that influence decision making process? It is urgently needed a study to address the aforementioned study and make pragmatic recommendations to the government of Nepal so that the mainstreaming process become more effective and sustainable.

## IMPLICATIONS FOR 'RESILIENCE THE NEW RESEARCH FRONTIER'

Environment, climate change and disaster management are cross cutting issues. Thirteenth development plans of Nepal address these issues at macro level. However, further studies in these areas are essential to explore on how these issues are address at community level. Why people do not bring the agenda of environment into local development planning and budgeting process and what are the obstacles for their participation could be a subject of research in the days to come.

## ACKNOWLEDGEMENT

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# AN ASSESSMENT FRAMEWORK FOR SUSTAINABLE LAND DEVELOPMENT IN RAPIDLY URBANIZING CITIES

**Lai Choo MALONE-LEE<sup>1</sup>, Irina ORLENKO<sup>2</sup> and Chye Kiang HENG<sup>3</sup>**

<sup>1</sup> Director, Centre for Sustainable Asian Cities, National University of Singapore, sdemalon@nus.edu.sg

<sup>2</sup> Research Associate, Centre for Sustainable Asian Cities, National University of Singapore, a0122231@nus.edu.s

<sup>3</sup> Dean of School of Design and Environment, National University of Singapore, sdedean@nus.edu.sg

## ABSTRACT

A major development challenge in urbanizing cities is that land as a scarce resource is being rapidly taken up for development. Not only is this transforming low density settlements into more intensely developed urban centres, it is also encroaching into valuable agriculture land and nature areas. While supporting social development and economic growth, such development have impacts on water and air sheds, local climates, biodiversity and ecological integrity. Here, the research questions are: what constitutes “sustainable” land development, how can it be evaluated, what performance indicators or benchmarks can be applied?

This paper is based on a research project that evaluates urban sustainability in several thematic sectors, including energy, water, food, biodiversity, etc., but it focuses directly on urban land development. It seeks to develop an assessment framework with themes, dimensions, indicators and metrics, within an overarching vision to support sustainable growth, particularly for developing cities.

The proposed land sustainability assessment framework comprises three domains, namely, 1) Land as a resource, with a focus on conservation, cautious consumption, and land regeneration; 2) Urban economy, with a focus on compact development and land optimisation, and attention on resource productivity through intensification, multi-functionality, and enhancing development efficiency; 3) Social equity, with a focus on liveability, accessibility and community amenities. These three domains are supported by the governance realm, which focusses on effective land management and public participation.

*Keywords: Land, development, sustainability, assessment*

## 1 INTRODUCTION

In the coming decades, rapid urbanization will continue to be experienced in many parts of the world, and would be most intensive in developing countries, particularly those in Asia and Africa (United Nations, 1992a; United Nations Centre for Human Settlements, [1996] 2000). For many cities in these countries, population growth and expansion of economic activities would primarily be manifested in two spatial dimensions; one is the increasing concentration of urban functions and services in large cities, and the other is the horizontal expansion of cities into the surrounding lower density rural settlements and agricultural hinterlands. Both of these have significant impacts on land use and land management.

Urban land as a scarce resource would be increasingly stressed, in terms of higher use density, infrastructure inadequacies and environmental degradation. At the same time, land at the city periphery and greenfield sites further away will be subjected to increasing development pressure, with potential consequences such as loss of valuable agriculture land, impacts on critical water sheds and fragile eco-systems, as well as problems of accessibility and connectivity. Other direct and indirect impacts such as rising land costs, transport inefficiencies, under-serviced neighbourhoods, social inequity and poverty, are already evident in many of the already crowded cities in these developing countries.

In this context, cities have to define for themselves the critical issues of sustainable land development, taking into account the principles of sustainability as set forth in the Rio Declaration on Environment and

Development (United Nations, 1992b) and their respective development priorities. The tension between the need to conserve land of important ecological and cultural value, the importance of meeting social needs for housing and community amenities and the unrelenting economic pressures for industrial, commerce and infrastructural development have to be carefully managed through appropriate urban policies and planning instruments. To do this effectively, cities need a robust land assessment framework with well-defined metrics to support the evaluation process.

## 2 SUSTAINABILITY OF URBAN LAND

### 2.1 Scarcity of Urban Land

Urban land is a limited, non-renewable resource, and planners must seek to balance the priorities of economy, environment, and social equity in order to achieve “green, profitable and fair” sustainable development (Campbell, 1996). Campbell argued that the effectiveness of sustainable planning stems from more sharpened debates around the environmental-social-economic conflicts and the relationship between land and development.

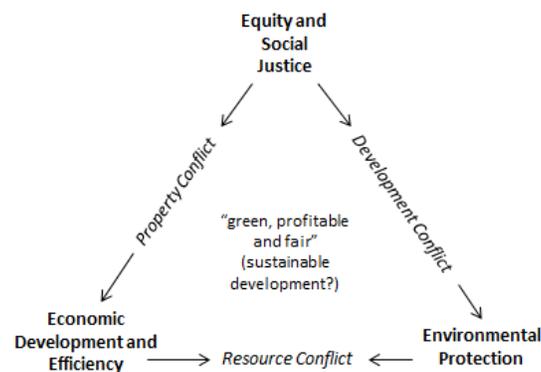


Figure 1: The Campbell's Sustainability (Planners) Triangle of conflicting goals for planning, and the three associated conflicts. Source: redrawn from (Campbell, 1996)

The Campbell Triangle as illustrated in Figure 1 synoptically highlights these major conflicts. Essentially, urban land is often prioritized for economic development, being the milieu for production, consumption, distribution, and innovation activities. Economic space in this context includes not only the land markets, but also its supporting infrastructure of roads, rails, ports, as well as ancillary residential and commuter zones. The competition for land in this space defines the basic economic structure of the city and its interaction with capital and labor. This is often in direct conflict with the ecological space that supports ecosystems such as water catchments, nature areas, wildlife habitats and biodiversity, all of which are constantly threatened by economic functions that consume resources, generate waste and all forms of urban pollution. The intense competition for land to serve a range of economic functions and the desire to keep them in their inherently natural (undeveloped) is probably one of the most challenging issues in land management within contemporary cities.

On top of this, urban land is also social space, where the contention for and distribution of resources, services, and opportunities occurs. The keen competition for urban land amongst different social and income groups is such that urban land becomes both a source of provisioning for all manner of social needs and their accessibility, but is also the cause of inequitable wealth distribution, social segregation and other conflicts.

The interaction across these three spheres – environment, economy and social - is highly complex. Single dimensional approaches that address ecological issues by land conservation alone, for example, may impinge not only on economic development, but also reduce opportunities that could lead to poorer social

outcomes. Likewise, all too often, infrastructure development to support economic growth has led not only to serious ecological damages but also erosion of social and cultural capital.

The figure starkly illustrates the importance of formulating the appropriate and strong policies to guide land development, and of defining clear sustainability goals. Of equal importance is the development of tools and methods to assess how cities are performing, in order to direct the attention of policy makers to the critical and urgent problems that must be prioritised and addressed. The assessment tool must be based on multi-dimensional evaluation that involves a multiplicity of metrics, given the complex interactions, as illustrated.

## 2.2 Land Sustainability

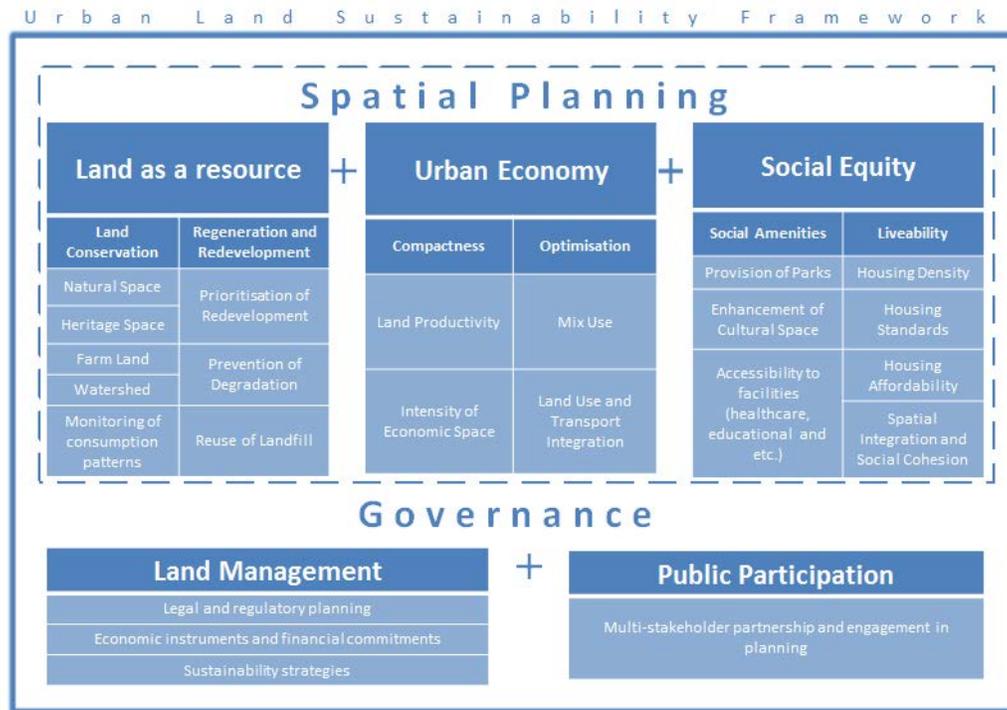
The development objectives and growth trajectory of a city depend very much on its economic ambitions, infrastructure possibilities, demographic profile and social-political context. Land use change takes place continually and in tandem with economic growth and social development over time. Since development is a dynamic process, the question of what is sustainable land development cannot be precisely defined, and must be understood in relation to the specific context of the individual city's urban economy. Nonetheless, drawing from the broad framework of the Rio Declaration (United Nations, 1992b), three principles are important for economic sustainability and social resilience: Firstly, given that land is recognisably a scarce resource and is necessary to meet human needs, cities must take action to protect its inherent land base. Secondly, as productive land is a good approximation for natural capital (Hubacek & Bergh, 2006), and different land uses reflect resource competition for a variety of societal needs, cities have to take anticipatory action to ensure the long term efficient and optimal use of urban land. Third, while the economic dimension of land is often prioritized, its social role is just as important to ensure that community needs are addressed in tandem, not just in terms of provisioning, but also to engender a conservation-oriented culture and sense of stewardship.

In this regard, the European Commission (2001)'s definition of a sustainable city, with specific reference to its use of land as 'one that enhances the efficiency of land use within the city, protects highly valued un-built land, biodiversity and green areas from development and restores contaminated and derelict land (brownfield sites)', is relevant and pragmatic. Based on this definition, the key principle of sustainable land development that is framed for this study will focus on the use of available land in a manner that sustains the city for the future through active conservation of undeveloped land, efficient or optimal use of developed land, and fair allocation and social justice. This working definition will be adopted for the purpose of developing the land sustainability assessment framework as set forth in the next section of this paper.

## 3 LAND SUSTAINABILITY ASSESSMENT FRAMEWORK

As defined in the preceding paragraph, the ultimate objective of sustainable land use and development is to balance the competing demands for limited urban land resources, minimize the loss of important natural land to developments, while supporting economic and social development, and enhancing already developed land through a process of restoration and upgrading.

The proposed multi-dimensional framework for land sustainability assessment is shown in Figure 2. In this framework we evaluate land sustainability in three domains of spatial planning, namely, Protecting Land as a Resource (Land Conservation); supporting the Urban Economy (Land Optimization); and Enhancing Social Equity. These are supported by a regime of land governance that involves effective land management that combines a robust legal and regulatory system, market-led incentives, and effective stakeholders' participation. The overall framework is illustrated in Figure 2.



*Figure 2. Urban Land Sustainability Framework*

### 3.1 Land as a Resource

The first domain highlights the scarcity of land as a resource and the importance of land conservation by active measures to ensure that an appropriate stock of the nature capital is preserved. Given that the consumption of land is conceptually linked to a city's sustainability, cities must closely monitor the conversion of yet "undeveloped" land. While there is no general agreement about the desirable extent of land conversion (Johnson, 2001), the Rio Declaration has suggested "limit(ing) growth to the degree that public facilities and services are in place to accommodate this growth" (United Nations, 1992b). While accommodating growth, cities should protect land of important value to its residents, which would include critical natural resources, such as flora and fauna, water resources, farmlands, as well as areas of archaeological, cultural, historical or architectural heritage. The integration of natural space in cities has been extensively studied in the fields of urban and landscape ecology, and well supported by several conceptual models, including the Integrated Human Ecosystem model (Pickett et al., 1997) and the Urban Ecosystem model (Piracha & Marcotullio, 2003), both of which demonstrate how the environmental (or natural) sphere and the social (or human) sphere are intrinsically interlinked in their processes, flows and interactions. In these models, the general principles for green space planning in urban settings recommend conservation and management of the nature-nurture-urban interfaces, by recognising both intrinsic as well as extrinsic values (e.g. amenity, recreation, social and health functions). Increasingly, the conservation of ecosystems and the creation of new and augmented green areas are also seen as a way to raise the quality of life and living conditions in urban areas. In addition, this social role of green spaces is also recognised in terms of fostering the sense of belonging, attachment, identity and place (Forrest, Grange, & Yip, 2008). Indeed, the World Commission on Environment and Development (United Nations, 1987) sees the conservation of diversity of species and ecosystems as an essential pillar of sustainable development, but recognises the importance of a balanced approach between preserving critical land and maintaining a stock of land for long term development needs.

With regard to conservation of the city's built heritage, this is recognisably important, not just in terms of a city's cultural development in its own right, but also increasingly linked to the idea of developing the

cultural milieu. The latter is seen as the “necessary precondition”, defined in terms of the physical and the social spaces that are part of the cultural hard and soft infrastructure that generate a continuous flow of ideas and inventions that add to attracting a critical mass of entrepreneurs, intellectuals, artists, etc. to a city, thereby contributing to its economy (Landry, 2008), as well as to enhancing its human capital.

Finally, this domain also looks at land as a resource that is constantly transformed in the process of economic development. This transformation implies physical changes which may include land dereliction. It has been argued that as much development as possible should take place on such land that has already undergone a process of development, namely brownfield sites, in order to minimise the loss of rural land (Owens & Cowell, 1994). Thus, in order to safeguard greenfield land for future development, and avoid depletion of the land bank, cities should prioritize urban regeneration against new development on greenfield sites. Brownfields must be remediated and restored to economic use in the medium and long term while active preventive measures must be taken against further land degradation, particularly through inappropriate and harmful industrial processes.

### **3.2 Urban Economy**

The second domain in the assessment framework relates to the concerns for more efficient and balanced land use patterns to meet a variety of social and economic functions in cities, given the dominance of oil-based production and consumption processes in contemporary urban economies. The rise of the New Urbanism and Smart Growth movements appear to be the response that have been widely adopted to guide the planning visions of many cities. New Urbanism with its Transit-Oriented development-planning-design philosophy addresses urban sprawl and mixed land use, focussing on congenial neighbourhoods based on short walking distances, with a diverse range of housing, jobs and open spaces (Congress for New Urbanism, 2000). Concurrently, “Smart Growth” (Ingram, Carbonell, Hong, & Flint, 2009) illustrates a spatial strategy that moderates land consumption to sustain a development-driven economy, by focussing on urban density, and the relationship between land use and mobility patterns (Cervero, 1989; Cervero & Duncan, 2003); as well as by promoting mixed land uses, directing development towards existing communities, preserving open space, creating pedestrian-friendly towns and providing a range of transportation choice. One example is the planning code adopted by the City of Miami which emphasises efficient land use principles that reinforce a pattern of neighbourhoods and urban centres, focusing growth at transit nodes rather than along corridors, with planned transportation systems in coordination with land use and transit opportunities (Miami 21, 2010).

In Europe, particularly in the UK, the Compact City concept has exerted a strong influence on planning policies in the last few decades. Here, the relationship between the quality of urban life and sustainable development is discussed in the context of diverse land use mix and higher densities, with the suggestion that strategies toward densification of the urban core are likely to improve economic performance and vitality of the cities. These strategies have been widely endorsed by international agencies such as UN-Habitat (2012) which actively encourages cities to “embrace land patterns that discourage urban sprawl”. The advocacy is that development should occur in a more ‘compact’ manner with mixed-use land and medium to high built densities, efficient public transport and population thresholds that support concentrations of economic activity, services and facilities, while allowing for ample green spaces. The “balanced” land use pattern envisaged is one that encourages alternative mobility (walking, cycling and public transit), provides proximity between jobs and housing and promotes social cohesion. This is epitomised in the model of Multi-Functional and Intensive Land Use (“MILU”) in Hong Kong, which integrates several land use types (beyond job-housing balance) and embraces the economic concepts of agglomeration and clustering (Lau, Giridharan, & Ganesan, 2003) by building on higher and subterranean levels, and facilitating land use by different users at different times (UK Department for Communities and Local Government, 2001). However, these strategies must be applied with care for cities in less developed countries which have not been through the processes of de-industrialisation, and thus may have less opportunities and spare capacity for more compact growth.

### 3.3 Enhancing Social Equity

To support the social domain, land must be available to promote wellbeing in the city in terms of providing affordable housing as well as a range of social amenities such as parks and urban spaces. The city should also ensure their accessibility to large segments of the population, as the qualities of mobility, accessibility, access to health care, education facilities, amenities and jobs are the prime benefits of urban living (Howley, 2009). In essence, urban land should be used effectively to enhance a city's liveability, a concept which is usually defined as the capacity or condition needed to induce a sense of wellbeing both individually and collectively in the city. This goes beyond provision of physical facilities, and must include qualities that promote a sense of belonging or social cohesion in the community (Barton, 2009; Sepe & Pitt, 2013). This is particularly important to address the potentially adverse consequences of dense and compact developments such as smaller residential spaces and increased crime levels as highlighted by opponents of the smart growth theory (Couch & Karecha, 2006).

### 3.4 Planning Governance

It is widely acknowledged that planning is more than spatial planning, but also includes governance of planning (Albrechts & Mandelbaum, 2005). This is particularly relevant to developing cities in Asia, where much attention has been given to the model of the *developmental state*, which is defined as one in which the state plays a dominant role in pushing economic growth strategies and maintaining a stronghold on land use and management (Sorenson (2010), largely through regulatory mechanisms, but also by harnessing private entrepreneurship using various means, including planning incentives and subsidies. Concurrently, as democratic institutions evolve, the planning process in cities has to increasingly embraced the public participation, in order to give citizens a voice in planning decisions. Collaboration and stakeholders participation in decision making is critical for successful spatial plan development and implementation (Brody, 2003; Portney & Berry, 2010); with the principles relating to public participation in the spatial planning process clearly recognised and enunciated in the United Nation's Local Agenda 21 (United Nations, 1992a). More recently, it is also acknowledged that public participation promotes diversity in physical design of built environment, of economic activities, and plurality of social groups in a city, all of which are positive factors, not least to stimulate growth by attracting human capital and encouraging innovation in cities (Fainstein, 2005).

## 4 OPERATIONALISING THE FRAMEWORK: POTENTIAL INDICATORS

To operationalise the assessment framework, a list of potential indicators has been compiled that would help cities to assess how well they are performing in managing land sustainably. This list is derived and modified from international sources, and underpinned by the principles as set forth in the preceding discussion. They were headlined through a Delphi process which includes experts in planning, land development and government agencies. The final shortlist of potential indicators which consists of both qualitative and quantitative indicators with their defined metrics is set out in Appendix 1. Apart from the land domain, the selected indicators cut across several thematic sectors that are normally found in the sustainability discourse, including the water, food, climate change and transport sectors.

The next step in this work is to apply this assessment tool to individual cities for a sustainability assessment of their land use patterns. The tool is adaptive as cities may choose to adopt the indicator list in full or selectively for the purpose of self-evaluation. It is recognised that there could be challenges when applying these indicators which are derived from various sources across the world, due to the unique nature of urban development in different cities. Nonetheless, this is still a step forward in the sustainability transition since a common set of definitions and metrics have now been defined which facilitates data sharing and comparison.

## 5 CONCLUSION

For many cities, land remains a single most critical resource for supporting economic and social development. But, very often, in the process of urbanisation, land is either used wastefully by sub-optimal

development or “over-used”, to the extent of irreversible depletion and degradation. Likewise, the impacts and ramifications of its use on other resources such as water shed, ecological systems and cultural assets, are often overlooked or under-estimated. The proposed land sustainability assessment framework with its suggested system of indicators, defines the important component issues of land sustainability, and enables cities to self-assess and monitor their land consumption patterns. It will contribute to more responsible use and stewardship of an important resource.

## 6 ACKNOWLEDGEMENTS

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## APPENDIX 1. SUGGESTED INDICATORS OF SUSTAINABLE URBAN LAND USE

Title	Measurement	Source
<b>Land Conservation</b>		
1. Amount of Developed Land	Area of developed land as a percentage of the total land area.	Modified from European Communities, 2001, and from Environmental Protection Agency, 2011
2. Protected Nature Land	The area and percentage of total land area of a. Legally designated nature areas by type of ecosystems relative to total city area respective to their ecosystem type; b. Other protected green areas by planning mechanisms	Modified from the Singapore Index of Biodiversity (Technical Task Force on the Singapore Index, 2012)
3. Protected Heritage Land	The area of heritage sites and percentage of total land and buildings legally designated for conservation	Modified from New Zealand Cultural Indicators 2006 & 2009, Australia Vital Signs Cultural Indicators 2011
4. Farming Land and Space and Productivity	a. Hectares of farming land per 1,000 persons or proportion of farming land compared to total land of a city b. Farming Space: Amount of farming space per 1000 person or proportion of farming space compared to total building space available in a city c. Farming productivity in terms of yield tonnes per ha of farming land or tonnes per square meter of farming space <i>Note: In evaluating (a) and (b), the extent of land included within a city's metropolitan boundary for the purpose of assessing its agriculture land should be clearly defined.</i>	United Nations Commission on Sustainable Development 2007. Indicators of Sustainable Development: Guidelines and Methodologies; Community Food Agriculture Coalition. 2012. Indicator Report: Our Foodshed in Focus; Department of Food and Rural Affairs, UK. 2006. Sustainable Farming and Food Strategy Indicators
5. Watershed	Internal renewable freshwater per capita that is available within a city's defined land area, measured as the average annual flow of rivers and groundwater generated from endogenous precipitation (m <sup>3</sup> per person/ year) <i>Note: this is a country-level indicator but cities should evaluate it wherever possible and appropriate</i>	Modified from Organisation for Economic Co-operation and Development (OECD), 2008 and The Food, United Nations Department of Economic and Social Affairs (UN DESA, 2007) Agriculture Organization of the United Nations (FAO) 1998
6. Monitoring Land Consumption Patterns	Area of new development on undeveloped land tracked from a specified base year (sq. km, trend).	Modified from European Communities, 2001 and from Environmental protection Agency, 2011
<b>Regeneration and Redevelopment</b>		

7. Prioritisation of Land Redevelopment	<ul style="list-style-type: none"> <li>a. Area of brownfield land restoration tracked from a specified base year (industrial sites) (hectares, trend).</li> <li>b. Area of non-industrial land redevelopment tracked from a specified base year (trend).</li> </ul>	Modified from European Communities, 2001
8. Prevention of Land Degradation	<ul style="list-style-type: none"> <li>a. Proportion of land which due to natural processes or human activity is no longer able to properly sustain economic function and/or an original ecological function without treatment at reasonable cost (trend)</li> <li>b. Are there any effective actions taken by the city to prevent land degradation and contamination? (qualitative)</li> </ul>	Modified from United Nations Convention to Combat Desertification, 1994 for Food and Agriculture Organisation of the United Nations, 1998
9. Reuse of Landfill	Percentage of waste disposed by landfill in the city and the extent to which such landfill is available for re-use.	Report of United Nations Conference on Sustainable Development (UNCSD, 1987), Indicators of Sustainable Development United Nations Department of Economic and Social Affairs (UN DESA, 2007), Sustainable Development Indicators developed by UK Department for Environment, Food and Rural Affairs (DEFRA, 2008)
<b>Compactness and Efficiency</b>		
10. Land Productivity	<ul style="list-style-type: none"> <li>a. Value added per hectare of industrial land for key industries</li> <li>b. Number of employees per 1 sq. km of net commercial land.</li> <li>c. Vacancy rate for office space - Grade A (trend).</li> </ul>	Modified from: FAO Land productivity index 2011; Smart Growth Policies 2009 and United States Environmental Protection Agency, 2011; agencies' inputs
11. Intensity of Economic Space	<ul style="list-style-type: none"> <li>a. Ratio of total floor area of commercial developments to the area of commercial land (number)</li> <li>b. Ratio of total floor area of industrial developments to the area of industrial land (number).</li> </ul>	Modified from European Communities, 2001; agencies' inputs
<b>Optimisation</b>		
12. Extent of Mix Use	<ul style="list-style-type: none"> <li>a. Area of land zoned under Multiple Use in the city tracked from a specified base year (hectares, trend).</li> <li>b. Ratio of employees to residents in the CBD (number).</li> </ul>	Modified from United States Environmental Protection Agency, 2011. Guide to Sustainable Transportation Performance Measures
13. Land Use and Transport Integration	<ul style="list-style-type: none"> <li>a. Proportion of population living within the transit shed (defined as 400 m radius of transit facilities);</li> </ul>	Modified from Maryland Smart Growth Indicators; Ambiente Italia Research Institute's (AIRI)

	b. Proportion of population employed within the transit shed (number of jobs within the transit shed over the total number of jobs in the city);	European Common Indicators (ECI), 2003; agencies' inputs (URA)
<b>Social Amenities and Liveability</b>		
14. Total provision of parks per 1000 population (trend)	Area of parks, including those with natural areas, provided per 1000 people in the city	Singapore Index of Biodiversity, Global City Indicators
15. Proportion of total city population within 400m radius of a park	Proportion of total city population within 400m radius of a park or its proxy.	PlaNYC, Boston Open Space Plan
16. Availability of healthcare services	Number of hospital beds per 1,000 population	OECD health indicators 2011
17. Population Density and Intensity	a. Total population over the total area in a city b. Number of inhabitants per 1 sq. km of residential land	Modified from European Communities, 2001; agencies' inputs
18. Housing Density	Number of dwelling units per 1 sq. km of land zoned for: a. all types of residential development; b. single-family housing zones; c. multi-family housing zones.	Modified from Indicators of Smart Growth in Maryland, 2011 and International City/County Management Association, 2003
19. Housing Standard	Floor area per person (sq.m/person)	UN Commission on Sustainable Development (UNCSD) Indicators of Sustainable Development 2001

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# SHORT-TERM RELIEF OR LONG-TERM SELF-RELIANCE IN HUMANITARIAN DESIGN: STORIES FROM ETHIOPIA AND NORWAY

**Brita Fladvad NIELSEN<sup>1</sup>,**

<sup>1</sup>Department of product design, NTNU

## **ABSTRACT**

It is challenging for designers to navigate the humanitarian market with its multiple and conflicting agendas. Storytelling and back casting during two workshops involving stakeholders from Ethiopia and Norway investigate their experiences and views on: relevant goals, barriers and strategies for humanitarian design based on the case of off-grid energy devices. The stories told illustrate an underlying wish to move from a technology focused decision-making and design for mass deployment approach to energy by humanitarian customers and donors, to the inclusion of human factors. Human factors is regarded as the connection between short-term and long term self-reliance objectives. Emphasizing information flow, end-user insight and the long-term commitment of technology designers and donors, the stories show how the creation of a more locally connected design approach which supports capacity building, can strengthen local resilience.

*Key words: humanitarian design, self-reliance, stakeholder-informed design*

## 1 INTRODUCTION

Humanitarian relief interventions frequently lead to chronic aid dependency lasting for decades. A refugee spends on average 17 years in a refugee camp[1]. This article focuses on stakeholders in the humanitarian market, where relief victims are supplied with donated items from humanitarian customers such as the United Nations High Commissioner for Refugees (UNHCR). The lack of follow-up and maintenance argues for contextually tailored designs that require little maintenance and end-user adaptation[2].

Off-grid energy devices represent one of the non-food items that are increasingly being deployed during humanitarian relief operations. Their introduction was aimed at mitigating climate change and preventing negative ecological effects and harm to people in relief settings, as stated UNHCR[3] and UNEP policy[4]. However, characteristics of the humanitarian stakeholders environment [5] inhibit the possibility of these technologies having a positive impact of on the environment and any longer term impact on local resilience within communities where they are deployed.

When an off-grid energy technologies are deployed, their performance and adaptation will in the long term, depend on host-country maintenance systems and policies. Humanitarian customers still supply items based on earmarked funding from donor countries operating on short-term budgets rather than basing their interventions on an informed context and needs assessment. This is despite the demonstrated need for contextually fitted designs which take into account end-users and their context, and also ignores the stated objective of affecting long-term environmental concerns with, for example, off-grid technologies. Contextual knowledge[6] is replaced by expert interviews and desk studies, and decisions are made based on the priorities of donor countries and policy trends.

It is challenging for designers to understand how to target long term self-reliance goals while working with humanitarian customers that focus on short-term objectives. This results in the designer having to make trade-offs between prudent product attributes, and stakeholder demands[2]. In order to further understand the components relevant to increasing the impact of design on mitigating long term negative effects of humanitarian interventions, stakeholder workshops were organized within the

donor country Norway, and the beneficiary country Ethiopia. This paper presents stories from these workshops.

## 2 OBJECTIVE, METHOD AND SCOPE

The participatory stakeholder workshops analysed for this paper are a contribution to the emergence of a theoretical framework for ‘humanitarian design’, that is sensitive to the particularities and dynamics of the humanitarian market. Ethiopia was chosen as the target beneficiary country for this research project due to its significant role as receiver of official development aid (ODA)[7] per capita. It is also a country that historically, and currently hosts refugees due to droughts, conflicts, political events and civil wars in neighbouring countries, including Eritrea, Somalia, South Sudan and Sudan. The Government of Ethiopia maintains what the UNHCR refers to as ‘an open-door-policy’ and has continuously allowed humanitarian access and protection to those seeking refuge within its territory[8]. Ethiopia also has significant challenges related to protecting their biodiversity, largely due to the lack of alternatives to firewood for cooking [9-11]. In Ethiopia, refugee camps and disaster relief are managed through mutual cooperation between the UNHCR and the African Refugee and Returnee Association (ARRA), an Ethiopian governmental entity.

*Table 1: Participants*

Role	Oslo workshop	Addis Abeba workshop
Designers/ Technology developers	Enterprises: 9	Enterprises: 0 Ethiopian University Mekelle: 2 HOA-REC&N: 2
Customers	Customers: NGO: 1 (NRC Technical adviser)	NGOs: End-user organization: 2 UNHCR: 2 Gaia Ethanol stove project: 4 UNHCR Energy and Environment: 1
Facilitators	NTNU: 4	NTNU: 4
Decision makers		ARRA (African Refugee and Returnee Association): 1 Ethiopian government: Ministry of Energy and Mining: 2 Ministry of Agriculture: 1 Ministry of Environmental Protection and Forestry (MEPF): 1
	Total: 14	Total: 21

During the preliminary research visit to Ethiopia in May 2013, a list of relevant participants applying technologies within Ethiopia were selected through snowball sampling techniques[12, 13]. These stakeholders, recommended by the humanitarian customers, were invited to participate in a participatory exploration of the challenges they face. In Oslo, the participant’s list was based on recommendations made during interviews with the Norwegian Refugee Council (NRC). In Addis Ababa the invited participants were based on recommendations from the UNHCR and preliminary interviews with the Horn of Africa Regional Environment Centre and Network (HOA-REC&N). All the selected enterprise participants were responsible for or highly involved and familiar with the product design process within their company in relation to off-grid energy solutions. They were further selected based on their supply of mass produced technologies, rather than small scale local production.

As one can see on the participants list (Table 1), the presence of private enterprises within the off-grid energy sector was not significant in Ethiopia, according to the preliminary study. This can be

explained by the high level of government control in technology sourcing; technologies are imported by, and technology development is initiated by government related institutions such as Mekelle University or the HOA-REC&N. This is in contrast to the Norwegian context where the interest in the humanitarian market is heavily represented by private industry. Indeed, the private sector is encouraged to enter this sector by the Ministry of Foreign Affairs through an innovation network called NOREPS. (NOREPS). The workshop design originated in information from the humanitarian customers and enterprises interviewed during an agenda-setting study. The diagnosis and relevance to product design was explained in three earlier publications [2, 5, 6]. In order to bring together the insights of, and an understanding of the objectives of experts from these very different backgrounds, it was essential to identify a method that could communicate insights on an equal level independently of the participants' background. Storytelling can be used for the purpose of transferring knowledge from one type of expert to another[14]. Combined with graphic elicitation tools, post-it notes and a ladder diagram for structuring ideas, this can be referred to as Case Based Reasoning [15], cognitive task analysis (CTA)[16] or graphic elicitation[17, 18]. Back casting was selected as an appropriate tool to move from the experience mapping phase into discussing a way forward for bridging multiple stakeholder agendas. It was also beneficial for gathering data for a deeper understanding of the barriers to product design impact within humanitarian markets. Back casting workshops[19, 20] are commonly used as a way to propose future directions for sustainability policy development in a participatory manner. The two workshops lasted eight hours each. The first three hours of the workshops were devoted to story-telling and analysis, the second half to back casting based on the identified lessons learned during the first half. The analysis of the stories was conducted in three groups. The groups were composed in order to balance the experience and role of the participants so that there were an equal number of designers, customers and decision makers in each group. Sound recorders were used to collect all the discussions during the back casting processes in each group, while video recording was used in addition. The additional visual data gathering allowed the researcher to analyse the participatory process on multiple levels. The sound files were transcribed in their entirety. The stories were coded in accordance with the overarching meaning of the stories told and also aspects that were dwelled upon by the participants during the back casting sessions. Further, the groups had divided their stories into goals, challenges and strategies and the topics discussed were further added to these categories and redundant topics removed. For this study, the transcribed data was then sorted into codes related to the gap between humanitarian relief and longer term objectives.

### 3 STORIES TOLD

Two story themes of particular interest crystalized from the analysis of the gathered data. The selections of goals and strategies of the participants divided the stories into a technology optimistic one, and a capability optimistic one. In addition, the role of human capacity building in the humanitarian sector divides the participants in two regarding future resilience perspectives. These two stories and two perspectives are presented below.

*The story about the aid receiving refugee:* A reoccurring question addressed in both workshops and all groups was the issue of whether or not refugees have a different potential than others to adapt to and benefiting from a new technology. This question created debate related to the functionality of the technology and the possibility of developing entrepreneurial and small scale industrial capacities with the product. The participants started off with different ideas of who the refugee is. One example of an interesting exchange during the second workshop:

Technology developer 1: 'but time is probably not so important in a refugee camp', Customer (agitated) : 'you think so?' Technology developer 1: 'I don't know. What do people do all day?' Customer (loud): 'Do you think that a person being a refugee doesn't have any time? Despite them being concentrated in a camp doesn't mean that they don't have any activities. The children they go to school [ . . . ] in the end of the day, time is equally very very important as in the cities themselves.'

According to the customers, particularly those in the ‘field’, too many technical solutions assume that the refugees are different from other end-users in that they only ‘sit around in camps’ receiving aid. This results in time-consuming technologies such as pedal driven energy solutions or solar cookers that need hours to cook beans, for instance. The knowledge of aid dependency [21] does not mean, according to the customer participants, that these end-users have more time or different capacities, or that they require anything less from the technologies than other end-users.

*The story about the capable refugee:* Many stories told both during the story-telling session and during the back casting sessions focused on the existing capabilities of the refugee. One story that became a topic of discussion in the first group was the ‘Dadaab millionaire’. The ‘Dadaab millionaire’ is a refugee in one of the largest refugee camps in the world, Dadaab in Kenya. He began by making and selling ice, but has since expanded into retail and earned over a million dollars. One customer participant argued that the humanitarian system in the future will move towards cash transfers rather than donated items. This will enable people to choose what they want in terms of shelter and other non-food items. An example given was how people use a Visa-card. The necessity of including a business component in the technologies distributed for households was further emphasized in the Ethiopia workshop. The participants in this regard discussed the need to identify and build capacities both on an industrial and entrepreneurial level in refugee situations. Stories shared during the workshop in Norway also showed that the enterprises had greater success when including local community stakeholders in developing and introducing technologies, something that could be compatible with a local entrepreneurship building approach. Local stakeholders can play the role as identifiers of existing capacities within a camp setting. The discussed main obstacles to creating self-reliance through capacity building in camps are that refugees are legally restricted when it comes to money-making, and that NGOs cannot have a profit-making objective because it will affect their access to humanitarian settings. One solution presented was to include the host-community as entrepreneurs and work on entrepreneurship as a local resilience component within the host community. Having the host community build capacities that will increase their benefit from the refugee populations would also help stabilize the often conflict filled relationship between host communities and refugee populations created by resource scarcity [22, 23]. One group started with a discussion on the unpredictability and lack of dependable and predictable resources in humanitarian settings. In deciding that there is no predictability regarding materials, stakeholders and financial support, one group recommended designing a system to encourage entrepreneurial capacities to bring technologies to the end-users and begin the creation of a sustainable market rather than starting with the product design. Much of the discussion centred on how a private actor can contribute in a humanitarian setting, provided the ban on for profit enterprise creation in refugee camps in Ethiopia. The groups agreed that this would more or less rule out NGOs working to provide tailor made solutions.

*Strategies for local energy resilience:* When asked to create targets for future reach, all groups selected strategies to improve the humanitarian system’s ability to stimulate the move from short-term to local long term resilience objectives. When the groups were discussing solutions, the participants repeatedly moved from focusing on product design and object focus into discussing issues related to how one can achieve longer term impact and sustainable solutions for relief and development. One observed difference was that stories in the first workshop focused on how one could bring down the cost of a stove by selling fuel, while the discussion regarding affordability in the second workshop centred on the cost and appropriateness of fuels. The technology itself might not be the problem, one might instead develop mixed fuel access and supply solutions. This illustrates the need for designing integrated product-service-systems within this setting which support local partnerships, capacity building and information flow. Discussions also focused on the *local stakeholder partnership motivations* needed to create change on an individual level. In these discussions, enterprises shared experiences on how to launch a technology in a sub-Saharan African market. The necessity of incentives to create something ‘sustainable’ was raised by designers. Designers interpreted the word

'incentives' as "everyone must have some benefit of using and implementing the technology" while for the enterprises, this term triggered a discussion on financial incentives given to sub officials in order to enter a market – in so many words, corruption. There was agreement in the prudence of working with local government officials rather than at a higher level. The participants' experience was that approaching a country's bureaucracy on a higher level was more expensive and time consuming, they were both referring to corruption expectations and the local decision maker's power relationship to the central decision makers as a positive element. For the designer, 'incentives' could also be shorter cooking time, less smoke, or something else immaterial, while for the enterprise 'benefit' and 'incentive' referred to paying someone for doing something.

*Strategies on learning and contextual knowledge:* Discussions in Ethiopia centered on the difficulties of implementing technologies and fuel access systems in remote Ethiopian settings. Resource scarcity and off-grid energy devices rely on single and often policy dependent fuel source. At the same time the different 'cooking cultures', or habits, make it difficult to introduce one type of stove. The participants referred to ergonomic factors such as the Eritrean women cooking in a standing up position and the Somali women sitting down, and the differences in the type of food they cooked, which require different sizes of flame and intensity from a cooking stove. These issues made current one-size-fits-all designs inapplicable. Still, the imported designs were aesthetically welcomed by the end-users, who saw them as a 'western standard', and they enjoyed keeping them in their house. During the back casting session, one group therefore decided to design a new and integrated implementation/design process; in other words a participatory design process for a multi-purpose stove. This would be a dynamic strategy fitting with different types of fuel and in different 'cooking culture' contexts. For participants responsible for product selection processes and implementation processes in the field and headquarters, as well as for designers, information flow was regarded as essential to achieve contextually fitted solutions and to understand problems on the ground. During the last decade, the UNHCR, other humanitarian customers and beneficiary countries have advocated strongly for receiving less earmarked funding. As argued by the UNHCR in the Ethiopia workshop, it is important for them to be able to select how to effectively and efficiently allocate funding for energy alternatives. However, this has changed the product selection process from a customer dependence on donor selection to one in which the customer must define the appropriateness of a technological product, a task they feel overwhelmed by. Collecting information from the field in a better way was chosen as a goal by the headquarter participants Stakeholders in the field focused on a lack of information "on the ground" about which technologies were available. Designers argued that an information tool could not replace first-hand knowledge, and from their experience, there are multiple barriers to achieving true information about anything in the very hierarchical humanitarian and sociocultural context in Ethiopian refugee camps.

A majority of the back casting sessions in the Oslo workshop were also centred on how contextual insights on numerous levels are necessary for the product designer. Customers emphasized that they do not have the time, resources or mandate to undertake the assessments needed, and more importantly that they do not know *how* to implement learning and apply knowledge accumulated within the humanitarian system. *Transparency* was another interesting theme discussed. Customers argued that humanitarian organizations only pay attention to failures of camp management and humanitarian relief, and that transparency in some regards works against longer term resilience building. Participant 1: "So you are saying that transparency is making trouble because all the bad stuff gets attention?" Participant 2: "Yes well it is like my girlfriend she will remember the bad things I've done for much longer than the good things. Beneficiaries are the same as girls". In the Addis Ababa workshop, some of the focus of the UNHCR participant was on the lack of funding and technology that is contextually fitted. This participant had numerous stories about the difficulties of introducing solar energy cooking stoves and the inability to find fuel for the technologies donated from central decision makers within the UNHCR.

#### 4 IMPLICATIONS FOR DESIGN AND IMPLEMENTATION

The stories presented indicate that design impact and implementation in humanitarian settings on longer term development objectives depends on how the role of *people and their capacities* is defined in a given humanitarian relief context. Design processes for humanitarian settings should pay attention to the importance of including multiple stakeholders in order to access end-users and to include hosts and refugees in the design of products and fuel access strategies. This will increase the benefits to all stakeholders. A relevant observation is that the participants used story telling extensively beyond the story telling session. This indicates the appropriateness of the chosen approach to include multiple stakeholder agendas in a design process.

These emerging stories particularly illustrate what the participants regard as against-the-odds examples, and the break-down of the stories represented how the stakeholders moved from discussing technological alternatives into the discussion of human capacity building. This information is also relevant to the strategy chosen by humanitarian customers during the emergency phase of a humanitarian intervention. In a protracted emergency situations, the ‘most sustainable’ solution may depend upon the early definition of a contextually informed resource strategy design that promotes resilience. As the discussions illustrate, the move towards local resource use is already taking place within other sectors such as food and shelter supply, and there is little reason why this should not also take place in off-grid technologies that are not even a minimum requirement within the Sphere standard[24]. The discussions demonstrate that enterprises are interested in access to a direct market, while host communities and national institutions within Ethiopia aim at providing and accessing solutions that are tailored to future fuel availability. This may signal a belief that the different designs and business models will adapt as soon as the resources that they depend upon are defined and mapped. A suggestion could be that the host government and regional stakeholders such as HOA-REC&N are made responsible for creating updated energy resource maps.

Designing products for use in low income, off-grid contexts with poor infrastructure and a lack of technological expertise suggests the need for a contextually informed design process. For immediate emergency phases however, emergency preparedness warehouses are increasingly used in regions of frequent disasters, and fuel saving stoves could be flat-packed for these situations and stored. The fast deployment during immediate emergencies excludes foreign led training, but the fuel required must be intuitive and fit with the local customs or local training. In addition, capacity building to produce, maintain and use the distributed equipment must be a part of the resilience measurement in the preparedness phase. Zero emission solutions or technically advanced solutions that require training and extensive capacity building may not be a good choice for the preparedness phase according to the findings. Instead, one can aim at protecting the environment from the preparedness phase by introducing fuel additions and holistic strategies together with the host community. At the same time, one must invite the private sector to the table and avoid stove donations. This can be done by selling stoves through local stakeholders rather than donating them through foreign NGOs. For the design process, the deduced insights argue for an active approach towards including multiple but relevant stakeholders both at the beginning, and continuously during the development of a product. Designing for humanitarian markets does not limit the designer to working only with decisions makers at the top, but should also include local and host government counterparts. These stakeholders are essential for creating policies that will ensure long term performance and enable capacity building, and thus the applicability of products in diverse contexts. The discussions from Ethiopia show that these stakeholder’s interests lie in protecting the natural resources for the future. However, they are unhappy with a lack of attention to their contextual needs and the use of local stakeholder capacity building as well as partnerships from the humanitarian sector. A solution could be for the wider research community to develop insights on resource availability in different regions, and design energy supply systems rather than focus on single product selection. The UNHCR could focus their attention on advocating for the development of business models run by host communities to serve the needs of

refugee populations. This would require the expansion of the rights of refugees and the ability of NGOs to assist the refugees in entrepreneurial activities.

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# RESILIENCE AS A SYSTEMIC PERSPECTIVE ON ESCALATION

Tor Olav Grøtan<sup>1</sup>

<sup>1</sup> SINTEF Technology and Society, Dpt of Safety Research, Trondheim, Norway  
tor.o.grotan@sintef.no

## ABSTRACT

The main theoretical framework for this paper is a multidisciplinary framework for resilience spanning many areas and applications, and a "resilience in context" approach of safety management which positions resilience as a "tacit" part of organizational life behind some sort of façade, preoccupied with its opposite (compliance). The paper argues that these approaches can be combined in a coherent manner that can be applied in a wide range of applications spanning from safety management to societal crisis management, providing opportunities for translation and mutual learning. Moreover, it is claimed that this perspective provides a unique opportunity for understanding and approaching the possibility of escalation on systemic terms, as well as extension of safety management regimes into security issues.

*Keywords: Resilience, compliance, escalation, safety, security*

## 1 INTRODUCTION

### 1.1. Background and scope

As put by Longstaff et al [1], the concept of resilience has been studied and described by various academic disciplines as a potential answer to move beyond survival and even prosper in the face of challenging conditions. These disciplines include: ecology, psychology, socio-technical studies related inter alia to safety management (e.g., Resilience Engineering), disaster research and a broad range of organizational studies. Publications concerning the concept of resilience have increased dramatically over the recent years [1]. Anno 2014, the concept of disaster resilience is also high on the agenda for the "Horizon 2020" research program of the European Union for the purpose of safeguarding and securing society, including adapting to climate change.

In industrial safety, Resilience Engineering (RE) is about engineering human and technological capabilities into systems operating in dynamic and complex environments. RE implies a search for patterns of normal variability of systems and an interest for the under-studied activities of sociotechnical systems that actually maintains their functions despite interruption and disruption. The RE notion of resilience includes a broad focus on anticipation, coping and adaptation related to unexpected events and extraneous couplings, and to surprising circumstances and combinations. RE implies an engineering ethos of searching for designs, options of intervention and leverage points that can move systems towards less vulnerable pathways by virtue of maximizing the number of successful adaptations rather than minimizing the number of failures and deviations in sociotechnical systems.

Breaches in industrial safety may lead to emergency situations which in turn may lead to societal disasters and crisis which may have to be framed and handled in a societal and socio-ecological manner. The chain of influence may also be the other way around. The concept of potential *escalation* - spanning industrial safety, industrial emergency, societal emergency and societal crisis - is therefore an additional motivation for seeking deeper understanding of how the generic concept of resilience may be applied in different contexts, and of what can be translated and learned across. This could be of interest for researchers across many fields, as well as for policy and decision makers.

## 1.2. Resilience in context

Bieder and Bourrier [2] describe the realm of safety science and management as being "trapped by rules", in which proceduralization of safety is part of a more general trend towards normalization of social interactions and practices. Rules and procedures are seen as key features for a modern organization (and society) to function. There seems to be an irresistible push towards a wider scope of norms, procedures and processes, "whatever the context implied".

Grøtan [3] emphasises that the introduction of resilience into the safety management arena must be understood in light of the ubiquitous imperative of compliance, manifesting in laws, regulations, management and the "sharp ends". Adaptive practices (resilience) are rarely part of an organization's official plan or deliberate self-presentation, maybe not even part of its (managerial) self-understanding. Rather, it takes place "behind the rational façades of the impermanent organization" [4]. Resilience is thus conceived as a sociotechnical, collective practice of continuous adaptations behind some façades, to a large extent lacking an explicit "language" for its own articulation (at least towards an external audience). Communities of practice, rather than individuals or formal organizational bodies, may be the actual possessors or containers of adaptive practices. Hence, resilience is potentially a "tacit" part of organizational life behind some sort of façade.

This paper is thus based on the presumption that *resilience in context* [3] is a useful approach for a variety of areas of application, ranging from safety management of industrial processes in normal circumstances, via emergency management in industrial system that may inflict civil society, to societal safety/security and emergency situations. In the first case, the "rational façade" may enjoy a high level of trust and confidence, and the actual achievements of resilience may pass unnoticed. In the second case, "everybody" involved knows that "fantasy plans are the first victims" (they can even be counterproductive when followed), and that "resilience" in some form is at least desired. In the last case, societal security, official institutions may make very deliberate plans and bold decisions, but it might be very unlikely that the public will refrain from acting on their own experience, agendas and rationalities, which may be highly "resilient" but not necessarily for the common good.

## 1.3. Aim of the paper

The aim of the paper is to investigate how the *resilience in context* approach [3] may be applicable across a range of applications spanning from its original context of industrial safety management into societal emergency and disaster management, with a specific emphasis of understanding escalation as a phenomenon on its own terms.

## 2 THEORETICAL FRAMEWORK

### 2.1 A Multidisciplinary Resilience Framework (MRF)

As depicted in Fig.1, the MRF developed by Longstaff et al [1] aims to facilitate the translation of resilience ideas between disciplines. It emphasizes two main differences that must be bridged.

First, the various disciplines differ with regard to their assumptions about their system's potential for stability and equilibrium. The second is the degree of normativity (resilience as a coping capacity vs. ('just') a desirable outcome). The framework based on these two differences allows them to make some distinctions that are "broad enough to find commonality put narrow enough to recognize differences", but they contend that these fields are not mutually exclusive.

They also differentiate between resilience that is seen as a capacity or a capability of the system. They use the term capability to denote human (& animal) skills that can be brought to bear on a challenge. The term capacity is used for anything you can hold/measure.

Degree of Normativity Level of Complexity	Low: Descriptive <i>Perception of Deviation: symptoms of change and strain</i> <i>Conceptual Orientation: Outcome and capacity</i>	High: Normative <i>Perception of Deviation: To be avoided/reduced symptoms of adversity and inefficiencies</i> <i>Conceptual Orientation: Process and capability</i>
<b>Low: Reductionism</b> <i>Aspect of stability: Single State</i> <i>Environmental characteristics: Short-term, Linearity and Predictability</i> <i>Dominant Logic: Bounce back (absorb and recover)</i>	<b>(I) Capacity to rebound and recover</b> <ul style="list-style-type: none"> <li>Elasticity (capacity to absorb deformation)<sup>1</sup></li> <li>Rapidity/rate (<b>time required</b> to return to pre-defined state/normalcy<sup>2</sup>;</li> <li>Robustness (resistance against perturbation)<sup>3</sup>.</li> </ul>	<b>(II) Capability to maintain desirable state:</b> <ul style="list-style-type: none"> <li>Maintaining systems identity and functions<sup>9</sup>;</li> <li>Ability to withstand and recover within acceptable parameters<sup>10</sup>;</li> </ul>
<b>High: Holism</b> <i>Aspect of stability: Multiple States</i> <i>Environmental characteristics: Long-term; Non-Linearity and Uncertainty</i> <i>Dominant Logic: Bounce forward (adapt and transform)</i>	<b>(III) Capacity to withstand stress</b> <ul style="list-style-type: none"> <li>Magnitude of disturbances<sup>4</sup>;</li> <li>Elasticity threshold<sup>5</sup>; Transition probability between states<sup>6</sup>;</li> <li>Emergent system property<sup>7</sup>;</li> <li>Balanced contingency between system and its environment by adjustments<sup>8</sup>.</li> </ul>	<b>(IV) Capability to adapt and thrive:</b> <ul style="list-style-type: none"> <li>Inherent and adaptive responses to disasters<sup>11</sup>;</li> <li>dynamic process encompassing positive adaptation within the context of significant adversity<sup>12</sup>;</li> <li>Degree of capability to self-organize, adapt and learn<sup>13</sup>.</li> </ul>
1(Timmerman, 1981; Wildavsky, 1988), 2 (Pimm, 1984; Zobel, 2011), 3 (Antunes 2011; Grimm/Wessels 1997; Zobel 2011), 4 (Gunderson/Holling 2002; Holling 1996), 5(Folke et al., 2004; Walker 2004), 6 (Holling 1973; 2001; Brock et al., 2002), 7 (Boin/McConnell 2007), 8 (Lorenz 2010), 9 (Cumming, 2005; Walker/Salt 2006), 10 (Aiginger 2009; Aven 2011); 11 (Rose 2004), 12 (Luthar 2007), 13 (Carpenter, 2001 ; Folke 2006; Walker et al. 2002).		

Fig.1. Multidisciplinary Resilience Framework (Fig.3 in [1])

## 2.2 Resilience In Context (RICO)

The RICO approach [3,5] is founded on active *contrasting* between compliance and resilience in the industrial safety management context. RICO is hence shorthand for "organizing, thinking and acting resiliently under the imperative of compliance". This contrast embodies a *complementary* but asymmetrical relation in which compliance is positioned as a "rational façade" that poses a "contextual shadow" for resilience to unfold, episodically and spanning across stratified (formal as well as practice-oriented) boundaries of the organization.

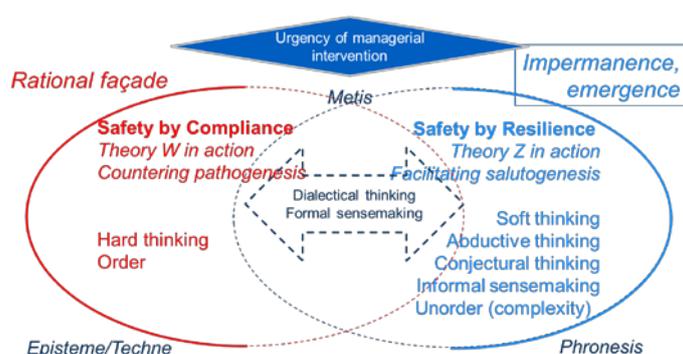


Fig.2. RICO: an ongoing dialectical reconciliation; striking the balance(s)

RICO also comprises a *dialectical* relation in which two diametrically opposing principles and organizational logics make a lasting and productive rendezvous, involving different types of organizational knowledge (episteme, techne, phronesis and metis; see [6]) forging a margin of maneuver that can be recognized as an extended, but also inherently fallible, safety envelope (Fig. 2). Finally, RICO also embodies a mutual and reciprocal *shaping* relation, driven by the inherent dialectic, in which a rule can be "followed" in terms of its malleableness in the dialectical relation with resilience. Such a trajectory may be seen as a sequence of stabilizations or equilibria that are found or created.

The *complementary, dialectical* and *shaping* relations of RICO also reflect the coexistence of two fundamentally different organizational orientations (to safety); compliance is about actively *seeking an absence* of organizational *pathogenesis*<sup>1</sup> in which "unsafe acts" are grounded by workplace conditions as well as organizational factors. In a symmetrical but inverse manner, resilience is about *seeking a presence* of an organizational *salutogenesis*<sup>2</sup> in which workplace conditions and organizational effort have the role of facilitating successful adaptation.

Moreover, founded on a concept of pragmatic diversity explained through cultural stratification rather than unity, and a composite model of complexity, the RICO foundation may be developed further into a foundation [7] for describing a *shape of safety* approach that can be used for managerially "following" the rule while also managing resilience, and also for a correlate *pulse of risk* approach that can be used to sensitize risk considerations according to the trajectory of an actual shape of safety.

### 2.3 Horizon 2020 specific challenges

The Horizon 2020 research agenda of the European Union identifies the following specific challenge related to (disaster) resilience in the following way [8]:

1. To increase Europe's resilience to crises and disasters is a topic of highest political concern in the EU and its Member States and Associated Countries. This concerns both man-made threats (accidents, terrorism) and natural hazards such as e.g. floods, storms, earthquakes, volcanoes and tsunamis.
2. While the term 'resilience' can be described as "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions." (UNISDR, 2009), it is necessary to break down and practically apply this definition to the different security sectors. Resilience concepts namely need to be developed for critical infrastructures (supply of basic services like water, food, energy, transport, housing/ shelter, communications, finance, health), but also for the wider public to integrate and address human and social dynamics in crises and disaster situations, including the role of the population, the media, rescuers (staff, volunteers and ad-hoc volunteers).
3. Resilience concepts need also to take into account the necessity to anticipate, to plan and to implement in the crises time a substitution process aiming to deal with a lack of material, technical or human resources or capacities necessary to assume the continuity of basic functions and services until recovery from negative effects and until return to the nominal position.

## 3 DISCUSSION

The issues to be discussed are related to the following: Can the "RICO" approach

Be applicable for all types of resilience as framed by the MRF [1]?

Be commensurate with the H2020 aspirations?

Accommodate other needs than just industrial safety?

Originate any specific insight on the issue of escalation?

Accommodate security (protection towards intentional disturbance and/or malfunction) in addition to safety?

### 3.1 RICO and MRF

The *complementary* relation of RICO is easily associated with resilience of Type I and III in terms of "defending" a (number of) preferred state(s) defined by virtue of a given set of plans and procedures. The *dialectical* relation is in turn a path to the inherent anatomy of the (Type II) resilient defences,

<sup>1</sup> A "disease-creating" metaphor for manifestation and conditions for failure (see [2]). The term "pathogen" is frequently used in safety science in order to frame organizational conditions for failure

<sup>2</sup> A "health-creating" metaphor for manifestation and conditions for successful adaptations that was coined by A. Antonovsky (see [2]), with a constituency that is symmetric to pathogenesis. The metaphor of salutogenesis thus signifies organizational facilitation of an adaptive process, *beyond the absence* of pathogenesis.

emphasizing the inherent contradictions between compliance and resilience, exposing the limitations of the underlying plans of defence. The *shaping* relation is directly supporting the idea of multiple states (equilibria) (Type III) but emphasizing that they are founded on an ongoing dialectical constitution and thus pointing to Type IV. Hence, the "full" RICO approach corresponds with the idea of resilience as a *capability* [1] of Type IV, which however at any time (state) can be "trimmed down" to the idea of defending *one* ideal state, or to a *capacity* [1], the latter rendering the complementary relation as dominant, and at the same time de-emphasizing the attention to and exposure of the limitations of the underlying plans of defence.

The RICO emphasis on (the absence of) pathogenesis vs (the presence of) salutogenesis also reflects an emphasis on the *social* dimensions related to *meaning* and *symbolic interaction*, resonating with holism rather than reductionism, and thus more with resilience Type III and IV than I and II. The RICO foundations in communities of practice (CoP), cultural pragmatics and stratification rather than formal boundaries and managerial structure reflects a *metaphoric that is more ecological (evolution-oriented) rather than structural (decision-oriented)*.

The clue is here that RICO per se is not normative on these preferences, but the actual choice of type of resilience must match the actual scope and aspiration of the *compliance regime* it is contextualized by. If the (safety) management regime mandates only to bounce back, there is no specific point in preparation for bouncing forward. In any circumstance, resilience is an inherently fallible practice, and the actual capability must be framed by a managerial mandate that 1) facilitates the salutogenic properties it expects to manifest, and 2) establishes a clear mandate ('stop criteria') that counteracts the possibility that the organization attempts to perform beyond its actual capabilities.

### 3.2 RICO vs H2020

As pointed out by Bieder and Bourrier [2], there seems to be an irresistible push towards a wider scope of norms, procedures and processes, "whatever the context implied". The H2020 aspiration that

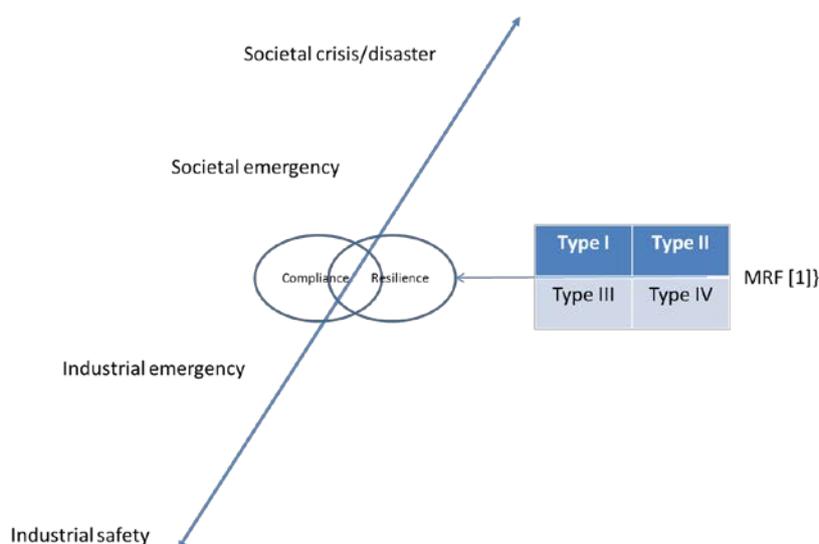
"resilience concepts need also to take into account the necessity to anticipate, to plan and to implement in the crises time a substitution process aiming to deal with a lack of material, technical or human resources or capacities necessary" [8]

is an excellent example of just that. It thus corresponds with the RICO premise of "resilience in the context of compliance", not only in the case of normal operation, but also in the case of emergency or disaster. However, the H2020 is also an example that in the latter case, resilience is no longer expected to be in the shadow, but be visible as a distinct capacity/capability. The RICO-derived comment is that such a capacity, not to say capability, cannot be expected unless resilience is also nurtured in less dramatic, normal circumstances.

### 3.3 A generic framework

Fig. 3 illustrates the claim that based on the above, the RICO approach can be used for a wide variability of contexts, herein engage a variety of framings of resilience [1], tailored to the specific aspiration of the compliance regime in the specific context. Moreover, the claim of Longstaff et al [1] that there is a potential for translation and learning between different types of resilience, is maintained and extended by the claim that application of the RICO approach bears a similar potential across different operational contexts, spanning from normal operation in industrial safety to societal crisis and disaster resilience as framed by H2020 [8].

Of special importance here is that the RICO metaphoric of the organization is primed equally (or even stronger) to the natural (ecological), rather than solely to a formal/structural attempt of (literally) "organ-izing" [9] a socio-ecological world that is in motion over multiple time constants, simultaneously. This implies that the RICO approach ultimately also is socio-ecological, that is, that it may convey a "dialectic" and a "shaping" process between societal decision and intent ("compliance") and ecological response and autonomy ("resilience"), in a way that also pays due attention to the social in terms of meaning, symbolic interaction, imagination and construction.



**Fig.3. The scalability of the RICO approach**

### 3.4 Escalation: sources and remedies

The potential of escalation may obviously be exogenously rooted, that is, beyond the actual grasp and reach of human or societal control. The concept of resilience is explicitly aiming for bouncing back and forward towards external surprise and shock, but from a RICO perspective, it is rather obvious that resilience is a fallible practice, which, especially without due managerial attention, support, calibration and mandating, may itself be a source of surprise and the unexpected; of escalation.

Hence, escalation may also be endogenously rooted, not only in over-confident resilience or in insufficient planning or compliance, but ultimately in the flawed or imbalanced *combination* of compliance and resilience. Hence, a RICO type of approach may also be a remedy for preparing for, avoiding and handling escalation.

### 3.5 Safety vs security

The RICO approach is developed in a *safety* context, for which the demarcation line towards *security* is the possibility of disruption or malfunction as a result of *deliberate intent*. Industrial safety is preoccupied with accidents, and thus traditionally not very primed for security issues.

From a safety point of view, the security premise may be conceived largely as an increase of uncertainty, and a higher need for imagination related to what can happen, and how a given situation may be understood from new angles ("outside the box"). Resilience is thus, from the outset, a strategy that is applicable also for security. The dialectical relation of the RICO approach is considered to represent a key potential for the benefit of security, because it is exactly about the skill and capability of imagining what a "strange signal" actually may imply in holistic terms. At the same time, a given interpretation "outside the box" should also here be reconciled with what must be expected (that is, the shaping relation).

## 4 CONCLUSION

The paper has outlined an approach to resilience that aims to support stakeholders that recognize that their safety needs and strategy can be framed as "thinking and acting resiliently under the imperative of rules and regulations". This approach may accommodate a variety of areas of application, from safety management of industrial processes in normal circumstances, via emergency management in industrial system that may inflict civil society, to societal safety/security and emergency situations.

By focusing on escalation, the possibility that industrial accidents can cause societal strain and crisis, and vice versa, the complex issue of sustainability and its relation to resilience in **nature and society** is addressed in broad manner. A comparison of systemic underpinnings for *resilience in context* across this scale is considered beneficial for several academic disciplines as well as decision makers.

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# AFRICA'S DEVELOPMENT TRANSITION: EMBRACING DEVELOPMENTAL CLIMATE CHANGE ADAPTATION RESPONSES AND HARNESSING OPPORTUNITIES

Edmore Kori<sup>1</sup>, and Ronald Mukanya<sup>2</sup>

Department of Geography & Geo-Information Sciences, University of Venda, South Africa; [edmore.kori@univen.ac.za](mailto:edmore.kori@univen.ac.za); [ekori1@yahoo.com](mailto:ekori1@yahoo.com)

<sup>2</sup> B&V TIGED Eco-solutions, South Africa; [ronald.mukanya@googlemail.com](mailto:ronald.mukanya@googlemail.com)

## ABSTRACT

Partnerships and communities of practice (COP) for climate change adaptation are important pillars for developing nations to harness the evolving adaptation opportunities. Africa's progress towards climate compatible development (CCD) needs to adopt low-carbon climate-resilient development (LCR). As Africa strives to fulfil its development trajectory, decisions concerning investments need to take into account climate change. Doing so is not easy for at least two reasons. Firstly, new infrastructure will have to be able to cope with a large range of changing climate conditions, which will make design more difficult and construction more expensive. Secondly, uncertainty in future climate makes it impossible to directly use a single climate model's outputs as an input for infrastructure design and there are good reasons to think that the needed climate information will not be available soon. Instead of optimizing based on climate conditions projected by models, therefore future infrastructure should be made more robust to possible changes in climate conditions. This implies that users of climate information must also change their practices and decision-making, for instance, by adapting the uncertainty-management methods they currently apply to COPs. However, new forms of COPs and multi-stakeholder partnerships emerging and factors affecting their success remain poorly understood within the context of sustainable development. Developmental activities that can have mitigation and resilient development benefits will be analysed. Multiple forms of partnerships have been established between stakeholders<sup>1</sup> to achieve adaptation aims. Adaptation–mitigation interactions call for integrated design and assessment of adaptation and mitigation policies, which are often developed by distinct communities.

*Keywords: Adaptation, Mitigation, Climate Change, Infrastructure, and Development*

## 1 INTRODUCTION

Africa faces considerable challenges in adapting to long-term impacts of climate change. Policy-makers have to contend with projections of huge changes to the region's climate, but also low levels of development and adaptive capacity in many countries and communities. Each of these factors is exacerbated by the complex interaction of wider social, economic, cultural and environmental drivers that affect the continent [1]. Added to this, uncertainties in Africa's ability to understand and simulate localized changes in the climate and large gaps in climate observation networks further confound the decision-making process. Needless to say, ensuring that policy-makers are able to respond to the medium- and long-term implications of climate change is a considerable priority. Yet evidence and detailed understanding of knowledge, partnerships and capacity gaps in the uptake of science for informing long-term climate-resilient development strategies are lacking, particularly for sub-Saharan Africa.

However, Africa, without a doubt, has come a long way, making substantial progress towards several MDGs since 2000. While not all the interventions that have worked in specific countries can be applied

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<sup>1</sup> Private sector companies, government, non-governmental organizations (NGOs), traditional authorities and community

everywhere, best practices and successful policy interventions can indeed inform interventions elsewhere. Indeed, Africa regional consultations led by the United Nations Economic Commission for Africa, African Union Commission, African Development Bank and United Nations Development Programme confirm that health, education, water, sanitation and the environment remain high priorities for African countries. In addition, stakeholders would like to see inclusive growth that creates employment and livelihood opportunities, especially for the continent's young. Stakeholders have identified structural economic transformation, human development, financing, partnerships, technology and innovation as the priority areas for responding to these challenges in the post-2015 development agenda. Africa has been registering rapid economic growth for the last decade or so [30]. Projections are that the post 2015 period is going to see Africa's economic growth soar. With the need for Africa to industrialize being stressed out in order to accelerate its economic growth and generate employment, increase income and diversify exports, a window of opportunity to adopting climate resilient, low carbon investments and adapting to a changing climate beckons. Decisions made now, if smart enough, will cushion Africa's development from future climate shocks and also avoid further GHG emissions as this industrialization happens. The green economy and green growth would be the passing fad or future paradigm of Africa's development. Green growth would be about recalibrating development whereas the green economy can be seen to be more about systemic, transformative change. Both concepts are instruments for achieving sustainable development (i.e. not replacing this super-goal). For Africa's developing countries, green growth means regaining sovereignty over their own resources, for example adaptation in the agriculture sector. There are good reasons to think that the economic response to climate change's direct impacts is nonlinear and will exhibit threshold effects, and that this nonlinearity and these thresholds result in a larger uncertainty for large warming. But it is important to account not only for sector-scale impacts, but also for indirect impacts and ripple effects in the larger economy. These knock-on effects are especially important because climate change impacts will both increase the need for adaptation investments, as well as potentially decrease the capacity of the affected economy to mobilize resources to carry out these adaptation investments. Moreover, these effects are particularly difficult to predict and model, as current economic models focus on marginal economic changes, without being able to capture and reproduce more significant structural shifts in the economic system [25].

For Africa, whose economic mainstay is mainly agriculture, sustainable intensification of agriculture is critical if she is to feed future world populations and tackle the continuing scourge of 1 billion hungry people. In some areas, the introduction of modern methods and equipment has increased production. However, much of this improvement has been in the growing of commercial crops for export, rather than food crops. Throughout Africa, population growth has outstripped increases in food output. As a result, most Africans have barely enough food to sustain themselves, experience acute food insecurity and many suffer from severe malnutrition. Whilst agriculture is not at the top of the agenda for many policy makers, there is much research, thinking and policy work on sustainable intensification in developing countries. New info graphics from the Climate Change Agriculture and Food Security programme (CCAFS) show that Africa needs to produce more, improve livelihoods and provide more nutritious food whilst using inputs better, reducing GHGs from agriculture and managing natural capital better. Furthermore, resilience to shocks and stresses is important. For developing countries, resilience is key in the agricultural sector but mitigation may be an additional by-product of improved management that could enable access to finance and technologies, whilst there are both trade-offs and synergies to be identified.

Cities in sub-Saharan Africa are the fastest growing in the world, where rapid economic growth and urbanisation drive demand for new "greenfield" investment [8, 10]. With changing patterns of population distribution, innovation, trade, and production in complex ways, not responding to climate change is risky. This creates a new development landscape with a need to nurture and sustain economic growth and social development in the face of multiple threats and uncertainties while also reducing GHG emissions. Climate Compatible Development (CCD) emphasizes climate strategies that embrace development goals and development approaches that integrate the threats and opportunities of a changing climate [17]. It heralds a new generation of development processes that safeguard development from climate impacts (*climate resilient development*) and reduces or keeps emissions low without compromising development goals (*low emissions development*), going beyond the traditional

separation of adaptation, mitigation and development strategies [15]. Achieving low-carbon, climate-resilient (LCR) development is a policy goal of many governments, and investment in built-infrastructure – in the energy, transport, water and building sectors for example – is a central part of the challenge. In the face of growing African city infrastructure needs and fiscal constraints, such transformational change will require large-scale partnerships and private sector engagement. This creates a window of opportunity and also creates developmental challenges in the wake of a rapidly urbanising African population [12]. CCD is essential if developing countries are to address the impacts of climate change, whilst continuing to develop [14].

## 2 GLOBAL CLIMATE CHANGE CHALLENGE: CLIMATE COMPATIBLE DEVELOPMENT AND PARTNERSHIPS

Achieving development in the face of global climate change requires the successful delivery of multi-sectoral and multi-stakeholder projects. In much of sub-Saharan Africa, development efforts must increasingly account for climate change impacts, with the acknowledgement that both adaptation and mitigation are necessary [4, 6]. The development challenges and opportunities presented by climate change have led to the concept of CCD, defined as “development that aims to minimize the harm caused by climate impacts, while maximizing human development opportunities presented by low emissions, more resilient future” [11 p.1]. CCD’s triple goal of delivering adaptation, mitigation and development cannot be achieved through discrete working in which actors in the multi-scale climate change arena undertake separate activities. Successful CCD requires development projects to work across sectors, scales and groups, allowing synergies to be harnessed, trade-offs to be minimized and specific gaps to be targeted [2]. Typical examples of CCD projects in sub-Saharan Africa include those related to the development of cities and provision of basic services to citizens [26], agroforestry [28], conservation agriculture, joint forest management and biofuel out grower schemes [21]. Given the developmental aspirations of Africa and the threat posed to this notion by climate change, stakeholders are increasingly entering into partnerships in order to facilitate such cross-sectoral, cross-scale projects [18]. A stakeholder is defined as anyone who affects or is affected by a decision or action [13]. A partner is an individual or group that unites with other individuals or groups [9].

Partnerships generally operate across sectors, involving actors from the public and private spheres, as well as non-governmental organizations (NGOs) and civil society. They usually centre on a shared goal or purpose, targeting an issue or cause that an actor or group cannot solve by itself [24]. By forming a partnership, stakeholders can work together, harnessing each other’s strengths to target regulatory, participatory, resource and learning gaps, while at the same time, cross-leveraging resources, knowledge and expertise [12], [18]. In working to deliver a CCD project, a network of partnerships may be required to overcome the shortcomings associated with single-sector approaches to addressing complex social and environmental problems [8]. They can also incorporate a range of governance levels, facilitating a move away from traditional top-down models towards more decentralized governance [15], [14], therefore facilitating the local implementation of international commitments [29]. While research into partnerships in the wider field of environmental governance is relatively well developed, [22], [3] the roles of partnerships and developmental communities of practice (COP) in delivering CCD projects for climate change adaptation have received very little academic attention to date. This is especially so in developing country settings where addressing the multiple impacts of climate change is an important priority [19], and where regulatory and resource gaps can be particularly significant. The adaptive capacities of developing world nations are acknowledged to be low [12]. Taking steps towards CCD can advance the sustainable management of the natural resource base, helping to provide adaptation options, while also allowing a country to develop. In many African nations, the natural resource base underpins the livelihoods of millions, with national economies highly dependent upon agriculture – a sector highly sensitive to the impacts of climate change [4]. If synergies can be harnessed through CCD so that natural resource management can advance development, as well as deliver adaptation and/or mitigation options, it will also enable benefits for adopting low-carbon, climate-resilient (LCR) development defined in Box 1 and sustainable natural resource management.

Box 1: Definition of “low-carbon, climate-resilient” infrastructure investments I think there is need to refer reader to this box somewhere in text

Choices of infrastructure or selected features of infrastructure will affect the greenhouse gas emission-intensity of service provision (e.g. water, electricity, mobility, shelter, goods exchange, sanitation services) as well as the exposure and vulnerability of businesses and people to climate change itself. In the context of this paper, green infrastructure or low-carbon, climate-resilient (LCR) infrastructure projects will either mitigate greenhouse gas emissions and/ or support adaptation to climate change in the area of transport, energy or buildings. While there are possible competing effects between adaptation and mitigation strategies in some infrastructure projects (i.e. air conditioning systems), important synergies exist, making the case for an integrated approach.

Despite the risk of lock-in into high emission and high vulnerability development pathways, infrastructure decisions are not irreversible. However it can be costly to change them. Infrastructure investment typically has high capital expenditure requirements and altering infrastructure post-construction can be difficult and more costly than if it were designed to integrate climate change consideration from the start. As a result, greening infrastructure investment may be directed at renovation of physical infrastructure (also referred to as “brownfield” investments), such as retrofitting power plants or energy efficiency projects, or at the building or extension of new infrastructure (“greenfield” investments), such as renewable energy projects or new public transport infrastructure systems. Investment to support green infrastructure may also be in the form of generating service sector activity (e.g. information provision, engineering or management advice).

Source: adapted from Kennedy et al. 2012 forthcoming.

Infrastructure lies at the heart of African economies. Buildings, electricity power stations, water and waste systems provide the basic services that households and businesses require, while transportation and communications infrastructure link consumers to producers to suppliers, enabling markets to function. Clean, efficient, well maintained infrastructure supports a high quality of life in OECD countries; and provision of such infrastructure in developing countries is critical to raising living standards.

Global emissions of GHGs are also to a large extent dependent on the choice and design of infrastructure systems. In 2009, power generation, building energy use, transportation systems and waste management infrastructure accounted for 74% of net GHG emissions for Annex 1 countries<sup>2</sup>. Moreover, these infrastructure systems are generally composed of long-term capital assets, which without re-investment provide lock-in to future emissions paths. Partnerships and transformation of infrastructure both in OECD and non-OECD countries is necessary to address climate change goals.

### 3 DEFINING PARTNERSHIPS AND RELATED TERMS

#### 3.1 Unpacking partnership models

Partnerships are formed to achieve shared goals. The first stage in understanding partnerships lies in identifying the partnership function in terms of that shared goal. [20] Focuses on the rationale for the formation of partnerships and frame this around four groups of “gaps” which can be addressed through actors forming partnerships. The rationale of this approach is that strengths can be harnessed from different stakeholders or groups of stakeholders, leading to outcomes that are not otherwise possible when actors work in isolation. The resource gap could refer to financial, tangible, resources or other, less tangible resources, such as knowledge and expertise [28]. For example, “private-public partnerships” (or PPPs) may form to help the private sector overcome public sector resource inadequacies associated with capital shortages, inefficient operation and poor service quality [26],[27].

<sup>2</sup> OECD analysis using the UNFCCC database. Net GHG emissions from public electricity and heat production, transport, commercial/institutional, residential and waste are 73.9% of total net emissions, including LULUCF/LUCF.

Indeed, in developing countries, where the private sector is strong enough, it is likely to play a strong role in partnerships to address resource gaps [12]. However, [8p.268] highlight that governments should be aware that “corporate interests will always be leading in a partnership” and that the private sector are only likely to establish partnerships in order to contribute to corporate profitability, which may be difficult to align with public sector priorities.

An individual stakeholder may be involved in multiple partnerships, which may each be working towards a distinct aim or contributing to a broader aim. The same private sector actor engaged in a partnership with the public sector may also form partnerships with NGOs in order to allow access to expertise in the local context and facilitate working with local communities, as well as supporting activities such as capacity building [25], therefore addressing learning and participatory gaps. For example, [9p.192] suggest that mining companies often build partnerships with NGOs to “head off trouble, accelerate innovation, enhance their ability to predict shifts in demand, provide input into shaping legislation and to help set industry standards”. In addition, there may be a plurality of gaps, whereby each individual partnership targets multiple gaps. For example, partnerships between mining companies and NGOs can help to enhance company legitimacy, providing the benefits of improved brand reputation and increased appeal to investors, customers and employees, while filling both regulatory and learning gaps [25],[26]. Finally, there may be plurality in the partnerships that all target the same specific gap.

The success of partnerships in filling gaps can be assessed in a number of ways and has been the focus of considerable academic attention, e.g., [27]–[29]. For example, [28] suggest that success can be defined through “efficiency” and “effectiveness”, that is, how efficiently an outcome is achieved, and how well the outcome matches the intended goals. Much discussion has focused on the ideal “form” of partnership for delivering success. Terms such as collaboration, cooperation, alliance and coalition are often used synonymously in the partnership literature, e.g., [11]. However, [23] suggests there are different levels of partnership and places these along a continuum, moving from alienation to integration, through co-existence, cooperation and collaboration. Such an approach shares parallels with the literature on participation, which develops similar continua [23]–[25], thus emphasizing the different influences and legitimacy of different approaches. Each form of relationship will be differently appropriate based on the partners themselves and their broader working context. Therefore, partnerships could be studied through a range of success factors that can be grouped into three subsets that focus on: (1) the partners; (2) the process; and (3) context related factors – centred on the broader environment in which the partnership is based (for example, governments could provide or prevent a facilitatory and regulatory function whereby the public sector establishes an “enabling environment” for partnerships [25p.268]).

In order to study partnership models within the context of CCD, these framings of individual partnerships need to be seen as part of a holistic process within the boundaries of development. In order to examine partnership models for CCD, Africa’s development transition, which can be aided by long-term low carbon investments and climate resilient infrastructure, has been chosen on the basis of their CCD characteristics.

At the partnership formation phase, individual partnerships must be identified and understood according to [9] “gaps” as the “partnership rationale”. The rationale is considered alongside, and in relation to, the “partner-related” factors, which could affect the success of the individual partnership. These then influence “process-related” factors during the implementation phase. Collectively, the partnership rationale, partner-related factors and process-related factors influence the partnership outcomes and therefore the success of the partnership, which can be assessed against progress towards its aims. The success of each partnership is then considered as a component within the outcome of the overall project. In order to examine partnership models for CCD, the 'Public Private People Partnership' for climate compatible development in Maputo (4PCCD) and the Climate Resilient Infrastructure Development Facility (CRIDF) are examined in section 5 Results chosen on the basis of its CCD characteristics. Case study selection was carried out as part of a broader research project, which seeks to identify successful CCD models and partnership activities involving different combinations of stakeholders in complex and dynamic governance and political economic contexts across Africa [14].

### 3.2 Governance and Public-Private Partnerships

Public private partnerships (PPPs) are one of the mechanisms through which governments can encourage investment in LCR infrastructure as illustrated in Box 2. Given the additional risks and complexity that may occur with some LCR projects, governments may be cautious in procuring infrastructure services through PPP contracts, especially when new technologies are involved. Ideally, the policy to develop LCR infrastructure would come before the choice of the financing mechanism (PPP or otherwise), and attributes of LCR infrastructure would be embodied within infrastructure design codes and standards. The choice of business models (public, private or mixed) for the provision of LCR infrastructure should be driven by efficiency and value for money. Infrastructure often requires public subsidy or other forms of public support, and LCR infrastructure may justify more financial support. Where PPPs are chosen as a way to bring in private sector engagement, the tendering and negotiation processes used may help governments make more efficient use of public funds, except on smaller projects. As use of PPPs requires government units that have the capacity and skills to effectively manage complex infrastructure projects and private sector engagement in these, they may also be suitable administrative units for managing the delivery of LCR infrastructure.

#### *Box 2: Private sector participation in infrastructure*

In a large number of OECD and other countries, private participation in infrastructure has increased in recent decades and helped boost both the coverage and efficiency of infrastructure services. Yet at the same time a number of failed public-private partnerships (PPPs) attest to the difficult challenges facing policy makers. Infrastructure investment involves contracting processes that are more complex and of longer duration than in most other parts of the economy, operated under the double imperative of ensuring financial sustainability while meeting user needs and public goals" provision. The challenges are even more acute when governments bring in international investors, especially sensitive to commercial risks involved in working in unfamiliar local environments and very exposed to public opinion and political scrutiny.

As a result, the choice between public and private provision and financing of infrastructure services should be guided by an objective assessment of what best serves the public interest. Factors to be taken into account include current levels of service delivery and the condition of assets, affordability to households and companies, coverage of networks, operational efficiency, long-term maintenance of assets as well as social and environmental sustainability. The decision also needs to be guided by the timeframe over which improvements are required and the sources of finance that are available in the market in question. In particular, the decision to involve the private sector has to be guided by an assessment of the relative long-term costs and benefits, and availability and reliability of private or public finance options. Ideally it will also take into account the pricing of risks transferred to the private operators and prudent fiscal treatment of risks remaining in the public domain.

Source: adapted from OECD, 2007, Principles for Private Sector Participation in Infrastructure

These case studies advance a "partnership" taking infrastructure investment as a starting point and looking only at climate change mitigation and adaptation. It highlights the significant opportunities and many challenges that exist today in developing countries to transition to LCR development through investment in both renovated and in new infrastructure. The cases suggest it is possible to generate multiple local development benefits from LCR infrastructure investment. It presents partnerships as a form to guide domestic reforms that can steer use of limited public funds while also enabling and incentivising private investment to support a transition across relevant infrastructure sectors to simultaneously deliver climate change and local development goals.

## 4 PROBLEMATISING LONG-TERM LOW CARBON INVESTMENTS AND HARNESSING DEVELOPMENT OPPORTUNITIES

There is an increasing agreement that many decisions already need to take into account climate change. Obviously, many decisions have only short-term consequences or are only weakly climate sensitive. A factory that produces electronic devices has a lifetime of less than a few decades, and climate conditions will not be that different over this timescale. Also, such a factory is not highly sensitive to climate conditions, provided that it is not built in a flood plain or along a coastline.

But many decisions come with a long-term commitment and can be very climate sensitive. Examples of such decisions include urbanisation plans, risk management strategies, infrastructure development for water management or transportation, and building design and norms. These decisions have consequences over periods of 50 – 200 years. Urbanisation plans influence city structures over even longer timescales. These kinds of decisions and investments are also vulnerable to changes in climate conditions and sea level rise. For example, many buildings are supposed to last up to 100 years and will have to cope in 2100 with climate conditions that, according to most climate models, will be radically different from current ones. So, when designing a building, architects and engineers have to be aware of and account for the future changes that can be expected. [16] Demonstrates why water management cannot keep using the stationarity hypothesis in its investment decisions. Since they report that more than US\$ 500 billion are invested every year in this sector, the implementation of new practices cannot be delayed. Also, [18] showed that, in 2070, up to 140 million people and US\$ 35,000 billion of assets could be dependent on flood protection in large port cities around the world because of the combined effect of population growth, urbanisation, economic growth, and sea level rise. But previous coastal defence projects (e.g., the Thames Barrier) have shown that implementing coastal protection infrastructure typically has a lead-time of 30 years or more. Also, urbanisation plans are very efficient to influence flooding risk, but they can do so only over many decades. This inertia suggests that action must begin today to protect port cities and to manage flood risk for impacts expected by the middle of this century. To be efficient, however, this action has to take into account sea level rise and possible changes in storminess linked to climate change.

*Table 1. List of sectors<sup>3</sup> by investment time scales*

<b>Sector</b>	<b>Time scale (year)</b>	<b>Exposure</b>
Water infrastructures (e.g., dams, reservoirs)	30–200	+++
Land-use planning (e.g., in flood plain or coastal areas)	>100	+++
Coastline and flood defences (e.g., dikes, sea walls)	>50	+++
Building and housing (e.g., insulation, windows)	30–150	++
Transportation infrastructure (e.g., port, bridges)	30–200	+
Urbanism (e.g., urban density, parks)	>100	+
Energy production (e.g., nuclear plant cooling system)	20–70	+

## 5 RESULTS DISCUSSION AND CASE STUDIES ANALYSIS

Southern African demand for electricity already outstrips supply, and the region is in an electricity deficit. One of the solutions to this is to invest in the expansion of hydropower in the largely undeveloped Zambezi River Basin. The Southern African Power Pool (SAPP) integrated expansion plans include more than 11,000 MW of new large-scale hydropower up to 2018. The plans for these major investments do not necessarily include an assessment of the growing upstream irrigation and urban demand along with potential long-term climate change impacts. The interaction of these elements creates a development, food, water, climate and energy nexus. But, it also presents a low-carbon, climate-resilient (LCR) development investment opportunity in built-infrastructure – in the energy, transport, water and building sector. In the face of growing infrastructure needs and fiscal constraints in Africa, such transformational change will require large-scale private sector engagement and partnerships. While many studies focus on the role of environmental and climate change policies to support a transition to a low-carbon, climate-resilient (LCR) economy, these case studies suggests that other factors like engagement and partnerships play a critical role to achieve this transition.

### 5.1 Public Private People Partnership' for climate compatible development (4PCCD)

According to [13p.6] “participatory approaches have been shown to improve the quality, effectiveness, and sustainability of development projects, and strengthen ownership and commitment of government and stakeholders”. Yet, there are few experiences of participatory urban planning partnerships, which explicitly address climate change. 4PCCD examined the potential of partnerships between public,

<sup>3</sup> List of sectors in which climate change should already be taken into account, because of their investment time scales and their exposure to climate conditions. In this table, the authors estimate exposure empirically.

private and civil society actors to bridge the gap between rhetoric and action in climate change policy. Partnerships may act as a bridge between development and environmental concerns in creating the conditions for CCD. Existing examples, such as the successful waste management system in Maputo, Mozambique, show the potential of approaches that engage a wide range of actors to develop partnership synergies for the achievement of common objectives. However there are also risks in the use of partnerships as a form of governance. 4PCCD empowers people living in urban poor neighbourhoods in Maputo to design and implement activities<sup>4</sup> to adapt to climate change.

### **5.1.1 Identified partners**

A senior FUNAB representative defined a partner as “anyone or any organization who are contributing in one way or another towards our objectives for a given action” (FUNAB representative, April 2013). This definition was used during stakeholder identification and subsequent separation of partners from stakeholders. The snowball sampling technique revealed that the sustainability department of FUNAB have initiated a number of different partnerships in order to achieve their 4PCCD project goals, and these partners are in partnerships of their own under the umbrella of the project. One of the greatest challenges identified by FUNAB during interviews was the lack of stakeholders that could be partnered with in the geographical area that possess the necessary capabilities to contribute to the aims of the 4PCCD. Relevant NGOs are particularly scarce, resulting in a lack of partners who could help to fill implementation gaps. Representatives from both FUNAB and Bartlett Development Planning Unit (BDPU) perceived the partnership between FUNAB and BDPU as key. BDPU are involved in all aspects of 4PCCD and, as such, are partnering with several others. These specific partnerships were chosen in order to highlight how the partnerships work individually and in unison with each other, in contributing to the broader project goals.

Although FUNAB stated they partnered with BDPU due to a lack of other actors with the necessary ability to implement the project, the partnership was felt by all parties to be working well. However, interviewees from FUNAB acknowledged that the government and private sector work at varying speeds and that this can make partnerships that span the private and public sectors very challenging. This was also the main reason why the government was not the preferred partner to fulfil the implementation gap. One of FUNAB’s representatives stated: “[FUNAB] is a national environmental fund and grabs the bull by the horns but government moves at a different pace” (Semi-structured interview with FUNAB representative, April 2013).

The “laissez-faire” attitude of government workers was also mentioned, as was the lack of resources in government departments, in particular the ministry for coordination of environmental affairs (MICOA). Despite these challenges, the partnership between BDPU and FUNAB was felt to be working well. FUNAB representatives at district and provincial levels stated that they felt BDPU recognized the skills and expertise they could bring to the partnership and allowed them freedom to use them and to propose project activities they felt were relevant and appropriate to the area. They could therefore use FUNAB resources to supplement existing BDPU activities and introduce new ideas where feasible. This led to increased research into the development of a participatory planning methodology to address climate change for communities around Maputo. In addition to the independence and flexibility encouraged by FUNAB, BDPU representatives noted the transparency and openness of the fund as positive aspects of the partnership. FUNAB had clearly defined the roles and responsibilities of each partner and developed a governance structure at the partnership formation phase, which enabled all partners to have a clear idea of what was involved. A representative from the BDPU stated that their relationship with FUNAB is easy because they know exactly who to contact and FUNAB knows what stage they are at with their Climate Change Action Plan projects augmented this perception of FUNAB as a partner.

This conflicts with FUNAB who stated that the technical assistants (TAs) recommended suitable community activities. However, data collected from community-level focus groups suggests that channelling communications through the TAs as gatekeepers to the communities can cause complications and may raise suspicions of issues such as elite capture even if this is not the case.

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<sup>4</sup> These activities include improving and maintaining drainage channels; protecting the water supply; managing local waste; and establishing awareness and communication channels between citizens and relevant institutions

Challenges in working with the communities were also expressed by both BDPU and FUNAB. FUNAB representatives stated that lack of communication options and low illiteracy levels made working with communities very difficult. In addition, lack of government resources, in BDPU and more broadly, meant there was a lack of supporting infrastructure and logistics such as transport, for FUNAB projects. BDPU representatives at the provincial level also referred to low adoption rates of new ideas and technologies within the communities targeted for 4PCCD activities. This may be a reflection of the lack of community consultation when instigating the projects.

While the 4PCCD is directly concerned with CCD-related outcomes, there is potential for it to contribute to development, adaptation (through livelihood diversification and increased income which could allow households to accrue assets that could enable them to better adapt to changing climatic conditions) and, to a limited extent, climate change mitigation (through successful waste management). The partnerships initiated by FUNAB are central to these outcomes as none of the partners identified could carry out the activities without the complementary inputs of the others.

## **5.2 Climate Resilient Infrastructure Development Facility (CRIDF)**

CRIDF is a flagship water infrastructure programme for Southern Africa focused on water services, water resource management, and agriculture, creating a lasting impact on the region's water, food and energy security. To achieve this, CRIDF works in partnerships through local networks, integrating local political economy considerations into regional decision-making. Climate compatible development is at the core of CRIDF's project development processes in order to mainstream climate resilience in delivery and leave behind a sustainable solution. The programme represents a catalytic intervention: it aims to leverage resources for a regional response to water security and climate change, to facilitate additional finance from other sources for the delivery of CRIDF infrastructure projects. CRIDF has a strong focus on trans-boundary water management, and the benefits that emerge from cross border cooperation. For this reason, the facility works closely with the trans-boundary River Basin Organisations.

### **5.2.1 Climate resilience**

Africa is characterised by a highly variable climate. Long severe droughts, often broken by extreme flooding, have affected the lives and livelihoods of the poor, and have impacted on economic growth. Climate change can magnify these impacts. Climate resilience is about building the capacity to cope with these climate extremes, whether they are due to the existing natural climate variability or rather exacerbated by shifting climate patterns. The facility champion's climate resilience by catalysing and mobilising a range of partnership projects that increase the ability of communities, policymakers and planners to predict, manage and mitigate climate extremes.

### **5.2.2 Infrastructure development**

Infrastructure development is critical if Africa is to realise its vision of "equitable and sustainable utilisation of water". SADC's third Regional Strategic Action Plan set out its ambition to achieve "social and environmental justice and regional integration and economic benefits for present and future generations" through good water use." Infrastructure development is central to realising this aim, which presents an adaptation window of opportunity. CRIDF is therefore working to catalyse a wide range of infrastructure projects that support this vision. In some cases, CRIDF supports pre-planned climate resilient infrastructure projects by providing finance for small-scale infrastructure, access to finance for larger projects, or else specific technical and engineering support and supervision.

Other projects are supported through the provision of Technical Assistance to build climate resilience into the scope, design and operation of planned infrastructure. CRIDF facilitates the implementation of trans-boundary Integrated Water Resources Management plans that inculcate climate resilience into water resources management and monitoring. By introducing global best practices – in drought management, agricultural production and food security, flood management and the provision of sustainable access to safe water and sanitation – CRIDF aims to mainstream climate resilience into infrastructure planning and operation at regional, national, and local levels. CRIDF projects are managed under one of three work streams. It is by recognising the integrated nature of water management that CRIDF can maximise the links between these work streams:

- i. **Agriculture:** Any use of water for agricultural purposes
- ii. **Water Services:** The supply of potable water or the disposal of wastewater
- iii. **Water Resource Management:** All other uses, including non- consumptive uses of water

### 5.2.3 Identified partners

Snowball sampling revealed 4PPPCD were partnering with fewer partners than CRIDF in order to achieve the aims of their participatory planning. These partners were also all involved in partnerships with each other – to both achieve the aims of CCD initiatives, as well as other unrelated aims. “Improving networking is the biggest challenge for 4PPPCD. Everyone has seen where the weakness is and they want to improve it” (Semi-structured interview with 4PPPCD representative, April, 2013).

While the data suggests the early stages of the CRIDF project have been challenging, there is clear potential for CCD goals to be met through the initiative. For example, if the anticipated increases in water management and infrastructure are achieved, then water and food security within the communities could increase. In addition, improved soil fertility and livelihood diversification could have important positive impacts on households’ ability to adapt to climate change. Agriculture being the mainstay of the region and water being available, furthermore conservation agriculture techniques could be employed to allow reduced carbon emissions through decreased tillage and fertilizer use.

## 6 CONCLUSION

Findings within the context of sustainable development show that the rationale behind the partnerships, partner-related factors, and process-related factors can all influence CCD. Countries can mitigate climate change and potentially deliver significant gains for adaptation and poverty reduction through CCD. Lessons learnt from the initiatives above stress the importance of building on existing institutional and governance structures and processes. The role of private sector companies and NGOs in developing new opportunities and multi-stakeholder partnerships through CCD schemes has also been identified as important. However there is a dearth of studies and evidence assessing the role of different partnership structures in complex dynamic governance situations. Cities represent unparalleled opportunity as humanity is now half urban and expected to be nearly 70% urban in cities by 2050 were 60% of their area is still to be built before 2030. In Africa for example, a major part of the infrastructure stock required to meet development goals is still to be built in the fields of energy, water, urban development, transportation and agriculture [23, 29]. These urbanisation trends across Africa, present multiple new development opportunities and challenges at national and local levels for example severely increasing pressure on the essential services, infrastructure and natural systems which underpin economies and social well-being. These challenges call for innovative solutions and also present a development opportunity Climate change adaptation. Infrastructure investment decisions play an important role in African cities, as infrastructure built or renovated today will be in use for decades to come and threatened by climate variations over the coming decades. Hence, there is an opportunity to advance forward-looking infrastructure development strategies that integrate climate change considerations to achieve LCR development through multi-stakeholder partnerships and COPs. Our final conclusion argues that adaptation and resilience is also a policy priority for greening city infrastructure, where evidence is showing financial risk also associated with the impact of climate change itself on capital investments.

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# ROLE OF RENEWABLE ENERGY TECHNOLOGY IN CLIMATE CHANGE ADAPTION AND MITIGATION IN NEPAL

**Tri RatnaBajracharya<sup>1</sup>, Shree Raj Shakya<sup>1</sup>, Ram C. Khanal<sup>1</sup>, Raju Laudari<sup>2</sup>**

<sup>1</sup>Centre for Energy Studies, Institute of Engineering, Tribhuvan University, Lalitpur, Nepal

<sup>2</sup>Alternative Energy Promotion Centre, Ministry of Science, Technology and Environment, Government of Nepal, Lalitpur, Nepal

Author for correspondence: [triratna@ioe.edu.np](mailto:triratna@ioe.edu.np)

## ABSTRACT

Despite having only 0.025% of total GHG emissions in the world, Nepal is one of the most vulnerable countries in the world from the context of climate change. Nepal has experienced an average maximum annual temperature increase of 0.06<sup>0</sup>C. It has been found that renewable energy technologies (RETs) provide socio-economic and environmental benefits to people that contribute for adopting and ensuring better adaptation to climate change based on the local context. They contribute to adaptation processes by contributing on reducing vulnerability of people, improving adaptive capacity and minimizing climate change risk. But, these are not without challenges either. Financial, technical, institutional, policy and legal issues are major challenges to promote RETs. This studies shows that theoretically altogether 4.45 million tons of CO<sub>2</sub>e of the GHG emission can be mitigated per year if all the remaining technical potential of deploying seven major RETs consisting of biogas, improved water mill, stand-alone micro-hydro plants, mini-grid micro-hydro plants, solar PV home systems, mud-ICS and metal-ICS were installed after 2012. Considering the average annual installation of these RETs, altogether 30.71 million tons of CO<sub>2</sub>e can be mitigated between the periods of 2013 to 2030 at an annual additional installation equal to average installation done in recent past three years. The initial technology investment required for implementing above mentioned RETs ranges from NRs 97 to NRs 23,247 per ton of CO<sub>2</sub>e mitigation. This indicates that though moderate level of initial investment is required for promoting RETs, the GHG mitigation potential seems to be quite promising. There is no liberty of inaction, so RETs can be a good case for a triple win strategy to address mitigation – adaptation – development nexus for climate compatible development in Nepal.

*Key words: adaptation to climate change, mitigation potential, renewable energy, socio-economic development, vulnerability, climate risk, technology investment cost*

## 1 INTRODUCTION

Despite having only 0.4 percent of the total global population and being responsible for only 0.025 percent of total GHG emissions in the world, Nepal is one of the most vulnerable countries in the world in context of climate change. Nepal has experienced an average maximum annual temperature increase of 0.06<sup>0</sup>C. It has been identified that climate change has impacts on different areas including natural resources. On the broad impact areas, vulnerabilities to energy resources can also be observed, for e.g. to the supply potential of biomass energy resources (due to degradation in land use pattern, agriculture productivity, migration, loss of lives etc). It means that climate change has implications to the current and future energy demand and supply chain of the country as well.

On the other hand, the reinforcement of adaptation and mitigation to climate change needs a strong effort to shift toward a low-carbon energy pathway – both in terms of the energy infrastructure and the energy production and consumption patterns – that would support continued country's sustainable development while lessening the level of its GHG emission increases. In this context, RETs may represent an important way for the country to support adaptation and enhance development, representing a more ecological mitigation pathway with emphasis on the introduction and use of clean and resource-efficient technologies, social and environmental sustainability and improved social equity. Given the high potential of RETs in Nepal to contribute to both climate mitigation and adaptation, it is increasingly important to understand clear role of

these technologies in addressing both issues. Energy linkages with promotion of RETs are not explicitly<sup>98</sup> defined but it is a fact that energy acts as a cross cutting tool in every social and economic development. Role of energy hence should be identified both for mitigation and adaptation processes and therefore contributing to building a resilient national capacity.

Alternative Energy Promotion Centre (AEPC) was established in 1996 with the objective of developing and promoting renewable energy technologies with focus in rural areas of Nepal. Since then, AEPC has been successfully implementing/executing several renewable energy programme/activities in Nepal. Nepal, along with over 150 other nations, signed the United Nations Framework Convention on Climate Change (UNFCCC) at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in June 1992. Nepal ratified the Convention on 2<sup>nd</sup> May in 1994, and this convention came into force in Nepal on 31st July, 1994. Subsequently, Nepal's Initial National Communication was prepared in 2004 and shared with the Parties through the Convention Secretariat. Between 1996 and 2006, the then Ministry of Population and Environment (now the Ministry of Environment, Science and Technology) was designated as focal point to implement the provisions of the UNFCCC.

In 2011, the Climate Change Policy was formulated which specifically points the need of assessment of ongoing and likely impact of climate change in natural resources, including water resources and other economic sectors. One of the targets of the policy is to formulate and implement a low carbon economic development strategy that supports climate-resilient socio-economic development by 2014. Similarly, the Ministry of Science, Technology and Environment was entrusted as the Designated National Authority (DNA) to promote Clean Development Mechanism (CDM) projects in the country. The National Adaptation Plan of Action (NAPA), endorsed by the Government of Nepal (GoN) in 2010, lists a priority adaptation options for Nepal's Energy Sector. However, to ensure effectiveness of the proposed options, it is imperative to have an understanding on how RETs could contribute to climate change issues both in energy and other sectors. This study analysed the role of RETs in climate change adaptation and mitigation and their nexus with overall socio-economic development. It is envisaged that this study will further act as the supporting document for the GoN during implementing climate change policy, NAPA and existing and future relevant strategy and plan based on quantified data on potential role of RETs in both mitigation and adaptation options.

## 2 ENERGY SYSTEM DEVELOPMENT AND GHG EMISSION IN NEPAL

Biomass and hydropower are the major indigenous energy resources available in the country. Nepal is endowed with a significant amount of water resources; the theoretical potential of its hydropower is estimated to be 83 GW while the estimated economical potential is 42 GW[1]. So far, Nepal has an installed electricity generation capacity of only 719 MW[2]. Despite the large hydropower potential, only a small fraction of the hydropower resources (i.e., less than 2% of the economic potential) is harnessed so far and only 67% of the population had an access to electricity from grid and off-grid systems in 2011[3].

Besides biomass and hydropower there exist several other locally available renewable energy resources which are mostly suitable for fulfilling the distributed energy demand in rural communities of the country. These include solar, wind, geothermal etc. The possible renewable energy technologies, which can generate power by exploiting the locally available energy resources, includes micro-hydro power, biogas plant, improved cooking stove (ICS), solar photovoltaic, solar thermal and wind powered plants. Of these technologies, micro-hydro, biogas, improved cooking stove, solar photovoltaic (PV) home systems, and solar water heaters are becoming popular and are at varying stages of commercialization. However, technologies such as solar cooker, solar dryer, briquettes, wind and geothermal are only in the research and demonstration phase, and still need to be commercialized [4]. The estimated total potential of biogas plants is about 1.1 million plants of which 277,226 biogas plants of varying capacities (4, 6, 8, 10, 15 and 20 m<sup>3</sup>) have been installed as of December 2012. There exist a huge potential for biomass technologies like ICS, small scale briquetting technologies and gassifier. More than 663,114 ICS have so far been installed through various governmental and non-governmental organizations. Besides large capacity hydropower, there exist potential of installing about 110MW of small scale pico-hydro and micro-hydro plants suitable for supplying electricity to distributed rural population mostly in the hilly and mountain regions of the country. As of 2012 altogether 3.2 MW of pico-hydro and 33.6 MW of mini-grid micro-hydro plants have been installed. There exist mechanical power capacity of about 33 MW of improved water mill (IWM), of which one third have been exploited. Nepal receives ample solar radiation with average value varies from 3.6–6.2 kWh/m<sup>2</sup>/day, and the sun shines for about 300 days a year. With national average sunshine hours of 6.8/day and solar insolation intensity of about 4.7 kWh/m<sup>2</sup>/day, there is a huge potential for solar PV as well as solar thermal devices such as solar PV home system, solar PV pumping, solar

water heaters, solar dryers, and solar cookers. About 285,000 units of solar PV home system have been installed till 2012. Presently, solar water heaters have been fully commercialized and, till 2009, more than 200,000 of them have been installed in the country. Wind is still an unharnessed energy resource in the country with recently estimated commercial potential as 3,000 MW (estimated under Solar & Wind Energy Resource Assessment in Nepal (SWERA) program). A pilot project for demonstration and dissemination is being carried out by various organizations like AEPC, Practical Action, etc. [4].

Total primary energy supply (TPES) in the country was about 292 Peta Joule (PJ) in 2005. It increased at the growth rate of 2.46% to reach 400 PJ by 2008/09[1]. The use of fossil fuels consisting of petroleum products, LPG and coal has increased at the growth rate of 3.93% mostly due to rapid increase in LPG consumption. Likewise electricity mostly from hydropower increase by 7.82% and other renewable excluding hydropower and traditional biomass increases by 15.19%. In terms of energy mix biomass still dominates with its share of 87.1% in 2008/2009 though its share has been slightly reduced as compared to 91.7% share in 1995/1996. However, there is an increase in the shares of LPG (by 1.1%), coal (by 0.9%), electricity (by 9.5%), and other renewable (by 0.5%) as shown in the Figure 1.

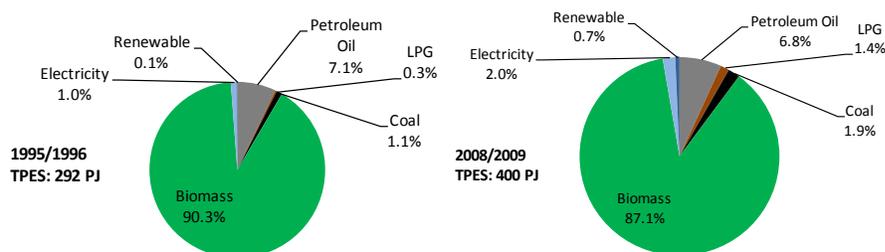


Figure 1: Fuel Share in the Primary Energy Supply, %

The energy consumption per capita increases by 10.1% from 14.26 GJ/capita in 1995/1996 to 15.71 GJ/capita in 2008/2009. In terms of fossil fuel consumption, the per capita consumption of fossil fuel increases by 32.4% from 0.12 GJ/capita in 1995/1996 to 0.16 GJ/capita in 2008/2009 indicating growing dependence on the imported fossil fuels. Likewise, economic activities shows improvement in terms of energy consumption with energy intensity of GDP at constant price changes from 90.04 MJ/100 NRs in 1995/1996 to 67.87 MJ/100 NRs @ 2000 price in 2008/2009.

Increasing trend of fossil fuels has contributed in an increase in the GHG emission in Nepal. As no time series GHG emission from the consumption of energy in the country is available from the related national government agencies, an IPCC default emission factors for individual greenhouse gas (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O) as mentioned in 2006 IPCC Guidelines for National Greenhouse Gas Inventories for dedicated economic sectors were used for estimating the national GHG emission[5]. It has been observed that, GHG emissions from energy use has increase by 48.3% from 4.1 million tons CO<sub>2</sub>e (i.e., CO<sub>2</sub> equivalent) in 1995/1996 to 6.1 million tons CO<sub>2</sub>e in 2008/2009. Figure 6.5 shows the sector wise GHG emissions from energy use during 1995/1996 to 2008/2009. The GHG emissions from the transport, industrial, and agriculture sectors would increase by 138%, 35% and 479% respectively during the period mostly due to dominance of the fossil fuels in their energy consumption. While the emissions from the residential and commercial sectors would increase by 23% and 44% respectively. The sectoral shares in total GHG emission are shown in Figure 2. In 1995/1996, residential sector dominates in the share of GHG emission with over 66.2%, followed by transport sector with 15.6% share and industrial sector with 13.9% share. Remaining sectors constitute about 4.4% in the sectoral GHG emission mix in 1995/1996. However, sectoral contribution of GHG emission changes significantly in 2008/2009, with residential sector constituting 54.9%, transport sector consisting of 25.1% and Industrial sector constituting 12.6%. Remaining sectors contributes 7.4% in the sectoral GHG emission mix in 2008/2009.

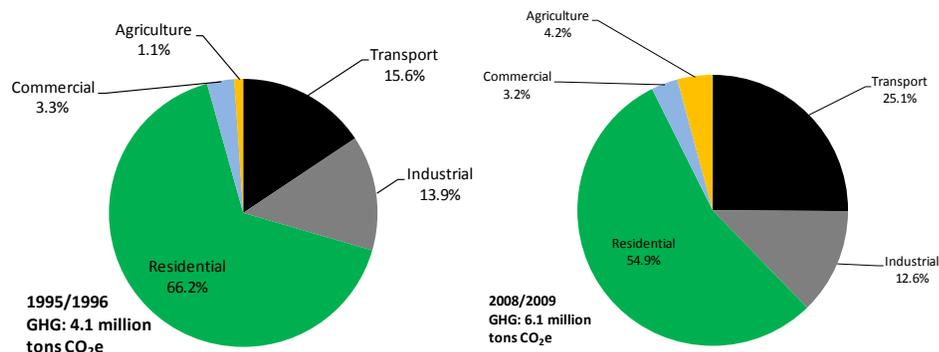


Figure 2: Sectoral Shares in GHG Emission in the Base Case, %

The per capita GHG emission increases from 0.20 ton CO<sub>2</sub>e/capita in 1995/1996 to 0.24 ton CO<sub>2</sub>e/capita in 2008/09. This indicates, future life style would be inclined towards carbon intensive fossil fuels mostly due to the limitation in the supply of the biomass energy resources and capital intensiveness of hydropower and other renewable resources.

### 3 METHODOLOGY

This study followed the standard framework for analyzing the role of renewable energy technologies in climate change mitigation and adaptation options in Nepal. It involves intensive literature review, conceptual model development, impact analysis, inception meetings and interaction with stakeholders, presentation, review and documentation of the findings from this study.

This study developed an integrated conceptual framework which allows a comprehensive analysis of the impact of renewable energy on climate change adaptation and also document some evidences how these technologies have been instrumental for adaptation to climate change. The assessment was mainly based on secondary information/literature - stocktaking of current situations through extensive review of relevant documents. The study reviewed the role of RET on various aspect of enhancing the adaptive capacity of community and household. These analyses were used to develop a conceptual framework as well as impact assessment of RETs on development benefits and adaptation services. Based on the conceptual framework and impact assessment, some lesson has been drawn and some recommendations were made which would be useful for decision and policy makers. The mitigation analysis was focused on determining the role of RETs in GHG mitigation, quantitative potential of GHG mitigation from selected RETs, technology investment cost and other co-benefits associated with GHG mitigation options through deployment of RETs in Nepal. An intensive literature review has been done on the evolution of energy consumption and GHG emission in the past in the country, interrelationship between RETs and climate change mitigation, methodologies followed by other studies for determining the GHG mitigating potentials. Based on the literature review, a standard accounting model was developed to analyze the GHG mitigation potential and technology investment cost associated with it. The results obtained from the analysis were cross verified with other studies for maintaining the realistic picture and thus help the policy makers during development, revision and implementation on the policy related to the RETs and climate change in the country.

### 4 ROLE OF RETS FOR CLIMATE CHANGE ADAPTATION AND DEVELOPMENT

The literature provides several definitions of RE. [6] define RE as “energy obtained from the continuing or repetitive currents of energy occurring in the natural environment”. The Dictionary of Energy edited by [7] says renewable energy is “any energy source that is naturally regenerated over a short time scale and either derived directly from solar energy (solar thermal, photochemical, and photoelectric), indirectly from the sun (wind, and photosynthetic energy stored in biomass), or from other natural energy flows (geothermal, tidal, wave, and current energy).” The most important RETs in the context of Nepal are related to micro hydropower, biomass energy (biogas, briquettes, improved cook stoves), solar energy (solar water heaters, dryers, cookers, generators and pumps), wind energy (wind turbines, windmills). These RETs have a large potential to contribute to the sustainable development (SD) of specific territories by providing them with a wide variety of socioeconomic and environmental benefits [8]. The [9] revealed that RETs offer the opportunity to contribute to a number of

important SD goals: (i) social and economic development; (ii) energy access; (iii) energy security; (iv) climate change mitigation and the reduction of environmental and health impacts. According to [9], RETs can be a good approach for contributing local sustainability. RETs can contribute to reduction of local and global pollutions (GHGs emissions), increasing employment, improving asset base (i.e. social/cultural and human) at household level, improving quality of life, increase household income and reducing vulnerability, among others. Based on the analysis, RETs have following characteristics which are central for adaptation to climate change and sustainable development.

They include: RETs produce less or no GHGs.

1. Most of the RE technologies can be deployed at the point of use (decentralized) in rural and urban environments. These technologies serve the local needs – especially the need of women and vulnerable groups;
2. Most of RETs are technically mature, proven and manageable. Deployment of RETs has been increasing rapidly;
3. RETs benefits are helpful to reduce households and community vulnerability.
4. RETs benefits are effective tools that is very likely to contribute to enhance adaptive capacity of people;
5. RETs can be directly used for adaptation activities; and
6. RE technologies, in particular non-combustion based options, can offer benefits with respect to air pollution and related health concerns.

Three theoretical directions (i.e. climate change, sustainable development and renewable energy) have been used to constitute the conceptual framework, since they are found to be complimentary. They can work together as tools for analyzing different aspects the role of RETs on adaptation (Figure 3).

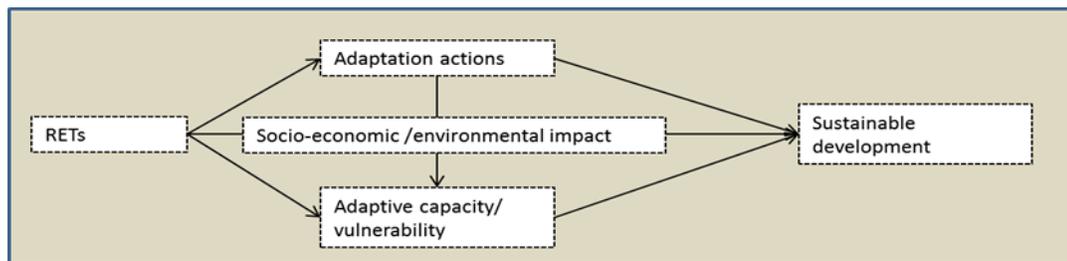


Figure 3: A heuristic model of relations of RETs, adaptation and development

Source: Study findings, 2013

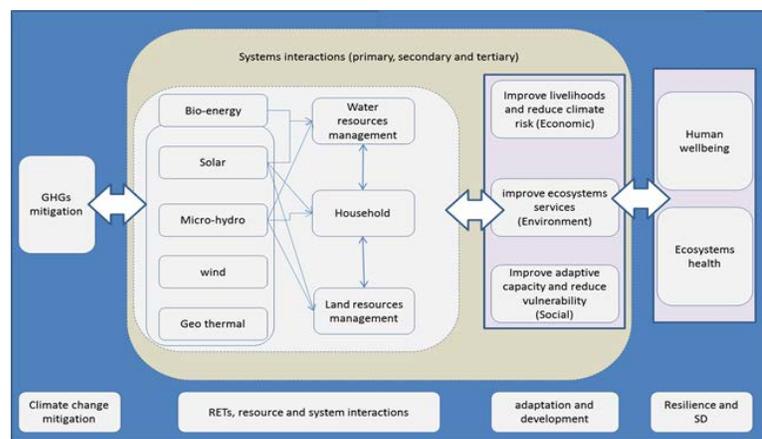


Figure 4: Conceptual framework of nexus of RETs, adaptation and development

Source: Study findings, 2013

For instance, RE provides energy for water pumping and post-harvest processing, which in turn provides new water resource management options and livelihood opportunities. Better lighting expands educational opportunities, improved health condition of human being, reduced exposure to indoor air pollution, reduced the drudgery of women and enhance livelihood options. Collectively these interactions contribute to poverty reduction and increased adaptive capacity for climate change. Adaptive capacity also reflects the resilience of

communities to variability, and change (including but not limited to climate change) and is a function of environmental, social and financial assets and the ongoing capability to transform these assets into human well-being (Figure 4).

#### **4.1. Barriers for integration of RETs and adaptation**

Development initiatives at national and international level have been considering the opportunities of integrating renewable energy systems in adaptation to climate change. Nepal NAPA and the thirteen development plan has recognized role of renewable energy in adaptation to climate change. The literature review, however, showed some challenges and barriers while integrating RETs for adaption to climate change. According to [10], organizing the energy transition from non-sustainable to renewable energy is often described as the major challenge of the first half of the 21st century. Technological innovation, the economy (costs) and policies have to be aligned to achieve full renewable energy potentials, and barriers impeding that growth need to be removed. There are some technology specific barriers and challenges which also affected easy promotion and scaling up of RETs. The major barriers can be grouped as below.

##### **Perspectives and existing development paradigm:**

Although renewable energy is recognized as a critical input to development, the traditional development paradigm has dominated on development plans and programmes to support economic growth. Nepal also followed the development model of developed countries which has been fossil fuel based. Although there have been some changes in thinking of integrating new, clean and efficient technologies, existing structure, institution and mindset are basic barriers to go ahead for integrating renewable energy in development process.

##### **Weak awareness/ knowledge**

The nexus of RETs and adaptation to climate change is in nascent stage. Policy makers do not have sufficient information of priority in national level energy planning and management process. The literature review also revealed that there is a lot of support available on RETs and mitigation research and less priority has been given on RETs, adaptation and development.

##### **Policies and harmonization**

Although the responsibility of managing renewable energy in Nepal rests on a specific ministry, there are many other sectors which are directly and indirectly involved in promotion, use and management of renewable energy technologies and services. Sectoral policies have often different goals in using energy so it has been difficult to get consistence renewable energy interventions across the sector. There has been very weak collaboration and coordination with other sectoral ministries such as agriculture, irrigation, energy and local development. Climate change Policy (2011) has emphasized a need for a renewable energy but the policy is still to be integrated in other sectoral policies. The recent thirteenth plan (2013/14 – 2015/2016) has also emphasized energy as the main building block of the development but, from the past experience, implementation would be questionable. These ‘policy and practice’ challenges are also resonated by other renewable programmes. A study carried out by Solar Energy Foundation also identified various policy gaps including a lack of Renewable Energy Act or similar legal framework to promote RETs. There are no clear policy guidelines, frameworks, methods and tools to integrate RETs in climate change adaptation planning and management. Neither there are viable strategies that consider emerging market regime, investment (both on research and enhancing capacities of stakeholders) and introduction of low- GHG emitting technologies.

##### **Cost of technology and technology innovation**

Technological innovation in renewable energy is a pre-requisite to transform a high fossil fuel based development path to clean and renewable energy based development path. Major technological advances are needed for conditions such as making renewable energy technologies cost competitive. The biggest challenge to promote RETs is upfront establishment cost. There are also other types of cost for the promotion of RETs. They include increased transaction cost of due to decentralized mechanisms, remoteness and dispersed settlements. Other cost may also include potential damages to the economy and other social costs i.e. loss of jobs and livelihoods. According to [11], there is some degree of uncertainty around the costs associated with the wider deployment of RE technologies. The risk of deployment with RE technologies entails longer payback periods, fluctuation or risk in carbon price and the future direction of the carbon market.

##### **Finance and innovative financial mechanisms**

Another important barrier is considered as financing especially accessing and allocating sufficient financing. To promote new and innovative approaches/technologies, up front support is prerequisite. In Nepal, most of the

people, who need immediate supports and where RETs can be promoted, are in remote areas with weak financial condition. For to support this initiative, a combination of financial support mechanisms and finance is needed. There has been a public-private – partnership (PPP) model practiced by AEPC to bring private sector, NGOs, local government institutions, micro-finance institutions and end user together. But, this mechanism is constrained by large scale financing, higher transaction cost and weak risk sharing mechanism (insurance). Besides these, local government institutions (DDC, Municipality and VDC) were not able to discharge their oversight role and appropriate monitoring, evaluation and learning mechanisms have to be fully developed.

### Way forward

Addressing climate change impacts is one of the most important challenges of the twenty-first century. There is no liberty of inaction. Studies, including [12] suggest that the cost of inaction is even costlier. As energy being a major source of GHG, the precautionary early action for reducing the consumption of fossil fuels, and promoting RETs are better and win-win strategies that help to reduce global development cost in both medium and longer run.

Literature review showed that RETs, in addition to reducing the GHGs emission, would positively contribute to socio-economic and environmental aspects that are central to improving the livelihoods of people and ensuring the sustainable development [13-16] The analysis showed that RETs contribute to adaptation processes by contributing on reducing drivers of vulnerability of people (for example increasing energy security and access, improving maternal health) , improving adaptive capacity (for example contribution on education and employment) and addressing climate change risk (for example improving family income and improving soil fertility, soil and water conservation). It is generally agreed that RETs can address risks from climate change and variability as well as development challenges, and can provide the adaptation and development benefits simultaneously. Hence, it is important to make a clear road map to address climate change while supporting sustainable development and green growth agenda through appropriate adoption of RETs. But, these are not without challenges. It is important to proactively engage on improving policy framework, work on reducing cost of technologies, providing financing opportunities (for service providers and end users) and create robust regulatory framework for monitoring and learning.

### Role of RET in GHG Mitigation Potential and Cost in Nepal

Intensive literature review on the GHG emission reduction from the RET, installation potential, cost of the technology, economic life and other parameters were done based on the existing national and international publications and literatures. Altogether 12 renewable energy related cleaner technology options were considered for the analysis of their contribution in GHG mitigation and investment requirement associated with it. The selected RET based on the available data for the estimating the GHG reduction potential in Nepal constitute, biogas, improved cooking stoves, solar PV home systems, solar thermal systems, solar PV pumping, wind electric generator. The study shows that altogether 4.45 million tons of CO<sub>2</sub>e of the GHG emission can be mitigated per year if all the remaining technical potential of deploying seven major RET options consisting of biogas, improved water mill, stand-alone micro-hydro plants, mini-grid micro-hydro plants, solar PV home systems, mud-ICS and metal-ICS were installed after 2012. In terms of shares of the RETs in GHG mitigation, biogas can contribute the most with GHG mitigating potential of 2.29 million ton of CO<sub>2</sub>e (51.4% of the total GHG mitigation potential from RET) with the installation of 822,774 number of biogas plants after 2012 (Figure 5). This is followed by the installation of 898,487 ICS with the GHG mitigation potential of 1.84 million ton of CO<sub>2</sub>e (share of 41.4%). The stand-alone and mini-grid micro-hydro plants can contribute 170 thousands ton of CO<sub>2</sub>e (3.8% of the GHG mitigation potential) by installing 73.2 MW of their combined capacity. IWM and Solar PV home system can contribute 114 thousands ton of CO<sub>2</sub>e (share of 2.6%) and 114 thousands ton of CO<sub>2</sub>e (share of 0.8%) of the estimated GHG mitigation potential from selected RETs by installing 22.7 kW of IWM and 215,903 solar PV home system respectively. Details of the analysis are given in Table 1.

Dissemination of these RET options are constrained by limitation in the existing infrastructure and human resource in the real world implementation. If we consider the average annual installation of these RETs in the recent past three years as the annual installation capacity, it has been found that 19,932 number of biogas plants, 30,711 numbers of ICS, 291 kW of standalone MHP, 2,325 kW of mini-grid MHP, 1,079 kW of IWM and 48,313 number of solar PV home systems can be installed in a year. Considering these, altogether 30.71 million tons of CO<sub>2</sub>e can be mitigated between 2013 to 2030 by deploying above mentioned RET options at an annual additional installation equal to average installation done in recent past three years. The detail of the information is given in Table 2.

This figure is within the range mentioned by other studies by [4], [17], [18] and [19]. The details<sup>104</sup> on the parameters considered, assumptions used are mentioned in the Table 6.2. [19] estimated the total GHG mitigation potential from thirteen different RET and energy efficient options for the year 2020 as 0.83 million tons CO<sub>2</sub>e. This figure is quite low mainly due to the limited number of RET options (solar PV home system, stand-alone micro-hydro plants and improved cooking stoves) considered for estimating GHG mitigation potential. The study used data intensive bottom-up least cost optimization model (MARKAL) for the analysis. [18] estimated the GHG mitigation potential from RET as 1.42 million tons of CO<sub>2</sub> in 2012. It compared the GHG emission due to the penetration of the selected RET technologies between 2000 and 2012. On the other hand, [4] estimated the GHG mitigation potential from RET as 4.98 million ton CO<sub>2</sub>e using accounting approach. Likewise [17] estimated GHG mitigation potentials from intervention of full potential of ICS, biogas and solar PV home system as 8.16 million ton CO<sub>2</sub>e.

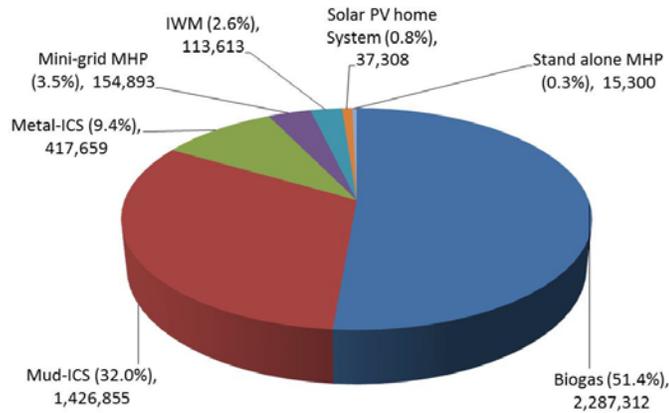


Figure 5: RETGHG Mitigation Potential of Renewable Energy Technologies in Nepal, ton CO<sub>2</sub>e  
Source: Study findings, 2013

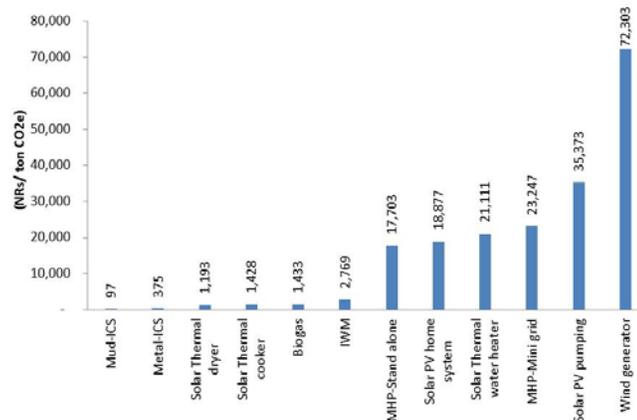


Figure 6: Annualized Technology Investment Cost @ 10% interest rate, NRs/ ton CO<sub>2</sub>e  
Source: Study findings, 2013

In terms of initial technology investment required for implementing above mentioned RET options to mitigate GHG emission, ICS stoves requires annualized initial technology investment cost below NRs 400 per ton of CO<sub>2</sub>e mitigation (Figure 6). Biogas and IWM would require annualized initial technology investment cost of NRs 1,433 per ton of CO<sub>2</sub>e and NRs 2,769 per ton of CO<sub>2</sub>e mitigation respectively. The annualized technology investment cost for mitigating GHG emission from stand alone and mini-grid micro-hydro plants are estimated as NRs 17,703 per ton of CO<sub>2</sub>e and NRs 23,247 per ton of CO<sub>2</sub>e mitigation respectively. Solar PV home system would require the annualized initial technology investment of NRs 18,877 per ton of CO<sub>2</sub>e mitigation. Proper application of RETs not only helps to mitigating GHG emission but also provide multitude co-benefits. The major co-benefits of these technologies can be summarized as follows:

- helps to reduce unsustainable use of fuel wood and thus reduces deforestation and preserve<sup>105</sup> local environment and ecosystem in sustainable manner
- results reduction in the use of fossil fuel (kerosene, diesel, LPG) thus improving energy security and economic vulnerability for net fossil fuel importer country like Nepal
- reduces indoor air pollution, related diseases and improves physical environment of surroundings
- supports the establishment of micro-enterprises like agro-processing, bakery, saw mill etc. in the rural communities
- helps to provide access to information (TV, Radio, Telephone)
- enables saved time to be utilized in income generating and community development activities
- brings about saving on regular expenses (energy, health etc.) of HHs
- supports women empowerment and provides opportunity for education to girl children
- contributes positively to gender and social inclusion
- enhances adaptive capacity to climate change through poverty reduction

Table 1: Technical GHG Mitigation Potential of Renewable Energy Technologies in Nepal

RET	Capacity/unit	Life (year)	GHG mitigation per unit per year (tCO <sub>2</sub> e)	No of installation till 2012	Total Installation Potential	Remaining Potential	Total GHG Mitigation Potential per year (tCO <sub>2</sub> e)	Remarks
Biogas	6 m3 unit	20	2.780	277,226	1,100,000	822,774	2,287,312	Considering saving due to substitution of non-renewable woody biomass as used in CDM PDD of Nepal Biogas Support Program. [4] uses 2.3 ton CO <sub>2</sub> e figure, [20] uses 7.6 ton CO <sub>2</sub> e figures and [18] uses 6.6 ton CO <sub>2</sub> values. The estimated remaining potential is around 29.3% of traditional fuel wood stove users in 2011.
Mud-ICS	two pot hole family size unit	3	1.898	654,639	1,406,421	751,782	1,426,855	Considering saving due to substitution of non-renewable woody biomass as used in CDM PDD of Promotion of the Improved Cooking Stove (ICS) – Nepal. Efficiency of traditional cook stove and mud-ICS were taken as 10% and 20% respectively. [4] used 1.2 ton CO <sub>2</sub> e figure, [17] used 1.09 ton CO <sub>2</sub> e value and [18] used 3.8 ton CO <sub>2</sub> value
Metal-ICS	two pot hole family size unit	6	2.847	8,475	155,179	146,704	417,659	Considering saving due to substitution of non-renewable woody biomass as used in CDM PDD of Promotion of the Improved Cooking Stove (ICS) – Nepal. Efficiency of traditional cook stove and metal-ICS were taken as 10% and 25% respectively.
MHP- Stand alone	per kW	15	2.246	3,189	10,000	6,811	15,300	Assuming estimated rural hh electricity demand for lighting purpose as 18 kWh per month, considering 1 kW serves 13 hh and emission factor for diesel based generation as 0.8 kg CO <sub>2</sub> e/kWh as used in CDM PDD for MHP, the annual GHG mitigation per kW comes out to be 2.33 ton CO <sub>2</sub> e. Shakyra and Shrestha (2006) [20] reported GHG mitigation per kW as 1.04 ton CO <sub>2</sub> e assuming 37.26 liters kerosene being used for lighting purpose by average rural hh.

RET	Capacity/unit	Life (year)	GHG mitigation per unit per year (tCO <sub>2</sub> e)	No of installation till 2012	Total Installation Potential	Remaining Potential	Total GHG Mitigation Potential per year (tCO <sub>2</sub> e)	Remarks
MHP-Mini grid	per kW	15	2.333	33,602	100,000	66,398	154,893	Assuming estimated rural hh electricity demand for lighting and milling purposes as 27 KWh per month, considering 1 KW serves 9 hh and emission factor for diesel based generation as 0.8 kg CO <sub>2</sub> eq/kWh as used in CDMPDD for MHP, the annual GHG mitigation per kW comes out to be 2.33 ton CO <sub>2</sub> e. [20]estimated GHG mitigation per kW as 2.17 ton CO <sub>2</sub> e considering 372.6 liters kerosene being used for lighting purpose and 38.2 liters diesel for milling purpose. [18]reported 1.4 tCO <sub>2</sub> reduction per kW and [4]reported 2.3 tons CO <sub>2</sub> e reduction.
IWM	per kW	10	4.990	10,635	33,405	22,770	113,613	Considering 1 KW serves 33 hh with milling demand of 9 kWh per month and emission factor for diesel based milling operation as 1.4 kg CO <sub>2</sub> /kWh as used in CDMPDD of Promotion of the Improved Water Mills (IWM) in Nepal. [4] mentioned the GHG mitigation per IWM system as 8 tonCO <sub>2</sub> e per year.
Solar PV home system	35 watt peak unit	15	0.173	284,097	500,000	215,903	37,308	Assuming estimated rural hh electricity demand for lighting purpose as 18 KWh per month and emission factor for diesel based generation as 0.8 kg CO <sub>2</sub> eq/kWh, the annual GHG mitigation per system comes out to be 0.173 ton CO <sub>2</sub> e .[20]estimated annual GHG mitigation per system as 0.104 ton CO <sub>2</sub> e assuming 37.26 litres kerosene being used for lighting purpose by average rural hh . [18]mentions GHG reduction of 1 ton CO <sub>2</sub> in its life time. [4]mentioned annual reduction of 0.22 ton CO <sub>2</sub> .

RET	Capacity/unit	Life (year)	GHG mitigation per unit per year (tCO <sub>2</sub> e)	No of installation till 2012	Total Installation Potential	Remaining Potential	Total GHG Mitigation Potential per year (tCO <sub>2</sub> e)	Remarks
Solar PV pumping	1 kW	15	1.780	145			-	Considering annual diesel saving of 606.7 liters per year[20]
Solar Thermal water heater	230 ltr	10	0.280	60,000			-	Assuming in 100 liters of kerosene per year being replaced [20]
Solar Thermal dryer	box type unit	5	0.430	2,396			-	Considering 750 kg fuel wood being saved for drying purpose [21]
Solar Thermal cooker	concentric type unit	10	0.860	1,920			-	Assuming 1500 kg fuel wood being saved for cooking purpose [21]
Wind electricity generator	200 watt peak unit	15	0.209	21 (13.6 kW)			-	assuming one HH use 100 watt for lighting application [20]
<b>Grand Total</b>							<b>4,452,940</b>	

Source: [4, 5, 18, 20-22].

Table 2: Techno-economic GHG Mitigation Potential considering existing RETs installation capacity in Nepal during 2013 - 2030

RET	Capacity/unit	Average Installation per year	2013	2017	2020	2025	2030	Cumulative GHG Mitigation Potential (2013-2030)
Biogas	6 m <sup>3</sup> unit	19932	55,412	277,059	443,295	720,355	997,414	9,475,433
Mud-ICS	two pot hole family size unit	59906	113,699	568,494	909,590	1,426,855	1,426,855	17,429,631
Metal-ICS	two pot hole family size unit	2549	7,256	36,280	58,047	94,327	130,606	1,240,761
MHP-Stand alone	per kW	291	653	3,264	5,223	8,487	11,752	111,642
MHP-Mini grid	per kW	2325	5,423	27,116	43,386	70,502	97,618	927,370
IWM	per kW	1079	5,385	26,924	43,078	70,002	96,925	920,789
Solar PV home system	35 watt peak unit	48313	8,348	37,308	37,308	37,308	37,308	605,797
Total			196,176	976,445	1,539,927	2,427,835	2,798,478	30,711,424

Source: [4, 5, 18, 20-22].

## 5 CONCLUSIONS AND RECOMMENDATIONS

Despite having only 0.025% of total GHG emissions in the world, Nepal is one of the most vulnerable countries in the world from the context of climate change. Nepal has experienced an average maximum annual temperature increase of 0.06°C.

It has been found that renewable energy technologies (RETs) provide socio-economic and environmental benefits to people that contribute for adopting and ensuring better adaptation to climate change based on the local context. They contribute to adaptation processes by contributing on reducing drivers of vulnerability of people, improving adaptive capacity and addressing climate change risk. But, these are not without challenges either. Financial, technical, institutional, policy and legal issues are major challenges to promote RETs.

This studies shows that theoretically altogether 4.45 million tons of CO<sub>2</sub>e of the GHG emission can be mitigated per year if all the remaining technical potential of deploying seven major RETs consisting of biogas, improved water mill, stand-alone micro-hydro plants, mini-grid micro-hydro plants, solar PV home systems, mud-ICS and metal-ICS were installed after 2012. Dissemination of these options is constrained by limitation in the existing infrastructure and human resource in the real world implementation. If we consider the average annual installation of these RETs in the recent past three years as the annual installation capacity, it has been found that 19,932 number of biogas plants, 30,711 numbers of ICS, 291 kW of standalone MHP, 2,325 kW of mini-grid MHP, 1.1 kW of IWM and 48,313 number of solar PV home systems can be installed in a year in Nepal. Considering these, altogether 30.71 million tons of CO<sub>2</sub>e can be mitigated between the periods of 2013 to 2030 by deploying above mentioned RETs at an annual additional installation equal to average installation done in recent past three years. The initial technology investment required per ton of CO<sub>2</sub>e mitigation for implementing above mentioned RETs ranges from NRs 97 for improved mud cook stoves to NRs 23,247 for mini-grid MHP.

This indicates that though moderate level of initial investment is required for promoting RETs, the GHG mitigation potential seems to be quite promising. Besides, introduction of RETs results other co-benefits like reduction of deforestation, preservation of local environment and ecosystem, reduction of indoor air pollutions, improve energy security, increase access to modern energy, contribute to gender and social inclusion etc.

There is no liberty of inaction, so RETs can be good base for a triple win strategy to address mitigation – adaptation – development nexus for climate compatible development in Nepal. All the stakeholders including Government should join hand to create enabling environment to address major challenges related to financial, technical, institutional, policy and legal issues to promote RETs in the country.

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# THE FOREIGN POLICY OF CARBON SINKS: CCS AND REDD+ IN NORWEGIAN CLIMATE POLICY

Jo-Kristian S. RØTTERENG<sup>1</sup>

<sup>1</sup> NTNU – Norwegian University of Science and Technology

## ABSTRACT

This paper investigates the political room of maneuvering that contributed to the establishment and reinforcement of Norway's policies for Carbon Capture and Storage (CCS) and Reduced Emissions from Deforestation and forest Degradation (REDD+) as climate change mitigation strategies. The paper engages with the academic field of environmental foreign policy analysis by examining the relevant features of the international and domestic political systems that constitute the Norwegian climate political room of maneuvering. It is here demonstrated how CCS and REDD+ as mitigation policies fit within these given framework conditions and also accommodate key interests by forming winning coalitions. Findings indicate that conceptual similarities make CCS and REDD+ politically feasible because they to Norwegian decision-makers represent policies that promise climate political effects based on public development assistance or technology R&D support. CCS and REDD+ are thus in contrast to policy tools that may have adverse effects on important structures within Norway's particular political economy.

*Keywords: CCS, REDD+, Norway, climate political room of manoeuvring, winning coalitions.*

## 1 INTRODUCTION

"The Norwegian rainforest funding could, if we succeed, lead to reductions that are manifold Norway's total emissions (...). We must also succeed with carbon capture and storage. (...) With this in combination, we have the potential to cut global emissions by half."  
Prime minister Stoltenberg's 2008 new-years speech [my translation] [1]

Norway's international policy programmes to advance carbon sinks as climate change mitigation options have gained a particularly strong foothold in recent years. In this paper are the drivers that led to the implementation of Norway's international initiatives for Carbon Capture and Storage (CCS) and Reduced Emissions from Deforestation and forest Degradation (REDD+) mapped with the following research question in mind: What decisive forces contributed to the establishment and later reinforcement of Norway's international CCS and REDD+ programmes subsequent to parliament's First and Second Climate Settlements of 2008 and 2012?

### CCS and REDD +: Mitigation options as strategic policy concepts

CCS and REDD + are similar climate change *mitigation options* in that they focus on *sequestration of carbon* in *sinks*, either in in reservoirs underground or in biomass [2, 3]. Both CCS and REDD+ readily intuitive as *concepts* and the IPCC and IEA have highlighted the crucial *emissions reduction potential* of both [4]. These are considered the lower-hanging fruits of the mitigation jungle; REDD+ because it offers incentives to reduce deforestation of tropical forests, and CCS because it allows continued fossil-based energy systems in a potentially carbon-restrained future [5, 6]. CCS and REDD+ have therefore been seen as particularly relevant mitigation options within the limited timeframe of the two-degrees target. Also as a basis for *policy programmes*, do CCS and REDD+ share similarities in that they entail development of new incentive structures, partnerships and institutions: They require clever trans-boundary political engineering to be turned into *effective mitigation policy*. Like other *public policy objectives*, can mitigation objectives be achieved using various *policy tools* and programmes – among which CCS and REDD+ offer two sequestration based means to the policy toolbox. Beyond their complementary status in global climate policy scenarios, the question remains as to whether CCS and REDD+ share particular features that make these concepts particularly attractive to Norwegian policy-makers?

## 2 OUTLINE, ANALYTICAL FRAMEWORK AND METHODS

In order to address the research question above, an analytical account of the key characteristics of Norway's climate change policy since 1989 is offered. The dynamic *framework conditions* are unravelled through four phases ("policy-generations") in an attempt to identify the present *climate political room of manoeuvring* in Norway. The argument is made that the evolving climate policy phases allowed for different policy tools, that accommodated not only national mitigation targets and Norway's international commitments in this regard, but also key interests administered by members of *winning coalitions* that influenced policy development and implementation. A foreign policy approach to mitigation of greenhouse gases holds particular promise in the case of Norway since national policy to a large extent has maintained a global perspective. The fruitfulness of Foreign Policy Analysis (FPA) as a point of departure for the study of public climate policies may also be argued on general terms, as national climate policies are responses to states' obligations under the international climate regime [7-9]. The essence of FPA is the potential to account for the *international political system*, here notably including the international climate regime, as well as the *national level* of decision-making [7, 10]. As part of this approach is an implicit assumption that diverse domestic actors, including government agencies, are seen to pursue separate agendas – thus is the executive government not considered a uniform "black box" [11-13]. Figure 1 below illustrates the climate political decision-making process. The present study is a case study adding to the literature of *environmental foreign policy analysis* [14]. In addition to studies of public documents, is data gathering based on twelve personal interviews with key actors across the executive branch of government, current and former policymakers, representatives from research institutions, NGOs and others that have been parties or close observers to the relevant processes (see appendix X) [15]. The present account of events is based on a minimum of two informants' independent reporting or one written and one oral source of information. Before identifying the framework conditions in which Norwegian CCS and REDD+ were implemented, it is necessary to become familiar with the objectives of these programmes.

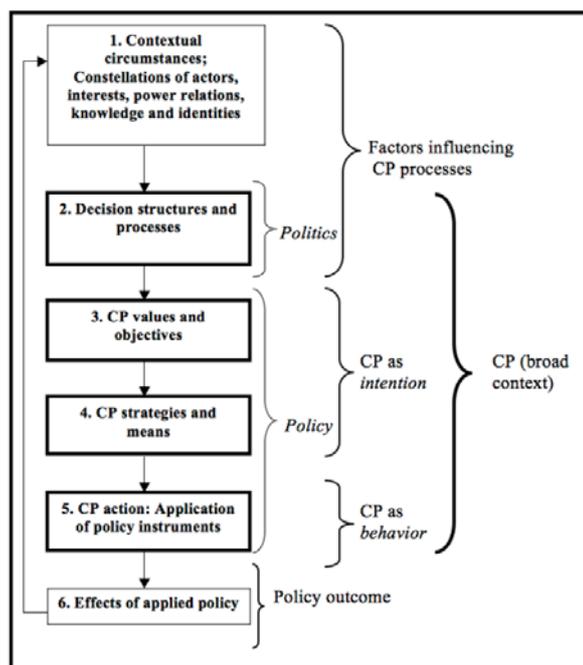


Figure 1. Climate political (CP) decision making based on the model of Foreign policy making [10]

### **The CCS and REDD+ concepts as Norwegian mitigation policy tools**

CCS comprises a *technological value chain* across three stages. The aim is to "capture" and "store" CO<sub>2</sub> away from the carbon cycle in order for it not to end up in the atmosphere and there contribute to climate change. CO<sub>2</sub> is captured from an emissions source, thereafter transported and eventually stored in geological formations as sinks under the seabed or underground [16]. The objectives of Norway's CCS programme are to "reduce national GHG emissions" and equally to "contribute to make CCS

technology available for global use” [6, 17]. Previous research on Norway’s CCS policy covered the field from the onset in the 1980s and to 2005. Focus has been on CCS as a technological means to mediate the national controversy over construction of gas power stations [18-20]. The Norwegian CCS portfolio is accounted for in chapter 5. REDD+ is an *incentive mechanism* under the international climate regime where industrialized countries pay developing countries with forest (forest countries) to avoid deforestation – to maintain or enhance – forests as carbon sinks [21]. Norway’s REDD+ initiative seeks to contribute to the inclusion REDD+ in a new international climate regime; generate early reductions of emissions from REDD+; and finally; contribute to the conservation of natural forests in developing countries [6]. The few previous studies of Norway’s REDD+ efforts have pointed to Norway’s dual external image, on the one hand is a global petroleum exporter, on the other hand a seemingly altruistic nation guided in its priorities by a “peace and engagement policy” [22, 23]. To my knowledge have no contributions examined Norway’s CCS and REDD+ programmes as competing or comparable mitigation policies, nor seen either of these in a broader national climate political context post 2008.

### 3 THE CLIMATE POLITICAL ROOM OF MANEUVERING: FOUR GENERATIONS OF NORWEGIAN CLIMATE POLICY

#### **1<sup>st</sup> Generation: Sustainable development and lead by example**

In 1989, parliament decided that the Norway’s greenhouse gas emissions would be “stabilized at 1989 level by the year 2000” [24]. This was prior to the initial formation of the international climate regime (UNFCCC) [24], as followed in the wake of the “Brundtland report”, which promised economic growth compatible with environmental integrity. Norway would lead by example in climate action by reducing its national emissions [25]. With the ultimate objective in place, and an approach to environmental policy-making assuming economic growth compatible with green targets, what remained was for policy-makers to agree on the means necessary to get there. Focus was on macro-economic sanctions and a carbon tax applicable at the national level. A sector-specific carbon tax was soon imposed to take effect from 1991 [26]. However, at the same time was the offshore petroleum industry undergoing significant expansion, resulting in soaring CO<sub>2</sub> emissions [27]. In 1991, an Inter Ministerial Working Group highlighted the potential conflict between petroleum industrial expansion and the “stabilization target”. The advice was that an *international carbon tax regime* would solve the climate problem more *efficiently* than a national approach [28, 29]. It effectively determined Norway’s positions to the regime negotiations. Soon was the era of the *national system scope* and *national carbon taxation* over, of what we may call *the 1st generation Norwegian mitigation policy*.

#### **2<sup>nd</sup> Generation: Global cost-efficiency and technology solutions**

This shift towards an *international scope* and *global cost-efficiency* became a political solution to what has since been the fundamental *Gordian knot* in Norway’s climate policy-making: How to reconcile responsible climate policy with a growing petroleum sector? [9, 30]. A monumental example of this conflict was the so-called “gas power issue” during 1990-2005 - namely the controversy over construction of natural gas fuelled power stations in Norway [31].<sup>1</sup> Its proponents framed gas power as a contribution to reduce emissions in a global perspective since natural gas allegedly would replace coal and cause fewer emissions abroad [25]. This “pro-gas argument” was central in legitimizing the *international* and *market-based quota approach* as means to achieve cross-sectorial, trans-boundary cost-efficiency in mitigation action.<sup>2</sup> The effects were soon evident as the “stabilization target” was officially abandoned in 1995 [32] on the basis of an anticipated 90% increase in emissions from oil and gas production in the period 1990-2010 [33]. CCS during the 1990s became a technological answer to the domestic gas power divide [18]. The technology was considered immature, however, and while allowing gas power stations, the government also established a CCS R&D programme in 2001 [34]. CCS stood out as promise as how new technology could be introduced to solve an

<sup>1</sup> Proponents of gas power, main industry actors, trade unions, and a pro-growth majority in parliament, wished for industrial expansion and abundant electricity based on natural gas refinement on Norwegian soil. Opponents, mainly environmental organizations and a pro-conservation minority in parliament, would not accept new domestic emission sources given the stabilization target and subsequent obligations under the climate regime.

<sup>2</sup> The argument was that quota trading would ensure optimal cost-efficiency in emissions reductions, at low administrative costs

environmental-industrial conflict without confronting powerful sector interests [30]. This *2<sup>nd</sup> generation Norwegian mitigation policy* also made a substantial imprint on the international level. Norway and its negotiating block succeeded with the Kyoto protocol in having an international regime that accepted a principle of cost-efficiency. The push for a quota approach domestically and internationally led to the implementation of a national quota market from 2005 and, from 2008, participation in the EU Emissions Trading Scheme (EUETS) [35]. The *2<sup>nd</sup> generation climate policy* thus attempted to cover potentially conflicting needs on two levels. First, there was at the national level a need to harmonize policy means that would accommodate the environmental-energy Gordian knot. Second, Norway worked on the international level for a flexible international regime that would allow for Norway's ambition of uniting its role as a petroleum energy producer with being an environmental frontrunner. With these framework conditions in place at the national level, and eventually paralleled by the flexibility of the climate regime, entered Norwegian climate policy into a phase where technological solutions like CCS could narrow the divide between proponents of the 1<sup>st</sup> generation climate policy and the prevailing advocates of the 2<sup>nd</sup> generation approach. CCS was here to function as "political glue" to reconcile the strategic energy-environmental Gordian knot [18].

### **From 1<sup>st</sup> to 2<sup>nd</sup> generation: Institutionalized sector interests and experts shift climate policy**

Studies of what I label the 1<sup>st</sup> and 2<sup>nd</sup> generations of Norwegian climate policy highlight that sector interests matter and so do political resources like organization and expertise. This applies to the extent that one may speak of key sector interests as networks and complexes, also including epistemic communities that research and rationalize policy instruments capable of harmonizing the dividing cleavages in Norway's climate political landscape [36]. Not only did private actors' positions depend on their individual interests, but also politicians, NGOs and government ministries fended for the sectors for which they had responsibility. An effect was that potential positive-sum outcomes at the macro level, as prescribed by systems oriented theory, did not materialize [37]. This is not entirely surprising, since positive-sum outcomes at the macro level may cause negative effects at sector level that, in turn, motivate actors to influence policy development and implementation. A crucial example is the effectiveness of a *policy network* around Norway's mainland industry, an extension of the Norwegian *corporative channel*, as the main reason why domestic industry could remain exempt from the carbon tax in the 1990s [38]. However, in the gas power debate did industry, trade unions and the pro-industry political parties join forces not only to resist policies (carbon tax), but also to advocate gas power plants. The petroleum industry itself has also been accepted as a key determinant of the national climate political room of maneuvering and, together with the "gas argument" and effective mainland industrial resistance; as the reason Norwegian climate policy was revised into the 2<sup>nd</sup> generation [27, 39]. This solution to the Gordian knot suggests the influence of a powerful petroleum industry with supportive actors in government, research institutions and others. The same alliances whom in the early 1990s sought to replace national carbon taxation with a quota scheme, were the same who later proposed technology development in order to reconcile the Norwegian climate policy goals with their joint petroleum-industrial interests [34]. As suppliers of terms did the Ministry of Finance, Statistics Norway and related analysts, provide a social economic system of knowledge that greatly facilitated the 2<sup>nd</sup> generation climate political thinking [30, 40, 41] Their logic of global cost-efficiency was soon supported by the mentioned sector interests [38, 42].

### **3<sup>rd</sup> generation: New targets and a call for action - CCS and REDD+ to the international stage**

A majority coalition government led by Labor's Jens Stoltenberg took office in 2005. New climate policy was needed now that the Socialist left party for the first time entered government and ran the Ministry of Environment (MoE). With climate change again high on the agenda, and the 2008-2012 Kyoto period approaching, there was a need to consolidate Norway's climate policy. Further, the regime negotiations in 2009 were expected to deliver a final global post-2012 climate regime, in which Norway needed clear positions. The result was the 2008 cross-political First Climate Settlement in parliament [43]. It set forth the 3<sup>rd</sup> generation of Norwegian climate policy, characterized by what could be termed the duality of the *negotiation track* and the *action track* within the 2<sup>nd</sup> generation's global cost-efficiency framework. The national emissions target of the First Climate Settlement was to reduce Norway's emission by 2020 to 70% of 1990 levels – or 60% if part of an ambitious international regime. By 2030, Norway would go carbon neutral if part of an ambitious international

regime [43]. These targets were guided by Norway's commitment under the UNFCCC as contributions to the "two-degrees target". In order to reach this objective was the negotiations track, covering Norway's efforts for an internationally binding climate change regime based on cost-efficiency, of primary importance. Second were CCS and REDD+ the international flagship initiatives of the *action track*. The settlement to this end entailed a clear objective that Norway "shall become a leader on environmental development assistance" [my translation] [43]. From now would Norway's climate policy be closely tied to development policy, in particular within the areas of CCS, REDD+ and energy technology (separate from the purchase of CDM quotas led by the Ministry of Finance). Since most of this funding was from the Official Development Assistance (ODA) budget, it meant that the Ministry of Foreign Affairs (MFA) now became more involved. The Norwegian climate political toolbox was thus expanded with a significant *international action* compartment. This political innovation was highlighted in that the Minister of the Environment also became Minister of Development Cooperation.<sup>3</sup> This did not challenge to the status of the 2<sup>nd</sup> generation's global cost-efficiency paradigm. Rather, its logic continued to determine what technological or external solutions were viable. This topic will be further pursued in the cases of CCS and REDD+ below.

#### 4<sup>th</sup> generation: What is meaningful action when the climate regime remains uncertain?

While few have studied Norwegian climate policy post 2008, there is reason to assume that the central structures have remained since [42]. Two exemptions were of international character: For one, the global economic crisis from 2008 lowered the global sense of urgency in climate action and available resources. Second, and most importantly, the fate of the international regime post 2012 became unpredictable after UNFCCC negotiations stalemated in 2009. The level of ambition for a global regime significantly lowered and its anticipated implementation was delayed until 2020 when negotiations made new progress in 2010. A Second Climate Settlement was reached in 2012 [6, 44]. It reaffirmed existing policy, while underlining the need for international *action* to facilitate the *negotiations* towards a globally binding regime. On the domestic level did the Second Climate Settlement increase R&D funding for technology and emphasize sector-wise "climate aligned" plans, without indicating anticipated effects in terms of tons of avoided emissions. This put new emphasis on Norway's *action track* but with only minor changes to the contents of the policy toolbox. This brief account of Norway's climate policy suggests a climate political room of maneuvering that has evolved as actors and sectors entered the climate political stage. The lessons from the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> generations of Norwegian climate policy revisions are that policy tools to Norway's ambitious policy goals need to accommodate the conflicting environmental-petroleum Gordian knot at a minimum at the domestic level, and ideally also at the international level. The chance for implementation increases if ODA or technology R&D resources are mobilized and, finally, if the promised results are of a character that contributes to regime formation through international cooperation or remain meaningful even if a binding international regime is further delayed. Table I below offers a schematic of these analytic accounts. The following chapters introduce CCS and REDD+ to this framework.

*Table 1: Main features of Norway's climate policy 1989-2014: Shaping the climate political room of maneuvering across 4 generations of policy revisions*

Generation label	Policy objective	System scope, preferred solutions	Key added policy tools	Selected Influencing factors	Previous labels given in literature
1 <sup>st</sup> gen - 1989-1995	Stabilize Norway's emissions at 1989 level by 2000 [24]	National, Lead by example	Initial carbon tax imposed	The Brundtland Report [45],	"The tax discourse"[30], "Act locally" [25]

<sup>3</sup> A final domestic highlight of the Climate Settlement covered the government's sector-specific efforts, notably including subsidies for renewable energy and incentives for phasing-in of electric vehicle. The contents of the Climate Settlement have also been labeled as the climate policy "that vanished" in that scant instruments were introduced to alter the steady growth of emissions in Norway, primarily from the petroleum sector.

2 <sup>nd</sup> gen - 1995-2008	Contribute to the objective of the UNFCCC [33]	Global, cost-efficiency within global cap  Domestic technology development	Domestic CCS R&D programme  Domestic, regional and global quota markets  The Mongstad projects	“Unacceptable” marginal costs from unilateral cuts  Flexible mechanisms in Kyoto Protocol  Gas power debate	“The quota discourse”, [30]  “Think globally.” [25]  “Climate policy becomes innovation policy” [34]
3 <sup>rd</sup> gen - 2008-2012	The First Climate Settlement:  70% of 1990 levels by 2020 and 2050 carbon neutral [43]	Global, cost-efficiency within global cap  Technological solutions,  Climate development assistance	Regional and global flexible mechanisms; EU ETS, CDM.  Global mitigation solutions: CCS and REDD+  Renewable energy subsidies, Electric vehicles phase-in  International CCS strategy.	Stern review coupling deforestation with climate <i>and</i> CCS as global solutions  Nobel Peace Prize awarded IPCC, increased scientific evidence,  2008-2012 Kyoto commitment period,  Expected global agreement post-2012	“The technology discourse,” [30]  “The vanished climate policy” [42]
4 <sup>rd</sup> gen – 2012-	The Second Climate Settlement: Previous target reaffirmed. [44]	Global but weak prospects for global regime  Technology solutions,  Climate development assistance	REDD+ prolonged thru 2020  Full-scale CCS project 2020-ambition maintained  Firming of domestic technology fund.	Post 2009, prospects of a weak global post-2020 regime  “Second Kyoto commitment period” implemented  CCM cancelled	

#### 4 CCS AS NORWEGIAN CLIMATE FOREIGN POLICY

By the 2008 First Climate Settlement, the Norwegian CCS portfolio already comprised three action tracks. The first of these was deployment of full-scale CO<sub>2</sub> separation and storage at the Sleipner gas field in 1996. This was a solely industrial response to the CO<sub>2</sub> tax regime based on industry know-how, so and only later “discovered” by the government to become the basis of Norway’s CCS policy (although CCS had first been introduced in the 1980s by SINTEF researchers). Similarly in 2004, as part of its terms for concession, was the Snøhvit LNG plant set up for full-scale CO<sub>2</sub> separation and storage. The Sleipner and Snøhvit experiences contributed significantly to the standing of CCS in Norway, in particular to CCS as a solution to the Gordian knot when petroleum industrial expansions were confronted with climate arguments [19]. The second and third CCS action tracks were specific responses to the domestic gas power debate in the 1990s and early 2000s: The second track, the R&D-track, started with the launch of the public CCS R&D programme from 2001, as a mediating action after the government eventually allowed construction of natural gas power plants. A third track of hands-on involvement was started in 2004, when the government’s CCS investment agency, Gassnova, was established. The paramount activity of this track was the government’s remarkably deep involvement in the CO<sub>2</sub>-capture Technology development Center at Mongstad (TCM) and full-scale Carbon Capture Mongstad projects (CCM) of 2006. Significant public investments in CCS technology development here became a necessary means to allow the construction of a natural gas power plant [17]. The Mongstad CCS project was a consequence of site owner Statoil’s ambition for a new natural gas power plant at Mongstad and the government’s position that any new such plants would be “CCS-based.” It is clear that the Mongstad projects primarily were a case of gas power implementation with CCS as an add-on. If CCS development and implementation were the primary objectives, as some have argued, then would a different less complex site been chosen for this first-of-a-kind full-scale endeavor – possibly also with other configurations of actors, as was highlighted by the parliamentary hearing on the issue [46, 47].

#### Making CCS count on the international stage

Finally, a fourth track was added with the First Climate Settlement. Now CCS found its way to the international action climate political toolbox introduced above. As part of the Settlement, the

Norwegian government developed an international CCS strategy in order to build global momentum for CCS [48]. Important countries, notably including key developing countries, needed convincing to see CCS as a legitimate or safe mitigation option, in which efforts Norway took a prominent role. This, for one, resulted in active diplomatic and high-level participation in international forums on CCS, energy and climate change. Second did CCS find its way to the ODA budget, and as such, entered the realm of the MFA, mainly aimed towards “capacity building” in developing countries. Also a World Bank trust fund was initiated by Norway to this end, funded by both ODA and the Ministry of Energy and Petroleum (MPE). This way would the World Bank gain a “CCS agency” that was helpful in order to build international support for CCS. An important aim of these efforts was to have CCS included in the Clean Development Mechanism (CDM) of the UNFCCC. As a technology neutral regime, the UNFCCC in general leaves choice of mitigation options to the parties. Its CDM mechanism, however, had a clear set of accepted activities. The global standing of CCS would be reinforced if it were allowed into the CDM. CCS was finally included in the CDM in 2010 after extensive debate [49, 50]. Other Norwegian international CCS funding was offered Eastern-European states as part of “The Norway grants”, Norway’s entrance fee to the EU market. Most notably was approx. USD 200 million offered to a Polish full-scale project in 2009 [6]. Norway’s CCS efforts have since the beginning been led by the Ministry of Petroleum and Energy (MPE) in close cooperation with the Prime minister’s office.

### **Norway’s CCS policy towards 2020 – the 2013 reset**

On the domestic level, an effect of the international turn in Norway’s CCS policy was that *technology development* for a global market increasingly became center of the CCS efforts - and arguably so at the expense of national emission reductions from the full-scale CCM. The argument was that a global market would demand Norwegian CCS technology developed at the TCM. My sources are divided in whether this “technology focus” was a consequence of the repeated delays and cost-increases of the CCM full-scale project. The CCM was abandoned in 2013 on the argument that it would be too costly to facilitate international replication. Other full-scale CCS projects globally were also cancelled in the 2010-2012 period, before investment decisions were taken. It has been argued that the framework conditions, mainly in terms of a carbon price, have been insufficient. My informants report that Norwegian policy-makers’ emphasis on CCS in international forums decreased accordingly. Still, the new 2013 Solberg minority government commitment to materialize a full-scale CCS plant by 2020, to which an updated CCS strategy is to be presented in 2014. This ensures the continuation of CCS as an important mitigation policy track in Norway.

## **5 HOW REDD+ BECAME NORWEGIAN MITIGATION POLICY**

Climate change was in 2007 again high on Norwegian and international policymakers’ agendas when the First Climate Settlement was being negotiated: Al Gore and the IPCC was awarded the 2007 Nobel Peace Prize, the IPCC’s 2007 Fourth Assessment Report (AR4) had underlined the importance of mitigation action and the 2006 Stern Review showed that early mitigation action would cost less than to wait. This context put pressure on politicians in position and opposition alike. As an innovation, the Stern review expanded the “mitigation pie” to also include deforestation: The argument was that incentives to end tropical deforestation would be among the lowest hanging mitigation options to yield globally significant emission cuts [5]. In Norway had environmental NGOs, Rainforest Foundation Norway (RFN) and Friends of the Earth Norway, picked up this message. Being aware of the Norwegian focus on cost-efficiency in mitigation action, the two NGOs in parallel presented the idea to the Social Left party in government and the opposition Conservative party: Norway should with its Nordic neighbors launch a large-scale initiative to end deforestation. The Conservative party soon presented the concept among its demands for any Climate Settlement. The Social Left party argued for same cause within government, but no definitive position was flagged. Behind the scenes were the coalition partners disagreeing on how such an initiative could find funding and the Nordic neighbors were hesitant. The labor party claimed that the “rainforest money” should be ODA, while the Social Left party argued for this being a “climate initiative” in need of new additional funding [51]. Towards the end of the year were the UNFCCC negotiations at Bali approaching, where little progress had been made lately. At Bali, Norwegian Prime Minister Jens Stoltenberg announced that Norway would provide up to USD 500 million annually to avoid

deforestation in developing countries in order to reduce emissions. With this were the government of Norway's Climate and Forest Initiative (NICFI) born. The international reception was exceptionally good, to an extent that took the Norwegian delegation by surprise. On the domestic stage was the political opposition surprised and felt that the government had "taken" their proposal. NICFI soon became part of the First Climate Settlement. Its funding plan was a compromise within government: It was to be ODA but in addition to the existing budget. This solution was possible since the government's policy was already that the ODA budget should reach 1% of Gross National Income (GNI). GNI was expected to grow over the coming years and so would ODA. This made it possible for novel policy-initiatives and serves as a main explanation why NICFI could be established in record time. It is also noteworthy how this initiative came from NGOs and directly to ministers in government. The proposal was not pre-treated in bureaucracy in MoE or MFA but came top-down based on the NGO proposal. Contrary to previous climate policy would the Ministry of Finance not question new initiatives that were within the set "ODA frame". With the Social Left party holding the Ministers of Development Cooperation and Environment, and of Finance, this meant that the party had apt influence on the profile of ODA. A joint MoE-MFA project group was set up and NICFI gained traction. In 2008 were partnerships established at the highest-level of political attention, including a USD 1 billion worth bilateral partnership with Brazil and a USD 500 million initiative with the UK on the Congo Basin. In 2010 a USD 1 billion bilateral partnerships with Indonesia was added, in addition to a USD 250 million agreement with Guyana, and later smaller arrangements with other countries followed. In addition came <USD 400 million support to and through the newly set up multilateral UN and World Bank REDD+ structures; support for global civil society organizations, and; active participation in the UNFCCC REDD+ negotiations track [52].

### **The politics and success of the REDD+ initiative**

The initiative became a hybrid of a Payment for Eco-systems Services scheme (with carbon stock maintenance as the service in demand) and traditional project-based ODA. This was also reflected in the initiative's joint climate and development goals: NICFI would contribute to a UNFCCC REDD+ mechanism, measurable emissions reductions *and* poverty alleviation [6]. NICFI's approach was based on phased "results-based payments" [53] The ultimate aim was that demonstrated avoided deforestation at national level in the forest countries, in tons of CO<sub>2</sub>-equivalents, would provide the basis for NICFI payments. Yet, funding were in initial phases of projects granted up-front for preparatory activities and institutional framework. MoE had project lead, while the MFA was responsible for ODA expenditure and the mandatory "development effect" of any ODA venture. This arrangement attracted some criticism, both in terms of its choice of partner countries, its "results-based" approach and its allegedly too excessive climate focus at the expense of development objectives. This mainly came from development policy actors in Norway, as within the traditional ODA bureaucracy [22, 23]. However, NICFI's wide international partnerships, spanning from top political leadership in forest countries and multilateral organizations, to local NGOs and international research foundations, supported the initiative. Various "co-benefits" related to rainforest protection, beyond reduced emissions, mobilized different stakeholders. Also national NGOs, WWF and RFN in particular, were included to take part in policy development – and sometimes even to take formal roles, as in the case of the Guyana partnership. Ownership among national NGOs, broad international acclaim from various stakeholders, and reduced deforestation results in Brazil (and Guyana), gave NICFI status as a successful initiative in the lead-up to the 2012 Second Climate Settlement [54]. This was in spite of limited financial contributions from other donor countries. Norway's annual USD 500 million commitment remained by far the largest contribution to REDD+ from any country during 2008-2013, and it was clear that Norway could not pull off a global REDD+ mechanism "alone". Still, and despite limited success on this important success criterion, did the new Solberg government that took office in 2013 prolong NICFI thru 2020 at the same level of funding. The motivation was that the "job was not done" and that NICFI had had unprecedented success so far, also as a contribution to the climate of the general UNFCCC negotiations [55]. With this was the future of Norway's REDD+ initiative secured up until a global mechanism under a new regime would take over post-2020. NICFI represents a primary example of the 3<sup>rd</sup> generation *international action* mitigation policy, based on assumed cost-efficient in maintenance of tropical rainforest as carbon stocks, paired with positive non-climate effects of rainforest protection. This REDD+ approach to carbon sequestration has remained

particularly powerful in the Norwegian context. As we have seen, this is much grace to a combination several features, notably including: Norway’s aspiring climate political targets; its domestically tight climate political room of maneuvering; availability of large-scale ODA funding; mobilization of wide rainforest-supporting alliances on various levels. Some informants also added that NICFI’s “results-based” national approach has contributed to its perceived success among political decision-makers; NICFI pioneered an approach to be replicated by other Norwegian development political initiatives.

## 6 CONCLUSIVE REMARKS

The cases of CCS and REDD+ demonstrate how the search for climate political solutions within a narrow room of maneuvering due to strong (vested?) interests at the national level, has highlighted *ODA* and *R&D* as areas that may yield climate political results in terms of *implementation*. This is particularly relevant as these approaches provide political solutions to the particular Norwegian energy-environmental Gordian knot. More research is needed, however, in order to identify the *effects* of these applied policies – of whether these strategies successfully have balanced Norway’s environmental and energy interests and provided effective mitigation action. Finally does this text on the Norwegian decisions and international implementation of REDD+ and CCS as mitigation strategies, indicate five findings: First, both the REDD+ and CCS concepts fit particularly well within the Norwegian climate political room of maneuvering that resulted in the 2<sup>nd</sup> generation climate policy: At the *national level* they seem to combine Norway’s strong climate change objectives with “actions” that are not at the expense of the existing energy-political economy. This becomes particularly evident in that Norway’s CCS and REDD+ policies have stood firm even when the global context has changed, as with events like stalemate in UNFCCC negotiations, global economic crisis and fallen EUETS carbon price, limited REDD+ funding from other countries or low international momentum for CCS. It was a *national* goal to reach an ODA budget sized 1% of GNI, and the Mongstad projects was the result of *national* stakeholders’ ambition of constructing gas power stations. Similarly, on the international level are both concepts seen as relevant contributions to mitigating climate change, in that both are “accepted by the UNFCCC” and hold significant emissions reduction potential if deployed at scale. Second, both fit within the scope of what I have labeled the 3<sup>rd</sup> generation climate policy: These are policy programmes along the action track and with an international footprint. ODA and R&D funds can thus be mobilized to build momentum for Norway’s climate policy objectives. Fourth, due to their features listed above, both concepts remain relevant in a context where the outskirts for a binding global climate regime are lowered. This is an important feature of 4<sup>th</sup> generation of Norwegian climate policy. Fifth, and overarching the above; both policies were in Norway and internationally able to mobilize actors focusing on the various “co-benefits” related to their deployment, these were the winning coalitions. The list of mobilized arguments and actors is long in both cases. Finally, this text is a contribution to encourage future research on carbon sequestration concepts as mitigation policy. As such may this text serve as a starter to the inquiry of whether carbon sequestration is politically more feasible than other more radical mitigation policy option, and in case; for whom?

## X LIST OF INTERVIEWEES

Informant A: Adviser to the Stoltenberg II government

Informant B: Minister of the Stoltenberg II government

Informant C: Representative of Bellona Foundation

Informant D: Representative of the Ministry of Climate and Environment 1

Informant E: Representative of the Ministry of Climate and Environment 2

Informant F: Representative of the Ministry of Foreign Affairs 1

Informant G: Representative of the Ministry of Foreign Affairs 2

Informant H: Representative of the Ministry of Petroleum and Energy

Informant I: Representative of Rainforest Foundation

Informant J: Representative of SINTEF

Informant K: State secretary of the Solberg I government

Informant L: State secretary of the Stoltenberg II government

Informant M: Representative of the Research Council of Norway

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# AN INTERACTIVE WORKFLOW FOR URBAN SOLAR DESIGN APPROACH: A CASE STUDY OF NORWAY

**Gabriele LOBACCARO**<sup>1</sup>

<sup>1</sup>Research centre on Zero Emission Building/Smart Cities; Department of Architectural Design, History and Technology; Faculty of Architecture and Fine Art; NTNU Norwegian University of Science and Technology; gabriele.lobaccaro@ntnu.no

## ABSTRACT

The paper presents an interactive workflow of a new urban planning approach controlled by electronic devices. It presents how could be conducted a feasibility study for preventing the overshadowing effect on a building's façade in a case study located in a high urban density area of Trondheim (Norway). The workflow simplifies the communication between experts and clients combining the digital language and the technical analysis. The real time manipulation and analysis of the 3D building's model using the generative modelling software (Rhynoceros/Grasshopper) and solar dynamic simulation tool (Radiance/Daysim), was developed for evaluating the solar potential of the buildings for different geometric configurations created by iterative parametric design transformations in every urban scenario and locations. The results demonstrate how an alternative design configuration could reduce the overshadowing effect on a building conducting a preliminary multi-level simulation during the early design phases. A future development of the work will be an app for tablets and smartphones used by experts in supporting decision making during the project.

*Keywords: solar optimized design, generative modeling tools, solar mapping, solar dynamic analysis.*

## 1 INTRODUCTION

Nowadays three-quarters of the world's population live and work in urban areas [1]. The cities became complex environmental systems, where the urban density is dramatically increasing. They are responsible to 75% of energy consumptions and 80% of CO<sub>2</sub> emissions [2]. The European Performance of Buildings Directives established the energy policy's targets for achieving the 20% emissions' reduction, the increase of 20% of renewable energy and 20% of energy efficiency. The urban regulations are going towards the land use's reduction, favouring the exploitation of the sites within the existing urban environment for a compact city model. The experts should cooperate in order to provide design strategies for increasing the quality of the cities and the solar potential of the urban areas as well as the use of renewable energy [3]. Improving the solar access of the buildings creates more solar gains and energy production through the solar integrated systems which contribute to cover a percentage of energy demand of the buildings [4]. The new buildings in existing urban areas should be well oriented in order to increase the solar access of the façades for installing the solar systems in order to provide as much energy as possible. It allows reducing the cooling loads in warm climates or the heating losses at high latitudes. A recent study demonstrated that the solar systems' installation in cold climate conditions can be technically and economically efficient. The PV's use in building or landscape scale is important in order to achieve the European 2020 energy goals. The use of solar systems in the Northern Europe has so far been discouraged due to the long darkness period, the different sun path and by the logistic and economic issues in installing solar systems [5]. The energy production through the integrated solar systems in the building envelopes can be reached by the optimized design process increasing the solar exposure and reducing the overshadowing effect in the city. The integration of solar systems is a complex operation in urban areas due to their high density: it is necessary developing design solutions in order to facilitate their installation and for incrementing the buildings' solar potential. The International Energy Agency - Solar Heating and Cooling Task 51 "Solar Energy in Urban Planning", is developing strategies for increasing the solar potential in urban areas supporting the integrated solar technologies for buildings. In the subtask B processes, methods and tools have been studied in order to provide new supportive design instruments for urban planning.

## 2 AIMS

By bridging the gap between design and solar analysis software, the paper presents a study of solar optimization of a building using a workflow that combines them. The methodology was developed in a PhD dissertation [6] and used in some previous works [7] [8] [9] [10] [11]. The case study is located in the centre of the NTNU Gløshaugen campus in Trondheim (Norway), where two tall buildings are positioned in front of each other in the North-West/South-East direction. In several days of the year the shadow created by the *Building 1*, covers the South-East façade of the *Building 2* (Figure 1).



Figure 1. (From the left) View of the South-East façade of the *Building 2* from the morning to the afternoon on the 19<sup>th</sup> of January 2014

The work aims to propose a feasibility study that could be conducted in the early design stages in order to prevent the overshadowing effect on a building's façade. A digital language workflow was used in order to achieve the optimized configuration of the building, reaching both: the improvement of its solar availability and the minimization of the overshadowing effect. The workflow consists in a user-friendly application that allows automatizing a complex process for solar potential in urban environment. It allows achieving different goals: optimize the shape of a new building in urban area [7] [10], and minimize the overshadowing effect created by the buildings on the surrounding [11]. The process permits to reach the solar optimized building's shape through parametric transformations and inspire the use of solar integrated strategies in urban scenarios. This new urban design approach was used in this study in order to achieve the following objective:

- Guarantee the solar access of the *Building 2*, optimizing its volume and minimizing the overshadowing effect caused by the projection of the shadow of the *Building 1*.

## 3 METHODOLOGY

The workflow is composed by logical and iterative steps combining generative modeling tools with solar dynamic simulation software (Figure 2). It intends to convey a valuable experience in using tools to know how they could help the experts in developing the project from the early design stages. In literature there are some definitions that combine modelling tools and analysis software for visualizing the simulations' results in 3D [12]. Using a similar approach was developed the workflow: it aims to provide a useful instrument for urban planning in order to estimate the solar potential of the buildings. It optimizes a building design shape and their solar access in order to exploit as much solar radiation as possible on the building envelope and localize the suitable areas for installing solar integrated systems. The process starts from the initial volume's configuration, fixing the urban parameters such as number of buildings' storeys, volume, footprint area and buildings' height. It can also possible to modify the generative parametric transformations like the floors' twist, sets from 45° West to 45° East, and the global building's slope from the vertical direction on South, East and West directions, changing from 0° to 20°. The graphical interface controlled by electronic devices allows the users to manage and visualize in real time all parameters and geometric transformations of the volume's configurations. The results are automatically updated and exported in Excel or Matlab: thus the experts can show to the clients the advantages of the design solutions in terms of solar access and energy production. The process was set for finding the best volume's configuration with the highest value of solar radiation on the building envelope, considering the overshadowing effect and the mutual solar reflections created by the surrounding. It is based on Rhinoceros' visual interface, a three dimensional NURB surface modelling software that generates complex shapes, and a visual scripting created by Grasshopper, a graphical algorithm editor. It is used in the modelling phase, given its capability to generate complex geometry transformations. The urban surrounding can be imported directly from GIS or photogrammetric data, using the Grasshopper's plug-in horsterReference. The

terrain profile and the buildings' surfaces are automatically imported by type, layer or other attributes from Rhinoceros to Grasshopper. The definition permits setting the urban parameters and the geometric transformations, in order to modify the volume's configuration. The users can vary their values within the set ranges, according to the urban and structural limitations. Others settings are directly fixed by the users, such as the uploading of the EnergyPlus weather data climate files for any location. The parametric transformations are linked using Galapagos Evolutionary Solver. This plug-in allows fixing the parameter that the users want to maintain constant during the all parametric transformations: in this case the volume has been fixed. A graph math multiplier element permits changing the all parameters and transformations following different analytic equation: linear, parabolic, etc. The communication between computer and devices was solved using a Grasshopper's gHowl plug-in [13]. It permits the information's exchange between applications and physical devices. The user-definable OpenSoundControl (OSC) [14] allows the communication with external tools and programming languages via OSC messages. TouchOSC is the software used for creating the control interfaces. Its peculiarity is the capacity to send and receive OSC messages, through Wi-Fi connection. The users can personalize their control interfaces for electronic devices (Figure 3). The wide variety of control's elements has been set from the TouchOSC Editor: each interface is designed according the urban needs and regulations. The interactive labels allow following the process and showing the updated changes. The workflow has been thought in order to conduct solar radiation analyses in urban areas. Two different ways of calculations are permitted using Daysim or DiVA-for-Rhino. For conducting the simulation in Daysim, a Radiance-based program [15], validated for complex daylight calculations [16], the users need to pass through Ecotect that represents the most widespread energy and environmental analysis tool used by architects [17] [18]. The Grasshopper's plug-in GECO allows exporting any complex geometry from Grasshopper to Ecotect environment, in which qualitative solar access analysis could be also conducted. The results in Ecotect are less accurate than using other more precise software [19] [20]. It was demonstrated that the radiance-based tools, are affected by lower accuracy errors: the right choice of the software is very important for the calculation's reliability and for the time of simulation. The program's accuracy should be verified, given that today software are integrated in design tools and their demand is very high from the experts. DiVA-for-Rhino, a high accurate daylighting and energy modelling plug-in, permits environmental performance evaluations of building and urban landscapes such as solar radiation maps and load calculations [21]. Some advantages in using DiVA-for-Rhino are run the simulations without exporting the model and its interoperability with plug-ins like Lunchbox, a collection of useful geometry tools, includes utilities for mathematical forms, paneling systems and workflow.

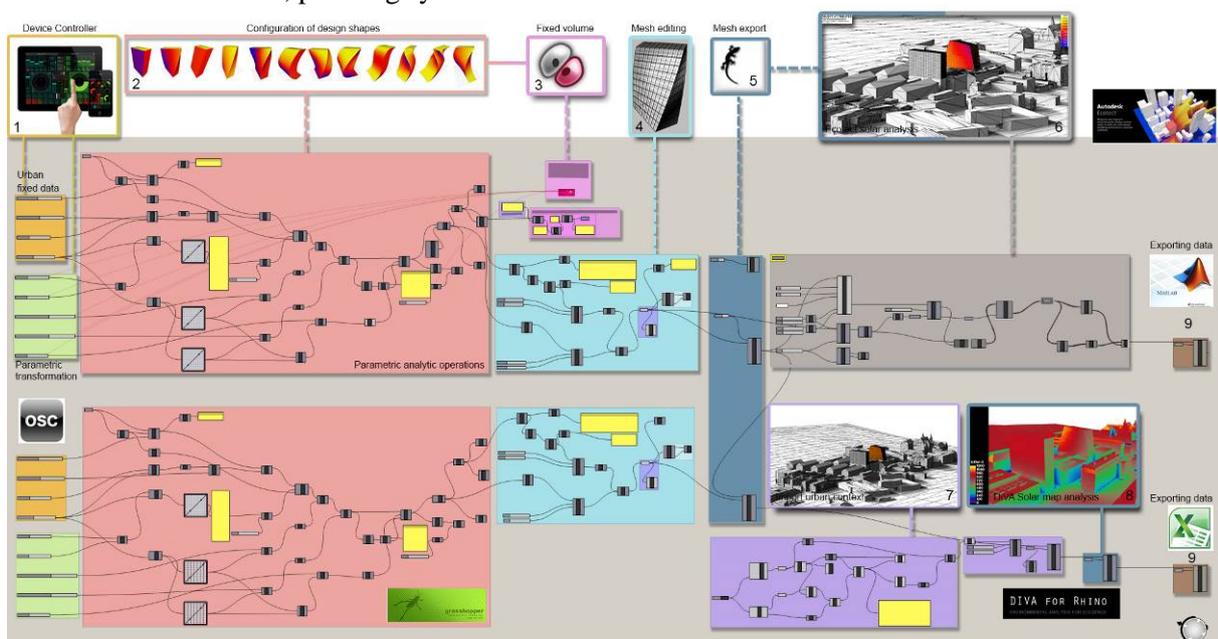


Figure 2. Grasshopper definition: 1. Urban fixed data (orange) and parametric transformations (green), 2. Analytic operations (red), 3. Fixed volume parameters (magenta), 4. Mesh editing (cyan), 5. Mesh export (clear blue), Solar simulation (6. Ecotect (grey)/8. DiVA (Blue)), 7. Import urban context (violet), 9. Exporting data (brown).

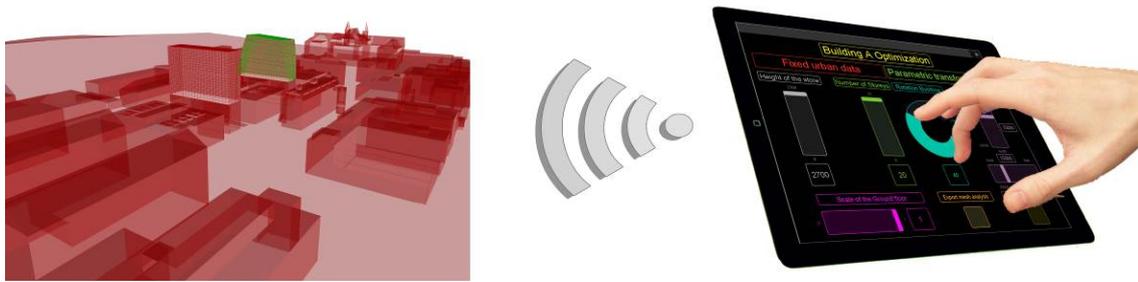


Figure 3. The examples of OSC interfaces (on the right): the users can set the fixed urban data, modify the parametric transformation of the 3D model (on the left) and run the simulation directly from the electronic devices.

It was used for exporting the simulations data in Excel and Matlab in order to manage the solar radiation results in a calculation matrix and evaluate how much energy could be produced by solar systems. The workflow permits also managing the thickness of the sensors' grid for estimating the solar radiation on the building envelope. It is strictly connected to the calculation's accuracy, while the time of simulation is influenced by different factors such as the time of analysis (annual, monthly, daily, hourly), the sky condition and the geometry's complexity [9] [12]. Daysim and DIVA-for-Rhino allow setting the input data such as location, materials, type of metric, radiance parameters and more.

#### 4 SIMULATION AND CALCULATION

The actual design scenario of the NTNU Gløshaugen campus presents two tall buildings, *Building 1* and *Building 2*, located in the middle of the campus in front of each other separated by a lower building (Figure 4). They are composed by 13 storeys about 440 m<sup>2</sup> each floor for a total volume of about 20000 m<sup>3</sup> each. The minimization of the overshadowing effect on the most radiated façade, the South-East, has been reached conducting a multi-level simulation approach using the workflow described above. The solar mapping analyses were conducted using DiVA for Rhino. It included an analysis of direct and global solar components, for localizing the areas receiving the highest amount of solar radiation. In the first analysis' level was calculated the solar radiation on the building envelope in the *isolated scenario*, estimating its maximum solar potential. While the second level evaluated the effects of the mutual solar reflections and the overshadowing effect in the *context scenario*.



Figure 4. (From the left) North-west view of the NTNU campus (*Building 1* in blue and *Building 2* in red) and the south-east view of the 3D model on the 19<sup>th</sup> of February at 11:00

##### 4.1 First level of solar optimization: solar access analysis in the isolated scenario

In the first level of simulation the global annual radiation on the most exposed façade of the *Building 2* has been estimated in order to find the optimized solar design of the building and minimize the overshadowing effect created by the *Building 1* (*isolated scenario*). The feasibility study starts considering the initial shape of the *Building 2* (*Initial*): several geometric configurations have been tested, for obtaining the best shape that guarantees the highest solar access for the *Building 2*. The volume of the building was maintaining constant in all analysis. The parametric transformations applied for reaching the optimized solar design of the building in the previous works has been tested in this case study. In those case studies the parametric transformations allowing to reach the highest value of solar radiation were: the 45° twist on West, combined with both 20° slope on South and on West direction following the linear equation (*Optimized\_Lin*). Other geometric configurations have been analysed in order to reach the maximum solar potential of the building: geometrical configuration

created by the same parametric transformation of the *Optimized\_Lin* scenario, but following the parabola equation (*Optimized\_Par*), and the one imposing only the slope (*Only\_slope*) transformation along north-west/south-east direction that gave the highest value of solar radiation. The all parametric transformations have been applied respecting the physical and structural limitations, in order to generate real, buildable and stable configurations: the maximum slope ( $10^\circ$ ) has been calculated considering the building's barycentre always projected inside the building footprint, while the maximum rotation has been limited to  $45^\circ$ , limiting the relative rotation between each floor. Secondly, in order to estimate the effect of the overshadowing effect a set of simulation has been done considering only the *Buildings 1* and *2* (*Two Buildings scenario*).

#### 4.2 Second level of solar optimization: solar access analysis in context scenario

In the second level of the analysis, the *Buildings 1* and *2* have been included into the existing surround of the campus in order to calculate the contribution of mutual solar reflections and the overshadowing effect caused by the surrounding (buildings and ground). Two different context scenarios have been compared: the actual design situation and the design scenario considering the optimized shape of the *Building 2* that carried out from the first level of analysis. They were considered in the urban context of the campus. In both scenarios has been calculated the direct ( $ab=0$ ) and the global ( $ab=3$ ) radiation.

Table 1. Set of "rtrace" parameters used for all radiance-based simulations.

ambient bounces	ambient division	ambient super-sample	ambient resolution	ambient accuracy	specular threshold	direct sampling	direct relays
0 – 3	1000	20	300	0.1	0.15	0.20	2

Table 2. List of radiance materials for simulation (for R,G,B values of reflectance).

Material	Radiance description	Number of values	R	G	B	Specularity	Roughness
Conc plaster 50%R	void plastic	005	0.549	0.549	0.549	0.00	0.00

Table 1 shows the final parameters, validated in some previous works, for all the Radiance-based simulations conducted in this study. Table 2 shows the radiance materials assigned to the buildings. The simulations were carried out using statistical data recorded for the city of Trondheim (lat.  $63^\circ 25' 47''$  N, long.  $10^\circ 23' 36''$  E) using the .epw weather data climate file taken from Meteonorm. The weather conditions in Trondheim are characterized by several snowy days during the year: two different scenarios have been analysed setting the roofs' material grey in the first scenario and white in the second. It has been estimated the effect of reflection due to the snow in terms of solar radiation's contribution on the south-east façade during the winter season (*ws*) (*Context White scenario*).

## 5 RESULTS AND DISCUSSION

### 5.1 Solar access analysis in isolated scenario

The results of the simulations expressed in term of annual direct and global radiation on the entire building envelope ( $\text{kWh/year}$  and  $\text{kWh/m}^2\text{year}$ ), have been calculated for *Isolated scenario* and for *Two Buildings scenario*. The data demonstrated that considering the amount of the solar radiation on the *Optimized\_Lin* configuration is less compared than the *Initial* ( $-0,7\%$  global radiation). Therefore other geometric configurations have been analysed in order to reach the maximum solar potential of the building. Among the results the geometrical configuration created by the same parametric transformation of the *Optimized\_Lin* configuration, but following the parabola equation (*Optimized\_Par*), and the one imposing only the slope (*Only\_Slope*) transformation along North-West/South-East direction gave these values: the *Optimized\_Par* reached  $+2,1\%$  for direct radiation,  $+2,7\%$  for global radiation, while for the *Only\_Slope* the increment arrives respectively until  $+4,3\%$  and  $+3,2\%$ . In Table 1 and Table 2 are reported the values of the most irradiated façade, South-East façade, of the *Building 2* in the *isolated* and in the *two buildings scenario*. The results confirmed that the *Only\_Slope* configuration has the highest value of solar radiation for the South-East façade: the increment of solar direct radiation arrives until  $14\%$ , while to  $12,6\%$  for the global solar radiation. It was also demonstrated that the shadow of the *Building 1* on the *Building 2* that reduces the solar

access more than 8% in the initial configuration. The *Only\_Slope* scenario covers the loss due to the overshadowing effect and increases the solar access of the façade until 6.9%.

*Table 1. Isolated Scenario. Solar radiation analysis (South-East façade):  $E_s$ : total exposed façade area.  $R$ : total solar radiation impacting on façade.  $R_A$ : average solar radiation on façade.  $\Delta_{isol}$ : % of variation of solar radiation.  $\Delta_{isol A}$  average % of variation of solar radiation*

Isolated Scenario	ab	Sup. sensor incidence	$E_s$	$R$ [kWh/yr]	$R_A$ [kWh/m <sup>2</sup> yr]	$\Delta_{isol}$ %	$\Delta_{isol A}$ %
Initial	0	2,79	1117,1	574097,7	513,9	0,0%	0,0%
Optimized_Lin	0	2,72	1087,9	602153,0	553,5	4,7%	7,1%
Optimized_Par	0	2,92	1169,6	599317,6	512,4	4,2%	-0,3%
Only_Slope	0	2,85	1138,7	659214,8	578,9	12,9%	11,2%
Initial	3	2,79	1117,1	990364,4	886,6	0,0%	0,0%
Optimized_Lin	3	2,72	1087,9	1034049,5	950,5	4,2%	6,7%
Optimized_Par	3	2,92	1169,6	1041537,3	890,5	4,9%	0,4%
Only_Slope	3	2,85	1138,7	1125171,9	988,1	12,0%	10,3%

*Table 2. Two Buildings Scenario. Results of solar radiation analysis (South-East Façade):  $E_s$ : total exposed façade area.  $R$ : total solar radiation impacting on façade.  $R_A$ : average radiation on façade.  $\Delta_{two}$ : % of variation of solar radiation.  $\Delta_{two A}$  average % of variation of radiation (for two buildings scenario).  $\Delta_{isol}$ : % of variation of solar radiation.  $\Delta_{isol A}$  average % of variation of radiation (compared to the isolated scenario);  $\Delta_{two rel}$  % of variation of solar radiation (compare to relative configuration in isolated and two buildings scenario).*

Two Buildings scenario	ab	Sup. sensor incidence	$E_s$	$R$ [kWh/yr]	$R_A$ [kWh/m <sup>2</sup> yr]	$\Delta_{two}$ %	$\Delta_{two A}$ %	$\Delta_{isol}$ %	$\Delta_{isol A}$ %	$\Delta_{two rel}$ %
Initial	0	2,79	1117,1	530207,5	474,7	/	/	-8,3%	-8,3%	-8,3%
Optimized_Lin	0	2,72	1087,9	561005,1	515,7	5,5%	8,0%	-2,3%	0,3%	-7,3%
Optimized_Par	0	2,92	1169,6	554431,4	474,0	4,4%	-0,1%	-3,5%	-8,4%	-8,1%
Only_Slope	0	2,85	1138,7	616655,6	541,5	14,0%	12,3%	6,9%	5,1%	-6,9%
Initial	3	2,79	1117,1	928652,8	831,3	/	/	-6,6%	-6,6%	-6,6%
Optimized_Lin	3	2,72	1087,9	976355,2	897,5	4,9%	7,4%	-1,4%	1,2%	-5,9%
Optimized_Par	3	2,92	1169,6	977373,2	835,6	5,0%	0,5%	-1,3%	-6,1%	-6,6%
Only_Slope	3	2,85	1138,7	1062213,5	932,8	12,6%	10,9%	6,8%	5,0%	-5,9%

## 5.2 Solar optimized scenario: urban context analysis

In the second level of simulations, the *Initial* and the *Only\_Slope* shape of the *Building 2*, have been tested inserted in the district (*Context scenario*) in order to calculate the effects of overshadowing, the reflected solar radiation by the surrounding. A set of simulation assigning the white colour to the roofs has been conducted in order to estimate the solar reflected radiation given by the snow. The results show that the increment of solar direct radiation on the South-East façade in the *Only\_Slope* configuration arrives until +14.1% while until +13.6 considering the global radiation both calculated in the *context* scenario. The results demonstrated that in *context scenario*, the South-East façade of the *Initial* configuration loses until -8.8% of the direct solar radiation and -8.5% of the global radiation. While for the *Only\_Slope* configuration the data demonstrate that respectively the increment are +6.5% (direct radiation in the *context*), +6.2% (global radiation in the *context scenario*). The results show that the *Only\_Slope* configuration permits, despite of the overshadowing effects caused by the *Building 1* and the surrounding, to give a positive solar radiation contribution until to 13.6% even if the surrounding reduce until 0.6% the global solar radiation comparing the *two buildings scenario*. In the *Context White scenario*, the results have been calculated considering only the winter season (*ws*), from December to February. They quantify the solar reflection contribution given by the white roofs. It is equal to +6.7% comparing the direct radiation in both configuration, *Initial* and *Only\_Slope*, while considering the global radiation the different is equal to +4.8%. Comparing the *Initial* configuration in the *Context White scenario* with the *isolated* one the direct radiation loses until 26%, but it increments more than 9% considering the global radiation. While for the *Only\_Slope* configuration the loss is equal to 21.4%, for direct radiation and the increment arrives until 14.4%, considering the global radiation. The results demonstrated that the reflection created by the snow gives a considerable increment of solar global radiation in both configurations.

Table 3. Context and white scenario. Results of solar radiation analysis (South-East Façade):  $E_s$ : total exposed façade area.  $R$ : total solar radiation impacting on façade.  $R_A$ : average radiation on façade.  $\Delta_{con}$ : % of variation of solar radiation.  $\Delta_{con A}$  average % of variation of radiation (for two buildings scenario).  $\Delta_{isol}$ : % of variation of solar radiation.  $\Delta_{isol A}$  average % of variation of radiation (compared to the isolated scenario);  $\Delta_{con rel}$  % of variation of solar radiation (compare to relative configuration in isolated and two buildings scenario).

Context scenario	ab	Sup. sensor incidence	$E_s$	$R$ [kWh/yr]	$R_A$ [kWh/m <sup>2</sup> yr]	$\Delta_{con}$ %	$\Delta_{con A}$ %	$\Delta_{isol}$ %	$\Delta_{isol A}$ %	$\Delta_{con rel}$ %
Initial	0	2.79	1117.1	527635.3	472.4	/	/	-8.8%	-8.8%	-0.5%
Only_Slope	0	2.85	1138.7	613998.6	539.2	14.1%	12.4%	6.5%	4.7%	-0.4%
Initial	3	2.79	1117.1	912708.9	817.1	/	/	-8.5%	-8.5%	-1.7%
Only_Slope	3	2.85	1138.7	1056293.9	927.6	13.6%	11.9%	6.2%	4.4%	-0.6%
Context White scenario	ab	Sup. sensor incidence	$E_s$	$R_{ws}$ [kWh/yr]	$R_{Aws}$ [kW/h/m <sup>2</sup> yr]	$\Delta_{ws}$ %	$\Delta_{Aws}$ %	$\Delta_{isol ws}$ %	$\Delta_{isol A ws}$ %	
Initial	0	2.79	1117.1	56079,6	207,18	/	/	-26.4	-26.1	
Only_Slope	0	2,85	1138,7	59864,2	212,38	6.7%	2.5%	-21.4	-24.3	
Initial	3	2,79	1117,1	83171.51	307.56	/	/	9.2	9.7	
Only_Slope	3	2,85	1138,7	87137.1	309.14	4.8%	0.6%	14.4	10.3	

Summarizing the analyses demonstrated that the *solar optimized design (Only\_Slope)* can improve the solar access of the *Building 2* until 4% compared to the *initial scenario*. The percentage increases until 16% considering the most exposed façade (south-east) of the *Building 2* in the *context scenario*. The solar mapping analysis in Figure 4 conducted in the context scenario, permits to localize the areas have the higher values of solar radiation for installing solar systems on the South-East façade.

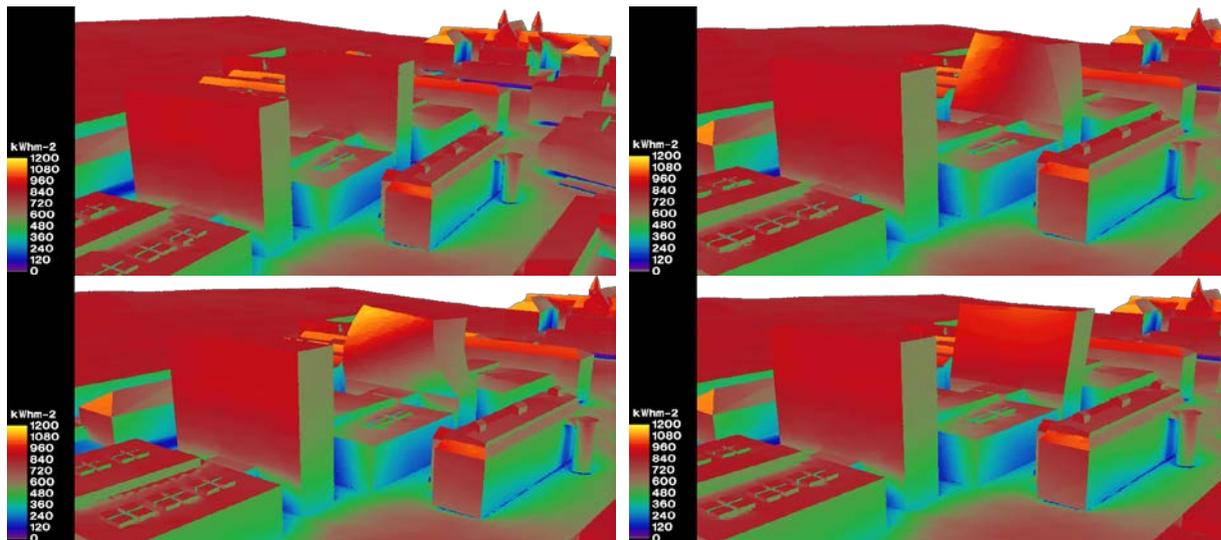


Figure 4. (From the top on the left): Solar mapping analysis for initial configuration, Optimized\_Lin configuration, Optimized\_Par configuration and Only\_Slope configuration

### 5.3 Energy demand vs energy production

The energy produced using active systems has been estimated. The actual energy demand for the Building 2 is equal to 607015 kWh/yr. Considering the results of solar radiation arrives on the South-East façade in the *context scenario*, the installation of the integrated solar technologies allows covering respectively until 12% for *Initial; ab=0; PV-monocrystalline cells* and 14% for *Only\_Slope; ab=0; PV-monocrystalline cells*, of the buildings' energy demands, 49% for *Initial; ab=0; Solar thermal collectors* and 57% for *Only\_Slope; ab=0; Solar thermal collectors*; 20% for *Initial; ab=3; Thin-film solar cells* and 24% for *Only\_Slope; ab=3; Thin-film solar cells*.

## 6 CONCLUSION

As demonstrated by the results and the analyses conducted in this paper, the workflow constitutes a useful instrument that can be used by architects and urban planners in the early design phases in order

to conduct preliminary analyses of solar radiation and solar access, combining the modelling tools with technical simulations software.

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# A CAR OWNER PERSPECTIVE ON THE FOSSIL INDEPENDENT CAR FLEET POLICY IN SWEDEN: ACCEPTANCE OR SUPPORT?

Zeinab Rezvani<sup>1</sup>, Johan Jansson<sup>2</sup>

<sup>1</sup> Research Institute for Sustainability and Ethics in Business, Umeå School of Business and Economics; zeinab.rezvani@usbe.umu.se

<sup>2</sup> Research Institute for Sustainability and Ethics in Business, Umeå School of Business and Economics; johan.jansson@usbe.umu.se

## ABSTRACT

Understanding public acceptance of environmental policies is important for bringing about more effective policies and achieving ambitious environmental goals in a climate constrained world. In the literature, policy acceptance has been synonymously used with other constructs such as policy support, which creates unnecessary theoretical and empirical ambiguity when evaluating policies and their effectiveness. Utilizing an online survey of car drivers, this study explores the level of policy acceptance and support as distinct constructs for an environmental policy (fossil independent car fleet by 2030 in Sweden). The results demonstrate a distinction between the acceptance and support measures. In addition a relatively higher acceptance than support for the policy is found in the sample, while significant differences between drivers of alternative fuel vehicles and drivers of conventional cars in their acceptance and support are observed. Although respondents are positive about the policy and its influence on decreasing environmental consequences of car use, they are sceptical about the achievement of the goal by 2030. This study emphasizes the importance of differentiating public acceptance and support for further theoretical development. Moreover, this study provides insights for policy makers for further promoting a fossil fuel independent car fleet.

*Key words: Fossil fuel independence, alternative fuel vehicles, environmental policy, acceptance, support*

## 1 INTRODUCTION

The European Union (EU) has established ambitious targets to increase the share of renewables in energy and mobility systems and reduce the environmental harms and carbon emissions of fossil fuels [1]. Along with EU, Sweden has decided on goals and environmental policies for increasing the share of renewables in various sectors, of which the policy ‘‘fossil independent car fleet by 2030’’ is a case in point. This environmental policy targets the replacement of fossil fuel based cars with Alternative Fuel Vehicles (AFVs, that can run on other fuels than fossil based gasoline and diesel primarily) by the year 2030. Above and beyond politicians’ commitment and consistency [2], public acceptance and support are essential for the successful implementation of environmental goals and policies [3], [4]. While a body of literature on public acceptance of policies use the terms acceptance and support synonymously, Batel et al. [4] differentiate between acceptance and support of environmental policies and suggest that acceptance comprise a reaction to an external phenomenon in a passive and non-decision form, while support is more action-oriented [4]. Accordingly, acceptance can be thought of as representing attitudes while support is more representing intentions or actual behaviour. Batel et al. [4] confirms the conceptual differentiation with data showing that social acceptance and support of new high voltage power lines are different in their sample of UK and Norway respondents. People can tolerate and accept a policy with passive yet positive responses to an energy infrastructure but not

actually support it. We recognize the conceptual differences of acceptance and support and accordingly examine these two constructs distinctively in this study on an environmental policy measure affecting a large part of the population now and in the future. The findings have both theoretical and empirical implications as this study further examines two important constructs of acceptance and support in relation to an important environmental policy and a significantly environmentally harmful behaviour (car use).

Sweden's "fossil independent car fleet by 2030" was announced in 2009 and ever since, related communications in terms of the policy itself and the implementation progress has not been without shortcomings. Whereas such policy is essential in realization of sustainable transport for Sweden by 2050 as discussed by Åkerman & Höjer [5], the policy has been criticized for being poorly communicated and overly ambitious considering the lack of actual measures so far taken to reach it [6]. In addition, little is known about the public acceptance and support of this specific environmental policy in Sweden. Previous studies emphasize the importance of public acceptance of renewables and environmental policies for successful implementation of them; explore the level of policy acceptance in different contexts; and investigate the factors contributing in formation of different levels of public acceptance (e.g. [7], [8], [9], and [10]). Given the importance of policies in reducing the environmental harm from the energy and transport sectors, this study explores the acceptance and also support of "fossil independent car fleet by 2030" among car owners in Sweden. Exploring public acceptance and support of this environmental policy can illustrate some of the drivers and barriers for the transition to a less fossil fuel dependent transportation system.

This research contributes to the literature on conceptualizing public acceptance and support for policies and eco-innovations and understanding the differences between these two constructs and responses to a policy and diffusion of an eco-innovation. The purposes of this study are to investigate the public acceptance and support of the policy "fossil independent car fleet by 2030" and to understand the individual factors which influence the level of acceptance and support. Implications for policy makers and environmental bodies for promoting and enhancing the implementation of environmental policies and eco-innovations for transition towards a more sustainable society will be discussed.

## 2 BACKGROUND

### 2.1. Public acceptance and support of environmental policies and technologies

Public acceptance of environmental policies and technologies is an important area of study. Since the mass introduction of environmental technologies and policies, a growing body of research has been covering the issue of social acceptance, assuming and confirming that acceptance of a certain policy and eco-innovations varies among different groups of the public [3]. But, what is public acceptance? Operationalization of the acceptance construct varies in different studies and context [4]. For instance, Eriksson et al. [10] measured acceptability of two transport policies in Sweden with attitude towards the policy (whether respondents were against it or not). Savvanidou, Zervas and Tsagarakis [11] studied biofuel acceptance among Greeks and assessed both attitudes and willingness to pay for biofuel and discussed them as acceptance. Investigating public acceptance of solar energy, Yuan et al. [9] looked into public awareness, attitude and intentions to adopt a solar water heater at home. Kraeusel & Möst [12] studied social acceptance of carbon capture and storage in Germany and measured it with attitudes towards this technology and the electricity that can be produced from it. Thorgersen & Noblet [7] studied acceptance of wind power in the US by asking questions on public attitudes and feelings towards wind power and also whether citizens would encourage wind power development in their area or not. From these examples one can conclude that public acceptance of policies and technologies in previous studies are mainly conceptualized as public attitude towards them. In fact, some researchers have gone further and included more action and intention oriented constructs as acceptance (i.e. [9]). A body of literature also uses public acceptance and support interchangeably, without clear definitions of either. For instance, Kraeusel & Möst [12] include willingness to pay for green electricity and Thorgersen & Noblet [7] include willingness to encourage wind power development in the acceptance measures. Batel et al. [4] identify the interchangeable use of acceptance and support in the literature, and points out the importance of conceptualizing social

acceptance and support in order to further our understanding of these two constructs and also implications for policy makers. They assert that these two concepts should be defined and tested separately since acceptance comprises a reaction to an external phenomenon in a passive and non-decision form, while support is more action-oriented [4]. Thus, based on Batel et al. [4] conceptualization of acceptance and support, in this study, we define policy acceptance as attitudes towards the fossil fuel independent car fleet policy. Regarding policy support which involves action-orientation, we define it as intentions to adopt AFVs for two reasons. First, intentions imply a probability of future actions [13] thus include the action oriented part. Second, as discussed before, ‘‘fossil independent car fleet by 2030’’ implies the replacement of fossil fuel based cars with AFVs. An active support of this policy should result in such replacement which requires public and especially drivers to move from fossil fuel based cars to AFVs.

Furthermore, on the basis of the theory of planned behaviour (TPB; [14]), attitudes, perceived sum of positive and negative possible consequences, are the major predictors of intention, while the actual behaviour is predicted by intention. For that reason, we investigate the relationship between policy acceptance (environmental attitudes) and support (intention to perform a pro-environmental behaviour). We expect to find a positive relationship between these two constructs.

## **2.2. Environmental beliefs**

Previous studies investigate the relationship between social acceptance of environmental policies and eco-innovations with climate change or environmental beliefs and often find positive correlations among policy acceptance and environmental beliefs. Public acceptance of carbon capture and storage [12], transportation policies [10], [14] and wind power [7] are positively correlated with environmental beliefs of respondents. Moreover, consumer attitudes and intentions towards AFVs are shown to be related with consumers’ environmental beliefs [13], [15], [16], [17], [18], [19], [20], [21]. These findings draw attention to the influence of environmental beliefs on the level of acceptance and support for an environmental policy. Hence, we investigate the relationship of drivers’ environmental beliefs with their policy acceptance and support.

## **2.3. Experience with AFVs**

Jansson [19] examined the differences between Swedish AFV adopters’ and non-adopters’ environmental beliefs and attitude towards AFVs. The study found significant differences among these two groups. AFVs adopters had higher environmental beliefs and more positive attitudes towards AFVs compared to non-adopters [19]. However there are no other studies corroborating these findings. The statistics of cars in Sweden shows, roughly 5% of cars in Sweden are AFVs. Therefore we investigate the differences between AFV adopters, who have experience with AFVs, and non-adopters, who have low or no experience with AFVs, in terms of their environmental concern, policy acceptance (attitude towards fossil independent car fleet policy) and support (intentions to adopt AFVs in the next car purchase).

## **2.4. Controlling for socio-demographics**

Socio-demographic characteristics such as age, gender, education, and income are assessed in some studies on social acceptance and support of environmental policies (e.g. [11], [9] ) as well as studies on consumer adoption of eco-innovations (e.g. [22]) and consumer pro-environmental behaviour (i.e. [23]). While some studies (e.g. [22]) do not find a significant relationship between the socio-demographics and adoption of eco-innovations, some studies (e.g. [11], [23]) do find a relationship. Perdini & Ferri [23] show that older, educated and wealthy consumers are more prone to consumption of green products and Savvanidou et al. [11] finds that older and educated people are more likely to accept and more willing to pay for green electricity. In this study, we investigate the relationship between socio-demographic factors and drivers’ acceptance and support of fossil independent car fleet policy in order to control for the effect of individual factors on the acceptance and support. Although as some previous studies have shown (e.g. [22]), we do not expect socio-demographics to explain the variance of public acceptance and support to a large extent.

## 2.5. Research questions

In this study, we aim to study the two important constructs of policy acceptance and support distinctively in the context of an environmental policy in Sweden; the “fossil independent car fleet by 2030”. We also look into: how and to what extent the acceptance and support are related with each other and with environmental beliefs. What is the level of acceptance and support for the “fossil independent car fleet by 2030” among Swedish car drivers? And finally, are there differences among AFVs adopters and non-adopters in terms of policy acceptance, support and environmental beliefs?

## 3 METHODOLOGY

### 3.1. Sample and data collection

The target population of this study is car drivers as the transition towards a fossil independent car fleet to a large extent depends on their policy acceptance and support now and in the future. According to this environmental policy, by 2030, ideally, the drivers owning fossil fuel based cars should replace their current cars in the near future for AFVs. According to the policy, AFVs owners should continue driving some type of AFV so that the fossil fuel dependent car will be phased out before 2030. As such the policy is vague on what is meant by a fossil fuel independent car fleet. In order to understand the likelihood of the policy being achieved it is important to understand the factors driving or hindering the acceptance and support of this policy among car owners the focus of the policy is not on decreasing car owning or driving why current future car owners are in focus. Thus we find the opinion of current car owners and drivers important for the main objective of this study as they can relate themselves more to this specific environmental policy than people who yet do not own and drive cars. The unit of analysis is the individual driver’s opinions.

This study is based on an online questionnaire survey which was administered in 2013 through the homepage of Bilprovningen ([www.bilprovningen.se](http://www.bilprovningen.se)). Bilprovningen AB is a leading company (state owned but in competition since 2012) which provides vehicle check-up services and the mandatory approvals of cars in terms of performance and safety measures in Sweden. During 2012, Bilprovningen tested 5.4 million cars which constitute about 80 percent of the cars in Sweden (Bilprovningen, 2013). Car drivers need to book examination time through the website and this is the major reason to visit the Bilprovningen website for them. Of 1,507 total responses to the web survey, 1,422 usable responses are utilized for analysis.

### 3.2. Measures

The measures used in the survey were classified into five sections: policy acceptance, policy support, environmental beliefs, experience with AFVs and socio-demographics. Policy acceptance or attitude towards the policy was measured with four items evaluated by respondents on a five point scale, to what extent they agreed with the statements (1 = strongly disagree, to 5 = strongly agree). The four statements of policy acceptance were adopted from [10]. The items included the general attitude toward the policy (it is a good policy), realism of the policy (the goal will be achieved by 2030), effectiveness of the policy (the goal is to help reduce the environmental impact of car traffic) and the pull nature of the policy as promoting AFV usage (the goal is to increase the use of alternative fuels, such as electricity, ethanol, and gas). Subsequently, the mean of the four items were combined into a measure of policy acceptance for each respondent. A Chronbach alpha value of 0.83 was yielded for this construct which is in the good range according to [24] and shows the reliability of the construct. Policy support was measured with a question on intentions to adopt AFVs, asking respondents to rate the probability of buying nine different types of fuels of cars separately (four types of fossil fuels: gasoline, diesel, efficient gasoline, efficient diesel; five types of alternative fuels: bio/natural gas, ethanol, hybrid, PHEV, BEV) in the coming 5 years, on a five point scale (1 = not probable at all, 2, 3, 4, 5 = very probable). The mean of ratings on five types of AFVs was considered as policy support, with alpha value of 0.70 which is in the acceptable range [24]. Environmental beliefs were measured with two statements related to respondents’ attitude towards the environmental impact of car driving. Respondents were asked to rate the extent to which they agreed with the statements (1 = strongly disagree, 2, 3, 4, 5 = strongly agree). The mean of these items were calculated for the environmental beliefs construct, with the Chronbach alpha value of 0.88. Experience of AFVs was measured with a

question on the type of current car fuel which included nine types of fuels: Gasoline, diesel, efficient gasoline, efficient diesel, bio/natural gas, ethanol, hybrid electric, plug-in hybrid electric, and battery electric. Owning and driving a type of AFV indicates experience with AFVs while driving a fossil fuel based car indicates low or no experience with AFVs. In this study, fossil fuel based cars are those that only can be fuelled by fossil gasoline or diesel, either in an efficient (or so called environmentally-friendly) or normal way, and AFVs are those that use any type of renewable or alternative fuel, either entirely or partly. Alternative fuels available in Sweden include bio/natural gas, ethanol (E85) and electricity. Vehicles based on electricity have three main categories: hybrid electric vehicle (HEV, the battery charges by regenerative braking from combusting fossil fuel), plug-in hybrid electric (PHEV, the battery is charged with plugging-in to the electricity network, a fuel tank is also available), and battery electric vehicle (BEV, works the same as PHEV and does not have any fuel tank). Even though some of current AFVs (HEV, PHEV) still use fossil fuels to some extent, we have included them as AFVs since they are categorized as such in Sweden and they have the option to run on an alternative fuel. Regarding the socio-demographic factors, previous research examines the age, education and income of respondents. In addition to age and education we also included mileage of driving in a normal year as it is related to the context of this research. Due to the sensitive nature of asking about income in Sweden, this factor was omitted.

## 4 RESULTS

### 4.1. Descriptive analysis

The sample has a significantly higher representation of males (90%) compared to females (10%) which usually occurs in the studies related to cars (Olsson, 2013; Egbue & Long, 2012). Also, the sample has a higher degree of fossil-fuel based car drivers (85%) than AFV drivers (15%). The overall sample is proportionate with the Swedish car owning population in terms of age, education and mileage of driving in a normal year. One should note that the sample may not necessarily be representative of the general population of Sweden and it has slightly higher AFVs adopters (15%) compared to 5% of them in the total car owners in Sweden. Table 1 shows the socio-demographic descriptive of respondents.

*Table 1*  
*Sample socio-demographic characteristics*

Sample size		1488
Gender	Male	90%
	Female	10%
Age	18 – 25	8%
	26 – 35	17%
	36 – 45	24%
	46 – 65	39%
	>66	12%
Education	High school	7%
	Pre-college	35%
	2 years of college	17%
	4 years of college or higher	41%
Annual driving distance (* 10 km)	1 – 500	4%
	501 – 1000	15%
	1001 – 1500	26%
	1501 – 2000	24%
	2001 – 3000	18%
	3001 – 4000	7%
	Over 4000	6%
	Fuel of Current car	Gasoline
Diesel		17%
Efficient gasoline		3%
Efficient diesel		8%
Bio and Natural gas		3%
Ethanol		7%
Hybrid electric		3%
Plug-in hybrid electric		1%
Battery electric	1%	

#### **4.2. Factor analysis of acceptance and support**

Result of exploratory factor analysis confirms the differences between policy acceptance and support measures. Measures of policy acceptance and support load on two different factors. The only exception is the measure of intention to adopt ethanol based cars that does not load sufficiently on the support factor (loading is less than 0.3).

*Table 2*  
*Exploratory factor analysis on acceptance and support*

	Factor	
	1	2
Acceptance- It is good goal	,781	
Acceptance- Goal will be achieved by 2030	,544	
Acceptance- Goal helps reducing the environmental impacts of car driving	,940	
Acceptance- Goal promotes the usage of alternative fuels	,664	
Support- Intention to adopt bio gas cars		,333
Support- Intention to adopt ethanol cars		,226
Support- Intention to adopt hybrid cars		,671
Support- Intention to adopt plug-in hybrid cars		,927
Support- Intention to adopt battery electric cars		,498

Extraction Method: Principal Axis Factoring.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 6 iterations.

### 4.3. Comparing means of acceptance and support

Policy acceptance (Mean= 3.26, SD= 1.07) is significantly higher than policy support (Mean= 2.16, SD= 0.88). Result of paired samples t-test shows that the mean differences of policy acceptance and support are significant ( $t(1,433) = 40,190$ ,  $SD = ,027$ ,  $p = .000$ ) and the sign of  $t$  indicate that acceptance mean is larger than support mean (mean difference= 1,094)

### 4.4. Predictors of policy acceptance and support

In order to understand the predictors of policy acceptance, a multiple regression analysis was run in which policy acceptance was the dependent variable and environmental concern, experience with AFVs and socio-demographics were the independent variables. Results showed that environmental beliefs significantly predicted policy acceptance ( $\beta = 0.57$ ,  $p < .001$ ). Experience with AFVs, also significantly predicted policy acceptance ( $\beta = 0.07$ ,  $p < .001$ ). The model explains a significant proportion of variance in policy acceptance ( $R^2 = 0.36$ ).

*Table 3*  
*Regression model A*

<b>Model</b>	<b>B</b>	<b>Std. Error</b>	<b>Beta</b>	<b>Sig.</b>
(Constant)	1.072	0.209		0.000**
Environmental beliefs	0.507	0.019	0.573	0.000**
Experience with AFV	0.225	0.064	0.076	0.000**
Age	0.018	0.045	0.009	0.685
Mileage	-0.076	0.046	-0.035	0.095
Gender	0.046	0.078	0.013	0.552
Education	0.067	0.046	0.031	0.147
Adjusted R square: 0.36				

Dependent variable: policy acceptance

For examining the predictors of policy support, a second multiple regression analysis was run in which policy support was the dependent variable and policy acceptance, environmental concern, experience with AFVs and socio-demographics were the independent variables. Results showed that policy acceptance significantly predicted policy support ( $\beta = 0.30$ ,  $p < .001$ ). Environmental concern ( $\beta = 0.17$ ,  $p < .001$ ) and experience with AFVs ( $\beta = 0.18$ ,  $p < .001$ ) also significantly predicted policy support. Moreover, age ( $\beta = 0.05$ ,  $p = .023$ ) and mileage ( $\beta = -0.05$ ,  $p = .045$ ) were significant predictors of public support. The model explains a significant proportion of variance in policy support ( $R^2 = 0.27$ ).

*Table 4*  
*Regression model B*

<b>Model</b>	<b>B</b>	<b>Std. Error</b>	<b>Beta</b>	<b>Sig.</b>
(Constant)	0.206	0.189		0.277
Policy acceptance	0.251	0.024	0.307	0.000**
Environmental beliefs	0.127	0.021	0.175	0.000**
Experience with AFV	0.454	0.057	0.188	0.000**
Age	0.092	0.040	0.052	0.023*
Mileage	-0.082	0.041	-0.046	0.045*
Gender	0.053	0.070	0.018	0.446
Education	0.026	0.041	0.14	0.536
Adjusted R square: 0.27				

Dependent variable: policy support

#### 4.5. Experience with AFVs

Results of t-test show significant differences of environmental concern ( $t= 7.34$ ,  $p < .001$ ), policy acceptance ( $t= 8.18$ ,  $p < .001$ ) and policy support ( $t=11.76$ ,  $p < .001$ ) among AFV adopters and non-adopters. The sign of t value also indicates the direction of differences. AFV adopters show significantly higher environmental concern, policy acceptance and policy support compared to non-adopters.

Table 5

Constructs and Mean differences between AFVs adopters and non-adopters

Constructs	Adopters		Non-adopters		Sig.
	Mean	SD	Mean	SD	
<b>Policy acceptance* (<math>\alpha= 0.83</math>)</b>					
It is a good goal.	4.23	1.12	3.59	1.47	0.000
Goal will be achieved by 2030.	2.60	1.28	2.19	1.21	0.000
Goal helps reducing the environmental impacts of car driving.	3.96	1.18	3.40	1.36	0.000
Goal promotes the usage of alternative fuels.	4.07	1.07	3.46	1.26	0.000
<b>Environmental concern** (<math>\alpha= 0.88</math>)</b>					
I want to do more to reduce the environmental impacts of my car driving.	4.05	1.17	3.57	1.24	0.000
I feel a moral obligation to reduce the environmental impacts of my car driving.	4.15	1.17	3.43	1.32	0.000
<b>Policy support*** (<math>\alpha= 0.70</math>)</b>					
Bio/Natural gas-based car	2.53	1.47	1.75	1.11	0.000
Ethanol-based car	2.33	1.33	1.79	1.09	0.000
Hybrid electric car	2.41	1.29	1.95	1.15	0.000
Plug-in hybrid electric car	3.23	1.36	2.43	1.35	0.000
Battery electric car	3.03	1.50	2.19	1.37	0.000

These days you hear about the Sweden goal to have fossil fuel free car transport by 2030. What do you think about this goal? (Four statements were available to rate. scale: 1, strongly disagree, 2, 3, 4, 5, strongly agree)

\*\* To what extent do you agree with the following statements? (Two statements were available to rate. The same scale as previous construct)

\*\*\* How probable is that your next car is a car that runs on ... (4 types of fossil fuels and 5 types of alternative fuels were available to rate. Scale: 1, not probable at all, 2, 3, 4, 5, Very probable)

## 5 DISCUSSIONS

One aim of this study was to find further support for differentiating the two important concepts in the policy literature, namely policy acceptance and support. In this study, based on Batel et al. [4] and a review of policy acceptance literature we defined policy acceptance as attitude towards the policy and policy support as intention to adopt AFVs. Results of data analysis show that acceptance and support of an environmental policy are two different constructs in line with predictions. Compared to acceptance, support for this environmental policy (intention to adopt AFVs) is considerably lower. One can conclude that the conceptual differences between acceptance and support as Batel et al. [4] asserts also exist for the respondents in the context of this study. Public can indicate positive attitude and acceptance yet weak support for an environmental policy. Overall, respondents' acceptance/attitude towards the fossil independent car fleet by 2030 is positive. Looking into the policy acceptance in detail, the results show that respondents think that this policy is promoting the usage of AFVs instead of fossil fuel cars. Respondents are slightly positive towards the environmental

impact of this policy and think this goal can reduce the environmental impacts of car driving; however, they are sceptical about the achievement of the policy by 2030.

Meanwhile, public acceptance and support are related to each other to a certain extent. Results of regression analysis confirm the positive relationship between policy acceptance and support and show that a more positive attitude towards the policy can lead to a higher probability of supporting the policy and having intentions to adopt AFVs. In addition to acceptance, which has the strongest effect, environmental beliefs, mileage of driving in a year and age of respondents were correlated with public support. The higher the age, experience with AFVs and environmental concern of respondents the higher the support for the fossil fuel free car transports. The environmental concern has the second strongest effect on policy support and in-line with previous research has positive influence on the intention to adopt AFVs and pro-environmental behaviour. Experience with AFVs, which is high for AFVs adopters and low/none for non-adopters also have relatively strong influence on the policy support. To conclude, AFV-adopters are stronger supporters of the policy “fossil independent car fleet by 2030”. The influence of age, though very small, is in-line with previous studies as well. Lower levels of driving in a year correspond with higher support for policy and intention to adopt AFVs in future. In relation to this one can conclude that an impediment to wide adoption of AFVs is range of driving with alternative fuels and people who drive less would perceive this impediment less important. On the other hand this could also mean that AFV owners would be more willing to significantly reduce their driving and perhaps even not own cars at all. Looking deeper in to acceptance, the results of a regression analysis on acceptance show that the higher levels of environmental beliefs corresponds to the higher level of acceptance. In addition, experience with AFVs influences drivers’ attitude towards this policy.

The effect of experience with AFV on policy acceptance and support was further investigated and results illustrated that AFV adopters indicate significantly higher acceptance and support compared to non-adopters which can point to the fact that once people have adopted an AFV and practically experienced driving on an alternative fuel, they are more positive towards a fossil fuel independent future and are more prone to continue driving an AFV and support the policy. Yet, this group is also sceptical about the achievement of this goal by 2030 which could indicate the lack of confidence in the measures taken to achieve it

The present study contributes to the literature examining public responses to environmental policies and technologies by clearly distinguishing two well-known responses namely public acceptance and support. By defining and testing these two concepts based on Batel et al. [4] suggestions; this research shows the importance of studying acceptance and support as distinct and yet related responses to a policy. Based on our results, acceptance predicts a certain percent of support and thus research needs to examine other factors which can explain the public support in order to understand the drivers and barriers to successful implementation of policies and technologies. The differences between acceptance and support can be explained with well-known attitude-intention (behaviour) gap. Identifying this gap and also the factors which can influence this gap has been the subject of different studies, including environmental studies (i.e. [25]) for a long time.

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# THE IMPACT OF VOLUNTARY MANAGEMENT SYSTEMS ON INDUSTRIAL ENERGY EFFICIENCY

Thomas Zobel (presenting)<sup>1</sup>, Charlotte Malmgren<sup>2</sup>

<sup>1</sup> Luleå University of Technology; thomas.zobel@ltu.se

<sup>2</sup> Luleå University of Technology; charlotte.malmgren@ltu.se

## ABSTRACT

Voluntary industrial environmental management initiatives such as management systems based on the international standard ISO 14001 has been widely spread over the world in recent years. Previous research on the influence of these systems relies heavily on how the benefits of the systems are perceived by companies' representatives. Additionally, most studies tend to focus on the impact on the overall environmental performance of the companies, not identifying differences in different environmental aspects. The purpose of this paper is to explore the impact of voluntary environmental management systems on energy efficiency in Swedish manufacturing industry by means of objective industrial waste data derived from mandatory annual environmental reports. The study focuses on changes in energy efficiency over a period of 12 years and includes both ISO 14001-certified companies (66 companies) and non-certified firms (50 companies). Consideration is given to energy improvement efforts in the companies before ISO 14001 adoption. Analysis has been carried out using statistical methods for two different industrial energy parameters: electricity and fossil fuel consumption. The results indicate that ISO 14001 adoption has an impact on the energy efficiency regarding the use of fossil fuel. In contrast no impact has been found concerning the use of electricity.

*Keywords: industrial energy efficiency, voluntary management systems, ISO 14001*

## 1 INTRODUCTION

Global warming resulting from the use of fossil fuels is without a doubt one of the major challenges the world is facing today, and improving the industrial energy efficiency is one of the most important means ways to deal with this challenge, as industry together with transportation is the highest energy-using sector in the world [1]. About one third of global energy use and 40 % of carbon dioxide (CO<sub>2</sub>) emissions are attributable to manufacturing industry [2]. Therefore it is of the utmost importance that the industry sector contributes with a fair share towards energy savings and climate mitigations.

Energy efficiency is also one of the most dominating areas when companies have turned their attentions towards voluntary environmental agreements and standards [3]. One such international standard that has spread rapidly over the world the last 10-15 years is ISO 14001, containing specifications for the implementation of environmental management systems (EMS). Such a system is a set of management processes and procedures that allows organizations to analyze, control and reduce the environmental impact of their operations and services to save costs, improve efficiency and oversight and to streamline regulatory compliance [4]. Of central importance in an EMS is the concepts of continuous incremental improvement (Plan-Do-Check-Act- Cycle or Deming-cycle) and management by objectives (MBO), which in turn is based on goal-setting theory [5]. During the period from 1996, when it first became possible to certify to ISO 14001, until now, almost 286 000 organizations worldwide have chosen to certify their EMS [6].

With the study presented in this paper we want to contribute to the knowledge base concerning the usefulness of the voluntary management system approach for improving energy efficiency of industrial processes. Due to the nature of previous studies, we aim to do this by means of objective environmental data, in which we have extracted specific energy related data. The purpose of this paper is to explore the impact of voluntary management systems on energy efficiency in Swedish manufacturing industry. Specific focus is on EMSs based on ISO 14001.

Results from a study based on industrial energy related data derived from mandatory annual environmental reports from 116 manufacturing facilities in Sweden are presented. A more specific hypothesis is derived in the next section. Following the problem description and hypothesis development in section 2, the data set and the statistical methods used in the study are outlined in section 3. Results are presented in section 4 followed by the last section where the results are discussed and conclusions are drawn.

## 2 PROBLEM DISCRPTION AND HYPOTHESIS DEVELOPMENT

The worldwide distribution and commercial success of ISO 14001 has led to extensive research on different phenomena and issues connected to the adoption of EMSs based on the standard [7, 8], of which studies concentrating on the usefulness and possible benefits of the EMS approach are one of the most popular areas among scholars. However, with few exceptions, studies on the influence of EMS are relying heavily on firm representatives' perceived benefits, which is associated with a number a drawbacks [7, 8, 9]. Moreover, previous studies tend to focus on firms' overall environmental performance, not identifying differences in different environmental aspects [3, 7, 8]. The studies that do exist that are concentrated on specific environmental aspects are mainly targeting various types of emissions. Some of these studies show positive results following the adoption of EMSs [e.g. 10, 11, 12, 13, 14], while other are more pessimistic in their evaluation [e.g. 15, 16, 17, 18], and some show undeceive results [e.g. 19, 20, 21].

The nature and results of previous studies together with the fact that no previous quantitative study have focused specifically on the connection between EMS implementation and ISO 14001 certification and energy efficiency makes good arguments for further studies in this field. As a result of previous research and its empirical evidence we have chosen to collect empirical industrial energy data with low degree of subjectivity and use this data and relevant statistical tests to test the following null hypothesis and alternative hypothesis:

*$H_0$  = the change in energy efficiency for ISO 14001-certified firms do not differ significantly from the corresponding change for non-certified firms*

*$H_{ALT}$  = the change in energy efficiency for ISO 14001-certified firms differ significantly from the corresponding change for non-certified firms*

## 3 METHODOLOGY

When studying the connection between certified EMSs and energy efficiency focus must primarily be on changes in efficiency over time as EMS is a tool for continuous improvement and do not say anything about the level of performance [22]. Furthermore, the studies must include not only firms with a certified EMS but also firms without systems or possible simpler non-certified systems for comparison. Finally, the improvements of firms that existed before the introduction of the EMS must be taken into account.

### 3.1 Research approach

In this study, we have chosen 2000 as the base year and we choose to study the change in energy efficiency over three-year intervals over the period 1994-2006, i.e. six years prior to certification and 6 years after certification. The three year intervals were chosen primarily in order to limit the amount of data. Figure 1 shows a schematic illustration of the time periods that forms the basis for statistical analysis. The basis for analysis has been the change in the energy efficiency improvement before and after ISO 14001 certification and the corresponding periods for non-certified companies. Before analysis, all parameters (e.g. electricity) have been normalized to each firm's production rate (e.g. total weight of products or total weight of input raw material), in order to be able to study changes in performance independent of the level of production. Since we are using the change in energy efficiency improvement measured in percent we have been able to use the individual indicators of production rate for each firm. This means that we have studied changes in eco-efficiency (e.g. Mwh electricity/ton products, year) rather than changes in absolute numbers.

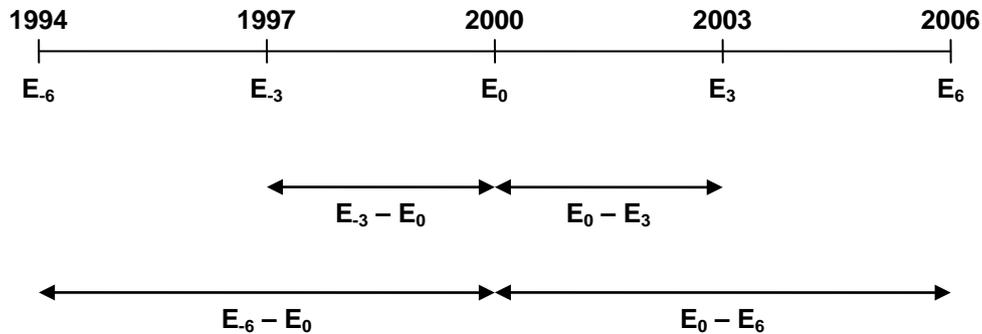


Figure 1. Schematic picture of the time periods over which the change in energy efficiency has been measured in certified and non-certified firms ( $E_{-6}$  = energy efficiency in 1994, six years before the base year 2000;  $E_{-3}$  = energy efficiency in 1997, three years before the base year 2000;  $E_0$  = energy efficiency in the base year 2000;  $E_3$  = energy efficiency in 2003, three years after the base year 2000;  $E_6$  = energy efficiency in 2006, six years after the base year 2000)

We chose to analyze differences over six year periods (2000-2006 compared to 1994-2006) since we wanted a fairly long time period but not so long that too much has changed in the companies' production setup and product mixes making analysis of energy efficiency hard to perform. We also wanted specific focus on the period right before and after ISO14001 certification and therefore also chose to analyze differences over three year periods (2000-2003 compared to 1997-2003). The shorter period 1997-2003 has the advantage that the production most probably has not changed so much during the period and it is therefore easier to follow changes in performance. In addition, it was easier to find energy data from the years 1997, 2000 and 2003. However it is a disadvantage that changes are most likely smaller than for the longer period 1994-2006. The major disadvantage with the longer period is that energy data from 1994 was hard to find, which made the statistical analysis more difficult. The change in the energy efficiency improvement has been calculated for two different energy categories: electricity and fossil fuel consumption. The parameters that have been the subject of analysis are the following if the designations from Fig. 1 are used:

$$\text{Change in rate of improvement (short)} = ((P_0 - P_3)/P_0)*100 - ((P_{-3} - P_0)/P_{-3})*100 \quad (1)$$

$$\text{Change in rate of improvement (long)} = ((P_0 - P_6)/P_0)*100 - ((P_{-6} - P_0)/P_{-6})*100 \quad (2)$$

### 3.2 Data collection

To gain access to energy data that are reported by limited elements of subjectivity, mandatory yearly environmental reports from firms with regulatory environmental permits have been used. Environmental reports have been collected from both ISO 14001 certified firms and non-certified firms. We have chosen to study manufacturing firms (NACE code 15-37) since energy efficiency is likely to be an important environmental issue in these companies and the adoption of certified EMSs are widespread in this business category. A list of such companies, created by information from all 21 County Administrative Boards in Sweden, showed that the total number of such firms was 2331. The list was supplemented with information on ISO 14001 certification from all certification bodies in Sweden.

The year 2000 was chosen as the base year because it was the year that the most certified manufacturing companies with permit got an ISO 14001 certificate. A total of 130 such companies could be found. A comparative sample was created by a random sample of 130 firms taken out of the

total population of non-certified manufacturing firms with a permit. Environmental reports for the years 1994, 1997, 2000, 2003 and 2006 were collected from the companies' local and regional environmental agencies. Documents were received for 217 of the 260 firms (83%). All 217 companies were not included in the study for various reasons, for example, that not enough necessary documents could be found, the facility has closed down or there was poor document quality. After the removal of non-usable firms, 66 certified companies and 50 non-certified companies remained.

Summary statistics of the two samples are illustrated in Table 1. Average company size is greater for the certified companies ( $t$ -test,  $P < 0.05$ ). This fact should be taken into account when interpreting the results of the study, since the data from the two groups of companies might be biased concerning company size. Unfortunately, this was unavoidable because company size was not available in the original lists of companies that we received from the County Administrative Boards. The size of the companies in the random sample was identified after the sample was drawn.

Table 1. Summary statistics over the samples of certified and non-certified firms.

Parameters	Certified firms	Non-certified firms
Count*	56	48
Average firm size (emp.)	329	69.1
Standard deviation	647	99.2

\* The number of firms in the table is less than 66 and 50 since information concerning the number of employees was not available for all firms.

### 3.3 Statistical methods

Certified and non-certified firms were compared using the  $t$ -test, which is one of the most commonly used methods for comparing two samples [23]. It should be noted that for the  $t$ -test to have full validity, assumptions about normally distributed data and equal variances must apply. Therefore, the sample distribution has been tested using the parameters standardized skewness and standardized kurtosis [24]. Variances were tested by means of Levene's test, which is a commonly used test to compare variances between groups. When extreme values are present, the standard method included in the software SPSS has been used for identification of outliers.

## 4 RESULTS

When analyzing the change in improvements of energy efficiency, two different parameters have been used: electricity and fossil fuel consumption (excluding fuels for internal transports). Fossil fuel use often consists only of consumption of fuel oil but can sometimes include several fossil fuels such as oil, LPG and natural gas. In such cases, the total energy content of the various fuels has been calculated. Parameters that are related to renewable energy sources are not included (even though such data occasionally are reported in the environmental reports) as separate parameters because an increase in the use of renewable energy sources can be counted either as an improvement (if fossil fuels are replaced) or as deterioration (if the total energy use increases). Renewable energy is therefore hard to use as a parameter in our analysis.

### 4.1 Time period 1997-2003

A relatively small number of non-certified companies reported electricity use in 1994 (see Table 2), but we are still able to perform a  $t$ -test with enough validity for a comparison between the two groups of companies since a common rule of thumb is that one should at least have more than ten observations in a sample [23]. In Table 2 we can see that one of the values of standardized skewness is outside the range limit of  $+2$ , but it is rather close and we should still be able to consider the distribution as normally distributed. Furthermore, we see that the mean value of the change in the rate of improvement indicates a slight increase in efficiency for both certified (1.53 %) and non-certified companies (4.05 %). A  $t$ -test, after one outlier has identified and removed in the certified group, gives the value  $P = 0.839$  and we can therefore not reject the null hypothesis and we can be rather certain that there is no difference between the two groups of companies. Levene's test shows no significant differences ( $P = 0.067$ ) regarding variances and the  $t$ -test is therefore valid also in this regard.

*Table 2. Summary statistics on the change in electricity efficiency improvement in the period 1997-2003.*

Parameters	Certified comp.	Non-certified comp.
No. of companies	33	12
Average change (%)	1.53	4.05
Standard deviation	28.2	53.9
Std. skewness	0.234	0.0160
Std. kurtosis	0.823	2.21

Almost twice as many of the non-certified firms have reported their use of fossil fuel compared to the use of electricity (see Table 3) and a t-test therefore should have slightly more explanation power. We do not have any problems regarding the validity of a t-test (skewness and kurtosis values are well within the limits and Levene's test gives a high P-value of 0.86). The poor fossil fuel efficiency in the non-certified companies after the base year compared to the previous period (Average change -34.2 %) gives us cause to suspect that the certified companies are performing better. Indeed, after the removal of one outlier in the non-certified sample and five outliers in the certified sample, a t-test gives us  $P=0.019$  which makes the difference significant (and we can reject the null hypothesis). The low P-value means that we can be relatively certain that the certified companies are performing better regarding their work towards improved electricity efficiency in production for the shorter time period close to the ISO 14001 certification year.

*Table 3. Summary statistics on the change in fossil fuel efficiency improvement in the period 1997-2003.*

Parameters	Certified comp.	Non-certified comp
No. of companies	40	22
Average change (%)	7.13	-38.1
Standard deviation	75.2	61.2
Std. skewness	0.729	0.214
Std. kurtosis	1.29	-0.712

#### 4.2 Time period 1994-2006

In the same regard as for the shorter time period we also have some problems with non-usable environmental reports for the time period 1994-2006. There are only seven observations in the non-certified sample and we should therefore be careful when interpreting the results. However, the average changes in both groups are limited to its extent and the change seems to be very similar in both groups, see Table 4 (2.03 % in the certified group and 2.46 % in the non-certified group). Despite the fact that one of the kurtosis values is somewhat outside the limit a t-test can be regarded as valid both regarding normality and the assumption of equal variances (Levene's Test gives  $P=0.536$ ). After the removal of one outlier in the non-certified sample and two outliers in the certified sample, a t-test gives us no reason to question the null hypothesis ( $P=0.977$ ). Even though we have so few observations in the non-certified sample, the results seem to be rather robust and we have no reason to believe that there is a difference between the two groups of companies.

*Table 4. Summary statistics on the change in electricity efficiency improvement in the period 1994-2006.*

Parameters	Certified comp.	Non-certified comp.
No. of companies	23	7
Average change (%)	2.03	2.46
Standard deviation	37.5	23.7
Std. skewness	0.0870	-0.750
Std. kurtosis	2.39	0.704

As before we are somewhat limited by a low count of observations also regarding fossil fuel use over the longer time period due foremost to the quality of the 1994 environmental reports from the non-certified companies. Nevertheless, the data is nicely normally distributed and there is no reason to believe that we cannot regard the variances as equal (Levene's test gives  $P=0.485$ ). After the removal of one outlier in the non-certified sample and two outliers in the certified sample, a t-test gives us  $P=0.171$  which not make the difference significant (and we cannot reject the null hypothesis) even

though the non-certified companies seem to perform rather poorly after the base year. However, we have reason to suspect that the certified companies are performing better than the non-certified regarding fossil fuel use also in the longer time period.

*Table 5. Summary statistics on the change in fossil fuel efficiency improvement in the period 1994-2006.*

Parameters	Certified comp	Non-certified comp
No. of companies	36	14
Average change (%)	3.32	-34.2
Standard deviation	84.5	88.9
Std. skewness	0.897	-0.670
Std. kurtosis	1.54	-0.986

## 5 DISCUSSION AND CONCLUSIONS

To summarize the results of our study, we have found some evidence that companies adopting an EMS and certifying to ISO 14001 might improve their energy efficiency concerning fossil fuel use at a faster rate than firms choosing not to certify. We were not able to find significant differences comparing the development over six year intervals before and after ISO 14001 certification, even if a difference between the two groups of companies could be suspected. But over a shorter interval of three years closer to the certification year we can conclude that certified firms perform better. In contrast, we were not able to find any significant differences concerning electricity use. The differences in the results is not easily explained but it might be the case that the certified companies estimates that the use of fossil fuel in production is a more important environmental issue than energy efficient related to the use of electricity and therefore focus their improvement effort on fossil fuels. Such a choice might be natural since fossil fuel use is a rather high profile issue and the electricity production mix in Sweden is not associated with a high degree of CO<sub>2</sub> emissions.

However, we should be somewhat careful in our conclusions since the used data set gives us some problems. Our data is nicely normality distributed and it is clear that the distribution of the data does not influence the statistical methods used. In contrast, the variances in the energy data both from the ISO 14001-certified firms and the non-certified firms are large hindering us from seeing clearer differences. Nevertheless, we have been able to limit the variation to some extent by identifying and removing outliers in the data set. The large variances are somewhat surprising considering that the data is derived from mandatory environmental reports. One factor influencing the variances might be the methods and approaches used by the firms to measure energy parameters. It is obvious when studying the reports that most firms do not measure the use of electricity or fossil fuel themselves. Instead they rely on data from suppliers. On the other hand, we have every reason to believe that the approach taken in this study to try to exclude the effects of factors other than the introduction of EMSs is accurate.

We have not been able to find any other quantitative studies focusing on similar energy parameters as in our study to compare with. However, our rather mixed results seem to be in line with the overall picture given by the quantitative studies addressing the effects of ISO 14001 on emissions mentioned in Section 2. In addition, somewhat surprisingly our results can only to some degree be regarded to be in line with the majority of the previous research based on subjective perceptions of firm representatives. These studies for the most part show rather significant influence of certified EMS on energy parameters [e.g. 25, 26, 27, 28], even if some studies are more pessimistic regarding the usefulness of EMSs for energy efficiency improvements [9, 29].

Considering the wide adoption of ISO 14001 in many types of industries over the globe, we have to regard the research findings as rather disappointing, even if some of the later studies are showing more promising results [e.g. 13, 14]. Hence, it is too early to regard ISO 14001-based EMSs as unsuccessful corporate sustainability approaches. The mixed results in the quantitative studies, the differences in results in quantitative studies compared to the findings in studies based on subjective perceptions, and the lack of studies that specifically focusing on energy-related parameters, are all reasons for performing further studies in this field so that we can better understand the role of voluntary management systems for energy efficiency and climate change mitigation. It might also be a good idea

for further studies to analyze the influence of the rather new energy management standard ISO 50001, which is showing similar spreading pattern as ISO 14001 in its early year [6]. Future studies should preferably be based on objective environmental data from a large number of firms so that small differences in environmental performance can be detected by statistical methods.

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# TOWARDS LOW-CARBON CITIES IN CHINA: INTEGRATING GREENHOUSE GAS MANAGEMENT IN URBAN PLANNING

**Guanghong Zhou<sup>1</sup>, Hongling Liu<sup>1</sup>, Ying Yin<sup>2</sup>, Björn Frostell<sup>1</sup>**

<sup>1</sup> KTH Royal Institute of Technology, School of Architecture and the Built Environment, Department of Sustainable development, Environmental science and Engineering, Industrial Ecology, Stockholm, Sweden

<sup>2</sup> KTH Royal Institute of Technology, School of Architecture and the Built Environment, Department of Urban Planning and Environment, Urban and Regional Studies, Stockholm, Sweden

## ABSTRACT

Low-carbon development has been proposed as one of the key national environmental strategies by the central government of China. There are hundreds of Chinese cities that have set low-carbon goals and there are many types of plan within the urban planning system. However, these plans face great challenges. For example, the current urban planning approach focuses on spatial arrangements while it has difficulties in recognising the complexity of GHG metabolism. As another example, urban planning lacks stakeholder involvement and cooperation which contributes to the failure to monitor GHG emissions. This study compares the situation in China with that experienced in Stockholm, Sweden and proposes an approach to improve low-carbon planning. This approach involves integrating GHG accounting into urban planning based on Industrial Ecology knowledge. Using lessons learnt from the Eco-Cycle Model 2.0 in Stockholm, the study highlights the intimate relationship between energy consumption and GHG emissions in Chinese cities, which requires integrating energy systems thinking and GHG thinking into the urban planning process. A life cycle perspective is needed in urban planning to integrate parallel energy consumption and GHG emissions budgeting in different urban sectors. Furthermore, a GHG metabolic approach may become a broad platform for communicating low-carbon development among different stakeholders in a city.

*Keywords: Low-carbon city, urban planning, GHG metabolism*

## 1 INTRODUCTION

Tackling the effects of climate change is becoming increasingly important and urgent towards sustainable development [1, 2]. By 2010, there were at least 42 cities world-wide had launched their low-carbon goals, aiming to reduce 50% Green House Gas (GHG) emissions in 2020 [3]. At the same time, the global political system has difficulties in reaching binding international agreements to reduce GHG emissions because of the ongoing urban development practices. Rapid urbanisation will create urban systems that will affect emissions for many years to come and as such the need to address this challenge is increasingly urgent. In China, for example, from 1978 to 2012 the urban population rising from 18 % to 51 %, while becoming the world's second-largest economy [4-6]. This great urbanisation has, however, been reliant on vast increases in energy consumption. China is the largest global energy consumer and relies on coal for 70% of its electricity production [7] and is the

largest GHG emitter [8]. Furthermore, China is still keen on further urbanisation, in order to reach the same level as the developed countries. According to the *Annual Report on Urban Development of China No. 6*, the urban population is expected to increase to 70 % by 2030, which means there are still 390 million people who will move to the cities in the next fifteen years [9]. In this regard, trying to reduce energy consumption and GHG emissions while maintaining economic growth is an inevitable challenge for China's government. Fortunately, the central government recognised the relationship between the economy and the environment in the early 1970s, and since then has devoted great efforts on GHG emissions reduction in order to reach sustainable urban development [10, 11]. The *11<sup>th</sup> Five Year Plan (2006-2010)* proposed low-carbon development as a key national strategy, and the following *12<sup>th</sup> Five Year Plan (2011-2015)* strengthened the low-carbon aims to reduce energy consumption per unit of GDP by 16 %, while reducing GHG emissions per unit of GDP by 17 % from the 2010 baseline [12, 13]. Besides, the State Council issued the medium-term aim of low-carbon development in 2009, aiming to reduce GHG emissions by 40-45% by 2020 compared to the 2005 baseline [14]. At the local level, more than two hundred cities in China have taken initiatives to adopt low-carbon agendas in 2012 [15].

Some studies discuss low-carbon development in China. These studies analyse general low-carbon policies [16-19] and approaches [20, 21]. Some of them summarise experiences and barriers in the implementations [22]. However, these studies have mainly focused on energy systems, while have hardly considered the importance of urban planning for low-carbon cities' development. Crawford and French [23] argue to recognise the role of urban planning in low-carbon development, especially from leadership, decision support systems, and place-based solutions. Williams [24] highlights urban planning can facilitate low-carbon development through urban infrastructures. Some countries find out the relationship between urban planning and energy consumptions, consider a GHG reduction in the urban planning process [25]. Therefore, in order to improve low-carbon city planning approach from the energy and GHG perspectives in a Chinese context, this study aims to integrate accounting of GHG metabolic activity in the urban planning process. The main research questions are:

- What is the definition of low-carbon city in China?
- What are the current situations and challenges of low-carbon city planning in China?
- Is there any chance to improve low-carbon urban planning process by using knowledge developed in the research field of Industrial Ecology (IE)?

## 2 PLANNING LOW-CARBON CITIES IN A CHINESE CONTEXT

### 2.1 What is a low-carbon city?

Although planning for a low-carbon city has been highlighted as a route to tackle climate change, its definition can vary. The Climate Group defined low-carbon cities as '*cities that decouple economic growth from the use of fossil fuel based resources by shifting society and the economy towards consumption based on renewable energy, energy efficiency and green transportation*' [26]. Asia-Pacific Economic Cooperation (APEC) defined the concept as '*towns, cities and villages which seek to become low carbon with a quantitative CO<sub>2</sub> emissions reduction target and a concrete low carbon developing plan irrespective of its size, characteristics and type of development*' [27]. In general, the concept of low-carbon city highlights to address climate change from reducing GHG emissions. Therefore, fossil fuel consumption based economic growth is required to change [28]. Besides, in a Chinese context, developing low-carbon city is not only an environmental friendly program, but also a kind of market behaviour. That is because the rapid economic growth has

improved living standard of citizens, and the urban middle class can afford living with high quality and healthy environment. In this regard, low-carbon construction, which promotes GDP growth is also a driving force in developing low-carbon cities in China [29].

## **2.2 Status quo of low-carbon city planning**

### **2.2.1 Low-carbon city plans in the urban planning system**

Low-carbon planning in China can be classified from two perspectives: planning scope and city condition. Depending on the planning scope, there are two types of low-carbon city planning. With the first type, taking Guiyang as an example, low-carbon planning results in an independent plan that is separate from the existing urban planning implementation system. The second type of planning integrates low-carbon planning into the *Master Plan* or *Detailed Plan*, such as in Shenzhen and Wuxi. In practice, the latter is more effective, because it works as a guideline for implementation, and gives direct advice to urban constructions.

From the city condition perspective, most of the low-carbon plans are for new urban districts, while a few cities, like Shenzhen, have tried to adopt overall low-carbon strategies for the existing city as a whole. Compared to planning for new urban districts, Shenzhen's low-carbon planning has more limitations on buildings and transport innovation in the existing built-up areas.

### **2.2.2 Two programmes of low-carbon development: Low-Carbon City and Low-Carbon Eco-City**

In China, there are several concepts used in practice that are related to low-carbon development. Among them, two of the most similar and popular concepts are 'Low-Carbon City' and 'Low-Carbon Eco-City'. The WWF and China's National Development and Reform Commission (NDRC) proposed the Low-Carbon City concept for their joint programme in 2008. This programme chose Baoding and Shanghai as the low-carbon pilots [30]. In 2010, NDRC launched the first batch of national pilots of low-carbon province and low-carbon city, including five provinces and eight cities [31]; the second batch was launched in 2012, including one province and twenty-eight cities [32] (see Table 1). According to NDRC, these projects have responsibilities to practice low-carbon policies and technologies, which can later be adopted by other cities in China. In other words, they are the low-carbon city experiments that are required to fulfil several main tasks. Firstly, the projects should adopt low-carbon development as the primary goal. Secondly, the low-carbon planning needs to take into consideration local conditions, and should try to maintain economic development while reducing GHG emissions. Thirdly, the industrial structure needs to be improved in order to establish a low-carbon, green, or circular economy. Fourthly, it is necessary to set up a GHG data and evaluation system for managing GHG emissions. Finally, the projects should promote a low-carbon lifestyle and consumption pattern of behaviour amongst its citizens.

In 2009 the concept of the Low-Carbon Eco-City was proposed under the umbrella idea of national eco-civilization [11]. This concept basically added one more aspect to the Low-Carbon City concept, which is to create harmony between human beings and the natural environment. Therefore, this concept is an extension of the low-carbon city, adding features of harmony and recycling [33]. Shenzhen, Wuxi, and Hebei province have launched joint national Low-Carbon Eco-City programmes with MOHURD in 2010 [34]. In 2011, MOHURD established a leading group to organise Low-Carbon Eco-City planning [35]. The aim of this group is to improve low-carbon and ecological development. The group's main tasks are to focus on giving policy recommendations, formulating

indices, and advising on low-carbon studies. According to the group, Low-Carbon Eco-City planning needs to highlight energy saving, ecological conservation, green buildings, and urban infrastructure.

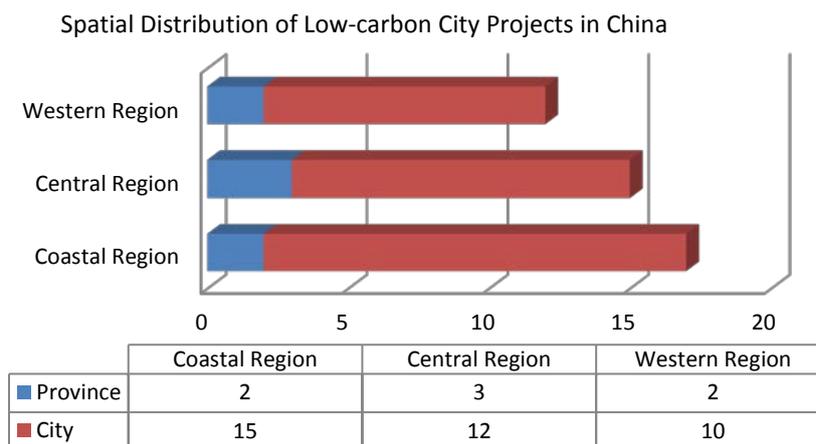
*Table 1. National Low-Carbon Pilots: Provinces and Cities*

Date		National Low-Carbon Pilots
2010-07	Low-Carbon Province (Total in 5)	Guangdong, Liaoning, Hubei, Shanxi, Yunnan
	Low-Carbon City (Total in 8)	Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang, Baoding
2012-12	Low-Carbon Province (Total in 1)	Hainan
	Low-Carbon City (Total in 28)	Beijing, Shanghai, Shijiazhuang, Qinhuangdao, Jincheng, Hulunbeier, Jilin, Daxinganling, Suzhou, Huai'an, Zhenjiang, Ningbo, Wenzhou, Chizhou, Nanping, Jingdezhen, Ganzhou, Qingdao, Jiuyuan, Wuhan, Guangzhou, Guilin, Guangyuan, Zunyi, Kunming, Yanan, Jinchang, Wulumuqi

(Source: based on [31, 32])

### **2.2.3 Average spatial distribution of low-carbon projects**

When the Chinese economic reform programme was introduced in 1978, China was divided into three regions: western region, central region, and coastal region. Under the strategy of Ladder-Step Doctrine, until the late 1990s the coastal region was given priority regarding resource allocation, relating to industry and finance for urban development [36]. This policy widened the economic development gap between the coastal and other regions. Meanwhile, it also resulted in high carbon footprint in the coastal region, where reduction of GHG emissions was much more urgent than other parts of China [37-39]. However, among the 44 national projects of low-carbon development, nearly two-thirds of them are located in western and central regions (see Figure 1). That means low-carbon development opportunities are distributed more or less evenly across the country. Cities in the western and central regions can also get financial and technological support for low-carbon development. Moreover, although from a technology perspective there may be common approaches to achieve low-carbon development in different cities, in practice the pathways taken towards low-carbon cities may be very different. That is because cities have their unique economic, geographical, historical and other local conditions. The average spatial distribution of low-carbon projects suggests China is now exploring different pathways towards a low-carbon future, based on local conditions in different cities.



Note:

National Low-Carbon Province (6): Guangdong, Liaoning, Hubei, Shanxi, Yunnan, Hainan.

National Low-Carbon City (35): Tianjin, Chongqing, Xiamen, Hangzhou, Nanchang, Guiyang, Baoding, Beijing, Shanghai, Shijiazhuang, Qinhuangdao, Jincheng, Hulunbeier, Jilin, Daxinganling, Suzhou, Huaian, Zhenjiang, Ningbo, Wenzhou, Chizhou, Nanping, Jingdezhen, Ganzhou, Qingdao, Jiyuan, Wuhan, Guangzhou, Guilin, Guangyuan, Zunyi, Kunming, Yanan, Jinchang, Wulumuqi.

National Low-carbon and Eco-city (1): Wuxi,

National Low-carbon and Eco-Province (1): Hebei

National Low-carbon city & National Low-carbon and Eco-city (1): Shenzhen

*Figure 1 Spatial Distribution of Low-carbon City projects in China*

(Source: based on [31, 32] [34])

#### **2.2.4 Integrated planning approaches for a low-carbon vision**

According to the IPCC Fourth Assessment Report 2007, in 2004 GHG emissions mainly came from the energy sector, including the production and use of power for transport, residential and commercial buildings, and industry. Other GHG emissions came from urban sectors such as waste and wastewater, agriculture, and forestry [40]. Therefore, reducing GHG emissions also requires action in these related urban sectors. Low-carbon planning projects in China differ when it comes to the focus within urban sectors and varying approaches are adopted depending on cities' GHG emissions situation (see Table 2).

Table 2. Planning approaches for a low-carbon vision

Low-carbon approach		National Pilot City					
		Tianjin	Xiamen	Hangzhou	Guiyang	Baoding	Shenzhen
Land use sector	Develop compact city		×				×
	Develop underground space		×	×			×
Transport sector	Develop public transport system	×	×	×	×	×	×
	Encourage non-motorised travel	×	×	×	×	×	×
Household sector	Increase waste recycling				×		×
Energy sector	Upgrade industries	×		×	×	×	×
	Improve energy efficiency	×	×	×	×	×	×
	Increase energy saving buildings	×	×	×	×		×
	Optimise energy mix	×	×	×	×	×	×
Environment sector	Improve the carbon sink capacity	×	×	×	×		
	Protect environment and ecological system		×	×			×
Society sector	Improve low-carbon technology	×		×			
	Encourage low-carbon lifestyle	×		×	×		×
	Develop CDM		×			×	
	Set up GHG evaluation system	×		×			

(Source: collated by author)

## 2.3 Limitations of low-carbon city planning

### 2.3.1 General difficulties in understanding GHG metabolism

Apart from the biological processes of nature, human activities affect GHG flows by burning fossil fuels, changing land cover, and producing waste. Therefore, low-carbon planning must be built upon the analysis of GHG metabolism and an understanding of the complexity of GHG flows in cities. However, current low-carbon planning in China still focuses on a 'spatial plan', while ignoring GHG emissions from a more comprehensive perspective. On one hand, since urban planning is recognised

as an extension of the economic development plan, its main task is to combine spatial development alongside economic progress. Thus, the current urban planning approach is mainly based on architectural design and urban geography principles, focusing on land use plans, urban forms and the built environment [41]. On the other hand, because different concepts are used in China, planners have vague ideas about low-carbon development [11]. Therefore, low-carbon planning still operates in a conventional way, highlighting residential areas, business buildings, industrial parks, transportation, and infrastructure.

The Shenzhen government and MOHURD started its Low-Carbon Eco-City programme in 2010. The aim of this joint programme was to make the south China city of Shenzhen, a model of low-carbon and ecological development for the whole country. The Shenzhen government started low-carbon planning and published the work plan in 2011. The plan presented low-carbon tasks to be achieved by 2015, including increasing compact land use, improving low-carbon transport, increasing green buildings, and preserving the ecological environment [42]. Nevertheless, the plan remains open to question in its ability to guide Shenzhen towards a low-carbon future. Although the plan identifies the development of a Low-Carbon Eco-City as the primary aim, the stated low-carbon goal is to improve the efficiency of resource use while keeping GHG emissions at a low level. The specific quantitative goals of energy consumption and GHG reduction were not included. Moreover, although the plan had several low-carbon tasks from different urban sectors, there were no indicators, neither quantitative nor qualitative to reflect how much GHG emissions should be reduced from these urban sectors. These omissions show that knowledge and understanding GHG metabolism in the urban system is poor in current urban planning practices.

### ***2.3.2 GHG emissions are not adequately monitored in the implementation of urban plans***

Low-carbon planning in China lacks GHG monitoring, which is essential to evaluate low-carbon development. There are two reasons for this limitation. Firstly, there is little cooperation among different government departments. Low-carbon development requires cooperation from different sectors, such as land use, transport, energy, and waste management. These sectors belong to different government departments. Because of administrative boundaries and the absence of an internal cooperation mechanism, low-carbon planning has not been well integrated into government departments to enable implementation [43]. Each department acts unilaterally and therefore the process lacks overall GHG monitoring. Secondly, urban planning is an expert-driven process that does not involve a wide range of stakeholders. Urban planning is mainly a top-bottom process that reflects governmental policies and planners' wishes. In one way it could be considered a political and academic process, and it is criticised as a technological exercise by some researchers [44]. The low involvement of stakeholders such as energy companies, transport companies, and community representatives results in insufficient public awareness and monitoring of reduction in GHG emissions during the implementation stage.

Wuxi also joined the national Low-Carbon Eco-City programme with MOHURD in 2010. In addition, the local government of Wuxi signed a cooperation memorandum with Sweden [45]. The purpose of inviting Sweden to join the project was to strengthen international cooperation between the Chinese and Swedish governments in tackling climate change. The Sino-Swedish Low-Carbon Eco-City (2.4 km<sup>2</sup>) project gave Wuxi the license to transfer advanced technology from Sweden, whose lessons could also be learned by other Chinese cities. The project is located within the Taihu New City (150 km<sup>2</sup>), which is about 6 km from the old city centre of Wuxi. Low-carbon planning started in 2010, and mainly focused on improving land use efficiency, promoting energy efficiency, and protecting the

environment. The plan established an indicator system to guide implementation. There were six categories with 62 indicators in the plan, including urban function, green transport, energy consumption, ecological environment, green building, and social harmony [46]. However, even with a strong national and local will to support low-carbon development in the Wuxi programme and specific indicators in urban planning for implementation, there are still challenges in practice. The indicators do not include GHG emissions monitoring. The 62 indicators listed their own aims and actions from different perspectives, but did not identify a method to evaluate results post-implementation, especially their influence on reducing GHG emissions. In addition, the indicators are difficult to enforce because there is no an appropriate planning regulation system. According to the current urban planning system in China, the environmental indicators need to be integrated into the *Regulatory Detailed Plan* and *Land Use Agreements* for implementation. However, both *Regulatory Detailed Plan* and *Land Use Agreements* in China are missing this indicator. Moreover, the urban planning department, with responsibility for the Sino-Swedish Low-Carbon Eco-City project, is not involved with environmental issues, such as water and waste management. The absence of multi-sector coordination between government departments results in no shared information of GHG emissions. Finally, during the process of designing indicators, only some government departments were invited to comment. Other stakeholders from society, such as energy companies were also not consulted.

### 3 CHANCE TO CHANGE: THE STOCKHOLM EXPERIENCE

The city of Stockholm, capital of Sweden is located in the heart of Scandinavia. The city had a total area of 188 km<sup>2</sup> and a population of 881 thousand in 2012. The Stockholm region, including 26 neighbouring municipalities, had a population of 2.1 million by the end of 2012 [47]. Stockholm has a long history of concern for the environment, which can be traced back a hundred years or so. During this time, Stockholm has focused attention on the built environment, traffic, building heating systems, waste sorting and lately climate initiatives [48]. The city's first target to reduce GHG emissions by 25 % between 1990 and 2005 was successfully reached and the medium-term target of reducing GHG emissions to 3 tons per capita is under way. The long-term goal of Stockholm is to become fossil fuel-free by 2050 [49]. Thanks to its important environmental achievements, Stockholm was the first city to be granted the European Green Capital award in 2010 [50].

#### 3.1 Understand GHG metabolism from Eco-Cycle Model

Stockholm has carried out several projects to explore a way towards sustainable urban development and Hammarby Sjöstad (HS) and the Stockholm Royal Seaport (SRS) are the two such major projects. The HS project was started during the early 1990s. This project used a systems approach to illustrate the energy, water, and waste (material) metabolism in the area and developed the first eco-cycle model (see Figure 2) [51]. The model visualised resource flows in the urban system and was integrated into urban planning for infrastructure development and construction. The environmental results of HS urban development - evaluated in 2008 - were positive, with lower energy consumption, lower water consumption and 48 % reduction of GHG emissions from transport compared to the baseline [52].

Based on the experience from HS, the SRS project which was started in 2010, developed an improved eco-cycle model, the so called Eco-Cycle Model 2.0 [51]. The model emphasises three physical resource flows: energy, water, GHG (material) and their metabolism in the SRS area (see Figure 3). Compared to the HS model, the Eco-Cycle Model 2.0 visualises in much more detail the urban

metabolism in the SRS area at different system scales, from the individual to the global level. Moreover, this version proposes physical recourse accounting for energy, materials (GHG) and water to monitor energy, GHG flows and water flows in support of monitoring progress towards sustainability (see Figure 4) [53].

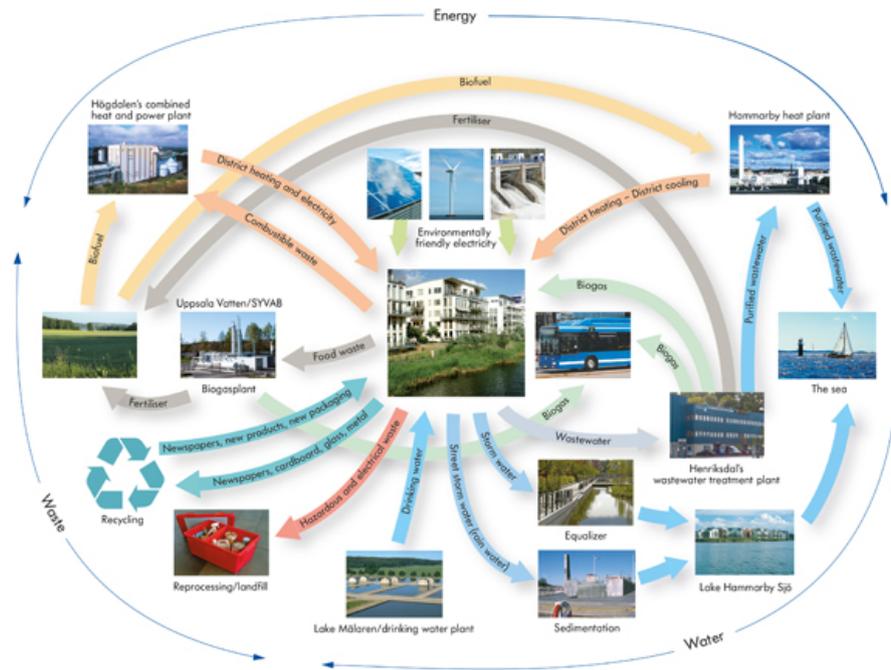


Figure 2. The eco-cycle model in Hammarby Sjöstad

(Source: [51])

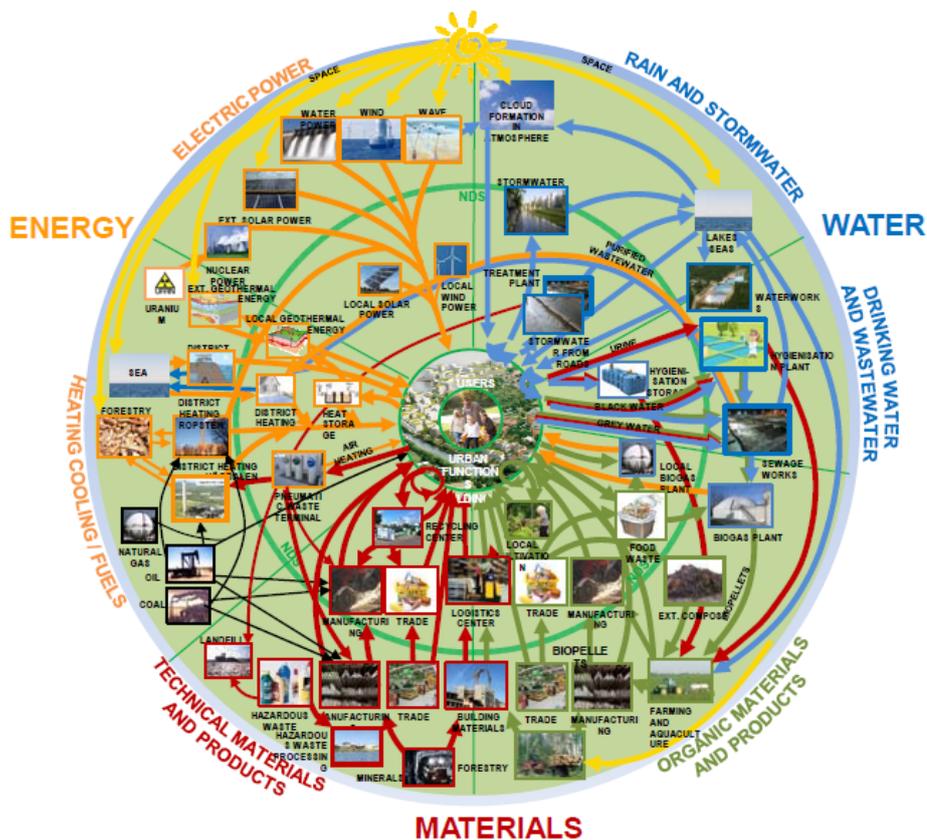


Figure 3. Eco-Cycle Model 2.0 in Stockholm Royal Seaport

(Source: [53])

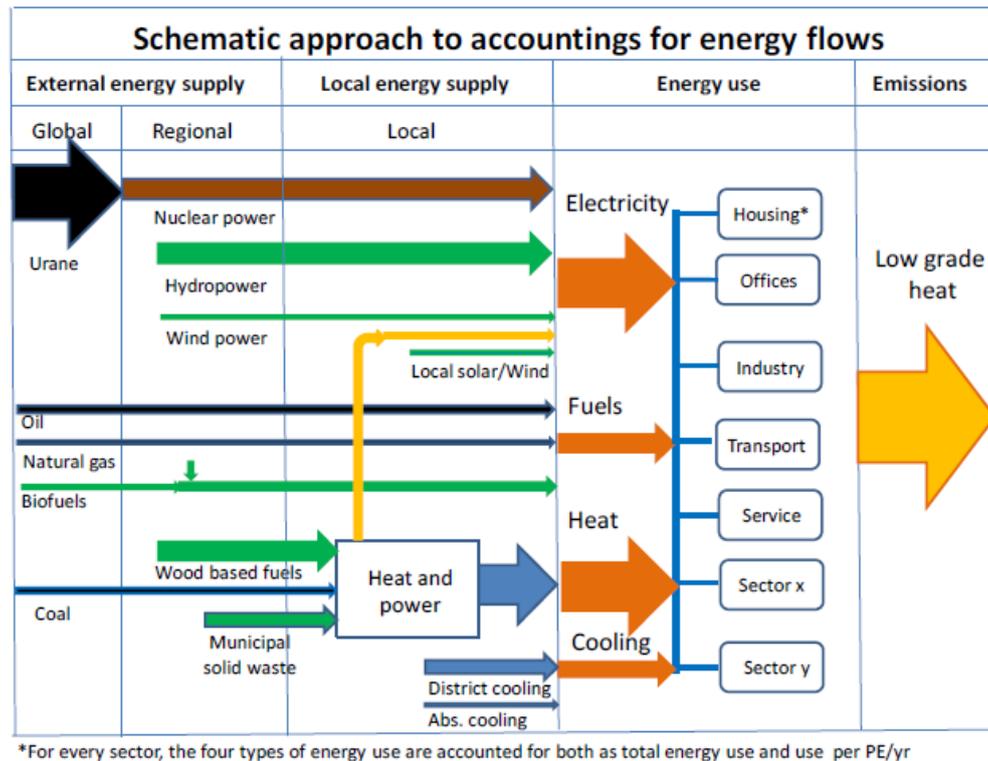


Figure 4. Proposed energy accounting's approach for the Stockholm Royal Seaport area

(Source: [53])

### 3.2 Stakeholders involvement

During the process of planning, the key stakeholders are involved in Stockholm. These stakeholders include related governmental officers, company representatives, researchers, and community officers. Taking the development of the Eco-Cycle Model 2.0 as an example, there were two workshops involving stakeholders in the model planning process. Each workshop had around twenty participants, who came from different governmental departments, the port representatives, and the energy companies. These stakeholders worked in groups to discuss objectives, resource flows and future scenarios [53].

### 3.3 Challenges and criticism of the Stockholm model

In short, Stockholm has clear goals to become fossil-fuel free and meet sustainable development targets in the long term. The overall plan, related programmes, and their planned implementation point to a high determination to become a low-carbon city. However, some researchers [54] have been critical of these achievements. Although systems thinking and eco-cycle models may help in reducing energy consumption and GHG emissions in the specific urban area, the achievements are challenged by the GHG accounting boundary. It is true that GHG emissions in Stockholm have been continuously reduced for several years. However, the results are based on a geographical boundary and lack consideration of product consumption by individuals. Since most of the products purchased and used in Stockholm are imported from other countries, geographic boundary accounting cannot reflect GHG emissions in material and manufacturing phases in other countries. In addition, it is

difficult to stimulate a low-carbon lifestyle for citizens. The efforts of urban infrastructure constructions and policy implementation in Stockholm can help citizens to change some living habits significantly e.g. by saving electricity, saving water, taking public transport, cycling, sorting waste, and other changes. Nevertheless, the influence on certain types of consumption is slow, such as food and IT products. These product consumption patterns have complex driving forces, based on e.g. culture, technical innovation, and fashion. Critics therefore argue that it will take a long time to truly establish a low-carbon lifestyle in Stockholm.

## 4 DISCUSSION AND CONCLUSIONS

### 4.1 Definition of a low-carbon city from a GHG flows perspective

Although there is no universal definition of the concept, it is known that a low-carbon city development focuses on reducing GHG emissions in order to tackle the climate change challenge. Both Chinese cities and Stockholm understand the concept in a socio-economic way, with proposed approaches within economic, energy, land use, transport, industry, water, and waste sectors. Theoretically, to define a low-carbon city concept, a GHG flow perspective would be needed. There are two suggested ways forward in this respect. The first definition considers GHG flows within a geographical boundary. International organisations [55-58] have identified and studied three scopes of GHG emissions inventory with the municipality as a boundary. The second way uses a Life Cycle Analysis (LCA) based definition. This definition considers GHG flows from the individual product manufacture and consumption perspective. Globalisation has encouraged the transfer of product manufacture from developed to developing countries and often only GHG emissions from the product use stage are considered. In this instance, applying life cycle thinking to production and consumption would work in China's favour, given its role as 'the world's factory' and the related GHG emissions that really connect to consumption in other countries. An LCA perspective would therefore show Stockholm's hidden GHG emissions from material extraction, production, shipping, and waste management of a product. Therefore, a life cycle based definition would be valuable to evaluate progress towards a low-carbon lifestyle from a product consumption perspective.

### 4.2 Industrial Ecology can take responsibility for GHG accounting and monitoring in urban planning

Outdated spatial arrangement plans in China risk failure to recognise GHG flows in cities and a paradigm shift in urban planning is needed. Since human activities influence the GHG metabolism, urban planning needs to involve systematic approaches for understanding GHG flows in the urban society [20]. Therefore, a quantitative approach is needed in low-carbon city planning. Stockholm's experience has led to a proposal to introduce a physical resource accounting system for energy, GHG, and water in urban areas. It shows a potential way of GHG accounting and monitoring by integrating IE methods such as urban metabolism into urban planning. Urban metabolism tries to understand the relationship between human society and nature in a systematic way, while simplifies the complexity of material flows in the urban system [59, 60]. The basic principle of urban metabolism, aiming to account energy consumption and GHG flows in the urban area is the main idea of the Eco-Cycle Model 2.0. The model is a visualisation of urban metabolism. It emphasises the complex energy, material (GHG) and water flows caused by human activities in the urban system. In addition, the model uses quantitative methods to measure GHG emissions. Learning from the Eco-Cycle Model 2.0, IE has the potential to bridge the gap between urban planning and low-carbon city development in

China. Using IE knowledge, the intimate relationship between energy consumption and GHG emissions in Chinese cities should be highlighted, while integrating energy systems thinking and GHG thinking into the urban planning process. Here, a life cycle perspective is suggested to discover and account for energy consumption patterns and GHG emissions in different urban sectors. Using this method, efficient sector as well as whole city indicators on energy efficiency and GHG efficiency could be derived and communicated. Such an indicator system could become an important contribution to GHG monitoring. It could also improve collaboration across China's government departments at the local level.

### 4.3 Low-carbon city development needs broad cooperation

To become a low-carbon city is a long-term objective and requires comprehensive work. It therefore requires collaboration in different ways. Firstly, cooperation is required at the organisational level. A low-carbon city goal needs leadership at both the national and local levels, with participation from a wide variety of stakeholders. The central government of China proposed low-carbon development as a national strategy and issued related laws and guidance material. Following this, local Chinese governments have adopted various programmes to explore low-carbon pathways. However, compared to Stockholm, cooperation between stakeholders in Chinese low-carbon city projects has been poor. On the one hand, governmental sectors in China lack an effective cooperation mechanism. On the other hand, low-carbon city programmes in China lack the requirement of participation from a wide variety of stakeholders. These shortcomings delay the implementation of low-carbon city plans. Another aspect is that low-carbon city development needs international cooperation. Like other developing countries, China faces many barriers of a technical and institutional character. International organisations and developed countries like Sweden may provide support to Chinese cities and exchange knowledge and technology. Lastly, the lifestyle of citizens also plays an important role in low-carbon city development. Patterns of production, consumption, and modes of travel are related to energy use and GHG emissions. Thereby, a low-carbon lifestyle with an environmentally friendly basis may help to reach a low-carbon city.

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# USING WASTE HEAT FOR CULTIVATING IN GREEN HOUSES

Dr. Eva-Lotta Thunqvist<sup>1</sup>, MSc. Samuel Christiansson<sup>2</sup>

<sup>1</sup> KTH, Royal Institute of Technology; Marinens väg 30, SE13640Haninge, Sweden, [elj@kth.se](mailto:elj@kth.se)

<sup>2</sup> KTH, Royal Institute of Technology; Marinens väg 30, SE13640Haninge, Sweden, [ekoman71@icloud.com](mailto:ekoman71@icloud.com)

## ABSTRACT

Sweden is importing more than half the food needed. In the near future there will be a necessary to produce food more sustainable and local. In Sweden where the season for growing vegetables and fruit is short there is a need for cultivation in greenhouses. Industrial waste heat is an unexploited resource which could be used for processes which require heating. In this paper the use of waste heat for heating of greenhouses where vegetables are grown in Sweden was investigated.

Systems for using waste heat are technically and economically feasible. The reason why they are not more common are often legal and/or organisational. Whereas in Sweden there is no charge associated with the release of waste heat to the surrounding environment, the incentive to stem emissions is limited resulting in heat pollution and GHG-emissions. In the study three cases of successful cooperation between a company delivering waste heat and a company producing vegetables were identified and investigated. The companies were visited and the greenhouse cultivators were questioned in semi-structured interviews.

Whereas the heat production in these studies was not the company's core business, the successful concept involved several parties: the industry generating waste heat, the owner of the property and the farmer responsible for cultivation. Furthermore long-term agreements between the parties were required. Two key issues of the waste heat collaboration were: (1) how the investments were distributed between suppliers and users, and (2) how the waste heat was valued.

*Keywords: waste heat, greenhouse, vegetables*

## 1 INTRODUCTION

Sweden import more than half of the food needed for its population. The dependency on food import and the domestic distribution of food resources makes the present supply system vulnerable. In the future climate changes, decreasing oil reserves and water resources, will increase the costs for transport and production. There is a need for a more local and sustainable food production, and food security is emerging as an important issue. In Sweden where the production season is 4-6 months greenhouses including heating and lighting for food production are required.

Imported vegetables are inexpensive and available all year around and thus local production has decreased. So far not much effort has been invested in methods for improving the energy efficiency or adapt the constructions of the greenhouses to Swedish conditions. Industrial waste heat is an unexploited resource which could be used for processes which require heating. Industrial waste-heat recovery systems could reduce emissions by providing heating for industry and society. Use of waste heat could provide a way to reduce the use of primary energy and to contribute to global CO<sub>2</sub> mitigation [1]. The prerequisite is however that the greenhouse is closely tied to the industrial operation.

The potential of industrial waste heat available for heating is not easy to assess. Attempts have been made on a national level, e.g. in Japan where a study was conducted to determine the current status of industrial waste heat. A database for available waste heat was created by investigating high-energy-consumption industries with exhaust heat characteristics such as chemical and paper factories [2].

In Sweden the waste heat potential was investigated for a county and approximately 0.8 TWh/year of industrial waste heat in Gävleborg County was not utilized [3]. Waste heat has hitherto mostly been used for heating of houses by district heating systems [4]. The use of low temperature waste heat, e.g. from ventilation systems or computer servers have so far been limited.

The use of waste heat for cultivation in greenhouses could be a viable option, since greenhouses require heat at relatively low temperatures to maintain ambient conditions and therefore are able to effectively utilize a large portion of the available enthalpy even from temperature sources which are lower than combustion temperatures. Plants also require CO<sub>2</sub> and if the exhaust gases could be cleaned from harmful pollutants it would be possible to use the CO<sub>2</sub> in the greenhouse. In Canada the technical and financial conditions for establishing greenhouses utilizing waste heat from industrial processes in northern climates has been studied. In an exchange between a tomato greenhouse and a flat glass manufacturing plant, the waste heat system was significantly more economical to operate than a purely natural gas system [5].

An energy efficient concept would include greenhouses located in the vicinity of a waste heat resource close to a larger market [5]. In a study in Sweden the waste heat potential was investigated [6]. Especially high tempered waste heat resources on the west coast of Sweden and medium tempered waste heat resources in the Stockholm area met the requirements of good waste heat potentials and large populations. However, there are no greenhouses cultivating vegetables on a commercial scale using waste heat in those areas.

Although there is a potential, in reality not much has been built. There are technical and organisational obstacles to overcome. In order to identify the problems and suggest measures to facilitate further development of the concept, examples where waste heat has been the source for heating greenhouses for vegetable production were studied.

## METHODS AND MATERIALS

This article presents three case studies where the waste heat has been used to cultivate vegetables in greenhouses. The three cases were identified by interviewing trade associations, searching the internet and using snowball sampling. The companies were visited and the owners were interviewed on site using an open ended questionnaire and via informal telephone and email correspondence.

## RESULTS

### **Habo**

In Habo a greenhouse producing organic vegetables and fruit is heated by waste heat from a biogas facility. The facility is sustained by organic material from manure from cows and waste from a local candy producer. The biogas facility is producing electricity by means of a biogas engine driving a generator which produces electricity. The electricity is sold and delivered to the national grid. Only 40% of the biogas energy is used to produce electricity, the rest becomes waste heat. The waste greenhouse-system in Habo is small scale and in principle nutrients recycling. The area of the greenhouse was dimensioned for the calculated amount of waste heat delivered from the biogas plant and set at a size of 1500 m<sup>2</sup>. The greenhouse consists of specially treated polyethylene plastic and not PVC, as the latter had become a waste problem. The farmer produces fruit and vegetables, mostly tomatoes.

Investment needs for the future are many: better climate control system that can communicate with the biogas plant. Furthermore to be able to utilize the carbon dioxide in the biogas for fertilization in the greenhouse, as in conventional greenhouses, would increase the yield significantly. In conventional greenhouses carbon dioxide is purchased or generated by burning propane. In theory effluent CO<sub>2</sub>-gas from the biogas plant could be supplied to the greenhouse - tubes for this is already covered. But it is not clear which hazardous gases are discharged except carbon dioxide when they are burned affecting the delicate tomato plants in a negative way.

A used storage tank has been purchased, but so far, it is considered too expensive to install. When installed some of the waste heat that today dissipated in the greenhouse can be stored and used in a way that may increase the energy efficiency of the entire system.

### **Slite**

The Cement factory in Slite has a large surplus of heat from processes which are producing both electricity and district heating. District heating is supplied by Gotland Energi AB, GEAB, especially for public buildings and major customers in Slite. When the factory shut down its operations for maintenance a few times a year, GEAB supplies heat to their customers by burning reserve boilers with oil.

From the factory a separate pipeline delivers waste heat to Slite Greenhouse where cucumbers are cultivated. The greenhouses comprise 17 000 m<sup>2</sup> of glassed houses in which 800 tons of cucumbers of various varieties are grown between February and the end of October. The waste heat is also used to cool to the largely volunteer-built stadium in Slite. After recovery via a so-called absorption cooler, the waste heat creates ice in the hall, all year round. Previously the farmer bought seeds and started cultivate between Christmas and New Year, planted out in late January and harvested the first time in late February, but today the cultivation season has been shortened.

At Slite the cultivation of cucumbers could be made more energy efficient by increasing the yield per energy input device, by the supply of carbon dioxide from the cement factory and by putting insulation also in the old walls of the building and by improved daily and annual regulation of the greenhouse climate. The carbon dioxide needed is not provided by the cement plant. The cost for waste heat has increased during recent years since Slite Cement Factory now has the possibility to deliver waste heat to the village.

### **Elleholm**

Södra Cell in Mörrum produces various kinds of wood products, from paper pulp to timber for construction and biomass to energy companies. Through improved energy efficiency a surplus of electricity and heat is delivered to the electricity and district heating networks. The delivery of heat is made of Karlshamn Energi AB, KEAB, to different parts of the Karlshamn municipality.

The growing season for tomatoes in the greenhouse in Elleholm runs from February to the end of November. The first tomatoes are harvested in March. The potential for improved energy efficiency include increased precision of climate control and the installation of energy lattice on the walls of the old greenhouse. Since the mid-1990s the heat has been delivered through KEAB's district heating system, which in turn receives most of the heat from the pulp mill Södra Cell. Previously the greenhouses were heated with oil, but through the connection to the district heating net system they have drastically reduced both their energy costs and CO<sub>2</sub> emissions.

Waste heat for food production in the three studied cases showed to have several advantages:

- Decreased total emissions of GHG
- Local sustainable vegetable and fruit production
- Goodwill for companies involved

## **DISCUSSION**

Two key issues of the waste heat collaboration were: (1) how the investments were distributed between suppliers and users, and (2) how the waste heat was valued. The profits were commonly distributed in accordance with the investment but also the long-term financial situation was of importance. The personal relations between the contracting parties were stressed as an important factor. However, the waste heat itself has an uncertain future, given other objectives to reduce and improve energy efficiency in the country. If the industry is made more energy efficient less waste heat will be available. A contract where heat is provided to another company may hamper such an objective of increased energy efficiency.

The uniqueness of the Habo system was that the biogas plant and the greenhouse originally presupposed one another. It was not the farmer, who took the initiative, but both were active in the project and the two parties were completely interdependent. Both companies took different types of risks, but both companies also had an established base industry: bull breeding with its meat production and greenhouse cultivation with a loyal customer base.

In Slite, the cost for waste heat has increased during recent years since Slite Cement Factory now has the possibility to deliver waste heat to the village. Consequently the farmer has considered changing to a different heating system. Despite the fact that the farmer repeatedly have asked the Cement factory if they could supply the carbon dioxide he needs, he has not yet received a response. The lack of response was assumed to be due to the difficulty for the factory to deliver pure carbon dioxide gas without any pollutants.

In Mörrum, the agreement on the heat supply is between Elleholms Tomatoes AB and KEAB, but the relationship and conversation also includes the heat producer Södra Cell. The duration of contracts are governed by the agreement between KEAB and Södra Cell and extends until the year 2019. Even if the relationship with the heat producer and heat supplier is described as good, it can be changed as other users of the waste heat may be envisaged.

Another challenge was the legislation concerning waste heat usage. The laws that must be followed are many including: environmental legislation, tax law, some 20 different laws for employees (holiday legislation, working time legislation, laws for minors, etc.), the comprehensive Environmental Protection Act, laws on food security, EU regulations for organic production, Waste Ordinance (oils, garbage, etc.), a building permit and Rescue Service regulations on fire security. The bureaucracy surrounding a biogas plant was described as "catastrophic" since the laws in several ways oppose each other.

There are potential of increasing the energy-efficiency of the greenhouses and thus reducing the amounts of waste-heat required and/or extending the growing season. In a previous investigation the largest risk associated with the implementation of a waste heat greenhouse, was the possibility of an intermittent source of heat either due to an unreliable process, or else reduced production run in the supplying company [4]. The importance of long-term contracts for delivery of waste heat was stressed by the participants in our study.

In a survey where partners in five different collaborations between industry and district heating supplier were interviewed mechanisms for a sustainable project guidelines were identified [7]. The important factors proved to be valid also for waste heat and greenhouse collaborations:

- present proper energy data and make it available to all parties
- allow all parties to make money, but do not discuss finances at an early stage
- design stable agreement that overlooks a longer time period, 5-10 years; heat is an important part for the receiver, but probably a peripheral part of the producing waste heat
- focus on the overall benefits of the collaboration (environmental, PR)
- from concept to realization always takes longer than you think

## CONCLUSIONS

Systems for using waste heat are technically and economically feasible. The reason why they are not more common are often legal and/or organisational. The heat production is not the company's core business and therefore the incentive to stem emissions is limited. A successful concept often involves several parties; the industry generating waste heat, the owner of the property and the farmer responsible for cultivation and requires long-term agreements between these parties. If the waste heat production and the greenhouse are planned and integrated from the beginning positive synergies may occur. Example of that could be large computer server halls integrated with greenhouses.

The successful Habo plant cooperation has a greater symbiotic relationship, where both parties needed to find ways of strengthening each other's operations and added value, subsequently increasing the

sustainability. That is generally not the case when a large industry is supplying waste heat to a greenhouse cultivator; the industry is basically financially independent of the greenhouse grower's successes and failures.

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# BEHAVIOUR-BASED WOOD CONNECTION AS A BASE FOR NEW TECTONICS

**Marcin WÓJCIK<sup>1</sup> and Jan STRUMIŁŁO<sup>1</sup>**

<sup>1</sup>AHO, Arkitektur- og designhøgskolen i Oslo (The Oslo School of Architecture and Design)

## ABSTRACT

This paper joins into the debate on sustainable architecture and construction and the resilience of the architectural practice. It takes up the case of solid wood construction where heterogeneity of timber is considered a disadvantage in construction. Wood industry utilises expensive processes in order to overcome rather than exploit natural wood properties. We suggest a different approach that could lead to the reduction of environmental pollution and more economic use of resources, that is discussed with a proposed wood connection method based on harnessing material behaviour induced by a change of moisture relationships -- i.e. shrinkage. Two design paths are presented: (i) involving clinging of green component on dry insert and (ii) utilising anisotropy in green wood shrinkage. The main contribution of this paper is a new view on tectonics -- understood as proper use of materials -- that bridges the gap between wood material science and design disciplines. Both theoretical and methodological frameworks are presented and, supported by the demonstrated concept, showcase the potential of inducing far-reaching changes in the timber industry. By reducing waste and by reducing the need for chemistry and supplementary materials in wood joining and improving economic performance we can get closer to a sustainable practice.

*Keywords: wood tectonics, material-oriented design, wood properties, digital manufacturing*

## 1 INTRODUCTION

The project presented in this paper belongs to the intersection of the fields of (i) architectural tectonics, (ii) sustainable construction and (iii) construction technologies. Its main goal is the resilience of architectural practice. It is framed by the problem of solid wood construction, where it is argued for an alternative joining technique, based on material behaviour. The central research question being asked is how the inherent material properties can be used in the design and construction processes, with a working hypothesis that applying these may lead to a more sustainable and more feasible construction. Outlines of both theoretical and methodological frameworks together with designed and manufactured prototypes are presented in order to induce discussion.

### 1.1 The tectonic approach

The tectonic quality of architecture emerges from the interplay between material, construction technology, environmental and cultural factors, as evident in the development of splicing joints in the Japanese carpentry. In the seismic condition of Japan long timbers must be used for the necessary building rigidity, a fact that caused the depletion of tall trees as early as 11<sup>th</sup>-12<sup>th</sup> centuries. That environmental influence combined with the traditionally developed building forms, aesthetic canons -- such as the dislike for an exposed endgrain (*koguchi*) -- and the resistant yet easy to work with *hinoki* wood (Japanese cypress), had effectively led to the richness and sophistication of the *tsugite* joinery technique (Figure 1). At its peak, Japanese carpentry distinguished 200 different wood joints, both *tsugite* (splicing) and *shiguchi* (perpendicular), with more than 100 joints needed for construction of a single shrine or temple in the 17<sup>th</sup>-19<sup>th</sup> centuries [1].

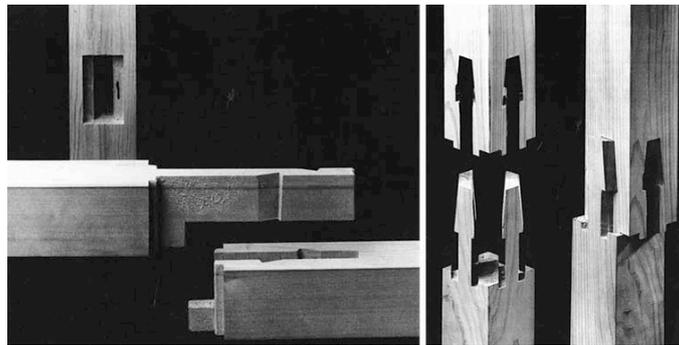


Figure 1. *Tsugite – Japanese splicing joints (image source: [1])*

The tools used affect the tectonic expression in a similar manner, as demonstrated by the example of the introduction of the old Germanic tool *klingeisen* – a curved drawknife, known as *medrag* in Norway (Figure 2) – and its influence on the appearance of log buildings in Scandinavia [2, 3].

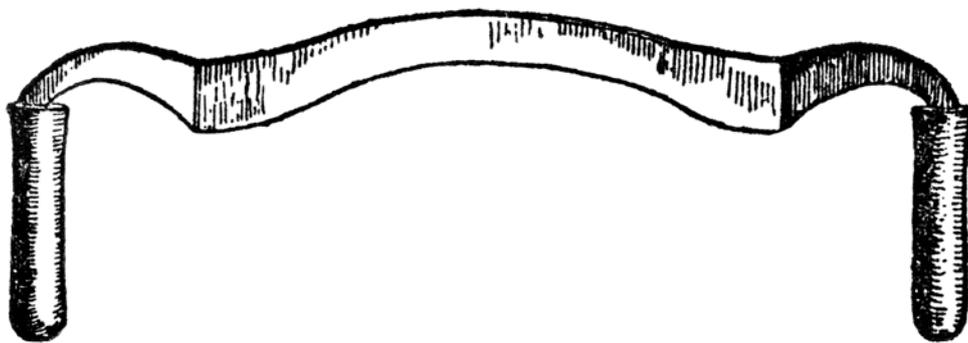


Figure 2. *Drawknife*

In the same vein Christoph Schindler, architect, designer and researcher, sees wood construction as the interaction of matter, energy and information, on which he based his periodization model that integrates fabrication with manual, industrial and information technology. Through the production technology we can see the wood construction and acknowledge that the technology not only radically reshaped the production of buildings, but equally their construction and appearance [4].

In our project the term *tectonics* is understood as the *prescriptions regarding the proper use of materials* [5]. Its root -- the Ancient Greek term *tektōn* (τέκτων) -- denotes a carpenter, a fact that signifies the important role of wood construction in the development of architecture. It is intended to take part in the historical discussion of the relation between form and matter in architecture, where it is proposed to see the form as emergent from the material and its capacities, as opposed to imposed onto the materials, like in the design based on proportioning systems and architectural orders. In the proposed tectonic approach two aspects are critical: (i) integration of material properties and behaviour with manufacturing and assembly logic and logistic and (ii) integration of the heritage of wood construction with state of the art technology.

## 1.2 The material

Wood is an extremely variable and stochastic material, involving a degree of randomness, where the physical properties are specie-specific while there exist approximately 30,000 species of trees. Its anisotropic behaviour, porosity and heterogeneity reflect the material's complex internal structure [6]. The modelling of the mechanical behaviour of timber is further complicated by the fluctuations in material characteristics being dependent on environmental conditions: moisture, temperature and time. The very specific characteristics and behaviour of wood are a result of reciprocal hierarchies: heterogeneous structure of the cellular network dependant on the fibre arrangement and anisotropy dependant on the fibre direction, tree specie, piece shape and thickness.

Today we face a similar problem to the aforementioned depletion of large trees in old time Japan. Small dimensional sizes, variation and heterogeneity of timber are seen as a disadvantage: *In the past some of the difficulties could be overcome by selective utilization of certain species and reliance on*

the larger and older age classes of trees possessing more uniformity. It is now clear, however, that we are no longer able to enjoy such luxuries. More and more trees are characterised by small sizes and greater variability [6]. Thus remanufacture of timber is a way to meet the needs of modern economy. Remanufacture is a process not without impact on the environment. Approaching the problem from a different perspective our project utilises roundwood – a low-processed forest product.

## 2 THEORETICAL FRAMEWORK

The theoretical framework of the project is constituted by three concepts: (i) bio-cybernetics, (ii) biomimetic and (iii) material-oriented design. Sustainable solutions require transdisciplinary integration of multiple knowledge bases.

(i) Frederic Vester (1925-2003), a German biochemist, ecologist and the originator of *networked thinking* that is based on systemic and cybernetic approaches, opposes constructivist against evolutionary types of management. In the former the system is produced at great expense of material and energy, in the latter it emerges spontaneously at little expense. The 4<sup>th</sup> rule of his eight basic rules of bio-cybernetics outlines the strategy: *exploiting existing forces in accordance with the ju-jitsu principle rather than fighting against them with the boxing method* [7]. (ii) That in turn resonates with the comparison of biological and technological systems as presented by Julian Vincent (Figure 3), professor of biomimetics at the University of Bath. Vincent argues, that our technology *kills the information* of raw materials, by *reducing, melting, dissolving, homogenising*, thus achieving *random material with no intrinsic information*, further *moulded, cast, turned, joint* with a substantial expense of energy to make the material *ordered with imposed shape and structure* for the final product. Conversely to technological systems, biological systems use information, stored in the genetic code, rather than energy to solve technical problems. Information is used to self-assemble structures, that unlike the engineered solutions are hierarchical. Vincent points to our ability to tap abundant and cheap fossil fuels during the Industrial Revolution as a key turning point in our relationship with nature [8].

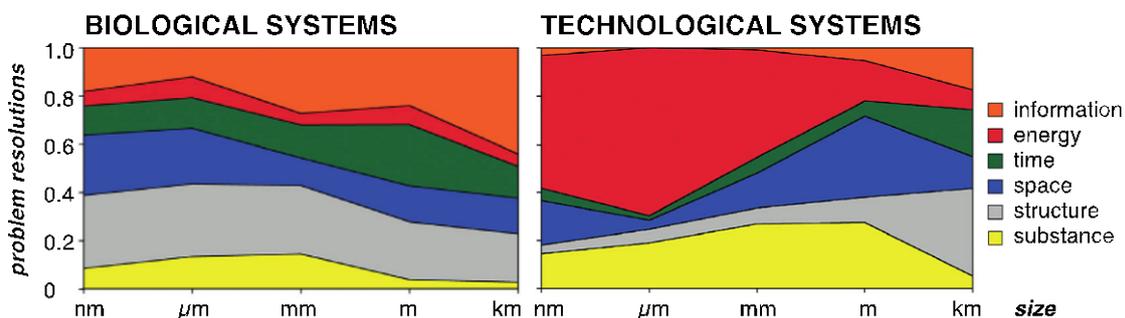


Figure 3. Comparison of biological effects and engineering TRIZ<sup>1</sup> solutions arranged according to size / hierarchy. Technology uses energy as the primary driver for solving engineering problems across the nanometre to metre scales, with information playing a smaller role. In contrast, biological systems use energy sparingly (about 5% of the cases), relying instead on information and structure. The similarity in solving problems between those two systems is only 12% [9].

Applying these principles to wood construction means to find solutions based on material behaviour and self-organisational capacities rather than enforcing form over material. This approach would promote manufacturing and construction techniques that are non-wasteful, less energy consuming and toxic and provide vital alternatives to manufactured wood products in order to overcome the scarcity of good quality and large-dimensional timbers. By replacing energy-expensive industrial processes with the naturally occurring changes in the material and using its potential, such solutions, when scaled up, would constitute a significant move towards sustainability.

(iii) The problem of material agency of wood in construction can be tracked back to the 19<sup>th</sup> century and the rapid development of structural design induced by the introduction of homogeneous and isotropic materials – namely iron and later steel. *Iron provided the physical basis for a mathematically*

<sup>1</sup> a theory of inventive problem solving developed in 1950s Soviet Union

*oriented formulation of design, thoroughly justified by science* what resulted in a shift of focus to a *more rational, abstract and analytically driven understanding* of construction in structural design [10]. The process of standardisation affected wood construction as well -- the balloon frame system based on the 2 x 4 inches module has been introduced in 1830s. Manuel de Landa, Mexican-American artist and philosopher, argues that with the invention of standardised and homogenised building materials design has been reduced to a routine and consequently *the linguistically unarticulated knowledge* of craftsmen about complex material behaviour has been disregarded [11].

Michael Hensel, architect and professor of architecture at the Oslo School of Architecture and Design (AHO), identifies architecture as a domain of *active agency*, where the spatial and material organisation complex is defined as a synthesis of the various scales and their interactions. While in the industrial tradition architects and engineers prefer materials that can be considered homogeneous and predictable -- as exemplified by the case of steel and iron -- Hensel postulates dynamic condition required by the spatial and material organisation characterised by *active agency*. Wood structure must be understood in relation to environmental conditions affecting its growth. Higher in the hierarchical organisation system, material behaviour is determined by the material properties and environmental conditions. This in turn has to be harnessed by architectural design, what is the basis of the *instrumentalisation of material behaviour as performative capacity* [12].

### 3 EXISTING EXAMPLES

Contemporary solid-wood building technology, primarily represented by cross-laminated timber (CLT) must still be considered a recent invention, although it has matured since its appearance on the market in the early 1990s. However when compared to the abovementioned balloon frame, post-and-beam or log constructions (pre-historic inventions) this must be considered young. CLT has become an industry-standard but its development is not over. CLT's production started in European alpine countries and it involves laminating planks by means of polyurethane glue (Figure 4). Polyurethane is a synthetic polymer and as such it is non-biodegradable. This is problematic when the entire lifecycle of the composite element is considered. Solid-wood panel building systems rely on metal connectors for assembly e.g. self-tapping screws. CLT manufacture overcomes the anisotropic nature of wood. Dried wood is used to yield a product that is as homogenous and standardised as possible. CLT production and assembly leaves room for improvement and innovation, which has been recognised by researchers and entrepreneurs. The following examples challenge the established standard CLT solution. They have to be considered parallel tracks within the same line of development as this research. One objective of innovation is to achieve panels free from volatile organic compounds. A number of research projects and available products tackle this issue.

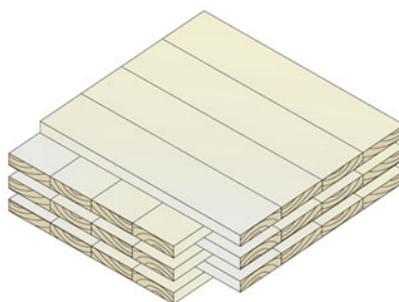


Figure 4. CLT cross-laminated timber (image source: [13])

Starting in the 1970s Julius Natterer, German engineer and professor of wood construction at the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland, has worked with stacked-plank panels. Initially the softwood planks obtained from low-quality raw material were joined by steel nails, in later versions they were connected by means of dry beech dowels that swell by drawing moisture from the elements that they connect. This system, called Brettstapel, avoids using toxic adhesives in construction and allows all-wood element production. It employs the natural swelling phenomenon for the creation of a durable joint between the panel layers. Natterer chose not to patent the system and to make it available to everyone. Subsequently many firms have taken up the production based on his

research. E.g. Austrian firm Thoma is marketing the system under the name Holz100 (Figure 5) and has been producing it since 2000 [15].



Figure 5. Thoma Holz100 system (image source: [14])

A similar principle is employed in the production of NUR-HOLZ (timber-only) elements (Figure 6), produced by the firm Rombach in Austria since 2009 [15]. They have the form of panels that can be used as walls and floors. Instead of glue (or dowels, as in the case of Holz100 system) the layers of timber slats are connected by means of hardwood screws. The system does not exploit the behavioural potential of the material (e.g. swelling) but it achieves an adhesive-free bond to yield a commercially viable product.

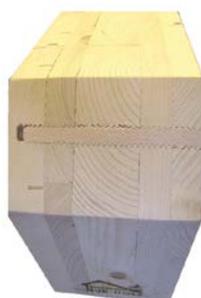


Figure 6. Rombach NUR-HOLZ system (image source: [16])

Interlocking Cross Laminated Timber (ICLT) system is being developed at the University of Utah (Figure 7). ICLT avoids the use of adhesives or mechanical (metal) connectors in the manufacture of panels by using dovetail-joint connection. The panels are designed to make use of wastewood – they use beetle-kill pine – a sub-standard timber material abundant in North America after a longhorn beetle infestation. Boards are CNC-milled to form interlocking elements that provide bonding action for the panel. Similarly to CLT, the ICLT panels can be manufactured in many variants with different number of layers and corresponding element thickness for different structural and physical parameters. As of 2013 two experimental buildings have been constructed in Utah using the technology [17, 18].



Figure 7. ICLT – Interlocking Cross Laminated Timber (image source: [17])

A different approach characterises the Swiss TopWall system invented by the engineer Hermann Blumer. It uses the natural properties of wood for constructing walls (Figure 8). The low shrinkage

and high compressive strength of timber along the grain is exploited by positioning the wall elements vertically. The system has been used with success to erect a six-storey apartment complex in Zurich (Pool Architekten, Badenerstrasse, completed 2010). The 10 x 20 cm softwood studs are positioned next to one another and held in place by means of dowels that fix them to horizontal elements forming the top and bottom of each storey-high wall. They are also connected by dowels between themselves. The vertical elements are put in individually, allowing for a construction without using a crane. The resulting wall has a compressive strength comparable to concrete and many times that of a masonry wall of similar thickness [19].



Figure 8. TopWall (image source: [20])

Composite timber-concrete floor slab system developed by Julius Natterer of the EPFL in Lausanne is an example of low-treated wood use (Figure 9). One of the tested versions of the timber-concrete composite makes use of halved logs. An example of the use of this system is a house constructed in Clarens, Switzerland (1992). The composite action between timber members and the poured slab is provided by means of notches and complimentary steel anchors. Use of halved logs allowed the achievement of favourable economic results [21].

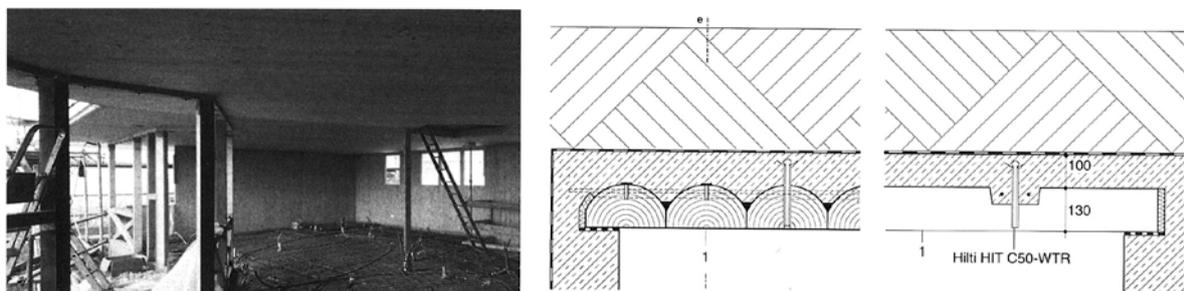


Figure 9. Composite timber-concrete floor slab (image source: [21])

The AV3 system developed in Norway [22] features a composite panel for the erection of walls in single-family houses (Figure 10). Panels are composed as a three-layer sandwich: between two layers of tongue-and-groove connected heartwood elements of sitka spruce an insulating core of pressed wood shavings is placed. The machined elements make use of the natural, conical shape of logs. Their long edges are tapered and only by alternating their directions an overall regularity of the panel is maintained.



Figure 10. AV3 system (image source: [22])

Friction welding of wood, explored by the IBOIS team at the EPFL in Lausanne employs the material properties of wood at its molecular level to create a permanent adhesive-free joint (Figure 11). Described in a number of papers (see for instance [23]) the technology of friction welding is used to bond metals and thermoplastics. It was shown that the same process can be used for bonding flat elements of wood. At present stage of development the technology can be used for creating joints that can be used inside of buildings/elements i.e. to create furniture or composite structural elements (*weldlam*). The limiting factor for large-scale elements is the costly machinery needed to produce sufficient pressure and high-speed friction required to achieve the bond. It is however imaginable, that large-scale solid-wood panels could be produced in the future using friction-welding.



Figure 11. Friction welding (image source: [24])

#### 4 DESIGN POTENTIAL IN MATERIAL DEFICIENCIES

In line with the established theoretical framework it is proposed to harness the anisotropic shrinkage in timber as it dries, use roundwood -- a low-processed raw material, and avoid additional fasteners and bonding agents. Various deficiencies -- dimensional instability, anisotropic behaviour, round and irregular shape -- are worked with and used to minimise the energy expenditure in production.

##### 4.1 Orthotropic shrinkage and movement in timber

*Anisotropy may be utilised as a design strategy leading away from digital form-finding to trait-finding [25].*

Anisotropy present in timber is a result of the alignment in the vertical axis of a tree of 90 to 95% of the cells as well as the orientation of the microfibrils in the middle layer of the secondary cell wall. Longitudinal and transverse degree of anisotropy of timber shrinkage due to water relationships amounts to approximately 40:1, in regard to thermal movement to 10:1 and for thermal conductivity to 2.5:1 [26].

Dimensional instability of timber is often seen as a serious problem to overcome. As far as water relationships in wood are concerned it can be divided into two separate phenomena: (1) shrinkage -- activated on drying and (2) movement -- present in service throughout the component life-span due to seasonal or daily changes in relative humidity or a fluctuating environment. The dimensional instability in timber is anisotropic, dependant on the fibre direction, the degrees of anisotropy are further dependant on the tree specie and the way the log was converted.

1. On drying wood begins to shrink as its moisture content drops below 30%. For green wood it is equal to 60-200% and below ca. 30% the moisture is no more in the cell cavity but in the cell wall. That stage, called fibre saturation point (FSP), marks dramatic change in wood properties, for instance compression strength increases three-fold between there and an oven-dry state. As timber is orthotropic in its water relationships shrinkage is different on the three principal axes, dependent on the tree specie: longitudinal 0.1-0.3%, radial 2-6% and tangential 5-10%, however -- as wood is not used in the oven-dry state but in-service moisture content amounts to 8-15% -- we should consider 50-75% of the aforementioned values [26], [27].
2. The anisotropy of movement can be accounted for by the same set of values as for shrinkage, yet its magnitude amounts to approximately one third [26], [27].

## 4.2 Green wood in construction

Strength and stiffness of timber decreases with the increase of moisture content, and above 20% of moisture content timber is susceptible to attack by fungi. For these reasons moisture is removed from commercial timbers by air-seasoning or in the drying kilns [26].

Using green timber has a long history in vernacular architecture. European, Russian and Japanese carpenters developed various techniques in order to factor-in different rates of longitudinal, radial and tangential shrinkage in timber components. Some vernacular methods, like the fabrication of hay and crop forks or using dry dowels in green wood exploit the inherent properties and behaviour of the material. It is generally not known when the practice of drying wood prior to working it has been introduced, but up until late gothic times wood was worked green [2]. An interesting feature can be found in traditional Scandinavian log house construction: horizontal orientation of logs -- the most common building method for hundreds of years -- took advantage of the radial shrinkage of the logs when drying, making the building tight. Interestingly, changing the orientation of the logs to vertical in the 18<sup>th</sup> century in order to achieve more freedom in shaping the building plan, resulted in the lack of tightness varying with the moisture content in the air. This effectively led to the increased use of dried timber boards in construction from the 19<sup>th</sup> century [28].

## 4.3 Small diameter roundwood in construction

Small diameter roundwood has been widely used for centuries -- mostly for their convenience in size and where quality was of secondary importance -- in such structures as sheds, barns or fencing. Today it is not commonly used in the developed countries as a structural material due to the lack of design guidelines and readily available and reliable connectors, unavailability of the material through normal commercial channels, the difficulty when attaching cladding to irregular and round structure [29, 30].

Embodied energy of roundwood material is 40% lower than of sawn lumber [30]. Further, small diameter roundwood self-replenishes over a much shorter period of time than that needed for sawn timber. The cost of debarked round timber is roughly a half of sawn timber while the characteristic bending strength of unsorted material may be even double the value of sawn timber [29].

Furthermore, processing a material means energy expenditure and may have an impact on health risks posed by this material, and also on this material's recycling: *The higher the degree of processing, the lower the potential for quick and unproblematic decomposition* [31].

## 4.4 All-wood connections

Today's wood construction systems use metal fasteners -- brackets, plates, screws and bolts for connections, which is problematic for the three reasons mentioned below:

1. Metal fasteners impede recycling of wooden components due to the difficulty with parting-out in a demolition process. Only about 0.03% of industrial wood comes from recycling -- some 0.5 million cubic metres of wood is reclaimed yearly (242,000 tones in 2000 [32], while it is estimated that about a third of the 3,400 million of cubic metres of annual worldwide timber harvest [33] is used in construction [34]).
2. Metal fasteners penetrating wooden beams in unheated rooms rust where their galvanised coating has been damaged by abrasion upon entering the wood and the surrounding wood rots due to condensation on the cold metal. These processes are delayed by using toxic, chemical wood preservatives [1].
3. During a fire, metal fasteners become red hot after only 15 to 25 minutes causing structural failure of the joints and quick collapse of the building. *The wood-to-wood joints guarantee burning buildings a longer resistance than do metal-to-wood joints* [1].

A timber building system eliminating the need for metal connectors would substantially lower the environmental impact of structures erected using it by reducing the amount of energy used in the process and improving recyclability of timber components.

## 5 METHODOLOGICAL FRAMEWORK -- RESEARCH BY DESIGN

The chosen *research by design* method is based on experimental design projects. This method is not only best suited to address the research question but also the only possible to look at the topic of study from the chosen analytical perspective. There are three main reasons for carrying out research through physical experiments at full architectural scale:

1. Firstly, it provides for the interaction between construction, manufacturing and material

behaviour. It would not be possible to merely speculate about or simulate that interaction, as the number and character of involved parameters exceeds beyond computability. That interaction can only be captured by a physical process combining the digital and material domains. The sought solutions emerge from this synthesis of the digital and the material [35, 36].

2. Secondly, some phenomena are not scalable. It has been known since Galileo Galilei (1564 – 1642) that structural sizes cannot be increased by increasing all dimensions proportionally [37]. When scaled linearly by the same factor areas increase by a squared ratio while volumes increase by a cubed ratio. By the same token material behaviour is size-dependent too.
3. Thirdly, the mock-ups built at full scale allow for taking quantitative (using sensors and measuring equipment) measurements and qualitative (sensory) surveys that could be used in the evaluation and feedback thus enhancing the interactivity of the process.

This approach, contrary to speculative or simulation studies has a potential to shed some light onto the possible strategies of integration in architectural form of various criteria belonging to different domains.

Application of scientific working methodology, as formulated in natural science in the 17<sup>th</sup> century due to its reductionist character considerably limits design potential [38]. That becomes evident in the working method of Antonio Gaudi (1883-1926) -- hanging chain models serving to establish catenaries, Heinz Isler (1926-2009) -- funicular and pneumatic models used to determine geometry of freeform shell structures or Frei Otto (b.1925) -- form-finding method using membrane models, suspended nets, soap films and bubbles, glue, paper, sand or the wool thread machines. This experimental working methodology *and the resulting logical reasoning in the development and description of form does not (...) define any kind of design technique that can be generally applied in architecture* [38].

Figure 12 depicts our proposed framework for the *research by design* process with integration of the intuitive and scientific working methods. Out of the synthesis of multiple input factors a problem is formulated, for which qualitative design questions are posed, addressed by a series of design solutions proposed and evaluated in a heuristic process. This approach builds upon the work of Herbert Simon (1916-2001), American scientist who defined design solutions as based on ill-structured problems, that cannot be solved by linear reasoning, and advised avoidance of optimised subsystems in favour of solutions *satisficing* (a portmanteau of *satisfy* and *suffice*) each subsystem. The *satisficing solution* in Simon's definition is not a singular solution but a multiplicity of solutions [39]. Further, for the satisficing solutions scientific problems and more specific, quantitative questions may be formalised and addressed by logical reasoning, as a basis for evaluation feedback and refinement, and finally a selection and development of a chosen path.

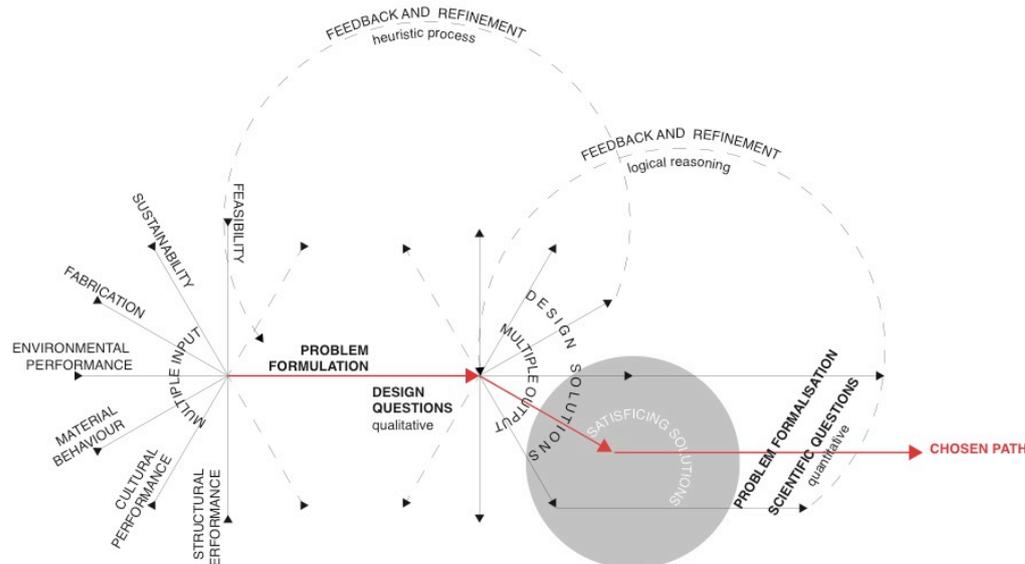


Figure 12. Research by design method framework

## 6 BACK-TO-BACK – A TEST BED

As a test bed for the proposed theoretical and methodological frameworks a design and production of a solid timber wood panel has been selected. The chosen design solution – in line with the minimum energy expenditure and minimum intervention principles -- is the *BackToBack* method, based on (i) harnessing the material behaviour – i.e. shrinkage, for a connecting mechanism, and (ii) using halved wood logs with the cut faces as the finish, while the raw round backs directed to the inside are used for connection.

Two Norway spruce trees aged ca. 15-20 years had been felled in a forest east of Oslo. The acquired 100-140 mm roundwood was converted to two panels within 10 days while still green. Two design paths were followed (Figure 13):

1. Dry-in-wet. The connecting mechanism based on green wood tightening on dry wood while shrinking. Dry wood inserts were fitted into the receiving incisions in green wood.
2. Wet-in-wet. The connecting mechanism based on green wood anisotropic shrinkage. Special incisions were CNC-cut to harness the tangential shrinkage on the active side of the panel and tighten on the passive side.

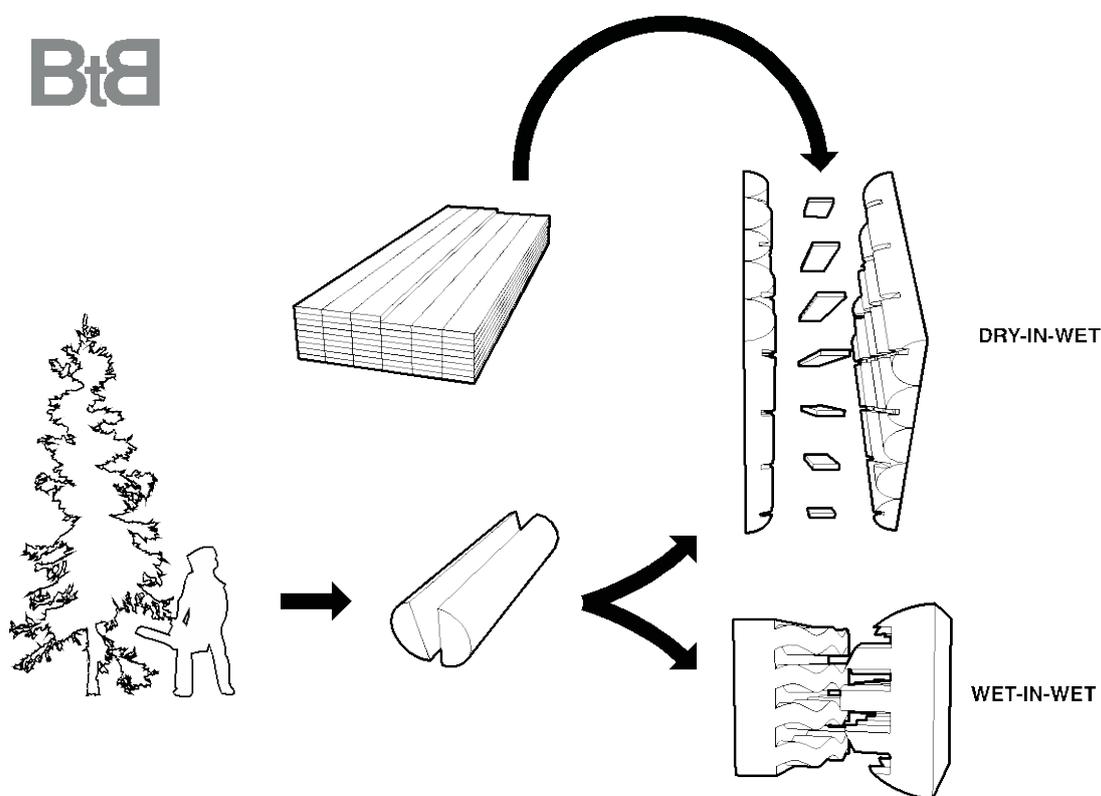


Figure 13. Two BackToBack design paths

### 6.1 Dry-in-wet

This project demonstrates and tests how material behaviour, i.e. green wood shrinkage activated on drying could be used for tightening on dry wood elements.

A series of incisions -- 20 mm wide and 150 mm apart -- was cut at 45° angle to the halved-log axis on the bark side. As the inserts dry pine boards 20 x 120 mm were used (Figure 14). The resulting empty space inside of the panel could be used for thermal insulation, e.g. by means of injecting cellulose fibre insulation.

It has been assumed that the oblique orientation of these incisions would harness the natural shrinkage in green components and make them cling on the dry inserts. The further research questions involve the distribution, geometry and dimensions of these incisions and inserts.



Figure 14. The BackToBack dry-in-wet concept

## 6.2 Wet-in-wet

This project demonstrates and tests how material behaviour, i.e. anisotropic shrinkage activated on drying could be used for producing all-wood connections in solid wood panels. In Norway spruce, depending on author, tangential shrinkage amounts to between 4% [26] - 7.8% [40], radial to 2% [26] - 3.6% [40] and longitudinal to  $<0.1\%$  [26] - 0.3% [40] (Figure 15). Our test pieces indicated 5% tangential shrinkage after 2 weeks of keeping the wood at room temperature.



Figure 15. Orthotropic shrinkage in Norway spruce

A series of waving incisions -- 20 mm wide and 20 mm apart -- were CNC-cut perpendicular to the halved-log axis on the bark side, in order to produce the active elements of the panel. According to the abovementioned figures their width after drying should shrink to 18.5-19 mm and cling on the receiving ribs resulting from the identical incisions cut parallel to the log axis on the corresponding passive elements of the panel (Figure 16).



Figure 16. BackToBack wet-in-wet concept

The waving pattern of the incisions and resulting ribs has been proposed in order to harness the tangential shrinkage, however its precise geometry, size and proportions remain subject to further research and development.

## 7 DISCUSSION

The main task of the presented prototypes is to illustrate the approach that makes use of material properties and behaviour instead of attempting to overcome them at the same time using material that is otherwise wasted. The minimisation of processing is achieved by halving (and/or debarking) only instead of full sawing on four sides prior to cutting the incisions. The connecting mechanism utilises only the phenomena already present in the material, without any external bonding agents at zero-energy expense. In this perspective the tests performed demonstrate that it is indeed possible to construct a behaviour-based connection and open way for further study.

If this path of development succeeded one could foresee large savings in chemicals, energy and time. The prototyped joint proposals exploit just two out of the many possible implementations of wood behaviour. Both proposed prototypes make use of wood shrinkage. The phenomenon of warp could potentially serve as a basis for the development of different types of joint. The presented prototypes must be further tested. More detailed and precise larger versions should be produced to allow accurate testing. Market viability of new products based on these principles requires further inquiry. And so does the exact environmental impact improvement and the resulting contribution of this technology to the sustainability of building practice.

### 7.1 The incisions pattern

The waving pattern of the incisions and resulting ribs in the wet-in-wet scenario has been proposed in order to harness the tangential shrinkage, however it remains subject to further research and development. The pattern: its geometry, sizes and proportions must factor in the structural behaviour of the panel as a building component, that is except of not being easily pulled apart it should transfer shear stress. Providing a shear force resistant connection between the pieces would dramatically increase the stiffness and hence the panel load-bearing capacity. The heterogeneous wood grain structure must be taken into account during sizing of the incisions regarding the shear force, a manifested reference to the material-oriented design. The material-informed design should include other variables affecting the shrinkage such as moisture content, tree specie and wood structural features.

A software model that would take into account the complex interplay of the abovementioned factors could help find a solution for the geometry of the incisions.

### 7.2 The tools

In the process both hand tools and a CNC milling machine were used.

The use of hand tools in the process was a potentially limiting factor due to two main reasons:

1. It did not permit to achieve sufficient precision to be able to accurately assess the results.
2. Additional work time was required to readjust the machines to the varying thickness through which they cut -- result of the conical, half-round cross-section and irregularity of the individual bores.

Both of the abovementioned problems applied to the CNC machining process as well, though these could be more easily overcome by different software and hardware setup. It has been noted during the experiment that CNC machining of green timber requires higher spindle speeds that offered by the milling machine available to us. At 6000 rpm the quality of the cut required a great deal of post-processing. In case of straight incisions a much quicker and producing better cut quality option would be to use a CNC machine with a circular saw rather than milling bits for cutting. Also, another CAM software, not based on STL solids as input but simply accepting CAD lines would highly speed up the process.

To this end -- besides the aforementioned development of software -- an important line of progress of the project includes the development of hardware setup allowing for spending less energy and time on production.

### 7.3 The material

The aforementioned is highly affected by the wood material properties. This in turn, besides the moisture content, geometrical and structural traits heavily depends on the wood specie. Finding wood species making the most of the desired features is of paramount importance to the development of our project.

This approach draws inspiration from the *Spruce Goose* or Hughes-Kaiser HK-1 aircraft story: *Teams were dispatched into the woods of the United States and Canada to find specific trees for specific parts of the plane. The HK-1 was designed not with the invariant code of aluminium but with the variant performance of specific and unique traits in actual material* [41]. Originally, birch was chosen as a building material, but due to shortage in supplies fir, cottonwood, maple and balsa were used in different parts of the airplane accordingly to the specie-specific properties. In building construction, before the introduction of structural steel, builders often applied hardwood dowels in softwood structural elements, for their greater strength, connecting elements with more ease and saving time [42].

One recent example that illustrates that approach in architecture includes sports hall in Sargans, Switzerland where spruce and ash wood were used accordingly to their specific characteristics and role in the building (Blue Architects, completed in 2008).

As explained earlier, shrinkage for various popular woods may vary by as much as 200% (see 4.1). Further -- following the line of minimum intervention -- as some species are more resistant to fungi, insect and rot attack than others, they could be used without any additional treatment. This feature is often combined with toxicity of the wood: yew (*taxus baccata*) and black locust (*robinia pseudoacacia*) are well known examples. There are rare cases of architectural application of yew for its properties (as the wood is scarce and currently under protection). Some 16<sup>th</sup>-18<sup>th</sup> century churches in Slovakia: in Hervartov (Figure 17), mainly, and in Tročany and Kežmarok, partly, were made from yew [2]. More recently the Albisgüetli forestry operations centre in Zurich (Fahrländer Scherrer Architekten, completed 2013) features cladding with three layers of yew shingles [43] (Figure 17).



Figure 17. 16<sup>th</sup> century church in Hervartov (Slovakia) made from yew (photo M. Wójcik) and 2013 Albisgüetli forestry operations centre in Zurich clad with yew shingles (photo H.Henz, source [43])

### 7.4 The supply chains

Another question concerns forestry and wood supply: as roundwood and green wood are not available through normal commercial channels, working with this kind of material is not possible in standard practice. Implementing this solution would require a general remodelling of the current supply chains. On the other hand finding use for the product of forest thinning can have long-reaching advantages. In silviculture the initial narrow spacing and later thinning strategy -- necessary for improving the growth rate and wood quality -- makes the remaining trees twice as expensive as planting to a wider spacing, unless there was a commercial market for the thinned material [44].

The product of forest thinning contains juvenile wood affecting the longitudinal shrinkage that, from green to oven dry, amounts to 2%, result of shorter cells and high microfibril angle [44]. That feature, providing for an interesting synergy, could also potentially be investigated in the development of the shrinkage-based connection.

## 7.5 Implications for architecture

The presented panels are designed to be used as structural elements and double as exposed surface. This biologically inspired approach -- in nature often single material serves multiple functions -- saves energy, production time and money potentially spent on additional finishes. As discussed above (see 7.3) some species may even offer high resistance of untreated exposed surface. While it would be difficult to meet the present day thermal requirements with wood only without increasing the wall thickness to 40-50 cm, the dry-in-wet panel is more suitable for external walls as it provides internal space that, as mentioned earlier, could be used for additional insulation. The wet-in-wet scenario would be suitable for internal partitions or as a load-bearing leaf of an insulated wall.

Both presented examples result in flat panels of even external surface. It remains to be answered how the wood-behaviour based connections could be further exploited architecturally by application of geometry, e.g. for their formal and aesthetical appeal, self-support, sound or light-wave reflection or attenuation.

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# SUSTAINABLE SEAPORTS: INCORPORATING SUSTAINABLE DEVELOPMENT IN PORT REDEVELOPMENT APPROACHES

**Dr Angela Carpenter**

School of Earth and Environment, University of Leeds, Leeds LS2 9JT, United Kingdom

Email: [a.carpenter@leeds.ac.uk](mailto:a.carpenter@leeds.ac.uk)

## Abstract

Seaports often form the historic hub of urban development, many towns and cities having grown up around natural harbours. Seaports often have a very specific heritage - a strong sense of place and community - resulting from the mix of peoples, ships and goods which flowed through them. They provide jobs and economic prosperity through activities ranging from transport of goods to fishing. Technological change, increasing ship size, the growth of mega-ports, and changes in fishing methods have all contributed to the decline of both historical and more modern port areas. This paper considers how ports and port buildings can be repurposed or redeveloped in a sustainable way, opening up new avenues to secure the long term economic viability of the companies operating those ports. It presents examples of port and waterfront redevelopment identified in the academic literature. It argues that port redevelopment and societal integration can contribute to the economic, social and environmental sustainability of the local area and community, with factors such as employment, a sense of community identity, and long-term economic prosperity all being vital in creating resilience in urban areas around seaports. It proposes alternative solutions for redevelopment, repurposing and reuse of redundant port buildings and infrastructure, taking into account sustainable development principles. The research being developed from the scoping study discussed in this paper will benefit the port industry and policy-makers, and contribute to debates on port planning and urban policy.

## 1 INTRODUCTION

Seaports are gateways between the sea and land and are generally considered to be man-made locations where ships can be loaded or unloaded using cranes or other equipment, and have developed in response to the need to transport goods or people within a region or across vast distances. Ports differ widely in terms of size – from small fishing ports to very large container ports; in ownership – including publicly owned and operated, privately owned and operated, or a combination of the two; and also in the very wide range activities that take place in them (Bichou and Gray, 2005)<sup>[1]</sup>.

Many ports are located in towns and cities which grew up around them over many centuries and have a varied and unique history and culture (Wakeman, 1996)<sup>[2]</sup>. In recent times, a number of factors have led to a need for ports to adapt in order to continue to operate. This includes the port being surrounded by urban areas, resulting in a lack of space and no room to expand to accommodate the increasingly large ships used to transport containers or the very large cranes required to load and unload them. Older ports may also lack access to adequate transport links (road, rail, inland waterway) necessary to operate as modern intermodal transport hubs. Conversely, improved working practices or operations may result in goods transiting the port area more rapidly via improved road and rail links and a consequent reduction in need for warehousing, resulting in derelict buildings and abandoned spaces. Ports may also have contracted their operations into smaller, more secure areas in light of increasing security threats posed by thieves entering the port area, from stowaways trying to get on or off ships, from smuggling, or from the potential threat of terrorist attacks on ships berthed at quays or against the port itself (see, for example, Carpenter, 2013<sup>[3]</sup>, Cowen and Bunce, 2006<sup>[4]</sup>).

Ports also face competition from mega-ports such as Shanghai, Tianjin and Guangzhou in China, Singapore Port in Singapore, Busan in South Korea, Rotterdam and Hamburg in Europe, and Los Angeles in the United States<sup>[5]</sup>. New ports are also being built in areas such as Jebel Ali in Dubai, United Arab Emirates, and these port developments can take advantage of locations where space is not limited, where the largest ships can be easily accommodated, and where there is room for the new

warehouses, processing plants, large equipment, transport hubs- and the infrastructure required to operate a modern port. New ports may also be developed as free zones or in areas where low taxation and less restrictive customs regulations mean there is an economic incentive for companies to transfer their business away from older ports.

The result of industry changes is that many ports are left with unused or infrequently used warehouses and other buildings, and dock areas that cannot accommodate large ships. They may also have been affected by the decline of traditional industries within, or in close proximity to, the port. Port owners may therefore hold a portfolio of resources, both infrastructure and land, that costs money to maintain but does not generate income. Potential ways to use those resources in new and sustainable ways is the topic discussed in this paper

## 2 PORT REDEVELOPMENT LITERATURE

Articles on seaport and waterfront redevelopment can be found in many categories in academic literature including planning and policy, regional studies, ocean and coastal management, environmental planning, and urban policy, for example. Examples of waterfront developments range from the regeneration of the Mersey Basin in North West England<sup>[6]</sup> to high profile redevelopment projects in Tokyo and New York City<sup>[7]</sup>. Vayona (2011)<sup>[8]</sup> notes that waterfront revitalisation is not new idea, having started in England around the Liverpool area in the 1940s, in response to damage caused during the second world war, and in the United States with the Baltimore Inner Harbour revitalisation of the 1970s.

Port redevelopment may also be for a specific purpose, for example where a city is to host a world exposition<sup>[9]</sup>, or the building of an iconic new cultural destination such as the Opera House in Oslo<sup>[10]</sup>. It can also be as a result of a change in the physical relationship between the port and city, identified previously, where lack of space means that a port is no longer able to expand out into the surrounding area and the city needs to find new space to house a growing population and is expanding into the port area instead. In this latter example Wiegman and Louw (2011)<sup>[11]</sup> highlight the life-cycle concept for port areas, developed by Charlier in the early 1990s.

That life-cycle concept, Wiegman and Louw note, identifies that the port progresses through five stages: i) *growth*, where investment helps create and expand the facility; ii) *maturity*, where the full potential of the facility has been achieved; iii) *obsolescence*, where modern, higher capacity facilities take over business; iv) *dereliction*, where the berths are abandoned by shipping; and v) *redevelopment*, where new and non-port economic activities occur. Many ports currently face the possibility of obsolescence and dereliction as a result of the industry changes, and so need to consider how they can redevelop and adopt new activities which allow them to continue to operate and generate an income for their owners, rather than leave port areas derelict and abandoned.

Vayona (2011) suggests that successful redevelopments should capitalise on any instrument that can bring in the maximum possible benefit to the community around the port, or a waterfront area, and should take into account the preferences and tastes of the local population. It may also be the result of recognition by that there is a need to preserve the cultural heritage and history of a port and its wider urban environment. Pinder (2003)<sup>[12]</sup>, for example, indicates that port activities frequently dominate local economies and provide a source of economic well being, while also instilling a sense of place and identity for local communities. Ports are also, according to Pinder, a source of permanent immigration which creates a cosmopolitan urban culture around them. Commercial ports may also have been closely associated with naval ports, where docks for military vessels were located within the same waterfront area as commercial docks, and military barracks and hospitals were located in the local towns. In this way, they can also contribute to the cultural identity and heritage of an area through the buildings and other structures left behind when the military has left or been concentrated into a smaller area (see Pinder, 2003; Gordon, 1999<sup>[13]</sup>).

However the examples of Millers Point in Sydney (Waite and McGuirk, 1996)<sup>[14]</sup> and the Old Town waterfront in Mombasa (Hoyle, 2001)<sup>[15]</sup> illustrate that problems can exist about what actually is the cultural heritage of a port area, and the reason why is it being considered for redevelopment. Heritage tourism was a driver of redevelopment at Millers Point but the heritage being retained was that relating to its history as the oldest British colony (established 1788) in Australia, and as a merchant society during the second half of the 19<sup>th</sup> century. The waterfront redevelopment of the late 1980's was identified as ignoring many aspects of Australian national identity such as its indigenous population, and also the area's local identity from its more recent 20<sup>th</sup> century industrial heritage. That heritage

will, Waitt and McGuirk suggest, be lost fairly quickly as the older population die and important 20<sup>th</sup> century events are not commemorated.

In the example of the Old Town waterfront in Mombasa, Hoyle indicates that the area had become neglected and disassociated from modern urban growth on Mombasa Island, and the development of the new Port of Mombasa/Kilindini deep-water port. Redevelopment had to take into account the very long history of trading through the Old Town (since the 11<sup>th</sup> Century) with migration, Islamic expansion, and Portuguese colonisation just some of the changes which took place. The area included a mosque, an old fish market, government buildings and Fort Jesus, and redevelopment had to take into account conservation of historical buildings, improving public spaces, finding new uses for buildings and how to bring money and jobs into the local economy. It also needed to consider the cultural attitudes of the local population and the value they placed on the inherited structures, recognition of the distinctive nature of the area within the wider context of the urban fabric of the port city, and the practicalities of funding, involving local people, and what the redevelopment could bring to the area (tourism, education and training facilities, for example).

Port redevelopment is also considered within the literature on sustainable development (see Wakeman, 2007, Bunce, 2009<sup>[16]</sup>, Girard, 2013<sup>[17]</sup>, for example). Wakeman indicates that a benefit of using a sustainability approach to port redevelopment is that it recognises the need to diversify, reuse or adapt so that the port and its maritime activities remain viable in the face of economic or environmental shifts. Wakeman also notes that, by looking at ports from the perspective of sustainability, it can help redefine the relationship between the port and the urban region around it, which could lead to a renaissance of both the port and the city.

Bunce, in setting out the case of redevelopment of the Toronto waterfront, also indicates that it has been guided by a “three pillars” concept for sustainability – balancing economic development, social growth and environmental protection – to create a localised understanding of what is required to redevelop the waterfront area. Similarly, Girard suggests that redevelopment should take into account economic, social and ecological factors when considering the wider urban redevelopment of port cities and surrounding urban areas. In particular Girard identifies that ports may be entry points for wider urban development and that the waterfront regeneration of cities such as Rotterdam, Barcelona, Liverpool, Tokyo, Hamburg, etc has resulted in a range of new, creative and innovative developments, both in the ports and in the wider cities that they are part of.

### 3 EUROPEAN PORT INDUSTRY APPROACH TO PORT REDEVELOPMENT

Waterfront redevelopment offers the potential for ports to develop sustainably, and with the involvement of their local communities. The European Sea Ports Organisation, an industry organisation representing a large number of European ports, published a Green Guide (ESPO, 2013)<sup>[18]</sup> on how to combine effective environmental management and effective port management to both improve port practice and also to improve community stakeholder relations.

In recognition of the need to improve integration between ports and their wider community (local residents, businesses, local government agencies etc.), ESPO developed a Code of Practice on Societal Integration (ESPO, 2010)<sup>[19]</sup>. That Code called for port authorities to optimise relations between the port and it’s surrounding societal environment, with a focus on the human activities in ports such as (future) employees, people who live in and around the port area and the general public. In particular, it set out three interconnected themes addressing three related target groups, set out at Table 1.

The Code of Practice emphasised that ports can only sustain their economic functions in the longer term if societal factors are taken into account, and that co-operative synergies within cities play an important role in doing so. A similar approach is also necessary when considering port redevelopment projects which should, according to the Code, ideally combine residential urban functions with port activities. As a result, ESPO, in establishing an Award for Societal Integration of Ports, also recognised that public support for seaports has eroded, with competition for land use, environmental concerns about port operations, and safety and security issues contributing to a negative image of ports over the last few decades (ESPO, 2009).<sup>[20]</sup> Ports were, ESPO suggested, often seen as necessary evils and the fundamental contributions ports can make to economy and society have been ignored.

*Table 1. Main themes of ESPO Code of Practice*

Theme	Target Group	Aim
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General public support and image	General public	By involving the general public the image of ports will improve and will result in public support which is needed to maintain the licence to operate of ports and to achieve expansion and development projects.
Education and labour market	(Future) employees	To have an impact on the supply side of the labour market in order to attract better educated workers to ports. This concerns investment in education, connecting port companies to educational institutions and to engage support of government bodies
Port-city relationship	People living in and around ports	To conserve good relations with inhabitants in and around port areas, but also to co-operate between cities and ports within transformation areas. This should result in a good quality of life in the surrounding areas of ports supporting an attractive business climate.

Source: *ESPO Code of Practice, page 15*

The ESPO Award aimed to promote innovative projects in European Ports which would improve societal integration, especially at city or community level, and also establish a better dialogue between ports and cities. Three categories of projects were outlined for the award: a) improving sustainable development synergies between ports and cities; b) improving quality and accessibility of port areas; and c) promoting the image of the port as a place to experience, live and work. Out of 30 entries from 26 ports, the winning entry in 2009 was the Port of Genoa, which had developed a Port Centre which offered a range of services including permanent exhibits, publications, a website, and educational facilities (including visits, learning materials and laboratories), and also offered facilities for businesses and companies. The project aimed to improve both physical access to the port and also break down the “psychological distancing” between the port and city.

In subsequent years, the winners of the award were the ports of Stockholm (2010), Helsinki (2011), and Gijon (2012). The most recent winner was the Port of Antwerp in 2013, under the theme of Heritage – contemporary use and disclosure of port heritage (see ESPO, 2013).<sup>[21]</sup> In winning the Award, the Antwerp Port Authority not only sought to protect its port heritage through the restoration of buildings and renovation of quays, but also made port buildings available for cultural projects – a key element of community/stakeholder involvement and creating a good port-city relationship.

#### 4 POTENTIAL REDEVELOPMENT OPPORTUNITIES FOR PORTS

There are a number of possible options when a port seeks to introduce sustainability within its core business and also to develop or improve links with its local community. These opportunities are relevant to ports irrespective of size or location, as long as they have unused buildings or land which has the potential for redevelopment. They may be considered as ‘add-ons’ to normal port operations such as freight transport or ferry operations and, while they may not initially generate income, they will generate interest in the port and have the potential to offer new income streams in the future.

This paper examines some of the wider redevelopment possibilities – things that go beyond the standard luxury housing, corporate offices, or hotels, restaurants and theatres, that are the familiar idea of a waterfront/port redevelopment. It sets out ideas arising from discussions with a small number of representatives from European ports and also published in an article for a trade journal which is available to ports across the globe (Carpenter, 2014).<sup>[22]</sup> It therefore presents the initial findings of a scoping study for potential future research into sustainable port redevelopment. A survey of ports is the next planned stage once feedback has been received on these ideas set out in the paper.

There are many opportunities for ports and much will depend on the specific circumstances of the port and its surrounding community, and the needs of local businesses and local government. For the purposes of this paper, the potential opportunities for development are discussed under four main headings: housing/other accommodation; educational activities; cultural and heritage opportunities; and tourism opportunities. Many of the potential opportunities are considered under more than one heading since they were intended to guide discussions with ports, rather than as strict categories.

##### 4.1 Housing/Other Accommodation

#### **4.1.1 Housing**

Where ports have vacant buildings or unused land, one of the most common forms of redevelopment has been to sell the land off for urban redevelopment, often in the form of expensive waterfront apartments which are priced outside the financial reach of local people. However, for some ports and communities, a better option may be to redevelop the existing buildings to provide low cost housing, a mix housing types, or as hostels or other types of accommodation.

The feasibility of such a development will depend on a range of factors including: the type and state of the existing buildings; whether they can be made habitable at relatively low cost or whether they need to be replaced; how much investment is required, if the buildings can be brought up to a habitable standard, and who will undertake that work; whether the port is able to fund the renovation or needs a partner (building firm, investment company, regional or local development agency, for example) to share the costs; and if it is in the best interests of the port to retain ownership of the land or to sell it off to a developer.

In the mixed housing option, the port may sell off part of its available land stock for the building of expensive waterfront apartments, but including a requirement that the developer must also build low cost housing for the local community or for port employees on a separate port-owned/retained piece of land. This option would have the benefit of providing affordable housing to keep local people in the area, rather than them having to move away to find somewhere affordable to live. It could therefore be viewed as a way of improving the port-city relationship and also be a way of attracting workers to the port by improving the employment package they are offered.

Providing port employees with affordable housing, and consequently reducing their need to travel to and from the port, should lead to a reduction in transport emissions compared to the situation where employees need to travel some distance between their existing accommodation and the port. A combined housing option would also provide income to the port in two ways – through the sale of some of its land to a property developer and through rental charges for any port owned housing.

#### **4.1.2 Other Accommodation**

Converting buildings into hostels or accommodation blocks may potentially be a lower cost option, as buildings may not need to meet the same standards required for houses. For example, they may only need a single large kitchen area, and shared facilities such as recreation areas, bathroom facilities, and dormitory-style sleeping areas. As a result, this would mean that large buildings could be converted, rather than demolished to make room to build individual houses.

This type of accommodation could be used to support a range of activities for local groups and groups visiting from further afield. Those activities could include: outward bound type courses such as hiking and orienteering; sailing, canoeing and diving courses; or local scout and guide camps, for example. The same facilities could also be used to accommodate students undertaking educational courses. Under this option, consideration would have to be given to how to feed the people staying in the port area, whether through catering in-situ, or using restaurant or cafe facilities developed for other visitors to the port such as tourists, or by port employees, leading to economies of scale for bulk catering.

#### **4.2 Educational activities.**

Potential educational activities that could be developed by ports, or by local groups working with the port include examining the history of the region around the port, looking at its local ecology, local traditions, local industrial heritage, or even looking at the local cuisine of the region. Educational activities may include offering courses to groups from local schools or community groups. Ports could also liaise with local heritage groups or experts in a specific field to come in and teach groups of school children, and potentially to manage these activities rather than the port doing so.

With unused buildings comes the possibility of providing classroom spaces or laboratory spaces, particularly in buildings that cannot be converted into housing or accommodation due to location, accessibility, or the costs involved. Provision of classroom and laboratory spaces opens up the possibility for the port to work with Universities offering courses in subjects where the student learning experience, and course curriculum, would be enhanced by working in or near the port. This might involve short-term (weekend, one week) options, where students are provided with an overview of the local ecology/ecosystems, the port's marine or freshwater biology (dependent on location), its geography and environment, the local culture and history, or even courses in photography and art, for example. It might also involve longer-term opportunities (several weeks or even several months)

where data collection over a longer period of time is required. Students could, for example, undertake water quality monitoring, look at the biodiversity around the port at different times of the year, examine interactions between port dredging activities and fish stocks/aquaculture activities in the area, identify ways in which the port might minimise any environmental impacts from its core business activities, or improve its environmental performance. Additionally, business and management students might undertake case studies into redevelopment opportunities available to the port.

It is also possible to develop exhibitions of the local marine life, such as The Deep, a large aquarium built near the marine in Hull, or the National Marine Aquarium in Plymouth, both in the UK. These types of spaces can serve as educational resources for local or regional schools and also serve as tourist attractions, where local people can take their children to visit during weekends and people visiting during school holidays also have somewhere interesting to take their children. They can also potentially offer local communities a venue for events related to local maritime heritage such as the history of the local fishing industry, or history of the port as a gateway for migration, for example.

### **4.3 Cultural and Heritage Opportunities**

Empty buildings may also be suitable for conversion into workshop and training spaces, for the development of local heritage museum spaces, or for gallery spaces and craft shops available to rent by local craftspeople. There are a range of possibilities for the development of cultural and heritage activities. This depends on the buildings available, how much work and investment is needed to convert them, and the history of the port and its environs.

Where there is a strong local culture and heritage, some significant historical event, or even a specific architectural style locally, these may attract tourists to the area. Those visitors will often want to purchase locally produced crafts as souvenirs or gifts and so anything that can be produced on site, or exhibited through museum spaces, can potentially generate income, improve the public image of the port and also improve the port-city relationship by bringing in new opportunities, jobs and income into the wider economy. In addition, visitors to the site may also wish to stay in local hotels or bed and breakfast accommodation, and need to eat in local restaurants or purchase food from local shops.

Linking in with the development of educational activities, there is also the possibility for local craftspeople to offer training courses, to host exhibitions featuring local culture and history, and to run special events such as craft fairs, historical re-enactment events, boating events or offer concert venues for local singers, for example, providing additional benefits to employment and the economy locally.

### **4.4 Tourism opportunities**

If the port is able to redevelop some of its existing buildings to provide accommodation, there is the added potential that it could be used for self-catering accommodation during the main holiday periods, and as student accommodation at other times of the year. In this scenario, however, it is important to consider what tourist accommodation is already provided locally, in order to avoid directly competing with local hoteliers or other businesses providing accommodation. This opportunity may be particularly suitable for smaller ports, close to tourist areas, where the scope for the development of additional tourist facilities is limited locally by, for example, lack of suitable land or amenities.

If a port did wish to investigate this option, it will need to identify the demographic groups that already visit and stay in the area (where and why they stay there, the main attractions in the area etc.). Once this has been identified, they can consider marketing to attract different demographic groups and offer new reasons to visit the area. This links back to developing museum, gallery or craft shop spaces, and providing craft workshops or training spaces.

It may also be possible to offer accommodation on ships moored in the port which can be used for evening cruises, as a dinner venue or for weddings and party functions. Using historic vessels or converting ships that previously operated in the port may be an attractive option for visitors and there is also the potential to offer conference facilities and accommodation packages to businesses outside tourist season, or team-building activities for companies through outward-bound type courses.

## **5 SUMMARY**

Rather than offering any conclusions as to the best way of undertaking seaport/waterfront redevelopment, this paper provides some suggestions on how ports might offer a diverse range of activities, change the use of empty or underutilised buildings, integrate community activities and strengthen community ties, and also potentially increase tourism within its area. There is, of course,

scope for a range of other possibilities depending on the size, location and business activities of a specific port. There is also, quite clearly, a need to consider port security and protection of key port areas, when developing new activities around the port and its environs.

The next stage in this research is to develop a questionnaire for ports to look at whether they have undertaken any redevelopment and, if so, whether it incorporated sustainability and community involvement elements. As a new project, no results or conclusions are available at the current time.

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# INTEGRATED POLICIES TO IMPROVE THE SINGAPORE CONCRETE UTILIZATION INDEX – AN ATTRIBUTIONAL AND CONSEQUENTIAL LIFE CYCLE EVALUATION OF POSSIBLE EFFECTS OF SUBSTITUTING CONCRETE WITH BRICKS

Harn Wei Kua<sup>1</sup>, Susmita Kamath<sup>2</sup>, Marcus Maghimai<sup>3</sup>

<sup>1</sup> Department of Building, School of Design & Environment, National University of Singapore; [bdgkuahw@nus.edu.sg](mailto:bdgkuahw@nus.edu.sg)

<sup>2</sup> Master of Science (Environmental Management) Program, School of Design & Environment, National University of Singapore.

<sup>3</sup> Department of Building, School of Design & Environment, National University of Singapore.

## ABSTRACT

Singapore introduced the Concrete Utilization Index to promote the substitution of concrete products with alternate building materials. This study examined the environmental impacts of replacing concrete with bricks. Using an attributional life cycle approach, it was found that replacing concrete with bricks may actually increase the net environmental impacts. In the first ever consequential life cycle assessment done for bricks in the literature, we found that replacing concrete with bricks may result in negligible reduction in global warming potential, provided there is no change to the amounts of bricks and concrete constituents being imported into Singapore. Considering there are changes to the import quantities, we derived a mathematical relation that enables us to know how much the import of concrete constituents must decrease in order to nullify the increased global warming potential resulted from the increased importing of bricks. In all these assessments, we found that the environmental impacts (including global warming potential) of the manufacturing stage of bricks need to be reduced. To achieve this, we reviewed a few new brick-making approaches that can produce more sustainable bricks; we also proposed a way of creating a “green demand” for these bricks and utilizing policies such as Singapore’s Business Angel Scheme to finance the upgrading of brick-making technologies through international partnership.

*Keywords: Attributional life cycle assessment, consequential life cycle assessment, concrete, bricks, integrated policy, sustainable building materials*

## 1 INTRODUCTION

With the goal to promote more sustainable building materials while reducing their life cycle impacts (including embodied energy), the Singapore Building and Construction Authority (BCA) implemented the Concrete Utilization Index (CUI) to promote the substitution of concrete products with alternate building materials. This has been incorporated into the current BCA Green Mark Scheme – a local green building rating system – and the use of CUI is becoming more and more popular in the industry. Recently, more firms are looking at using bricks as replacement for concrete. So far, there is no study on what the net consequences and resultant environmental impacts of such a replacement may be. Such a study is important to ensure that this policy will lead to improved environmental sustainability.

This paper has 3 main objectives: 1) compare the life cycle impacts of bricks to that of concrete relative to several environmental indicators. 2) Consider a number of likely scenarios describing changes in the flows of concrete and bricks into Singapore, as a result of bricks substituting concrete, and then evaluate the net environmental impacts of these scenarios. 3) Propose integrated policy strategies to improve the CUI so that it results in net reduction of adverse environmental impacts as much as possible.

## 2 COMPARISON BETWEEN CONCRETE AND BRICK CONSTRUCTION

For structural purposes, concrete can be replaced with wood, steel or bricks. Traditionally, wood is not widely used for construction in Singapore. While steel can be used to replace concrete columns, beams and, less commonly, slabs, it is not used to replace concrete in shear walls. Replacing concrete entirely with steel will decrease the walls' thermal resistance and increase the cost of construction. By contrast, bricks have similar thermal resistance as concrete blocks and have been widely used in Singapore in shear walls and internal light structural walls. In other words, there are more possibilities to replace concrete with bricks in Singapore.

Since its inception, there has not been a systematic and rigorous way of assessing the effectiveness of CUI in promoting sustainable construction, particularly as a result of substituting away concrete. The aim of this study is to apply the concept of life cycle assessment (LCA) to evaluate the resultant environmental impacts of replacing concrete with masonry (bricks, specifically), which is becoming a common strategy to achieve a lower CUI.

Concrete is arguably the most important and versatile material in construction today. It is composed primarily of cement, aggregates and water. Each year, more than 10 billion tonnes of concrete are produced globally for use in construction projects (Thi Do [1]). It is estimated that the amount of concrete used in the construction industry is almost twice that of all other building materials put together (UNEP [2]). Owing to its strength, durability and ease of casting, concrete is used in a variety of applications in the construction industry. Cement, the main constituent of concrete, is a major source of greenhouse gases (GHGs). It is estimated that the cement industry contributes about 5 - 7% of the global anthropogenic CO<sub>2</sub> emissions (UNEP [2]). The production of concrete also causes extensive quarrying for sand, gravel and stones for use as aggregates in the concrete mixture. The construction industry is by far the only consumer of bricks (Rose et al [3]). Bricks are one of the oldest and most popular building materials, owing to their low price, durability and ease of handling. Bricks are known to retain their colour much longer than concrete blocks. Furthermore, concrete absorbs water at a rate higher than bricks, thus causing larger changes in the dimensions of concrete blocks when they are being used. The thermal resistance of bricks and concrete blocks are similar and so replacement with bricks is unlikely to change the energy consumption of the building during the use phase. However, it is well known that brick making is an energy intensive process. In 2008, the Asian brick making industry consumed about 110 million tons of coal and the diesel used for transportation produced approximately 180 million tons of carbon dioxide (CO<sub>2</sub>) (Heierli and Maithel [4]).

## 3 RESEARCH METHODOLOGY

Life cycle assessment (LCA) is a popular and rigorous method for assessing the total environmental impact of building materials. While applying LCA to assess the environmental impacts of bricks, we need to take into account the net environmental impacts caused by the replacement of concrete by bricks under different possible consequences. This study analysed the net impacts of such a replacement, using both an attributional LCA (ALCA) and consequential LCA (CLCA). ALCA calculates the environmental burdens resulting from a given product, whereas CLCA considers higher order effects, including the net environmental impacts due to market response to material substitution (Earles and Halog [5]). In other words, CLCA extends the system boundary beyond what the conventional ALCA considers.

Most of the available literature on LCA for bricks is ALCA in nature. For example, a detailed ALCA was carried out for the manufacturing of clay bricks, with respect to energy consumption and CO<sub>2</sub> emissions, by Koroneos and Dompros [6]. It was a cradle-to-gate study that studied the life cycle stages of raw material extraction, brick manufacturing, packaging and transportation. Owing to the difference in processes employed for manufacturing and the difference in composition of clay from region to region, a large variation is obtained in embodied energy of bricks. It varies from 2,200 MJ/tonne (Ashby [7]) to 5,909 MJ/tonne (Utama and Gheewala [8]). In comparing brick and concrete, Venta [9] conducted a cradle-to-gate study in Canada to analyse the inputs and outputs from brick production; it was found that the embodied energy and the emissions due to the manufacturing and

transportation were substantially higher for clay bricks than concrete (for a functional unit of one cubic metre of bricks). Utama and Gheewala [8] studied the embodied energy of houses in Indonesia that might use either clay bricks or concrete blocks for their envelopes. The embodied energy of clay bricks was found to be half of that of concrete blocks, due to the manufacturing process employed and the tropical weather in the country. The results indicated that clay bricks perform better in global warming potential (GWP) and human toxicity potential (HTP), whereas concrete blocks fare better in acidification potential (AP), eutrophication potential (EP) and photochemical oxidation potential (PCOP). The AP impacts in clay bricks were mainly due to presence of hydrogen fluoride and chloride in the clay. The usage of higher amount of mortar for clay bricks and its replacement also contributed to the AP.

In comparison, CLCA for buildings materials has been rare. In the first CLCA study in the Singapore context, the effects of substitution of cement with copper slag were analysed (Kua [10]). The results of ALCA suggested that the substitution is desirable; however, the CLCA indicated a reduction in the benefits of such a substitution. Presently, there has not been any CLCA on the replacement of concrete products with bricks anywhere in the world. The need to assess possible consequences of the CUI in Singapore provides us with the motivation to conduct such a CLCA, in order to fill this important knowledge gap in the literature.

The overall research design of this study is illustrated in Figure 1.

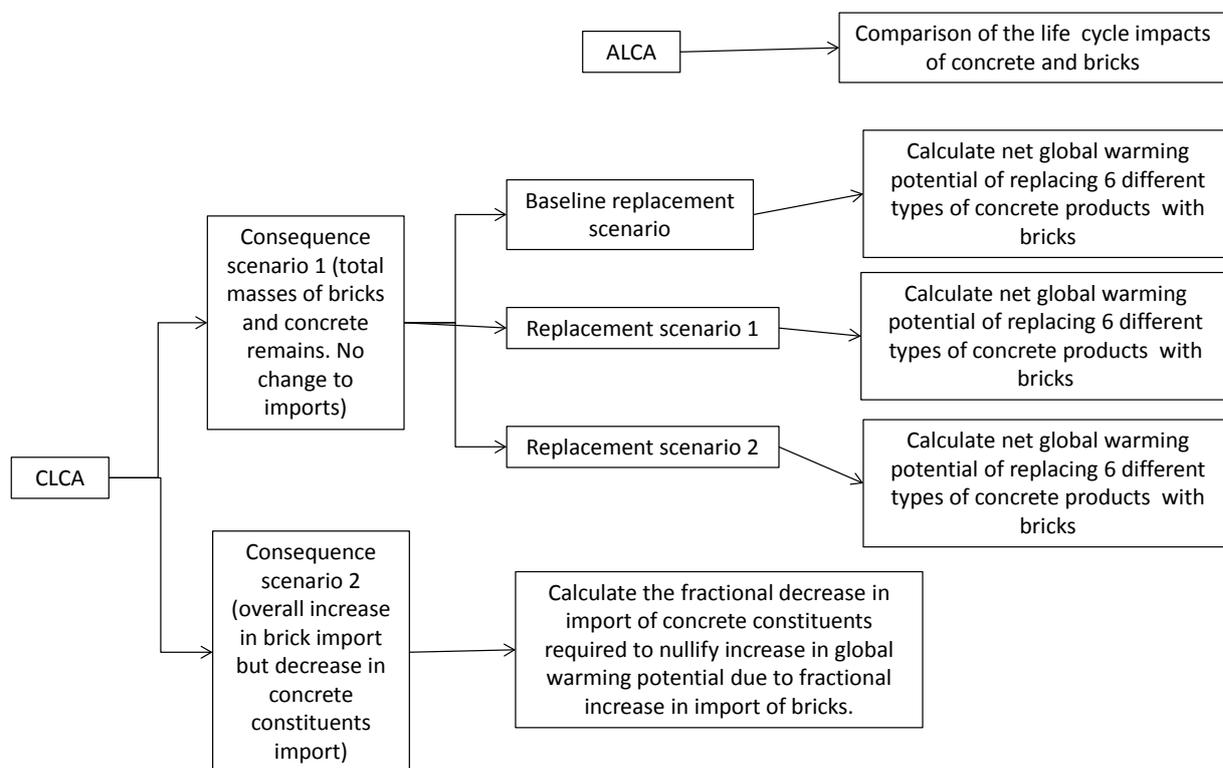


Figure 1. The overall research methodology, consisting of attributional and consequential life cycle assessments.

The data for this paper was acquired mainly through literature review, questionnaires, telephone interviews, emails correspondence with relevant stakeholders in the industry and collection of data from industrial processes in the relevant factories. Since Malaysia is the main source of clay bricks for Singapore, data is obtained directly from production facilities in Malaysia and calculations in the LCA were modelled after a brick plant in Malaysia. The system boundary for the ALCA is shown in Figure 2. For this type of assessment, the focus was put on five impact categories, namely Global Warming Potential (GWP), Acidification Potential (AP), Eco-toxicity Potential (EP), Human Toxicity Potential (HTP) and Cumulative Energy Demand (CED).

The life cycle inventory (LCI) of cement is taken from a study of a Taiwan-based cement manufacturing plant by Teo et al.[11]. In addition, the life cycle impacts from the transportation of concrete products and the concrete aggregates (sand and gravel) were adopted from Kua [10] and Thi Do [1]. We also compared the impacts due to concrete mixture containing granite as gravel and that containing 30% of recycled concrete aggregates (RCA). The data was taken from Thi Do [1].

In the CLCA, we considered two consequence scenarios (refer to Figure 1). In consequence scenario 1, the total consumption of concrete for building construction reduces by a quantity  $Y$  and that of bricks increases by a quantity  $X$ ; these changes in consumptions of both materials in buildings neither change the consumption for other purposes nor change their international trade (import and export). However, this means that additional  $X$  of bricks is taken from the national stockpile and  $Y$  of concrete is saved from the national stockpile. Overall, the total quantities (mass) of brick and concrete in the whole of Singapore are the same. The net GWP of this scenario can be calculated using the following equation:

$$\text{Net GWP} = \left(\frac{Y}{R}\right) [GWP_{\text{Brick}} - GWP_{\text{Brick not used}}] + Y [GWP_{\text{Concrete}_i(\text{not used})} - GWP_{\text{Concrete}_i}] \quad (1)$$

where  $GWP_{\text{Brick}}$  and  $GWP_{\text{Concrete } i}$  refer to the GWP of bricks and type  $i$  of concrete products respectively.  $GWP_{\text{Brick not used}}$  and  $GWP_{\text{Concrete } i(\text{not used})}$  refer to the GWP due to the bricks and concrete

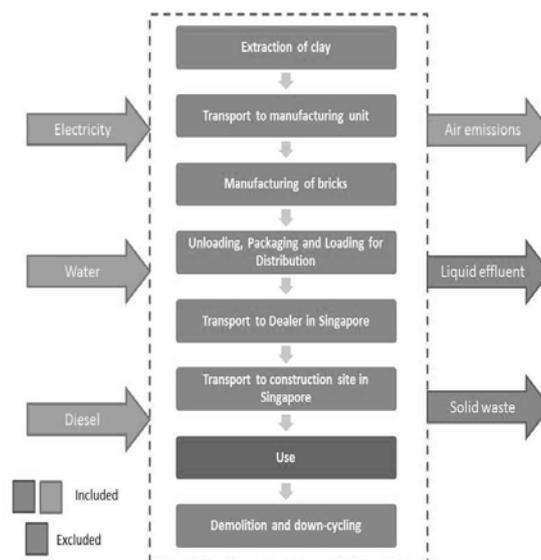


Figure 2. System boundary for clay bricks manufactured in Malaysia.

products in the national material stockpile; these materials are not used in construction sites and so the values do not include the GWP due to transportation to construction sites, deployment, demolition and recycling. We considered three replacement scenarios (refer to figure 1), in which the percentage of concrete mass being replaced away are 22% (the current industrial norm), 10% and 30%; these implies  $Y$  values of 2.2kg, 1kg and 3kg respectively for a functional unit of 10kg of concrete products.  $R$  is the replacement ratio of concrete mass to brick mass. We considered the values of  $R$  for six different types of concrete products, namely concrete block, precast concrete wall panel (90 mm thick), precast concrete wall panel (100 mm thick), and all these three types of products with 30% RCA. In summary, under consequence scenario 1, we considered three replacement scenarios; for each replacement

scenario, we used equation (1) above to compute the net GWP values for six different types of concrete products (refer to figure 1).

In consequence scenario 2, the total consumption of concrete for building construction reduces by a quantity  $Y$  and that of bricks increases by a quantity  $X$ ; although these changes in consumptions of both materials in buildings do not change the consumption for other purposes, over time it results in an increase in import of bricks and a decrease in import of materials for producing concrete. That is, although there are no changes to the demand for bricks and concrete (just like in consequence scenario 1), the total quantities of bricks entering Singapore increases and quantities of concrete constituents decrease. This can be explained as the market adjusting to the increase in demand for bricks and hence importers start to purchase more bricks in anticipation of future spur in brick demand for construction projects. The net GWP of this scenario can be calculated from:

$$\text{Net GWP} = \left(\frac{Y}{R}\right) [GWP_{\text{Brick}} + (f - 1) \cdot GWP_{\text{Brick}_{\text{not used}}}] - Y [GWP_{\text{Concrete}_i} + (e - 1) \cdot GWP_{\text{Concrete}_i(\text{not used})}] \quad (2)$$

Expressed as a fraction of the quantity  $Y$ , “ $e$ ” is related to the amount of imported concrete that is avoided due to a decrease in the requirement for concrete. “ $f$ ” is the fraction of the quantity  $X$  and it accounts for an increase in the requirement for bricks. Both coefficients “ $e$ ” and “ $f$ ” – ranging from 0 to 1 – describe how the market responds to changes in consumptions of bricks and concrete by changing the international import of these materials. By equating equation (2) to zero, “ $e$ ” can be expressed in terms of “ $f$ ”:

$$e = 1 + \left[ \frac{(GWP_{\text{Brick}} + (f - 1) \cdot GWP_{\text{Brick}_{\text{not used}}})}{R \cdot GWP_{\text{Concrete}_i(\text{not used})}} - \frac{GWP_{\text{Concrete}_i}}{GWP_{\text{Concrete}_i(\text{not used})}} \right] \quad (3)$$

This means that if the increase in domestic consumption of bricks causes an increase in import of bricks by a fraction “ $f$ ”, then to ensure that this does not result in a net increase in GWP, the fractional decrease in import of constituents of concrete “ $e$ ” must be of a magnitude as derived with equation (3).

#### 4 RESULTS AND ANALYSES

The ALCA found that the extraction and production of raw materials for both concrete and bricks are the largest contributors of environmental impacts – constituting 65% to 80% of the total life cycle impacts. The results for bricks are shown in Figure 3.

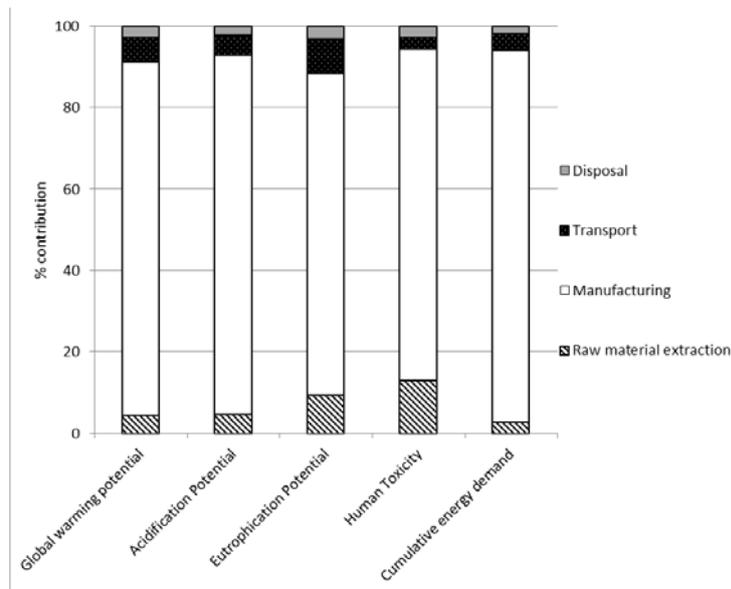


Figure 3. Life cycle stages' contributions of environmental impacts.

Irrespective of the types of concrete products used, the environmental impacts of concrete are actually less than those of brick (see figure 4). In particular, concrete in the form of concrete block has least impacts from an ALCA perspective.

The CLCA found that replacing concrete products with bricks results in negligible reductions in GWP. As shown in Table 1, from the perspective of the entire Singapore market, the higher the replacement rate, the higher the net reduction in GWP. Having 30% RCA in the concrete mixture reduces its overall GWP; therefore, replacing this type of concrete with bricks actually results in less net reduction in GWP. In other words, replacing concrete containing 30% of RCA reduces the overall benefit of substituting concrete with bricks. Finally, replacement of 1kg of 100mm-thick precast concrete wall requires the most amount of bricks; this explains why such a replacement produces the most reduction in GWP. Finally, Figure 5 illustrates the required reduction in concrete import necessary to make up for the increase CO<sub>2</sub> emissions due to increase in brick import. Generally speaking, for an increase of brick import by 1 time, concrete import would have to be reduced by 2-3 times in order to keep GWP the same. One may see this as an “impact penalty” for using bricks.

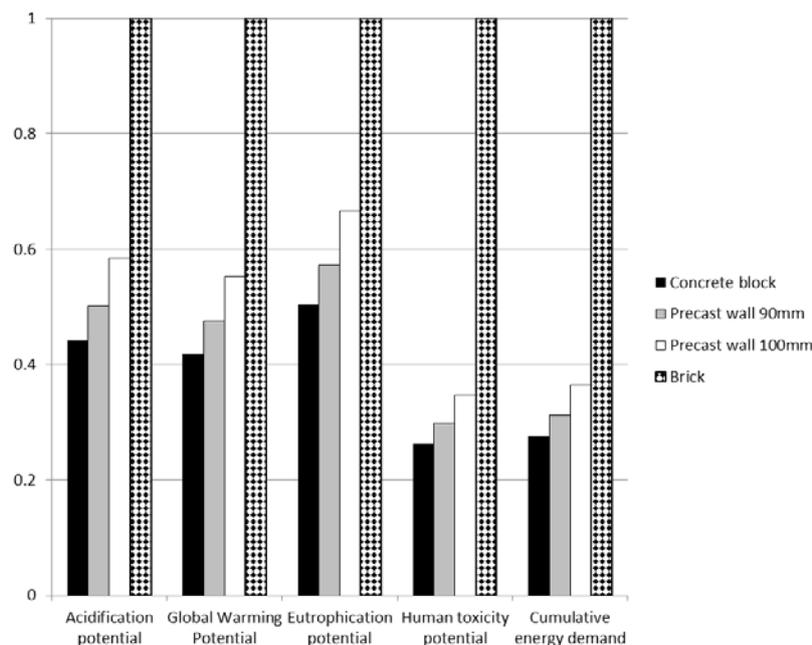


Figure 4. Impacts of concrete expressed as a percentage of impacts of bricks for 1 m<sup>2</sup> of wall.

Form of concrete	Baseline scenario (22% replacement)	Replacement scenario 1 (10% replacement)	Replacement scenario 2 (30% replacement)
Concrete block	-0.018	-0.008	-0.025
PC wall (90 mm thick)	-0.020	-0.009	-0.028
PC wall (100 mm thick)	-0.022	-0.010	-0.031
30% RCA Concrete block	-0.013	-0.006	-0.018
30% RCA PC wall (90 mm thick)	-0.016	-0.007	-0.021
30% RCA PC wall (100 mm thick)	-0.018	-0.008	-0.024

Table 10: Net Global Warm Potential (GWP) of different replacement scenarios due to the consequence scenario 1 for all the 6 types of concrete products. A negative value indicates a net decrease in GWP.

## 5 PROPOSED POLICY SOLUTIONS

This study showed that the recent strategy to reduce CUI and promote the replacement of concrete with other types of building materials may not be as effective in reducing greenhouse gas emissions as expected. While the CUI can still be implemented, results from this study suggest that we should use integrated sustainability policies to supplement it to ensure that it successfully promotes the reduction of GWP.

It was found that manufacturing of bricks cause considerable impacts; to a large extent, these impacts can be adequately addressed by technological innovation in kiln design and construction. A popular example of such an innovation is known as the vertical shaft brick kiln (VSBK), which was devised in

the early 1970s for burnt-clay brick manufacturers in rural China and was later developed by several countries in South Asia and Southeast Asia, most notably Vietnam and India. VSBK is about 40-50% more energy efficient than conventional kilns.

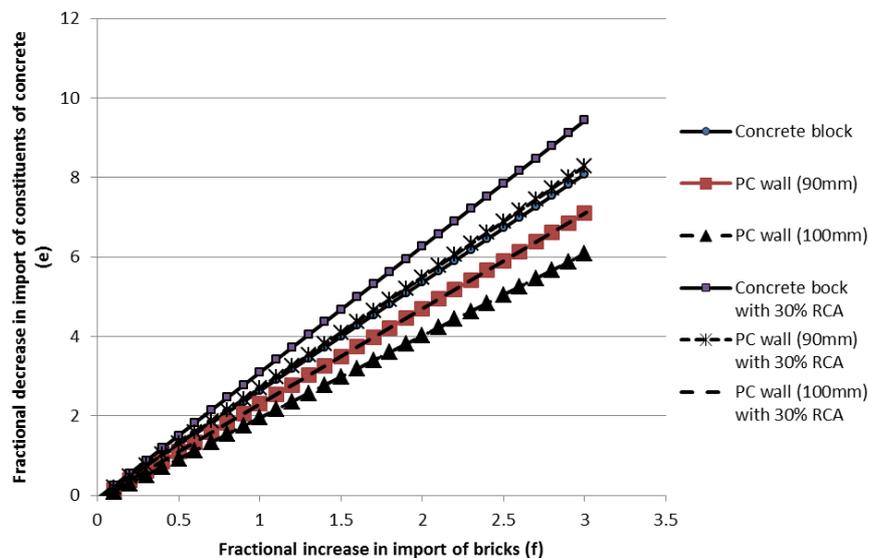


Figure 5. Fractional decrease in import of concrete constituents required to nullify increase in global warming potential due to fractional increase in import of bricks.

If coal is used in the kilns, the  $\text{CO}_2$  emission from VSBK is estimated to be about  $0.175 \text{ kg}_{\text{CO}_2}$  per brick, whereas conventional kiln (such as the fixed chimney type) produces about  $0.345 \text{ kg}_{\text{CO}_2}$  per brick (Tuladhar et al. [12]). However, widespread adoption and diffusion of such a technology requires a rigorous and yet effective financing mechanism. Funding through the UN Clean Development Mechanism (CDM) is known to be problematic. For example, CDM projects of this nature tend to have high development and transaction costs. Besides, there may not be in-country expertise on applying for CDM and management of CDM projects. Verifying emission savings from kilns requires special expertise and this adds to the overall cost of the projects. CDM projects also tend to demand considerable reductions of emissions that can only be achieved when a group of kilns participated in the program; however, engaging and committing a group of like-minded kiln owners can be challenging [12]. Hence, it is essential to create more options of possible funding mechanisms for upgrading of brick kilns. For this reason, we propose creating a “green demand” for sustainable bricks and then finance this new demand, through a business partnership scheme.

As a first step, the existing BCA Green Mark Scheme can be fine-tuned so that more points can be awarded to incentivize the use of green bricks; this is meant to stimulate the demand for such sustainable products. SPRING Singapore (a local governmental agency tasked to promote Singapore’s economic development), under the Business Angel Scheme (BAS), works with pre-approved private business angel investors to co-invest and nurture innovative start-ups based in Singapore. In our context, BCA may collaborate with SPRING Singapore to proactively encourage local entrepreneurs to partner brick companies in Malaysia and apply for capital funds through the BAS. Supported business plans must also include strategies to expand businesses overseas, beyond Southeast Asia. In a way, this is to enable sustainable bricks to be made available worldwide.

## 6 CONCLUSIONS

This study assesses the likely outcome of the CUI. Using an ALCA approach, we found that the environmental impact of construction may increase by replacing concrete with bricks. Using a CLCA approach, we found that replacing concrete with bricks may result in GWP reductions but these are negligible. Integrated technology and finance-related policy ideas were proposed to address this likely problem. Although our study has focused on Singapore, the methodology and policy ideas proposed

can be applied to evaluate any other building material and similar policies elsewhere in the world. From what we know, CUI is only practiced in Singapore. The main reason is that Singapore is facing a shortage in sand supply, which is an important ingredient of concrete. Hence, the results from this work serve as a precautionary note for governments that plan to incentivize a reduction in the use of concrete due to possible shortages of sand in the future.

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# ASSESSING AND MEASURING SUSTAINABLE DEVELOPMENT OF DEVELOPMENT ZONE IN CHINA: CASE STUDY OF TIANJIN ECONOMIC TECHNOLOGICAL DEVELOPMENT AREA

X.H. Ding<sup>a</sup>, W.Z. Zhong<sup>b</sup>, S.X. Zhang<sup>c</sup>, P. Madl<sup>d</sup>, X.B. Peng<sup>e</sup>, P.P. Tang<sup>f</sup>

<sup>a</sup> School of Finance and Economics, Xi'an Jiaotong University, 74 Yantaxi Road, Xi'an, 710061 Shaanxi, China. Email: xhding@mail.xjtu.edu.cn

<sup>b</sup> School of Finance and Economics, Xi'an Jiaotong University, 74 Yantaxi Road, Xi'an, 710061 Shaanxi, China. Email: weizhou@mail.xjtu.edu.cn

<sup>c</sup> College of Science, Northwest A&F University, 3 Taicheng Road, Yangling, 712100 Shaanxi, China. Email: zhyy@nwsuaf.edu.cn

<sup>d</sup> Division of Material Sciences and Physics, Department of Physics and Biophysics, Pairs Lodron Salzburg University, 5020 Salzburg, Austria. Email: pierre.madl@sbg.ac.at

<sup>e</sup> Department of Biological and Medical Engineering, ShangLuo University, 10 Beixinjie Road, ShangLuo, 726000 Shaanxi, China. Email: xbpeng1898@sina.com

<sup>f</sup> College of Economics and Law, Shaanxi University of Technology, Chaoyang Road, Han zhong, 723001 Shaanxi, China. Email: tangpingping17@163.com

<sup>a</sup>Corresponding Author, School of Finance and Economics, Xi'an Jiaotong University, 74 Yantaxi Road, Xi'an, 712100 Shaanxi, China. Tel.: +86 02984498196. E-mail: [xhding@mail.xjtu.edu.cn](mailto:xhding@mail.xjtu.edu.cn)

**ABSTRACT:** The adoption of the sustainable development indicator is fundamental in assessing sustainability at all levels. In China, the role of the development zone is critical to the local economy, and the track of its growth towards sustainability also largely determines the status of local sustainability. The purposes of this paper are to introduce a pragmatic method for assessing sustainability at regional scale, based on an integrated framework consisted of expert-lead top-down and community-based bottom-up methodologies – ‘Simplified Adaptive Learning Process’ (SALP), and an indicator specially design for assessing sustainability of the development zone – ‘Number of Similar Indicators from Local Yearbooks’. Then, a case study was carried out for assessing the sustainability of ‘Tianjin Economic Technological Development Area’ in 2011. Results showed that the sustainability of TEDA depicted a steady growth trend over the last two decades, and the local sustainability of TEDA was dominantly contributed from economic prosperity and industrial development in the early stage, while the shares of contribution from social and environmental dimensions on local sustainability gradually became larger with further growth of TEDA. As a target-oriented framework, the SALP framework is easier for local authorities or researchers to adopt since tasks or contents in each stage are well defined, and it can be flexibly modified to suit demands of its users. The NSILY, indicator particularly designed for this research, is proved to be suitable for evaluating sustainability of those areas with short-period of history, intensive industrialization and urbanization, fast-changing and multi-functional area.

**KEY WORDS:** *sustainable development indicator (SDI); development zone (DZ); number of similar indicators from the local yearbooks (NSILY); stakeholder analysis*

## 1 INTRODUCTION

After the ‘Conference on Sustainable Development and Environment’ hold in 1992<sup>[1]</sup>, the UN system adopted the Agenda 21 to guide programs and actions designed to achieve environmentally sound and sustainable

development at global, regional, and local levels. To render societies more sustainable, tools are needed to both measure and facilitate progress towards a broad range of social, environmental and economic goals<sup>[2]</sup>. According to the Local Agenda's 21 (LA21)<sup>[3]</sup>, the basic requirements for realizing local SD goal at regional scale are to achieve harmonized development in economic, social and environmental aspects<sup>[4-12]</sup>. Therefore, an appropriate indicator for measuring regional SD is vital for providing a solid base for decision-making at all levels<sup>[14]</sup>, the selection and interpretation of "sustainable development indicators" (SDIs) are increasingly used by the public administrators to underpin their local sustainable development strategies<sup>[13]</sup>.

Great interests have been given on assessing SD at regional scale by international researchers. Valentin and others (2009) believe that each local adaptation of Agenda 21 is individual<sup>[14]</sup>, and Fraser et al. (2006) stressed that identification and collection of sustainability indicators is not only a process to provide valuable databases for making management decisions, but also to provide an opportunity for community empowerment. The necessity of constructing a multidisciplinary conceptual framework for assessing the advancement of urban development, as well as environmental quality and human well-being, is also stressed by these studies<sup>[18]</sup>. Although it is still challenging to measure the natural capital of urban area<sup>[15]</sup>, some studies have developed tools, i.e. the dashboard of sustainability (DS)<sup>[16-17]</sup>, to evaluate the complex influences on sustainability of urban area. SDIs for assessing sustainability of cities have also gained increasing interests of international literatures<sup>[18-19]</sup>.

However, few researches have focused on SD of a special type of urban area - development zones (DZ, also called development area), which are intentionally planned for certain development purpose and vital for growth of cities in developing countries, especially China. Authorized by the national or local governments, DZs are approved to attract outsider investments by carrying out special polices and management tools. Numerous DZs of different scales and industrial preferences have been established in China. They can be grouped into national, provincial and municipal levels based on their administrative ranks, or the economic-technological development zones (ETDZs), the high-tech industrial development zones (HTDZs), the export processing zones (EPZs), the tariff-free zones (TFZs) and the border economic cooperative zones (BECZs) according to their preferential policies. In 2010, there were 1,568 DZs above or at county-level in China, including 223 at state-level and 1,345 at province-level<sup>[20]</sup>.

As power-engine of local economy, DZs have played a leading role in economic prosperity as well as city growth in China. In this research, we took "Tianjin Economic Development Area" (TEDA) as our research object, and aimed to develop methodology and SDI for assessing SD of DZs in China. In section 2, we reviewed literatures on SDI development, and provided steps for applying 'Simplified Adaptive Learning Process' (SALP) and SDI of "Number of Similar Indicators from the Local Yearbooks" (NSILY) for evaluating SD of TEDA. Then, we summarized the main results in section 3, and discussed the adaptive learning process for evaluating local sustainable development by using the SALP framework, and merits of applying NSILY to evaluate SD at regional scale in section 4. We concluded this research in section 5.

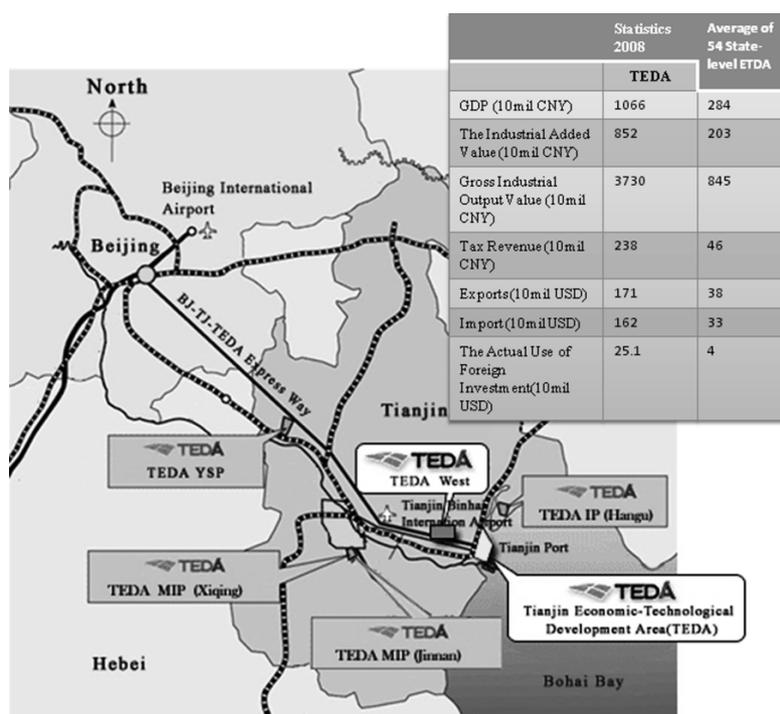
## 2 RESEARCH AREA AND METHODS

### 2.1 Research area

The TEDA was located at the joining point between the Circum-Bohai Economic Belt and the Beijing-Tianjin-Hebei Megalopolis, with Tianjin Port on its east and the Tianjin Binhai International Airport on its west. It is 45 km away from the Tianjin downtown and 140 km away from Beijing. In 2010, the total built up area of TEDA reached 84.21 km<sup>2</sup>, with 42.04 km<sup>2</sup> for industrial purpose and the rest used for residential purpose. As one of the first-class state-level DZs in China, "Tianjin Economic-Technological Development Area" (TEDA) was established in 1984, under the approval of the State Council. Based on the major economic

indicators of TEDA (Fig.1), it was far beyond the average level of the whole 54 state-level ETDA at the same period after 24 years of development.

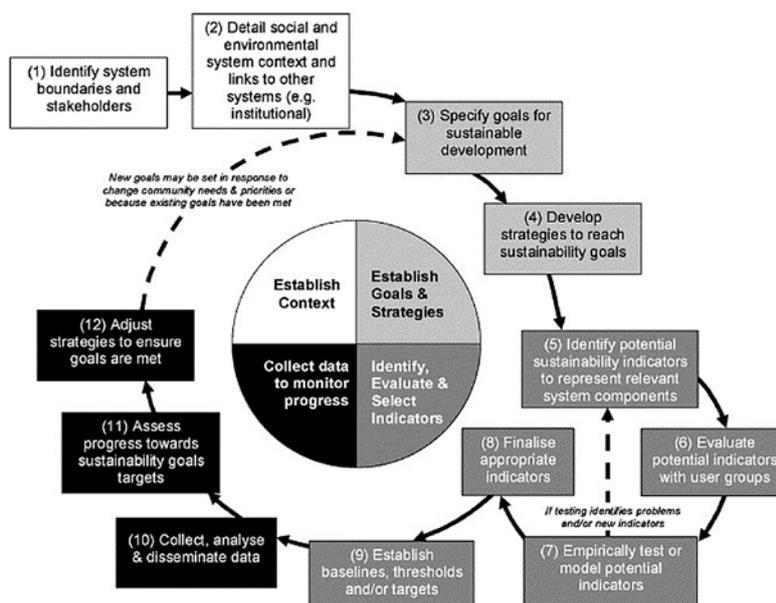
It has always been the aim for TEDA to build an eco-friendly and resident-friendly region. In 2001, it had obtained the ISO14000 environment quality certificate and was tagged as pilot zone for well environmental management of China's industrial parks by the State Environmental Protection Agency (SEPA) and later by the United Nations Environmental Programme (UNEP) in 2002. Furthermore, to reach the aim of "zero emission", TEDA has successfully improved its energy efficiency, built-up a model for material recycling among enterprises within its territory, and also encouraged enterprises to take procedures for waste lessening. Through building the first artificial wetland in China, the recycled water was used for irrigation in TEDA. For the purpose of carrying out cycling economy strategy, TEDA has determined to balance the GDP increasing and environmental protection, and advocated reutilization and recycling of wastes and by-products by means of industry upgrading.



**Fig.1. Tianjin Economic-Technological Development Area (TEDA)**

Source: Ministry of Commerce of PRC, State-level ETDA long-term indicators. 2008 Yearbook of TEDA

## 2.2 Simplified adaptive learning process for assessing SD at regional scale



**Fig.2. Adaptive learning process for sustainable development indicator development and adoption (Reed et al., 2006)**

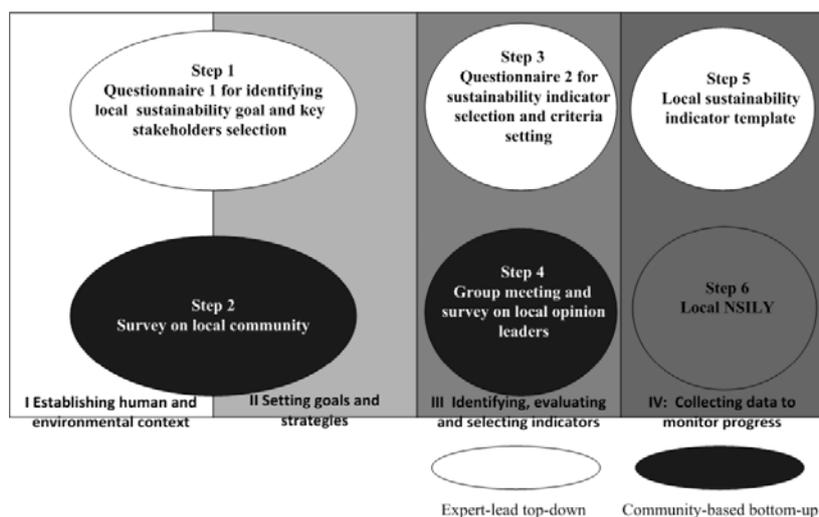
An simplified adaptive learning process (SALP) that integrates both bottom-up and top-down approaches<sup>[21-22]</sup> into one framework for assessing the local sustainability has been developed by Reed et al<sup>[2]</sup>. It proposes a logical adaptive learning process based on both the system theory<sup>[23]</sup> and social learning<sup>[24, 25]</sup>, and developed to identify changes of individuals and systems through an ongoing process of learning and negotiating, using both qualitative and quantitative tools (Fig.2). This adaptive learning process was applied for designing steps of this research.

### 2.3 Indicator for assessing sustainability of DZs in China

In this research, a new indicator – “Number of Similar Indictors from the Local Yearbooks” (NSILY) was developed especially for analyzing the sustainability of DZs in China. Two major steps for applying this indicator need to be addressed here: 1) a template of SDIs for research area is required. Since these indicators are taken as the template for assessing the local development, they have to reflect the ideal status of regional sustainable development according to opinions from local communities as well as experts; 2) how to understand the word “similar” and obtain score of NSILY. According to definition in Merriam-Webster dictionary, ‘similar’ means ‘having characteristics in common’ or ‘alike in substance or essentials’. Thus, the ‘similar’ indicators from local statistical resources have to meet the following conditions: a. the ‘similar’ indicators should represent the same contents as indicators from the template; b. the ‘similar’ indicators depict the same objects as the indicators from the template; c. specific procedure has to be taken to guarantee the accuracy and objectivity of ‘similar’ indicators selection.

### 2.4 Steps for applying ‘Simplified Adaptive Learning Process’ (SALP)

The SALP was applied to design research steps for developing template of SDIs and assessing SD of TEDA in this research. The working process was as follows (Fig. 3):



**Fig.3. Working process of SALP**

#### 2.4.1 Step 1

In this step, a group of experts, from environmental, social and economic departments of Xi'an Jiaotong University have been convoked and asked to design a questionnaire for identifying SD goals and key stakeholders of TEDA. Since respondents of this survey were of different professional backgrounds and with no academic background in neither environmental nor social science, designing of items of the questionnaire have to obey the following principles: 1) the multiple-choice question (MCQ) is preferential for items designing; 2) the depiction of items should be easy to understand and try to avoid any technical jargons utilization; 3) the questionnaire should include in-depth explanation or additional information if necessary.

Part 1 of the questionnaire was designed to develop the SD goal of TEDA. Participants could chose to write their own opinions in open question form or choose MCQ instead. Four different definitions of SD were listed in MCQ in the first part of the questionnaire (refer to Table 1). The respondents were asked to choose the SD definition which was mostly consistent with their ideas of SD of TEDA.

Then stakeholders of SD of TEDA, who were accordingly treated as opinion leaders in the following steps, was planned to be selected in part 2 of the questionnaire. The respondents were asked to pick up direct stakeholders from the choices against 2 criteria successively (Criterion 1, the direct stakeholders are those who exert major influence on or directly impacted by SD of TEDA; Criterion 2, indirect stakeholders are those who have little influence on or indirectly impacted by SD of TEDA). The aim of this arrangements was to avoid illegitimate choices by respondents who are lack of professional background (i.e. pick up some options as direct stakeholders and take the rest operations as indirect stakeholders for granted).

#### 2.4.2 Step 2

In this step, survey was carried out in TEDA. The purpose of this survey was to collect local communities' opinions on goals and key stakeholders of SD of TEDA. This survey was carried out from May to July 2011, and by means of hard copy, email, as well as on line survey<sup>1</sup>. By the end of July 2011, 300 copies of questionnaires were distributed, of which 295 have been returned providing usable responses.

#### 2.4.3 Step 3

In this step, a group of researchers and postgraduates were gathered and asked to preselect SDIs for TEDA from a large amount of international and national literatures on local SDIs. The finalized 92 preselected SDIs were then decided against two basic criteria, namely accuracy and objectivity.

Then, the second questionnaire was designed for selecting local SDIs of TEDA. The three-tier indicator system was used for questionnaire designing. The first tier regards dimensionality. There were three dimensions in this

<sup>1</sup> <http://spreadsheets.google.com/ccc?key=0Arr0SIpteerMdc1mVFhOSmNmdXEwak9IM2IET1BhVEE&hl=en>

tier, namely environmental, social, and economic dimension. Each dimension was composed by several fields, i.e., the environmental dimension was divided into nine fields, and there were totally 23 fields in the second tiers. The preselected 92 SDIs were listed according to dimension and field that fits for them. The Likert Scale was used in designing of the questionnaire. The respondents were asked to compare each of these indicators against the significance of its relationship to SD of TEDA, and score them from 1 to 5 (very strong as 5 and very weak as 1).

The second part of the questionnaire was to collect opinions of local communities on criteria for SDIs selecting. Nine criteria, namely easy to understand, developed by the stakeholders, highlighting the relevant issues, quantification to obtain a measurable unit, measurable, easy for the stakeholders to use, sensitive enough to reflect user concerns, using existing data, and few items, have been chosen through process of literature review and group discussion. A MCQ was used in this part.

#### *2.4.4 Step 4*

In this step, data collected in step 2 was used to identify both the local SD goals and the key stakeholders in TEDA. Then 30 representatives, according to key stakeholders of SD of TEDA, were invited to attend group meeting as opinion leaders. Results of local SD goal by the survey were summarized and informed to all representatives thereby to generate a common agreement on local SD goal of TEDA.

Thereafter, the second questionnaire was handed out to representatives. They were asked to make their own judgments on scoring each indicator of preselected SDIs, as well as suitable criteria for SDIs selecting.

#### *2.4.5 Step 5*

At this step, scores of each preselected indicator given by local opinion leaders were averaged, and then the average score of each field were treated as the final score of the field. Finally, the template of SDIs of TEDA was decided by the research group against criteria selected by the same representatives.

#### *2.4.6 Step 6*

Based on the principle that decisions from a structured group of experts are more accurate than those from unstructured groups or individuals <sup>[26]</sup>, the nominal group technique (NGT) <sup>[27]</sup> was carried out for scoring NSILY. A panel of experts was invited to the meeting who shared the same interests on regional sustainability but with different academic backgrounds (the domain of Economics, Ecology, Environmental Science, Geography, and Public Management). Based on the former designed SDIs template and TEDA-yearbooks from 1987-2010, they were asked to give their own opinions on each year's score of NSILY of TEDA against the definition of "similar" (mentioned in section 2.3). This process was then repeated, and consensus on scores of NSILY of TEDA was built after two rounds of such processes.

### 3 RESULTS

#### 3.1 The goal of SD of TEDA

Scores in Table 1 showed that the first and fourth definitions of SD were most familiar to local residents. A small part of respondents chose the third definition, which indicated that a harmonious relationship between human beings and nature resources was of major importance for SD of TEDA in their opinions. The fifth and second definition obtained the lowest selections, which indicated that most respondents were unwilling to develop their own ideas on local SD, or prefer to choose definitions which were unfamiliar to them ('entropy' is unfamiliar with people without certain academic background).

Hence, the SD goal of TEDA was described as 'to attain a way of development that meets the needs of present without compromising the ability of future generations to meet their own needs through interdependent and mutual reinforcement of economic, social development as well as environmental protection'.

**Table 1. SD goals of TEDA**

NO	Definition of sustainable development	No. of Choices
1	Sustainable development as development that meets the needs of present without compromising the ability of future generation to meet their own needs.	85
2	Sustainable development is development that minimizes resource use and the increase of global entropy	0
3	The term “sustainable” from the ecological point of view means the maintenance of the integrity of the ecology. It means a harmonious relation between humanity and nature, this is harmony in the interaction between individual human beings and natural resources	25
4	Three-component model of sustainable development: economic development, social development and environmental protection-as interdependent and mutually reinforcing pillars	80
5	Own opinions	5

<sup>a</sup> Defined by of the World Commission on Environment and Development (WCED).

<sup>b</sup> Defined by Smith 1991

<sup>c</sup> Defined by Mohammed (the co-coordinator of Asian-Pacific Peoples Environment Network) 1990.

<sup>d</sup> Defined in the final document of UN General Assembly’s World Summit of 2005.

### 3.2 Key stakeholders of SD in TEDA

**Table 2. The direct and indirect stakeholders of TEDA**

Direct Stakeholder	Score	Indirect Stakeholders	Score
Management Committee of DZ	115	Employees	90
Local Government	105	Individual Practitioners	65
Residents	100	Employers	60
Employers	85	Trade Associations	50
Universities and Research Institutes	80	Schools	50
Employees	70	Labour union	40
Individual Practitioners	55	NGO	40
Trade Associations	50	Media	40
Schools	50	Residents	35
Media	50	Universities and Research institutes	25
NGO	40	Management Committee of DZ	20
Labour Union	35	Local Government	15

<sup>a</sup> the Management Committee of DZ is the agency of the higher level of government (municipal, or provincial government), and has different functions from the local government.

According to score in table 2, the top 6 choices of direct stakeholders were the management committee of DZ, local government, residents, employers, universities and research institutions, and employees, and the top 6 indirect stakeholders accordingly were the employees, individual practitioners, employers, trade associations, schools, labour unions and NGOs. Whereas, comparing choices of direct and indirect stakeholders above, there were four choices appeared in both groups, namely the trade associations, individual practitioners, employees and employers (Fig.4). These four choices were thereby treated as undetermined groups.

For key stakeholders, SD of TEDA can attract their attentions and spur their awareness on environmental issues. On the local scale, the SDIs development needs to negotiate with the stakeholders to help them appreciate how their activities contributing to diminishing of local sustainability. Eventually, they will regulate their behaviours and hopefully change their attitudes. Based on this knowledge, the undetermined group above can be grouped into key stakeholders. Thus, the final list of key stakeholders of SD of TEDA was composed of the management committee of the DZ, local government, residents, universities and research institutions, trade associations and employers.



**Fig.4. Direct and indirect stakeholders related to SD of TEDA**  
 □the italics stand for the same groups in both direct and indirect stakeholders.

### 3.3 Criteria for SDIs selecting

**Table 3. Criteria for selecting SDIs**

Criteria	Score
Easy to understand	24
Highlighting key points	22
Developed by stakeholders	22
Quantifiable	20
Measurable	19
Easy to use	16
Sensitive	14
Using existing data	8
Numbered items	4

Score of criteria for SDIs selecting was listed in Table 3. Criterion with the highest score was ‘easy to understanding’. The following two criteria ranking 2 and 3 were ‘highlighting key points’ and ‘developed by stakeholders’. Thus, it was clear that most respondents believed that simple and understandable were most crucial characteristics for SDIs of TEDA.

### 3.4 SDIs of TEDA

**Table 4. Scores of fields in three SD dimensions**

Dimension	Field	Score	
Environmental dimension	Informatization	3.53	
	Energy	3.39	
	Air quality	3.37	
	Noise	3.36	
	Green land, eco-system and nature heritage	3.33	
	Waste	3.29	
	Transportation	3.19	
	Water	3.18	
	Social dimension	Management	3.62
		Housing	3.46
Education		3.45	
Health		3.24	
Social and community service		3.20	
Administration		3.3	
Safety		3.05	
Anthropological index		2.97	
Economic dimension	Macro economy	3.43	
	Investment	3.35	
	Sci-Tech innovation	3.35	
	Employment	3.32	
	Business	3.24	
	Family income and expenditure	3.22	

With data collected from step 4, scores of each field were calculated and ranking of these fields for each dimension were yielded and listed in Table 4. The average scores of each indicator were also calculated by the same data source.

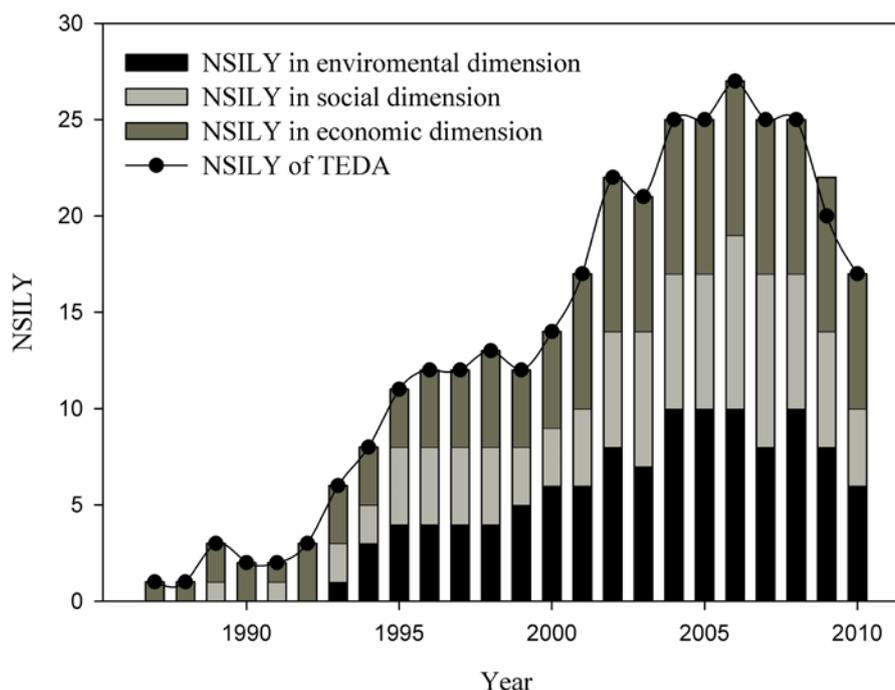
**Table 5 Selected SDI of TEDA**

Dimension	Field	Indicators
Environmental dimension	Informatization	Backbone network speed of MAN (metropolitan area network)
		Output bandwidth of MAN
	Energy	Amount of electricity expenditure
		Electricity supplying capacity
	Air quality	Amount of nature gas expenditure
		Inhalable particle concentration
	Noise	GHG (green house gas) emissions
	Green land, eco-system and nature heritage	Average level of environmental noise
		Coverage rate of green area
	Social and institutional dimension	Waste
Water		Capacity of sewage treatment
Administration		Water supplying capacity
		SD policies or strategies
Housing		Newly increased fixed assets
		Floor space of buildings completed
Education		Number of colleges and universities
		Junior/high school enrolment
Health		Number of hospital per 10000 capita
Social and community service		Number of accommodation per 1000 capita
Transportation	No of people using mass transit (MT)	
	Overall length of road system	
Economic dimension	Anthropological index	Urban population density
		Permanent resident population
	Macro economy	GDP
		Gross value of imports and exports
	Investment	Overall labour productivity
		Actually utilized overseas funds
	Sci-Tech innovation	Contracted investments
		Incubator for founding S&T enterprises
	Employment	NO. of Authorized patents
		Funds for scientific innovation
Family income and expenditure	Unemployment rate	
	Population ratio of high to low income	
		Mean or median household income per year

In this study, the median score of each field was taken as the standard for template SDIs selection. Those indicators, with scores equal to or higher than the standard, and also meeting the criteria of “easy understanding”, can be taken as the finalized SDIs of TEDA. Finally, there were 34 indicators selected as template SDIs of TEDA and listed in Table 5.

### 3.5 Assessing SD of TEDA by NSILY

In order to assess local SD, the template SDIs and indicators from TEDA-yearbook from 1987-2010 was compared, and score of NSILY from 1987-2010 was showed in Fig.5. The bar chart in Fig.5 described the dynamics of SD of TEDA from 1987-2010. The score of NSILY was calculated by summing up scores of NSILY in economic, social, and environmental dimensions. Generally speaking, the score of NSILY showed an upward trend from 1987-2006, and then turned down since then. Meanwhile, the proportion of the three dimensions of NSILY revealed different trends. The NSILY in economic dimension has been existed since 1987, and its score increased from 1 in 1987 to 7 in 2010. The NSILY in social dimension was emerged for the first time in 1989, and its score has showed an upward trend until 2007, and then decreased from 9 in 2006 to 4 in 2010. The appearance of NSILY in environmental dimension was with the shortest history from 1993-2010, but its score displayed the most rapid increasing rate, from 1 in 1993 to 10 in 2008, and then levelled down to 6 in 2010.



**Fig.5. Process of SD in TEDA from the perspective of NSILY**

Economic development was the only pillar that contributed to SD of TEDA before 1993 (Fig.5), since the original purpose for the establishment of DZs in China was to promote local economic development by preferential policies and high-standard infrastructure construction. With prosperity of economy, social issues and environmental protection have gradually drawn attentions of stakeholders in TEDA, which can be exemplified by the increasing contribution of NSILY from social and environmental dimensions in TEDA after 1993. The score of NSILY of TEDA has reached its peak in 2006 and then turned down since then. Main reasons leading to such trends were from two aspects: one was that the growth pattern of TEDA in economic, social and environmental dimensions has transformed from rapid growth to fine-tuning, since the DZ has reached its mature period and contents included in the local statistical resources has also gradually become steady; the other reason was that part of items included in the local statistical resources of TEDA, representing various aspects of social, economic and environmental dimensions, have changed due to multiple reasons, i.e. transition of management goal of local authorities, changes of statistical calibre, shifting of development focus, etc.

#### 4 DISCUSSION

Based on results of this research, we presented an adaptive learning process for evaluating local sustainability by using the SALP framework. There are four steps for employing this method: (I) defining the human and environmental context of research area; (II) establishing the local sustainability goal and strategies; (III) developing local sustainability indicators; and finally (IV) collecting data and assessing local sustainability.

Those who are willing to apply the adaptive learning process have to design specific procedures in field research in accordance with the real status quo of the research area. Such procedures have to follow two principles: firstly, it must involve local communities over the whole process, in order to guarantee that local opinions on goals as well as strategies of local sustainability may not be missed; secondly, experts and opinion leaders must play leading roles in the analytical process and have to act as decision-makers for SDI selecting.

Another key issue can be drawn from this research. Firstly, as a secondary indicator, several differential characteristics of NSILY empower this SDI to be more suitable for assessing the regional sustainability of DZs and similar regions. Firstly, method used to obtain score of NSILY enables assessment of sustainability to be applied in regions with uncompleted statistical resources; Secondly, adoption of NSILY can reveal the distance

between the status quo and idealistic situation, therefore provide a useful tool for (re)directing the local sustainable development; Lastly, through the adoption of the NGT, via the participatory and group structured procedure, we can guarantee accuracy and comprehensiveness of score of NSILY.

## 5 CONCLUSION

This research demonstrated adaptability and efficiency of the hybrid framework-SALP framework, in dealing with the issues of regional sustainability, and also reflected the necessity and significance of developing an ad hoc sustainability indicator-NSILY, especially for promoting sound development on regional scale. As a target-oriented framework, the SALP framework is easier for local authorities or researchers to adopt since the tasks or contents in each stage are well defined, and it can be easily modified to suit the demands of its users. The NSILY, indicator particularly designed for this research, is also suitable for assessing SD of those areas with similar characteristics as TEDA.

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# URBAN FORM AND FITNESS: TOWARDS A SPACE-MORPHOLOGICAL APPROACH TO GENERAL URBAN RESILIENCE

**Claudiu FORGACI<sup>1</sup> and Arjan VAN TIMMEREN<sup>1</sup>**

<sup>1</sup>Delft University of Technology, Faculty of Architecture, Department of Urbanism, Chair of Environmental Technology and Design

## ABSTRACT

Assessment is one of the greatest challenges of urban resilience research. The difficulty of this task arises from the increasing complexity of urban environments and from the unpredictability of external changes, two trends that have raised environmental awareness and, consequently, led to a growing debate on the relationship between city and nature. We join this debate by looking at urban resilience through the lens of urban form. We refer to urban form as a product of the continuous tension between recovery and adaptation on several spatial and temporal scales of transformation. Although recent resilience approaches, such as *spatial resilience*, *general resilience*, and *urban resilience*, have dealt with urban form indirectly, and, conversely, some studies in urban morphology have tried to grasp the complexity of urban-natural environments, an explicit morphological perspective on urban resilience is still lacking in research. The paper is divided in three main parts: formal treatments of resilience (spatial, urban, and general), resilience of urban form (fitness, performance, and sustainability), and a network perspective on the two concepts. It concludes with a discussion on the possibility of a space-morphological approach to general urban resilience.

*Keywords: general urban resilience, urban form, environmental fitness, space-morphology.*

## 1 INTRODUCTION

As a consequence of the population growth and the massive urbanisation of the last decades, the ecological, economic and social shocks<sup>1</sup> encountered by today's urban environments have been increasing both in frequency and magnitude. The full extent of the causes and the consequences of these shocks, however, are difficult to determine. As cities are growing in complexity, the planning of their forms, infrastructures and services must adapt to the needs of present and future urban dwellers and to the shifts in environmental baseline conditions. Such complexity requires a better understanding of urbanization, on the one hand, and a shift in the way cities are perceived in relation to their wider environments, on the other. In *Megacities: Exploring a Sustainable Future*, Buijs et al. [1] recognize this need by highlighting two dominant themes in the debate on current paradigms of urbanization. First, they acknowledge that networks have become the driving forces of urban development, and that the scale and complexity of these networks are growing at an accelerated pace. Second, they observe that the recent increase of environmental awareness draws considerable attention to the relationship between city and nature, be it conflicting or potentially synergic.

Can we assume then that networks are the cause, and environmental awareness is the consequence of our vulnerability to disruptive change? And, if so, what is the connection of these two driving forces to urban form and resilience? The answers are not simple. Physical networks have extensively interacted with the natural environment, but, so far, the two threads of the debate – network thinking and environmental thinking – have scarcely done so. Network thinking in urbanism, a considerable branch of what Juval Portugali calls Complexity Theories of Cities [2] and a core concept of Michael Batty's 'new science of cities' [3], is an approach that deals extensively with formal or structural characteristics of complex (urban) adaptive systems, but with little attention for the environmental

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<sup>1</sup> In the context of this paper, shocks are referred to as moments of sudden – usually unpredictable – change. Climate-change related events, such as floods and draughts, economic crises, and terrorist attacks are examples of such unpredictable shocks. They are often referred to as 'disruptive change'.

implications of networks. Conversely, environmental sciences have not sufficiently employed networks. It may be argued that their poor integration is due to their opposing orientation, in which city and nature are still regarded as separate entities, and that this lack of integration is the main reason for the vulnerability of urban environments in the face of unforeseen shocks.

The challenge, however, is not in stopping disruptive change – a task that has repeatedly proven to be impossible –, but in understanding it and, ultimately, in improving the capacity of urban environments to absorb it in one combined urban-natural system in dynamic equilibrium. Many authors have recognized that the concept of resilience, defined as the capacity of a system to bounce back, adapt, or transform in the face of disturbances, is suitable for this task [4]. Given its extensive applicability, resilience has generated several interpretations in a wide range of disciplines [4], of which *spatial*, *general* and *urban* resilience are of particular interest to urban environments. As a scholar of social-ecological systems (SESs) research, Cumming approaches resilience with a multi-scalar framework and proposes the concept of *spatial resilience*. This concept connects principles from landscape ecology, sustainability science, and complexity science, and it provides a strong framework for the analysis of Complex Adaptive Systems (CASs) [5]. *Urban resilience* adds lessons from Complexity Theories of Cities to this integration [2], a view according to which urban systems are often regarded as complex networks [3]. Moreover, as ecologists Brian Walker and David Salt suggest, every ecosystem has specific features, but also some inherent general characteristics, such as diversity, openness, modularity, or tightness of feedback. These characteristics are part of *general resilience* and represent systems' capacity to face change that is unpredictable both in nature and occurrence [4].

In the frame of this paper and the context of the two trends – networks and environmental thinking –, spatial, urban and general resilience have something in common: they are all concerned with urban form and network architecture[6]. But the nature of their relationship still needs to be clarified. How do they shape urban form? Or, conversely, how does urban form refer back to the performance of man-made or natural processes that have shaped it? The first question is typical of typology-morphology studies, while the second is characteristic of space-morphology studies in urban design [7]. The former refers to the process of formation, while the latter aims to identify processes that have led to a particular form. Although both questions are fundamental to urban morphology, the second brings a particularly interesting angle to the discussion. Given the complexity of the processes that shape urban environments, an analysis of spatial patterns is more likely to be attainable than a comprehensive system-wide description of processes.

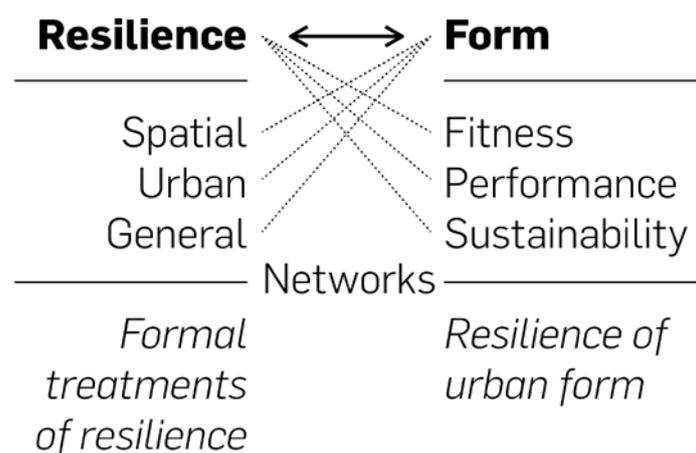


Figure 1. A theoretical framework for a space-morphological approach to general urban resilience.

Therefore, this paper proposes a combination of space-morphology with the nature-ecological approach to resilience that is already employed in urban design [7] and claims that this combination may improve our understanding of, and reaction to, disruptive change. Urban form and urban resilience are the concepts chosen to correlate the two perspectives. As shown in Figure 1, the two concepts structure the theoretical framework in two parts: formal treatments of resilience and resilience of urban form. The former identifies three spatial approaches from the resilience literature and the latter explores different interpretations of resilience in urban morphology. The structure of the paper follows the same division. First, spatial, urban and general resilience are briefly introduced and synthesized in the combined concept of general urban resilience. The second part provides a summary of the recent history of urban environmental performance research, from the 1960s until the present. The paper then discusses possible interdependencies between urban resilience and form, the current state of research on the topic, and concludes with recommendations for future investigations.

## 2 GENERAL URBAN RESILIENCE

Resilience has been increasingly used to describe social, ecological, and social-ecological systems (SESS). A resilient city is “a sustainable network of physical systems (the constructed and natural environmental components of the city) and human communities”[8]. Based on this definition and in light of the trends described in the introduction, we investigate how the physical form and the social fabric of urban regions will cope with future instability, while maintaining a reciprocal relationship and a dynamic equilibrium between city and hinterland.

To describe ecological systems, Holling [9] associates resilience with adaptability and transformability. Adaptability is the capacity of the actors in the system to influence resilience. It is “characterized by the ability of a system to move thresholds, change the resistance to external inputs, move the current state of the system and to manage the cross-scale interaction”. Transformability is of even more interest. It is defined as “the capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable” [10]. Transformability means defining and creating new stability landscapes by introducing new components and ways of making a living, thereby changing the state variables, and often the scale that define the system. It also refers to concepts such as ‘city of short distances’ [11] and the ‘city of small cycles’ [12], within a larger interconnected context.

Vulnerability, already mentioned in Section 1, is a concept that is strongly related to resilience. Vulnerability generally has a human- or society-centred perspective, for instance, in relation to climate change. In this context the Intergovernmental Panel on Climate Change (IPCC) states that “vulnerability to climate change is a function both of the sensitivity of a system to changes in climate, and the ability to adapt the system to such changes” [13]. The perspectives of resilience and vulnerability imply far-reaching consequences for how communities are organized, infrastructures are designed and integrated, and especially on how change is handled. It is important to realise that the stability or resilience of networks is directly related to their complexity. It is not the components of the various structures that matter, but how they are organized together as intelligent structures. In this context, Hollnagel [14] introduced Resilience Engineering with the premise that, due to a concept called ‘tight coupling’, the interdependence between the components of a system, be it social or technological, might become dangerously high. Thus, amongst other factors, the level of interdependency plays an important role in determining the resilience of the system.

However, resilience can be difficult to apply to systems in which some components are consciously designed [15]. The concept of general urban resilience proposed here is a synthesis of the current knowledge on spatial, urban and general resilience, discussed below.

### **Spatial resilience**

Generally speaking, spatial consideration of a given topic or object requires an understanding of characteristics, such as size, scale, shape, and grain. Yet there is still room for interpretation, depending on the field of inquiry. Graeme Cumming [5], [16], for instance, introduces spatial resilience from the point of view of social-ecological systems (SESS). According to his definition, “[s]patial resilience refers to the ways in which spatial variation in relevant variables, both inside and

outside the system of interest, influences (and is influenced by) system resilience across multiple spatial and temporal scales” [5, p. 21]. His understanding of resilience is very much rooted in complexity theory, and it contains principles of multi-scalarity, spatial relevant properties (e.g. shape, size, boundaries), and spatial dynamics driven by connectivity and feedbacks.

In architecture and urban design, spatial conditions with respect to the built environment are often linked to Vitruvius’ “*Utilitas, Firmitas, Venustas*”. Most people are inclined to call suitability for building open to objectification, usability less so and beauty actually not. The mathematician Alexander [17] was one of the first to recognize the importance of underlying structures as the basis for spatial planning, city form and the accompanying physical and social networks. His work, together with that of Habraken’s [18] and Portugali’s [19], forms an important point of departure for the research presented in this paper.

Design specification and translation of general concepts of resilience always comprises a scalar demarcation. In this way, stratification in the design decisions and environmental allocation comes into being, through which decisions at a higher level of scale hold as a framework for designs at a lower level of scale. However, design problems that come up at lower levels of scale should also be taken into account at higher levels of scale. In reality, the scale levels have “sliding” boundaries and each level of scale has its specific, often limited, absorption capacity<sup>2</sup> or scope<sup>3</sup>.

### Urban resilience

Urban resilience is a topic that has only recently come more to the forefront of addressing disruptive change in urban environments. Most of the findings in resilience research are still in the field of ecology, waiting to be tested and translated to urban systems. Studies, such as those compiled by Picket et al. [21] or Eraydin and Tasan-Kok [22], are some of the few trying to explicitly refer to resilience in urban planning and design, but their inquiries are still open-ended. Agreement on the meaning and application of resilience in urban planning is still expected.

According to Portugali, the city can be understood as the product of self-organization. This is somewhat contradicted by the heuristic that cities are the symbols of planned action with ridged boundaries, districts and urban fabric. While spontaneous self-organization seems diametrically opposed to planning that is aiming for controlled order, cities may be understood as *dual* self-organizing systems in which every city dweller is a potential planner at a particular scale [23]. As we saw earlier, spatial resilience is strongly connected to complexity. Thus, if we consider the dual-complex character of cities (spatial systems by definition) and the accelerated pace of current urbanization, the importance of studying their resilience becomes paramount.

### General resilience

Brian Walker and David Salt distinguish two types of resilience: specified and general [4]. So far, specified resilience has received most of the attention. A considerable part of resilience literature has dealt with case studies, stories about how resilient, say, a coral reef, a forest, or a human individual is. In this sense, components of resilience are characteristic of a particular system, and thus cannot necessarily be applied in systems with a different nature or in a different location. All these cases answer the well-known question: ‘resilience of what to what’ [15], or even ‘resilience of what and to where and at what temporal and spatial scales’ [24].

For general resilience, on the other hand, these questions are irrelevant. In normal circumstances, one does not doubt the immunity of a living organism to a particular diseases or a specific external disturbance. An immune system is meant to prepare and protect an organism to as many external

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<sup>2</sup> The absorption capacity has a technical and a social component. For example, from a technical perspective, it can result from the maximum amount of daylight that is available and can be converted for the purpose of natural purification processes or in order to generate solar energy (in terms of W/m<sup>2</sup>). Or, it may also result from social limitations (which are not always visible). It is important to combine the two.

<sup>3</sup> Scope plays a role in specific types of transport. It can be compared to how the size of settlements used to cohere with the way of transport, e.g., 5 km as a diameter for the “walking town”, 20 km for the “horse town”, e.g. [20], or with the number of inhabitants (e.g., 50,000 for the Romans, related to governability).

changes as possible, known or unknown. Thus, we believe that like an immune system, a resilient system has general characteristics that can be enhanced. And if we take the metaphor further, we claim that resilience is a form of immunity. General resilience is, in Carpenter et al.'s words, "the capacity to absorb shocks of all kinds, including novel and unforeseen ones" [25, p. 3250] or, as Walker and Salt suggest, a sum of inherent general characteristics that are found in every system, such as diversity, openness, modularity, and tightness of feedback [4, pp. 90–100].

Yet these attributes cannot be easily assessed. According to Jon Norberg and Graeme S. Cumming, "the world is essentially uneven" and one of its main characteristics, diversity, "is most valuable during times of change, when the integrity of a complex adaptive system is threatened" [26, p. 12]. Following this line of reasoning, general resilience has to be thought of and assessed by looking at cities as complex adaptive systems.

### 3 RESILIENCE AND URBAN FORM

As cities grow in complexity their spatial morphology, infrastructures and services must adapt to the needs of present and future urban dwellers and shifts in environmental baseline conditions. Interestingly enough, while urban regions produce two-thirds of global emissions, urban dwellers on average use 40 per cent less energy than suburbanites [27], [28]. From this perspective, the agglomeration effect that allows urban regions to have high population densities and economic activity could serve as a potential asset in the development of adaptive strategies towards mitigating the effects of disruptive anthropogenic change (e.g. climate change) relative to energy generation and much more. The question is, however, to what extent urban form should be adapted to better cope with disruptive change.

During the last five decades, several studies have sought to understand the impact of urban form on the environment. Environmental fitness, sustainable urban form and the environmental performance of urban patterns are three approaches that have not explicitly (or centrally) used the term 'resilience', yet their scope has considerably overlapped with resilience thinking. Therefore, this section introduces the environmental fitness discourse of the late 1960s [29], with a special emphasis on Ian McHarg's work [30]. Then, it outlines the current descriptions of sustainable urban form given by Burton et al. [31] and Jabareen [32], and it introduces Alberti's [33], [34] investigation of urban patterns in relation to environmental performance.

#### **The form of a fit urban environment**

In 1968, the Smithsonian Institution published the papers delivered at its Annual Symposium under a title that was very representative to the concerns of that time: *The Fitness of Man's Environment* [29]. The fifteen contributors – biologists, anthropologists, architects, and planners – acknowledged that the environmental changes caused by urbanization had led to undesirable consequences and that a future vision on the performance of urban environments was needed. Environmental fitness – just as resilience is today – was the common denominator in their writings. In parallel, and very shortly after the Symposium, Ian L. McHarg – one of the participants – published *Design with Nature* [30], a book that, since then, has received considerable attention in the field of urban design and landscape architecture. Strongly influenced by one of his precursors Lawrence J. Henderson, author of *The Fitness of the Environment* [35], McHarg disqualifies "the old canard 'form follows function'. Form follows nothing", he says, "– it is integral with all processes. Then form is indivisibly meaningful form, but it can reveal ill fit, unfit, fit and most fitting. [...] Fitness is then by definition creative and will be revealed in the form of fitness that is life-enhancing" [30, p. 173].

This worldview had increasingly dominated the discourse in urbanism at that time, most certainly because scientists were becoming aware of the environmental consequences of the unleashed urban growth of the previous decades. The separation of city and nature had reached a point in time when it could not be sustained anymore. That dichotomy was not just the consequence of urban development, but more than that: the cause of environmental degradation. As a result, it became an acknowledged threat to human well-being. The concept of fitness, together with subsequent applications, came as a possible solution to this crisis.

As many planners and designers of that time were fascinated by the image of blues, greens and greys of Earth seen from space, McHarg applied the concept of fitness with a careful regard for land cover and land use. In his view, natural-process values are inversely proportional to urban use suitability. For instance, land covers that are richest in biodiversity – surface water or marshes – are the less hospitable for urbanization, while flatland, the less likely to host abundant biodiversity, is the most suitable for urban development [30, p. 57]. Yet, as we have observed throughout history, these two extremes tend to pair up; urban environments have grown as close as possible to rich natural areas, such as floodplains and deltas. Recently, their relationship has become conflicting: urbanization has ended up damaging its environments, rather than shaping it in a synergistic way. In addressing the spatial dimension of this conflict, McHarg claims that open-space distribution in urban environments must respond to natural processes [30, p. 65]. In other words, urban form – as a result of the spatial distribution of open and occupied land – was (and is) considered highly relevant to the study of the relationship between city and nature. According to him, “it is [...] essential to understand the city as a form derived in the first instance from geological and biological evolution, existing as a sum of natural processes and adapted by man. [...] This enquiry is described as an investigation into the given form – the natural identity – and the made form – the created city” [30, p. 175].

His concern for the separation between *given form* and *made form* is obvious. Yet he, together with his contemporaries, still seems to look at city and nature separately. Even though they offer valuable solutions, in essence they praise nature and blame the city. As the relationship between given and made form has suffered considerable changes in the years that followed, an increasing number of researchers have shared McHarg’s concern. Not the character, but the spatial extent of this relationship has changed. Today’s urban reality is different from that of the 1960s in the sense that man-made networks – as pointed out in the introduction – have grown into the main driving forces of urbanization, leading to a complex, dense and globally interconnected web of urbanization. Urban environments (rather than ‘free-standing’ cities) are intertwined with natural processes, thus increasing our environmental impact at an accelerated pace. The problems anticipated by McHarg’s generation have grown into a harsh reality today, but the clarity of his observations is still valuable for current research.

### **Sustainable urban form**

Recent studies have continued to show interest in the environmental performance of cities under the umbrella of sustainability [31], [32], [36]. These studies have focused on the relation between land-use and transport systems and, accordingly, aimed for assessing these two features based on “archetypal urban geometries” [37]. It is commonly agreed that urban concentration, in contrast to dispersion, is a feature that makes urban form more sustainable, as it reduces travel distances and, correspondingly, environmental impact. Jabareen, for instance, identifies seven design concepts – compactness, sustainable transport, density, mixed land uses, diversity, passive solar design, and greening – and four models of sustainable urban forms – neotraditional development, urban containment, the compact city, and the eco-city [32]. Based on these two dimensions he proposes a matrix to assess the sustainability of the four types of urban form. Although the compact city has received extensive support [38], it has been acknowledged that a wider understanding of urban diversity is needed [31].

This research context faces two main challenges. First, as Marina Alberti states, the question of environmentally appropriate urban form still lacks a theoretical framework [33], [34]. Following Moudon’s classification of research clusters in urban design [7], we propose a theoretical framework that integrates both a nature-ecological and space-morphological approach to urban environments. Second, researchers addressing the relationship between urbanization patterns and environmental performance very often look for environmentally appropriate urban forms [31]. In the context of resilience, however, we believe that not forms but principles of formation are key to this relationship. A compact city can be equally resilient as a dispersed urban settlement, as long as it maintains a synergic relationship with its environment.

### **Urban patterns and environmental performance**

In an earlier paper, Alberti [33] summarizes the state of research conducted on interactions between environmental performance and urban patterns in a matrix of four environmental variables – sources,

sinks, support systems, and human well-being – and four structural variables – centralization, density, grain, and connectivity. Following this ‘synoptic review of existing studies’, she highlights four major implications for urban theory:

- Environmental processes are drivers of change;
- Consideration of scale;
- Including uncertainty into our enquiries;
- Consideration of thresholds.

Although she only briefly mentions resilience in relation to environmental response to change, the implications outlined above clearly resonate with the features of resilience. Yet sustainable urban form research has remained parallel, almost as an alternative to the emerging field of resilience.

#### 4 URBAN NETWORKS

One of the main challenges of any research dealing with the resilience (fitness, sustainability, or performance) of a system is the factor of uncertainty and complexity. Such a context requires tools that are fit to grasp and analyse the patterns and processes at hand. Network thinking in urban design, an approach that has emerged under the umbrella of Complexity Theories of Cities [2], has gained popularity among morphologists interested in complex urban adaptive systems [3]. As we show in this section, this perspective is useful not just for describing the form of complex systems, but it may, ultimately, serve to draw inferences about processes and system performance, i.e. resilience, too.

Generally, the study of networks is part of a broader field of science called complexity theory. Complexity theory aims to understand the rules of interaction between parts, such as atoms, amoeba, and biota in natural ecosystems, cars moving in traffic, or trades within the stock market, through the use of computer modelling. While a computer model can never truly represent the fidelity of the real world, there are some very useful ideas within complexity theory that can be used to better understand and potentially strengthen the basic principles of interaction within urban systems in the face of looming disruptive changes [39].

One essential concept to complexity theory is the complex adaptive system (CAS) and its characteristics of emergence and self-organization. Emergence refers to patterns and meaningful order that emerge spontaneously out of the interaction of parts within a complex system. These patterns are identified by accumulative change over time and can occur at different scales, for various reasons, and are usually difficult to predict (e.g. the shape of a flock of birds moving in the sky versus the collective will of the global economy). Self-organization refers to how complex order arises from the interaction of agents or components in an initially disordered system. A key element of CASs is that they have multiple potential equilibriums. From this perspective, the city serves as the perfect example of a CAS, where humans fulfil the role of agents, expressing behaviour based on internal rules (desires, actions, beliefs) and external rules imposed by both society (laws, culture) and the physical environment (streets, parks, rivers, etc.). But these emergent features (i.e. bottom-up initiatives and community building) of CASs are equally relevant to the description of urban form or formation, be it on neighbourhood, district or even city level of scale. As cities are the hubs of wealth, innovation, creativity and heterogeneous populations, they are also simultaneously hotspots for disease, crime and environmental pollution [40]. Additionally, similar to the historical findings of Diamond [41], network theory has shown that the world’s most important networks (economics, politics and ecosystems) are perpetually on the brink of instability and collapse [42]. As a result, there is almost a universal law within nature in which history is frequently marked by sudden and overwhelming events that completely shift system dynamics (i.e. dynamic equilibrium) [8].

Strogatz and Watts [43] studied the distinction between social networks and other networks and found that whether a network is created by man (power lines, social network, the world wide web) or by nature (neural net in the brain, nervous system of a worm) there is a distinct underlying “small-world structure” [42]. Small-world networks [44] are characterized by having a few degrees of separation between dispersed interacting parts due to weak, bridging links and being highly clustered around

particular important hubs. At some base level, regardless of the conditions in which networks developed there is an identical architecture [12], [39].

Further, it can be argued that the ultimate goal, when elaborating on resilient responses to city growth and continuing complexity of cities, is to introduce the principles of fitness and ‘economies of scale’. The idea is to create a complex, adaptive aristocratic structure of separate networks, or preferably of the whole that they form together. It implies ‘scale invariance’ and ‘self-organization’, with change as a precondition.

According to Barabási et al. [45], city and networks than should grow (change) continuously, e.g. through new links and (decentralized) clusters. However, new links also need to be connected to the whole following the power law, with so-called “multi-connected” links following the principle of ‘preferential attachment’. This principle implies the process that, in case of growing systems or networks, they expand because of new vertices being added that are connected with the vertices already present in the system. For most of the networks, this happens according to preferential attachment, dependent on the extent of connectivity of the vertices that are already there, the so-called ‘effective attachment’ [45], [46]: the bigger the connectivity the bigger the chance of a new link. So the existing city form and layout of networks, and their interconnections define growth, and therefore indirectly the resilience of the whole system.

Eventually, this combination of growth and “preferential attachment” is responsible for the scale-free distribution and the possibility of ‘power law’ scaling as observed in real (e.g., natural) networks. In order to understand the necessary process of clustering within this process, for the sake of resilience, it is of importance to know the underlying powers of the principle of ‘preferential attachment’, the ‘rich-get-richer’ principle. Regarding this principle, Bianconi and Barabási [47] argue that the aspect of fitness, similar to that to which McHarg [30] referred regarding natural systems, plays a role in competitive networks. This is referred to as the principle of the ‘fitter-get-richer’, where the aspect of competitiveness implies competition within networks rather than competition between networks. The aspect of fitness must be defined differently for the various networks. In this type of system, a node (e.g. an urban subcenter) can only link further at the cost of other nodes: the (theoretically) competitive character of this type of network is the result of the fact that already existing nodes in a system have to compete (linearly, as demonstrated) with a increasing number of other nodes in the continuous growing process of the system.

It is expected that the scale-free character is a principle, generic or universal for complex networks such as cities [45], [46], irrespective of their dynamics, geometry or structure [46]. The scale-free heterogeneity of transforming and competitive complex networks is a direct consequence of the principle of self-organization by local decisions made by individual ‘vertices’ and based on information that was led through the communication systems to the more visible, ‘richer’, heavier-linked vertices, irrespective of the nature and the source of this visibility [44], [47], [48].

## 5 DISCUSSION: TOWARDS A SPACE-MORPHOLOGICAL APPROACH TO GENERAL URBAN RESILIENCE

In summary, we explored the reciprocal relationship between urban form and resilience, first from an ecological, and then from a mostly morphological point of view (see Figure 1). We introduced the concept of general urban resilience and three chronologically consecutive interpretations of urban form in the context of environmental fitness. Then network thinking was introduced as a promising and overarching approach capable of describing the complexity of urban form and resilience. The reason for this exploration stems from our general hypothesis that the form of urban environments may be used to assess or build their resilience. Hence, this paper intended to discuss the potential of combining the knowledge of space-morphology and general urban resilience.

In our exploration, we identified four challenges in correlating urban resilience and urban form. First, the literature dealing with urban resilience does not have its own instruments; it still uses concepts from other fields, in which resilience is more consolidated. Urban environments are dual complex systems, as Portugali warns us [23], meaning that both the city and its agents – humans, communities, organizations – are complex systems in a dynamic equilibrium. The linkage to natural systems has been challenged by certain social scientists because it neglects the sociological fact that humans are malleable and conditioned by their social environment, not the natural environment [50]. Human behaviour is primarily influenced by societal norms rather than immutable natural laws. From this perspective, planning cities as a metaphor for a large biological entity is naïve because human relationships with the environment and other humans are more complicated [8]. In this sense, the frameworks used in ecology, for instance, cannot be directly applied to urban environments, as they will not fit the character and extents of urban processes. Second, the inconsistent terminology of research dealing with the relationship between environment and city seems to create confusion. Environmental fitness, sustainability, and environmental performance presented here are concepts developed with the same incentive as resilience: the causes and the consequences of environmental impact. Third, as Alberti pointed out in 1999 already [33], the literature still lacks a conceptual framework that integrates urban patterns and environmental performance. And fourth, current research in urban design is taking a nature-ecological approach to urban resilience, leading to methodologies adapted from ecological research that do not integrate existing (and consolidated) urban design research methods.

Therefore, we propose the following:

1. The concept of *general urban resilience* provides a coordinated knowledge of spatial, urban and general resilience. Additionally, research on general urban resilience requires a framework capable of assessing the complexity of urban environments. Networks offer a framework that is already applied in Complexity Theories of Cities and that is compatible with pattern-process descriptions characteristic of (landscape) ecology.
2. We extend our knowledge base on urban resilience and form to include studies that do not explicitly refer to resilience, but which have the same focus. There are similarities between studies concerned with resilience assessment and those dealing with the measurement of urban form in relation with environmental performance. These studies need to be correlated before a reliable theoretical framework and an integrated method of assessment can be developed.
3. The theoretical framework illustrated in Figure 1 contributes to a common body of knowledge for nature-ecology and space-morphology.
4. Space-morphology brings methods of analysis already familiar to urban design research, such as urban network analysis.

This paper contains the preliminary findings of an eight-month research; therefore, results on resilience and urban form cannot be claimed yet. However, the conceptual framework provides a good starting point for future research. A correlational research of spatial patterns and urban resilience indicators is essential for a reliable integration of nature-ecology and space-morphology. In addition, there is still need for research on how networks can be applied to assess urban form. Finally, both correlational research and network analysis of urban form have to be applied to case studies.

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# SUSTAINABLE DESERT TRADITIONAL ARCHITECTURE OF SAUDI ARABIA

**Hisham Mortada**

Dept. of Architecture, King Abdul Aziz University, Jeddah, Saudi Arabia

Contact: hmortada@kau.edu.sa

## ABSTRACT

For thousands of year's mud houses have represented the practical wisdom and spirituality of people, particularly those of desert regions, who learned how to use local materials to build homes that fitted the environmental and cultural conditions which they lived in. As a case study, the central region of Saudi Arabia exhibits a tradition of earth architecture that is unique in style, culture and sustainability. Aiming to contribute towards the local debate of the suitability of the traditional mud architecture for today's lifestyle of Saudis, this paper explores the sustainable nature of the traditional adobe architecture of this hot arid region from environmental, social and technical points of view.

*Keywords: Desert architecture, alternative materials, Saudi Arabia, arid climate, green architecture*

## 1 INTRODUCTION

The term 'sustainability' has been a keyword for many subjects concerning the continuity of human life in relation to the surrounding environment. It implies using energy and land resources with maximum efficiency at a rate that does not compromise the needs and life of future generations. The first communally accepted definition of sustainability was in the UN Brundtland report *Our Common Future*. It describes sustainable development that meets the needs of the current generation without endangering the opportunities for the future generations to meet their own needs [1]. According to Ch. Hendricks, the concept of sustainability encompasses not only the environment, but also social and economic concerns such as health and wellbeing, safety, care for living space, prosperity, sufficient employment, social justice and a fair distribution of resources.

As far as architecture, Elizabeth Wilhide has set up a list of principles for sustainable architecture. Some of these principles are as follows:

a) Energy efficiency: Since buildings make their greatest impact on the environment through the energy they consume over their lifetime, a sustainable building should feature a maximum thermal efficiency. This requires using materials of high thermal performance and renewable sources of energy, site and building situation or orientation toward the prevailing direction of sun and wind, and optimum volume-to-surface area ratio.

b) Material choice and use: As buildings are the large consumers of materials, sustainable architecture demands reduction of material over-use and waste, choosing materials that have low environmental impact or are reclaimed and recycled, as well as avoiding the use of toxic materials.

c) Site impact: A sustainable building should not be an intrusion or a source of disruption to the surrounding environment.

d) Longevity and flexibility: Buildings should not be considered as disposable or minimized over time. Instead, they should be designed and built for durability, minimum maintenance, and flexibility so they can address future needs [2].

Undoubtedly, traditional architecture, as exemplified below, is a vital source of reference for sustainability. Vernacular buildings developed out of a limited set of technological and material options.

## 2 HISTORY OF ADOBE

Throughout history mud has been used for everything from simple rural housing to the most extravagant architectural expression of religion and power (Figure 1). For as long as people have been settled, sun-dried mud has been provided them with shelter. Remains found in Fertile Crescent, Iran and Turkey show that adobe has been in use since at least 10,000 years ago. Villages of ancient

Egypt, from as far as pre-Dynastic times of more than 5,000 years ago, great Bronze Age cities in Ur and Babylon of Iraq, Mohenjo-Daro and Harappa in Pakistan, Chan-chan in Peru, and some pyramids of Egypt, all were raised from sun-dried adobe. Even the entire core of the Great Wall of China is from mud [3 and 4]. It is interesting to note here that the Qur'an, the word of God and the ultimate source of Islamic legal system, according to Muslims, mentions the mud as a source of mankind creation and shelter at least three times (28:38, 32:7 and 55:14) [5].

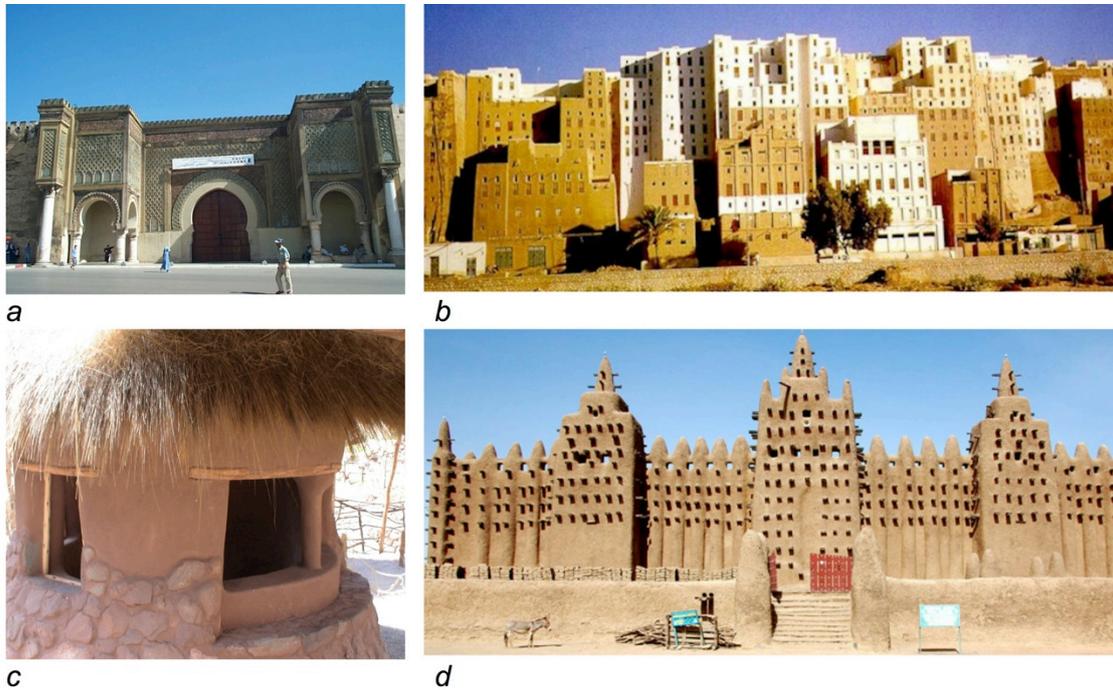


Figure 1. Examples of mud utilization in various in traditional cities (a. old city wall, Meknas, Morocco, b. mud towers, Shibam, Yemen, c. mud dwelling, Cusco, Peru, and d. Great Mosque, Djenné, Mali)

In modern world, adobe has been a source of inspiration for many architects such as the French Francois Cointeraux during the Industrial Revolution, Clough Williams-Ellis in Britain after the First World War and Hassan Fathy in recent times. Postmodern architects such as Frank Lloyd Wright and Charles Johnson have designed and built masterpieces of architecture from mud [6] (Figure 2).



Figure 2. Adobe houses around a central courtyard, Tucson, Az, USA

### 3 SAUDI CENTRAL REGION AND ITS ADOBE ARCHITECTURE

#### 3.1 Geographic and environmental background

The urban history of Najd, the central region of Saudi Arabia, goes back to the Neolithic period, 3000-5000 years ago. Najd is located between 19.8 and 37 latitude north and 37 and 42.26 longitude east. Its length from the extreme south to the extreme north is 1100 km and from east to west is 850 km, a total area of 420,000 square km, almost 19% of Saudi Arabia. Its two major sub-regions are Riyadh and Qasim and consist of 37 cities and 1200 villages.

There are many wadis (valleys) which pass through Najd, such as Wadi Hanifah, one of the greatest wadis of central Arabia. Toward one of its sides, wadi Hanifah is joined by a cliff of a different topography and nature. It drains the plateau of Tuwaiq Mountain, which, with its dramatic west-facing escarpment, forms a spine curving northeastwards through central Arabia for hundreds of miles. This eastern part of the central plateau of Arabia is called Lower Najd. Ground water is close to the surface, making cultivation possible by irrigation from wells. The Wadi has been inhabited along its length by farming communities since agriculture first came to this part of Arabia. Some of these settlements, such as Hajr al-Yammamh, al-Uyainah, al-Dir'iyyah and Riyadh, have risen to power and prominence over the centuries.

Climatically, Najd is among the most arid of all large regions of the world. It falls within the desert belt, which includes the Sahara Desert and most of the Arabian Peninsula. Najd suffers a long, hot and almost totally dry summer. Daytime temperatures can approach some 50°C in the shade, with the average July maximum at 42°C. Its cloudless skies, and its position far removed from the moderating effect of the sea bring temperatures varying sharply between night and day, and between summer and winter. In winter, the November-January daily minimum temperature averages a comfortable 8-9°C.

The prevailing summer wind comes from the south and is totally dry. In winter the cold, dry *shamal* wind blows from the north. By the time these winds reach Najd they have lost most of their moisture. However, the *shamal* or northern wind is replaced in late winter by depressions tracking southeastwards from the Mediterranean, and these winds bear the meager rainfall of Najd, including the most valued rains of spring that bring the desert dramatically to life. The annual average of rainfall is 84 mm. When rain comes, as it is typical of desert rainfall, it usually arrives in violent rainstorms. Half or more of a year's rainfall may fall in a single day. Such downpours can be very localized and occasionally as devastating to people in their path as drought. Torrential floodwaters roar through the converging tributary wadis to produce catastrophic floods, which have been known to sweep away entire settlements. On average four or five such floods turn Wadi Hanifah into a temporary river in winter and spring. In a dry year, this may occur only once or twice, while an exceptional season may bring as many as fifteen such storms [3].

#### 3.2 Architectural features

Desert architecture, such as that of Najd, can be characterized as 'architecture of the extremes', being basically similar to 'regular' architecture but differentiated from it by its obligation to address the extreme desert environmental conditions [7]. This is reflected in Najd dwellings, which are inward looking, leaving the desert outside. A typical Najdi house is rectangular or square in plan, often of two or more floors with rooms around a central courtyard (Figure 3).

The traditional house of Najd consists of two zones, one for the family or private and the other is public or for male visitors due to local custom of privacy. The family or females' section begins with an entrance or small lobby from a narrow alley or cul-de-sac. This lobby leads to an arcade of 1.5 m wide, around the courtyard, which is considered the social and climatic core of the house and major source of light and ventilation. *Qubat al-Ailah* (family dome) is the most used space, almost like the living room of today. It is large with a high ceiling. One of its sides is sometime directly open to the courtyard. In this ground floor there are also one or more rooms used by relatives for sleeping. However, the major bedrooms are in the upper floor and called *al-Rawashin*. Usually isolated from the rest of the rooms due to the smoke and smell associated with its function, the kitchen features a high ceiling with many openings for ventilation. Sometime a large opening exists in the ceiling for more ventilation (Figure 4). *Al-Sofah* is storage for commodities and food. The ground floor also

contains another but smaller (50 x 180 cm) storage, called *al-Sobah*, where harvested dates are kept. Some Najdi houses include a basement or an underground space called *al-khalwah*. While the upper floor consists of bedrooms and other family or multi-use spaces, the roof is divided into sections with doors in between, forming rooms for sleeping in summer. The roof is also used for drying food such as dates and locusts, a popular traditional meal in Najd. Camels, horses, sheep, chicken and birds were important to the daily life of Najdis. They were a source of food, transportation and children entertainment. Also their waste was used for soil fertilization. Therefore, most houses had a simple structure from palm leaves in the courtyard or roof for these animals.



Figure 3. Typical Najdi adobe house

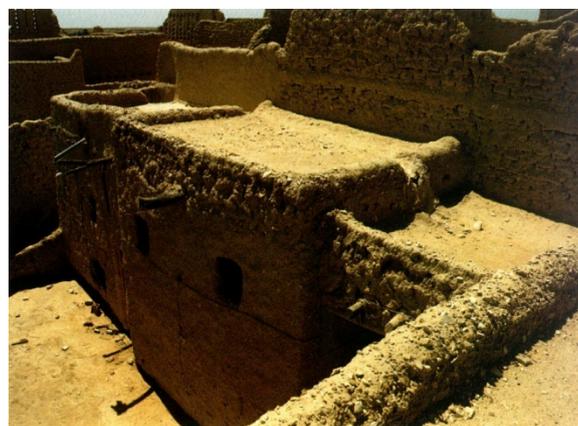


Figure 4. Courtyard of an adobe house, al-Dar'iyyah

The males' section is mainly characterized by *al-Qahwa*, where male visitors are received. It is also called *al-Majlis* or *al-Diwaniyyah*, adjacent to males' entrance, and adorned with elaborate stucco wall friezes [8].

From the previous description of the spatial arrangement of a typical traditional Najdi house, it might be noted here that these houses are conceived from the inside out. This strong introversion is accompanied by the strict segregation of family life from the reception of guests on the male side of the house. Hence, sometime two entrances, two staircases, two courtyards, and two sanitary blocks are provided. Extensive use is made of transitional circulation spaces by the inclusion of a colonnaded gallery around the courtyard on each floor.

In addition to its climatic and social function, the courtyard of a Najdi house symbolizes a spiritual meaning and importance to residents. For Arabs, the night sky, the moon and the stars hold a special place, which in their heat-seared land, they have not accorded to the sun. The night is a time of coolness and ease when the sky can be looked at and can become filmier, in total contrast with the hostile glare of the day [2]. This courtyard is like the walled garden, answers a deep need, certainly a social one, and perhaps an existential one too: the desire for an enclosed secure piece of outside space, placing one's daily life in a unique relation with the sky and season (Figure 5).



Figure 5. Arcade around the central courtyard, *al-Dar'iyyah*, Najd

From outside, the traditional Najdi adobe house can be viewed as boring or architecturally featureless (Figure 6). This is indeed obvious since the life of inhabitants is oriented toward the inside. In tribal societies, where the close-knit nature of kinship groups co-exists with insecurity outside the group, the protection and privacy of the family becomes a priority. The courtyard house answers this need effectively. Nonetheless, crenellated parapets of 'v' shape and patterns of ventilation holes in the form of triangles and lancets are common features of the facade though their function is to divert the raindrops away from the mud wall below (Figure 7). Openings and windows are small, limited in number and height. They are only to provide light and air [3].

### 3.3 Traditional construction materials and techniques

Construction in adobe or sun-dried mud bricks in Arabia is ancient. It is documented in pre-Islamic

times in Yemen and Saudi Arabia. The Prophet Muhammad used mud brick (*libin*) for his residence and mosque in Medina in AD 622 (Figure 7). Excavations at al-Rabadha, west of Najd, have shown that sun-dried mud was in use from the centuries preceding Islam through Abbasid times [9]. Mud was used in Najd because it was the only material available in the region and due to the scarcity of stones.



Figure 6. Plain façade of a typical Najdi adobe house



Figure 7. Crenellated parapets redirect raindrops away from the mud walls

Traditionally, the construction of a Najdi house starts with the preparation of basic materials: mud (*libin*), straws (*tibin*), palm tree trunks (for roofing), and cut stones (for foundations). This was done by either the families with their neighbors and relatives if their income was limited or by a master builder termed *al-Moualem*, *al-Austad* or *al-Banna* who was totally responsible for the construction process. Mud was brought from nearby locations called *Qe'an* in Wadi Hanifah. These locations were known for their unsalted soil resulting from the occasional floods that removed the salt. This type of soil was considered the best mud source. It was strong, sticky, thus added strength to the bricks when they dry.

A trench of 1-1.5 m deep was dug by *al-Moualem* at the house dimensions. Then it was filled with a mixture of clay and stones to form a continuous foundation. This foundation was left for a day to settle, dry and harden [9]. After that, the mud was mixed with straw by having a hole in the centre of the mud heap where water and a little amount of wheat or oat straw (*tibin*) were poured (Figures 8 and 9). *Tibin* was necessary to increase the adhesiveness and compactness of the mixture. Studies in England found that 1.5-2% addition by dry weight of chopped straw increased the compressive and tensile strength of the mud mix when dry. It also reduced any shrinkage that could occur during the drying of the mixture. Straw content also helped to prevent erosion by rain [3].



Figure 8. Preparation of straw bales before being chopped



Figure 9. Mixing mud with straw and water

Pure mud would be mixed with soil (*turab*), taken from the banks of a wadi where salt had accumulated when watercourse was dry. This *turab* would be mixed with the clay in proportions that varied according to the purity of the mud; if the mud was very pure then the proportion of *turab* was increased, and if the mud was less pure, then less *turab* was added. The role of *turab* was to prevent the mud from cracking [9].

After mixing the mud with water, straw, and if necessary, soil (*turab*) men compressed the mixture with their feet and hands. The next step depended on how the mixture was to be used. If the intention was to make bricks, then it was used immediately by pressing the mixture into a brick shaped frame from *athl* or palm trunk wood of 25 x 30 – 30 x 40 cm on a layer of straw on the ground, and then removing the frame (Figure 10). One man could make 200-500 bricks a day this way, and about 3,000 would be needed for a small house of about 60 square meters. The bricks then left in rows under the sun to dry. After a day or so they would be turned onto their sides to complete the drying process. Once dried, the bricks were removed from the frame so that the frame would be reused. The hardening bricks were then left in lines in the sun for 2-3 days to dry in the summer, the best time for construction for speedy dryness [8].

If the mixture was to be used directly for constructing a wall in continuous layers, the mixture was left to stand at least 4 hours for fermentation. The longer this process of clay fermentation went the better for the building material quality. If it were to be used for a fine adobe plaster finish on the complete wall, it would be left for as long as possible [3].

For construction in courses or layers, the fermented mud was shaped in small balls and used in rising up the wall (Figure 11). The balls or masses were lined up horizontally next to each other. The thickness of such a wall was usually 30 cm. Layers were preferred above bricks were as they were thought to be stronger and more enduring. In a day no more than five courses at a time were necessary to maintain the alignment and steadiness of the wall as it rose.



Figure 10. Pressing adobe mixture into wooden frames



Figure 11. Courses of an external adobe wall, al-Dar'iyyah

Limestone was sometime used in the lower part of the external walls for more strength. The height of this part was 3-4.5 m. Inside the house, the columns of the arcade around the courtyard were also built from cylindrical stones (Figure 12).

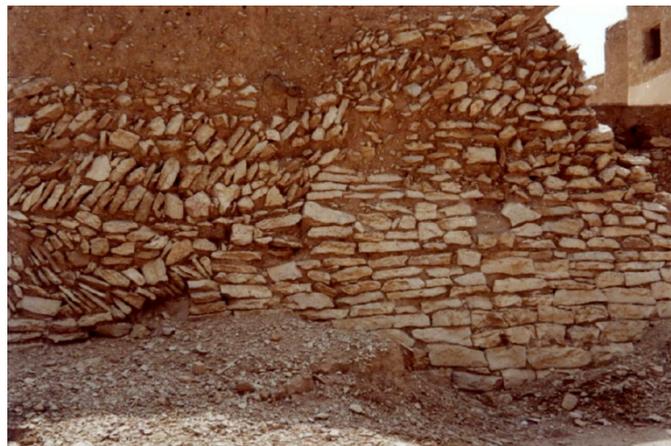


Figure 12. Stones of the lower part of an adobe wall, al-Dar'iyyah, Najd

*Athl* wood was used for roofing. It is an abundant tree in all farms of Najd. The length of the *athl* joist determined the size of the rooms, generally 3.5 m. *Athl* was obtained then cut to length, trimmed, then stripped of any loose bark (Figs. 13 and 14). Sometime palm trunks were used instead. Mats made from palm leaves were used to cover the beams.

Likewise, doors and windows were made from the ubiquitous *athl*. Najdi householders have always been proud of their wooden doors that featured lavish workmanship and artwork for emphasis. The

dullness of the mud facades and scarcity of wood were the reason of this elaboration, thus the pride. For finishing, after being built, walls were moisturized with water and left for fermentation for a period of a week to a month for the internal walls, and a few months for the external. The longer period for the external walls was necessary so the straw decayed and the clay colour became black and smooth. This gave exterior walls more strength and enhanced their waterproof quality and thermal capacity [8]. White gypsum mixed with water was applied to parts of the walls, particularly those of the courtyard, for painting.



*Figure 13. Athl wood for roofing, Riyadh, Najd*



*Figure 14. Layers of palm trunks, athl and mats for roofing, al-Dar'iyyah, Najd*

### **3.4 Sustainability of the adobe of the central region**

The eco-architecture of traditional houses of Najd represents people's response to the specifically harsh conditions of the hot arid environment of Najd. They have positive thermal, economic, social and above all environmental attributes.

It is well known that thick mud walls keep the indoor spaces cool in summer, particularly on the ground floor. There is a 15-degree difference between outside and inside of mud building [9]. In winter, when Najd can experience bitterly cold long nights, the mass of the adobe walls will radiate the heat it absorbed during the day back out into the house at night. Having almost no insulation value, mud walls provide thermal mass, slowing heat transfer from exterior to interior spaces during the day and from interior to exterior spaces at night. The rate of heat transfer through a mud wall is about 2.5 cm per hour. In the desert, this thickness prevents the sun's heat from reaching the building interior before nightfall. Substantial drops in air temperature at night cause the walls to cool off again before sunrise [10]. Hassan Fathy conducted tests in Egypt in the 1940s and came to the surprising conclusion that a well-made mud brick might be almost four times more thermally inert than a hollow concrete block [3].

The courtyard houses of Najd provided particular protection against heat when they were grouped together with shared party walls in neighborhood blocks, when relatively fewer walls were exposed to

the heat. This compact urban form appeared from above like a one mass of mud punctuated only by the light-wells, the courtyards and narrow streets (Figure 15).

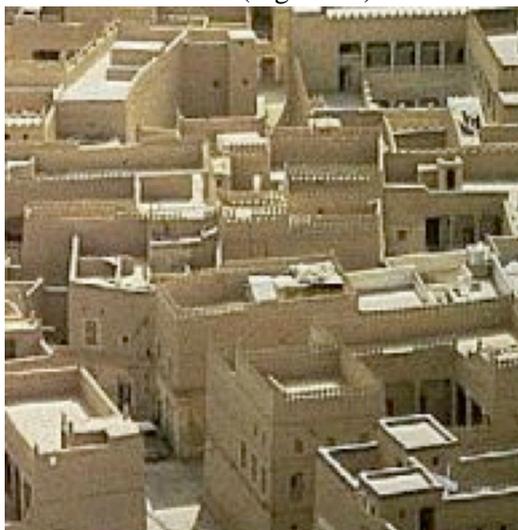


Figure 15. Urban compactness of adobe houses

For the poorest people, adobe constructions are the only option because of their low cost and the possibility of self-construction. Experiments by University of Arizona, Tucson, have found that constructing by adobe courses is more economic and practical [10]. The possibility of obtaining the clay from the site adds to the economic and environmental values of adobe, comparing with the high overhead cost of forms and scaffolding as well as the high labor and transportation investment which is unaffordable to most people. Furthermore, mud walls may require regular maintenance by replastering the exterior surface to counter the erosive effects of rainfall. However, projections on the walls and their parapets, as it is the case in Najd adobe houses, help to redirect the raindrops away from the mud walls. As far as durability, the resilience of mud was demonstrated in extreme terms at the wall of al-Rass in al-Qasiem in Najd in 1817. The wall of this town was bombarded with 30,000 rounds by the Egyptian Ibrahim Pasha's massed artillery over a period of three months. The adhesive quality of the mud was such that the cannon balls had no effect on the defenses. Similarly, the walls of al-Rashid's Palace in Hail, north of Najd, were so strong that they resisted the efforts by Saudi artillery to shatter them in 1921. Also mud walls have excellent acoustic properties [9]. The economic value of Najd adobe style is also reflected in the multi-functionality of the interior spaces. These spaces were used on seasonal basis. Also, traditional Najdi houses could grow with the inhabitants' needs and be dispensed with equally and easily. The way Najdi adobe houses were constructed created a unique social solidarity between people. As explained above, limited income families, which represented the population majority of that time, built their houses with assistance from relatives and neighbors. This custom was called *Faz'ah* [8].

### 3 SUMMARY AND CONCLUSIONS

Adobe architecture nowadays has unfortunately come to be identified with poor rural communities and a sign of backwardness, primitiveness and poverty. Saudis have abandoned adobe. Nonetheless, as previously analysed, adobe buildings have excellent qualities of sustainability. They are environmentally, economically and socially effective.

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# A SUSTAINABLE DESIGN METRIC TO ASSESS THE CONSTRUCTION OF PREFABRICATED HOUSING

Ruth SUTTON<sup>1</sup>, Timothy SHORT<sup>1</sup>, Stephen JONES<sup>1</sup>

<sup>1</sup> University of Liverpool

## ABSTRACT

Tools currently available to support the design of sustainable housing do not address the broad demands of social, environmental and economic sustainability over the whole life of the building. A tool for the use by architects and developers to optimise the sustainability of the whole life of a prefabricated building is required. This paper proposes a sustainability index for use within such a design tool, providing a quantitative method to compare design alternatives.

A literature review identified sustainability issues from the fields of design and construction. Criteria were reviewed with respect to the scope of the design tools and thirteen criteria covering environmental, social and economic issues were selected. The criteria chosen were applicable to all solutions and were measurable with the provision of reasonable resources.

It is argued that company stakeholders can be sufficiently well-informed to determine criteria weightings but that care must be taken not to introduce bias towards preferred solutions. As such weightings should be determined prior to and independent from the development of the design. This also allows for results from the sustainability index to be fed back into the design process.

Saaty's Revised Analytical Hierarchy Process was determined to be the most suitable weighting method by allowing weightings to be determined early on in the design process, and used to support the development of designs within the design tool.

*Keywords: Decision making, Criteria weighting, Construction, Sustainable*

## INTRODUCTION

It is now understood that economic, social and environmental systems have limits. The systems are interconnected and changes to one system can significantly affect the others [1]. As global consumption increases so do the stresses on the systems. Sustainable development offers a framework in which the stresses on the systems achieve a balance such that no system is irreparably damaged. This paper proposes a sustainability index for use within a design tool, providing a method for the quantitative comparison of prefabricated building design, manufacture and assembly methods.

Construction and the built environment have large impacts on social, environmental and economic systems. Buildings have aesthetic and environmental impacts on the local community and have lifespans that mean they can last for several generations.

The construction industry uses more than 400 million tonnes of material per annum [2]. A traditional four bedroomed house requires approximately 177.8t of material [3] and an additional 40% of material is wasted on site during construction [4]. They need maintenance and renewal throughout their lifetime during which time they are often altered significantly to adapt them to the householders' needs [5].

The value of new housing construction output, in the UK, in December 2013 was £1,993 million [2]. Despite changes in much of the construction industry, housing construction remains a craft based manufacturing process [6]. Bricklayers, joiners and plasterers are among the workforce needed to produce a house. Historically, the construction industry has been characterised by low skilled labour, short term contracts and a lack of job security [6] yet these trades are being challenged to achieve increasing build quality [6] and improved thermal performance [7].

Implementing sustainable construction methods could help reduce the significant negative impacts of the industry. Prefabricated building methods provide reliable performance [8]. They enable the use of materials with low embodied energy and the adoption of factory production methods reducing waste. Despite this traditional building still accounts for the majority of new housing [4].

This work is a part of larger project addressing the design of sustainable construction methods using off site prefabrication. The project will develop design tool for use by architects and developers, to optimise the whole life sustainability of a building. This paper presents the initial stages and outline of the scope of the tool, the focuses of the development of the sustainability index, a quantitative measure, which will be used within the design tool to compare and optimise alternative solutions.

## BACKGROUND

Historically, business has pursued profit and growth without consideration of the wider impacts on society and the environment. During the 70's economists such as Friedman [12] argued that as long as business's worked within the law they had no additional responsibilities beyond making profit for their shareholders. However, at this time, environmentalists were collecting evidence that business actions were causing environmental damage. Academics at Massachusetts Institute of Technology (MIT) were producing "Limits to Growth" which showed that continual growth of population, and use of resources could not be sustained on a finite planet. In 1972, "sustainability" was coined within "A Blue Print for Survival" and by 1986 the Bruntland Report had defined sustainability as:

"meets the needs of the present without compromising the ability of future generations to meet their own needs" [13].

### **Sustainable Design Tools in Construction**

While traditionally the architect's role has been one of "a creator", producing the elements of the space and form, leaving the structure and mechanical engineering design to others. The increased role of the architect in these areas has been driven by the need to reduce costs of construction and to address clients' desires to be more sustainable, by considering thermal performance, and the choice of materials [14-16]. However, factors which affect the performance over the buildings' lifetime are less often considered [17].

The key drivers for building design sit within legislation and regulations. The Building Act in 1984 led to the Building Regulations in their current form. Building Regulations cover structural safety, ventilation, fire safety among other factors, but do not address factors beyond the in use phase.

Environmental legislation includes the Environmental Protection Act, 1990 and the Landfill Tax in 1996. The nature of the construction industry means that many aspects of Health and Safety legislation are applicable including Health and Safety at Work Act, Reporting of Injuries, Diseases and Dangerous Occurrences (RIDDOR) and Control of Substances Hazardous to Health (CoSHH); however the construction industry is still associated with large numbers of notifiable incidents.

Code for Sustainable Homes (CfSH) [7] is a widely adopted tool, in the United Kingdom, addressing energy use, site ecology, materials, waste and other factors. Developed from the more detailed non-domestic Building Research Establishment Environmental Assessment Method (BREEAM), CfSH covers some aspects of construction activities in the management/procedure class. Waste management plans, and health and safety action plans are credited as is registration with Considerate Constructors Scheme. Credits are also gained from actions covering specification, construction and in-use phases of the building lifespan. Impacts of the maintenance of the building and end of life are not considered.

In 1996, the Building Research Establishment (BRE) introduced the Green Guide to Specification [4] to support decision making materials required by CfSH. It has been developed as a summary tool of life cycle assessment (LCA) data for a range of materials and element configurations. The BRE assess the impact of the materials up to the factory gate and does not consider waste during construction or disposal at end of life. In academia, LCAs undertaken on housing have addressed energy consumption during use, embodied impact of the fabric materials [3], refurbishment, and the impact of the local infrastructure [20].

The social responsibility of a business to the worker, customer and local and global community has been subject to limited attention by the designer [21]. Lifetime Homes [22] offer advice on designing a building so that it can be adaptable to households needs including minimum standards for access spaces and turning circles for wheel chairs. The document requires that the future needs of the householder are considered: walls must be designed to take the loads of the support rails, the floor must be able to accommodate the disability lift; affecting the material specification and assembly of the building.

Companies' sustainability aims are often outlined in the Corporate Social Responsibility documents (CSR) affecting behaviours and practices of the company. Guidance is offered by ISO26000 [23] and the areas covered should include the environment, human rights, labour practices, fair operating practices, consumer issues and community involvement and development.

These documents and practices cover many aspects of the construction process and building design but many of the impacts of construction methods, transport of materials, equipment, and quality assurance are not considered. Furthermore, they are present in separate documents and may be used by different stakeholders in the design process making optimal decision making difficult. As such, a tool that brings together many aspects of the construction design will improve the optimisation of the whole life sustainability of the building.

### Scope of the Tool

The sustainability index has been designed for use within a design tool. The tool is aimed at assisting the design of the construction of prefabricated housing systems.

The design assists decision makers in areas affecting material choice, manufacture and assembly methods, panel design, transport options and the degree of offsite or onsite manufacture. The whole life assessment considers the manufacture and assembly phases, the maintenance, adaptation and the end of life of the building fabric; but does not address the in-use performance which is covered more thoroughly elsewhere [9-11]. A set of performance calculations will sit parallel to the design to ensure that alternative solutions are viable.

### Criteria

Defining the functional requirements of the product, with respect to sustainability, creates a design space for the designer to work within. Several comprehensive sustainability frameworks, such as the global reporting initiative and the United Nations Commission on Sustainable Development Framework are available. While these focus on institutional behaviour rather than building design, they can be used to identify suitable criteria.

A literature review can identify the scope of issues but subsequently, a critical review is required to ensure the chosen criteria are appropriate. The number of criteria should be as small as possible in order that they can be ranked effectively, but must also cover the full scope of the aim.

Akadiri and Olomolaiye [24] identified criteria through a literature review and assessment of academic, institutional and commercial sustainability documents, which were focussed on design and construction. While Dalkey and Helmer [25] described the use of Delphi methods consulting industry experts to identify key criteria; Triantaphyllou [26] indicates that criteria should be derived from the proposed solutions to the problem.

Akadiri [24] proposed a number of qualities required by criteria in order to suit the decision making process. They should be **comprehensive, applicable, transparent and practical**. Comprehensiveness intends that the scope of the index is fully covered by all criteria. This is made easier by creating a hierarchy and populating the areas. By being applicable, the criteria can be measured in each of the design solutions. The method of choosing and weighting the criteria should be transparent. They should be practical; it should be possible to gather and analyse data for the metric using the resources available. In addition, there should be mutual independence of preferences in order to prevent double counting; such that each criterion could be assessed without knowing the scores gained for other criterion.

### Weighting Methods

There are a wide range of decision making methods available for the index. The adoption of a single unit of measurement onto which the other criteria are mapped, presents difficulties. The use of financial values to represent environmental impact could be calculated from the cost of implementing alternative solutions, but can lead to double counting; alternatively the cost of damage inflicted could be estimated, which is difficult. The use of industry values, such as carbon tax, to measure the impact of embodied carbon uses weightings set by others which can be affected by issues unrelated to the environment.

A deterministic, multi-dimensional criteria method is appropriate where the metrics have different units and a single solution is required [26]. It must be determined whether the problem is multi

objective, suitable for when the decision space is continuous, or if it is a multi-attribute problem with discrete design spaces. The multi-objective methods create optimised designs while multi-attribute decision methods decide between alternative solutions [26].

Simple Ranking is the simplest weighting method. The stakeholder orders the criteria in order of importance on an ordinal scale. There is no scale to the ranking so weightings increase in equal increments, reducing the level of complexity that can be reflected in the scores. Where many stakeholders' opinions are represented and the weighting only provides a representation of their views it offers a simple methodology, removing the need for "unrealistic assumptions about the underlying distributions" [24].

The revised Analytical Hierarchy Process (AHP) was based on the work originally by Saaty [26]. The criteria are presented to the stakeholders in pairs who, using their judgement, weighted the relative importance on a linear unipolar scale of 1-9, shown in Table 1. This pair wise comparison is used to create a hierarchy of values for the criteria.

Internal consistency is measured using Cronbach's  $\alpha$  as it is possible for the answers given to the pair wise comparison to conflict. Internal consistency ensures that rankings are maintained throughout. A practical example of this is to say that if the economy is determined to be of greater importance than the environment; and the environment to be of greater importance than social issues then the economy *must* be greater than social issues.

Table 1: Comparative importance of criteria rating (from Saaty [26].)

How important is A relative to B?	Preference Index assigned
Equally important	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Overwhelmingly more important	9

Eigen vectors are used to determine relative weights of the criteria. Once the weightings have been established, the scoring of the index uses a linear additive model. While the mathematical methods used to create the weighting are complex, they are usually achieved using software and the methodology is clear, requiring only that stakeholders consider criteria pairs [27]. There are some concerns that the theoretical foundations are poor because the rank order can be changed when a new criteria is added however, the revised AHP method reduces the likelihood of this over Saaty's methodology [26,27].

Simple Ranking and AHP are linear additive methods. Linear additive methods have three key stages, scaling of the performance of criteria, weighting the importance of criteria, and determining the relationship between the weight and the scaling. Triantaphyllou [26] indicates that normalisation should be undertaken once alternative solutions have been identified and a range is known. This allows the assessor to identify the range of values for the metric and from the range a scoring methods can be identified, typically linear or logarithmic scales are used. Normalisation methods are adopted so that the metric becomes unit less and can be added together. These are then combined with the weighting to create a criteria score. The sum of these values is the sustainability index.

Outranking methods are applied at the end of the design process and directly compare alternative solutions. Scoring is determined by the range of solutions identified. The method reduces the problems associated with prioritising criteria by removing the need to create weights. The scores are determined subjectively and so normalisation is not required and non-linear relationships between different criteria can be reflected in the distribution of the scores across the alternative solutions.

For the assessment, a table presenting the alternative solutions' data values for each criterion is prepared, an example is shown in Table 2. The criteria are considered one at a time and the solution with the preferred conditions is identified. Where no preference is identified the criteria is removed from the assessment. The most significant combination of criteria and data is identified and is given a score of 100 points. In the example below Criteria A, Solution Z is determined to be the most important. The remaining preferred solutions for each criterion are scored relative to this benchmark. Once all of the criteria have been scored the totals for each alternative solution are collated.

Table 2 Example of Outranking method scoring

	Solution X	Score	Solution Y	Score	Solution Z	Score
Criterion A	5	--	5	--	<b>15</b>	100
Criterion B	1	--	<b>4</b>	20	2	--
Criterion C	2	--	2	--	2	--
Criterion D	6	--	4	--	<b>10</b>	40
Total		0		20		140

## METHODS

A literature review of academic papers focussed on design and construction, institutional guidance, design tools and corporate sustainability reports to identify key sustainability issues. A broad representation of the issues covering social, environmental and economic sustainability was targeted. All issues identified were recorded for assessment.

While the CLG government guidance [27] suggests that criteria should be based on the alternative solutions, this has not been possible because the index is to be used as part of a design tool which creates the solutions. Instead, in order to ensure that the chosen criteria were suitable, a timeline of the manufacture and assembly process was produced and the issues identified were considered in this context. Once the initial criteria were selected, a network diagram of the relationships between the constraints and the criteria was produced. The remaining criteria were reviewed to assess whether any of the issues that had been left out previously should be included.

Criteria were reviewed to ensure they met the conditions outlined in the section above. Constraints for each criterion were identified and a network of the relationships between the constraints and the criteria was drawn. This allowed the criteria to be checked for redundancy and interdependence. Weighting criteria methods were compared in order to identify a suitable method. Several of the constraints have metrics which gave discrete values and as such the problem was confirmed to require a multi objective methodology.

## RESULTS AND DISCUSSION

The scope of the tool has meant that the order of the processes to develop the index varies from others methods. While others have chosen the criteria after the alternative solutions have been developed [26,27] here the criteria are used alongside design tools to optimise the solutions. The revised process is shown in Figure 1. Criteria are selected based on the design space described by the background research to the tool and are intended to assess all possible solutions. However, the identification of innovative solutions during the design process may require additional criteria to be included. As such, the weighting system is simple enough that these additional criteria can be incorporated into the index, at a later time, with the minimum of reworking. Identification of criteria weightings is independent of the final decision making process so that bias from personal preference is avoided.

From the issues identified in the literature review, shown in Table 3, thirteen criteria covering environmental, social and economic issues were relevant to the scope of the design tool; they are presented in Figure 2.

Table 3 Summary of sustainability issues identified during the literature review

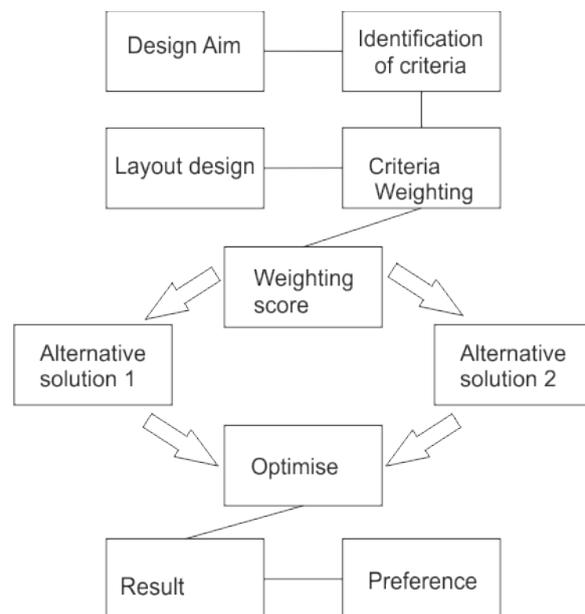


Figure 1: Process within the design tool, including development of the sustainability index (Design aim, Identification of criteria & Criteria weighting)

Environment	Ref.	Economy	Ref.	Social	Ref.
LCA / embodied energy of materials	24,28-34	Staff training/CPD staff retention	28-30,34	Adaptable /long life	7,31,35
LCA / footprint/ resource scarcity	18,24,31-34,36	Financial health	34	Housing to meet a mix of needs	4,28,30
LCA/pollution/ contaminants/ toxicity	7,24,28,32,35,36	Profit to company	30,34	Affordable	28,30,35
Waste minimise recycle reuse	18,24,28,30-33,36	Good governance	30	Impact during construction	7,28,33
Waste: hazardous material	18,24,29,32,34,36	Long term business model	29,34	Reporting and audit	4,7,28,30,33
Climate Change	4,7,18,31	Local employment	34	Health and safety	28,30,34
Acid rain potential	7	Life time cost (initial cost, maintenance and disposal)	36	Locally sourced material	36
Photochemical smog	24	Occupant influence:	7	Noise	33
Ozone	24	Economy national and global equity	4	Ethical sourcing	4,7,28,30,35,37
Energy consumption	7,28,30,31,33			Local employment	33,34,36
Renewable energy	30,35			Local heritage and culture/land use/aesthetics	4,28,30,31,36
Transport	28,34,35			Infrastructure and service	28,31,33
Nature/ Biodiversity	4,7,28,30			Listening to stakeholders	28,31,33,34
Water use on site	7,30			Occupant experience	7,31,34
Water in use	7,24,31,36				
Statutory compliance	7,24				

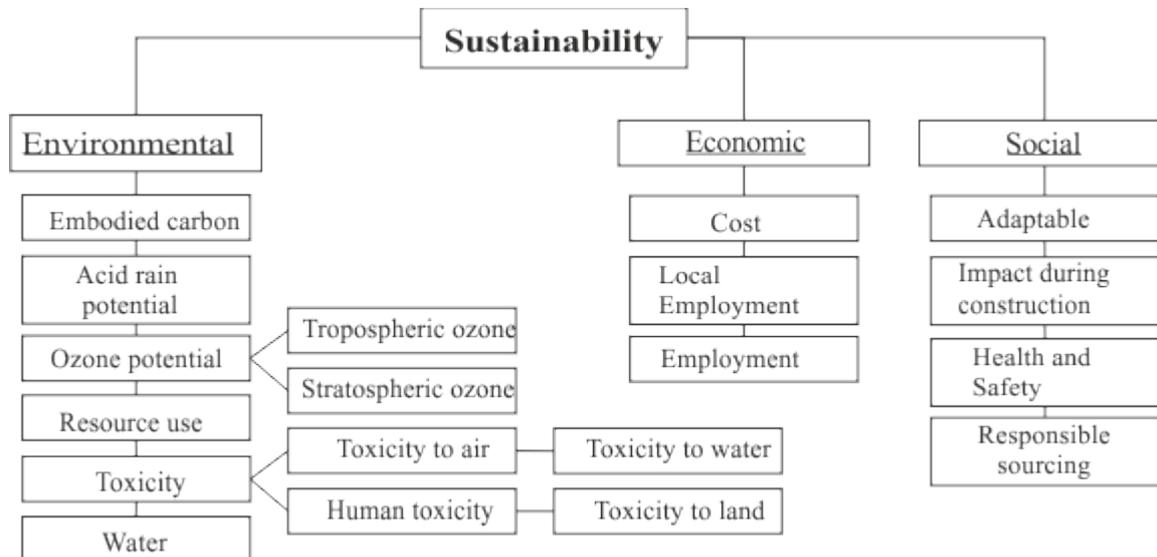


Figure 2 Criteria chosen for the sustainability index.

The first tier comprises the key issues of environment, economy and social. The environmental criteria selected were organised into three tiers in the hierarchy. The second tier details the key issues identified, the environment has six criteria, social issues have four criteria and the economy has three criteria. The third tier was created to reduce the total number of criteria in the second tier, to assist the weighting process and ensure that the issues were dealt with in sufficient depth.

Environmental criteria have local impacts in toxicity and water use during construction. Acid rain has a regional international impact. Embodied carbon, ozone depletion potential and resource use are global impacts. Timescales of these cover a range from potentially acute impacts of toxicity to the long term impacts of greenhouse gases.

The economic criteria have local and national impacts. No criteria with measurable international impacts were chosen. Local employment was considered important and is affected by the degree of offsite manufacture. Total employment affects the national economy and individuals. The metrics are measurable over the construction time period.

The social criteria have impacts on individual, local and global scales. The influence is mainly focused over the construction period. However, the adaptability of the building is both measurable over the lifetime of the building and will affect the potential lifetime of the building.

### Weighting

A number of ranking methods were reviewed and their properties are summarised in Table 4. The design space comprises discrete parameters and requires multi-attribute decision making process. While some criteria were described by continuous parameters, some, such as health and safety and adaptability presented discrete units. Each of the weighting methods presented above was suitable for multi-attribute decision making.

The weighting needs to be simple to apply; scores for each issue should be individually calculable so that they can be assessed and improved during the design process. It was noted that additional criteria may be required to fully describe the scope of the tool if innovative methods were identified. This would require the whole weighting method to be repeated because all of the relationships would need to be reconsidered. In a business setting, the initial weighting process will be resource intensive so, it is vital that the initial aim and scope of the design tool is as comprehensive as possible.

Simple Ranking methods do not allow for variation in the importance across the criteria. This would lead to removal of criteria, so that only the most important were presented, which conflicts with Akadiri [24] guidance that criteria should describe all of the issues. As such this is unsuitable for the needs of the sustainability index.

The use of the index as part of the design tool to identify areas for improvement requires weightings to be chosen before alternative solutions have been developed. One of the key benefits of AHP is that the weighting of the criteria is independent to the development of the alternative solutions and can be undertaken before the options are developed.

Scoring for the Outranking method requires solutions to be compared and, as such, can only occur at the end of the design process. This prevents the use of the index as a part of the design tool. However, it does allow for the importance of the criteria to be determined using the available data so scores can be made small where only small differences in properties occur across the alternatives. There is also the opportunity to introduce bias: if the stakeholders have a preferred solution, they may apply weights to affect the final decision.

Table 4 Comparison of criteria weighting methods

	Simple Ranking	Revised AHP	Outranking
Single stakeholder	Yes	Yes	Yes
Multiple stakeholder	By consensus	Yes	By consensus
Solutions needed prior to weighting?	No	No	Yes
Simple to calculate weightings	Yes	No	Yes
Include additional criteria during the process	No	No	Yes

Based on the needs of the tool identified above, the revised AHP method was identified as the most suitable weighting method. Criteria identified were arranged to form the hierarchy shown in Figure 2. The criteria and weighting are specific to the tool, as defined by its scope. While the first order issues, environment, society and economy will be presented as key issues in other tools; it is how the tools will be used that influences the weighting. Outside the scope of the tool, the company may be involved in other activities which affect the sustainability of the business as a whole, but do not influence the manufacture and assembly. For example, policies on staff retention, maternity leave, holidays and redundancy will have socially sustainable impacts but are not affected by the design of the manufacture and assembly process.

The issues identified significantly affect the behaviour of the company, and so it was deemed necessary that the weighting process was undertaken by company stakeholders who are well informed of the issues. Additional material was prepared to inform the stakeholders of the impact of the issues. Within the company associated with the current project, there is only one person within the company suitable to undertake the ranking procedure, so the method must be suitable for an individual to complete. Additional assessors may become involved in the future. Criteria weightings are confidential at present, for commercial reasons, but will be available in the future to ensure transparency in the whole of the tool.

Normalisation of the data is usually undertaken once the data is known and can use linear, logarithmic or qualitative scales. By creating weightings prior to forming alternative solutions, the possible values for each criterion are unknown. The range for each metric will be described by baseline design, existing design tools, literature values, and legislative targets.

As the design tool will be used again and again to develop optimised manufacture and assembly solutions, revised weightings can be developed and fed into the next design. In this case the weightings should be monitored to assess whether they stabilise to give a set of “ideal” weightings which reflect the stakeholders’ needs in the current design setting.

### **Application of the Tool**

The sustainability index sits within a design tool for the development of manufacture and assembly methods for prefabricated housing. The tool will provide quantitative data to assist the designer to make decisions regarding the material choice, module design and transport options, among others. The criteria are considered sufficient to support the development of a suitable manufacture and assembly method. It is considered that the sustainability index will be a valuable part of the design tool, highlighting choices that have the most significant impacts. The design tool alone will not be sufficient to design the building but it can be used once the form, performance and glazing have been determined.

The purpose of the sustainability index is, firstly, to create a single score which can be used to compare alternative solutions to identify a best design. Secondly, it is to assist the creation of design solutions by indicating how different properties of sustainability are affected by changes to the design. A solution is given a single index value to describe its performance for comparison against the alternative solutions offered, however in doing so it loses much of the information associated with the criteria scores. Pareto curves can be created by plotting all of the alternative solutions. By using the first tier scores a 3-dimensional pareto surface would be formed. The optimal solution would that with the greatest distance along the perpendicular from the surface to the origin [26, 37].

The purpose of the optimisation process is to give designers feedback about the sustainability of the manufacture and assembly methods. If the alternative solution with the highest score is not the preferred solution to the company then the management are still able to make an informed choice. The availability of data, scores and the final single index allows for the designs to be compared at a number of levels useful for the whole design team and decision makers.

The optimised solution applies only to the optimised building layout explored. The index is not suitable for the comparison of buildings with different forms or floor areas because many of the criteria are dependent on the layout of the building and size of the construction elements.

### **CONCLUSION**

Previously, there has been no method to assess the sustainability of prefabricated construction methods as tools focus on the in use phase of the building’s lifetime and this paper presents a new method.

While a broad consensus of the definition of sustainability is not achieved in academia, it is considered that creating a transparent method for the selection and weighting of the criteria defends against criticism. The chosen sustainability criteria covered environmental, social and economic issues over a range of time scales and geographic scales. The thirteen criteria were not equally spread across the spectrums three key areas, instead environmental had the largest number of criteria.

Pairwise comparison undertaken during a managed process with the stakeholder assists the informed decision making but allows for priorities to be reflected. The use of a single stakeholder to determine the criteria weightings risks individual personal bias. As such, the revised AHP was chosen because it was able to produce weighting prior to the creation of alternative solutions.

The sustainability index is limited to comparing building of similar forms and layout. This prevents its use as an assessment tool in the general sense, but it is suitable for its purpose to optimise the process for each design.

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# THE IMPLICATIONS OF RAPID URBAN GROWTH FOR SPORT DEVELOPMENT AND SOCIAL HEALTH AND WELL-BEING

**Dr Georgia Warren-Myers<sup>1</sup>, Associate Professor Pamm Phillips<sup>2</sup>**

<sup>1</sup> RMIT University; [dr.g.warrenmyers@gmail.com](mailto:dr.g.warrenmyers@gmail.com)

<sup>2</sup> Deakin University; [pamm.phillips@deakin.edu.au](mailto:pamm.phillips@deakin.edu.au)

## ABSTRACT

*The rapid expansion of Melbourne's outer urban areas over the past decade has left the planning, development and provision of sport and recreation facilities in disarray. The provision of sport and recreation facilities is playing catch-up to the booming population of the urban growth areas. The social health and well-being of communities in an urban growth area in the context of sport and recreation is often and commonly overlooked. To maintain and sustain a healthy community in terms of physical activity and social interaction there is increasing importance placed on the implementation of appropriate sport, recreation and open spaces within new and expanding communities. This research has found that the current provision of facilities fall short of planned provisions, with centralisation of key facilities and over concentration on certain facility and sporting types, that may not necessarily meet community needs and requirements. This research aims to highlight the need for better policy and implementation across a range of stakeholders to ensure appropriate sport, recreation and open space provision are actually created to assist in creating a more resilient and healthier lifestyle for communities.*

*Keywords: Sport, Recreation, Facility Provision, Planning, Urban Growth*

## 1 INTRODUCTION

Sustainability of our cities are often focused on environmental, and in the social context the provision of health care and education. However, the social health and well-being of communities in an urban growth area in the context of sport and recreation is often and commonly overlooked. To maintain and sustain a healthy community in terms of physical activity and social interaction there is increasing importance placed on the implementation of appropriate sport, recreation and open spaces within new and expanding communities. Exponential growth in urban areas, particularly growth areas are seeing reduced private outdoor living spaces, with limited, if any, public provision of public open space for recreation and sporting activities nearby. This research aims to highlight the need to for better policy and implementation across a range of stakeholders to ensure appropriate sport, recreation and open space provision are actually created to assist in generating a more resilient, healthier and sustainable lifestyle for communities.

## 2 BACKGROUND

The correlation between urbanization, environment and health and well-being is an established area of research and investigation since the 17<sup>th</sup> Century. At this time focusing on the broader environment and the impact on population health, deaths and causes. John Graunt (quoted in Wear, 1992, p. 130) surmised that the environment of the city had a detrimental effect on health [1]. An established body of research has been developed that identified the environment, infrastructure and built environment's effect on the health, well-being and social capital of residents in a particular area for example, see [2,3,4,5,6,7,8].

It is long accepted that active people and communities are healthier communities, however, how much does the environment surrounding those residents and communities affect their interactions and

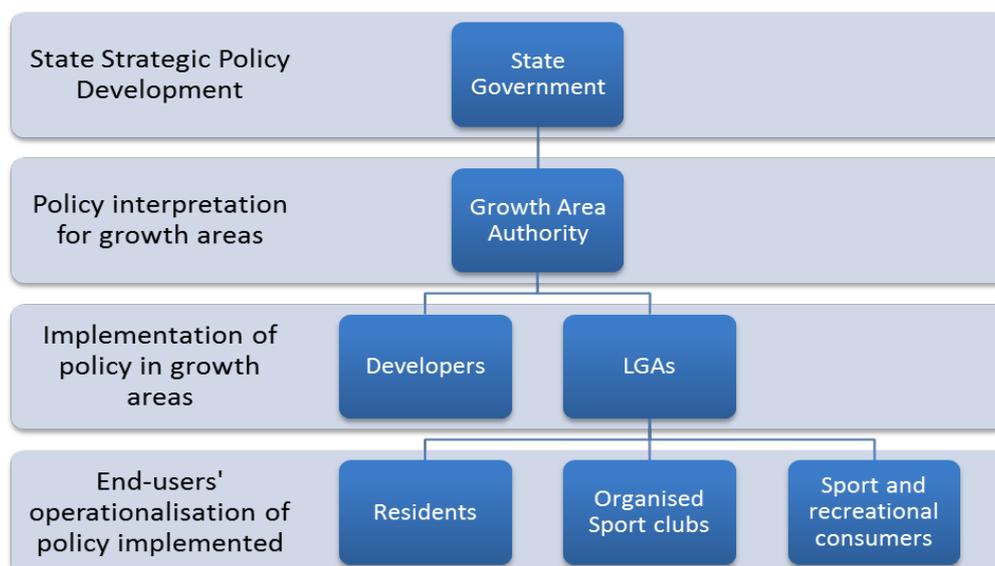
physical activity. Research has sought to identify the relationship between the opportunities for physical activity and the urban characteristics of an area [9, 10, 3, 11, 12]. It has been found that reduced availability of recreational and sport facilities has led to the lack of physical activity in a community, consequently leading to negative impacts on the health and well-being of residents [13, 14, 15]. Furthermore a positive relationship was found in studies between the provision of facilities and physical activity Lorenzo et al [16] and Sallis and Owen [17]. Consequently, in the planning and development of urban communities, both new and existing, there is increasing importance on ensuring the planning and implementation of sporting facilities, recreation areas and open space is adequate for the active needs of the current and future populations to maintain healthy communities.

This research examines Melbourne's outer urban areas, where over the past decade has seen exponential population growth and urban development. As a result of this level of growth, the planning, development and provision of sport and recreation facilities has been left in disarray, with the provision of sport and recreation facilities playing catch-up. This has been highlighted by recent media that suggests the planning, design and implementation of Melbourne's newest suburbs is leading to increased obesity as well as mental and physical illnesses, purported to be largely due to the lack of facilities and spaces to engage in physical activity and/or to connect with other people [18].

It has been established that the provision of sporting facilities has an indirect influence on the community's health and well-being, and the planning and implementation of these should be considered as a key component of public or local government authorities [19]. Despite the importance of facility provision to community health, little is known about the strategic development, implementation and operationalization of the provision of sporting facilities and open space. The broader research project aims to investigate the issue of sport and recreation facilities from a planning and development perspective, with the researchers' previously having investigated the policy changes and prescribed provisions for Point Cook, a case study area in Melbourne. This paper examines the actual provision of sport and recreation facilities within the urban growth areas of Melbourne to highlight the substantial disconnect between planned provisions and actual implementation.

Previous research by Warren-Myers and Phillips [20], investigated the policies at the different levels of government, primarily state and local government, in regard to provision of open space, sport and recreation facilities. What this research found through content analyses that definitions and policies varied substantially. The research established that State Government guidelines tended to be broad, vague, and inclusive, and gave little guidance for facility provision. While Local Government Policy (LGA) had more prescribed guidelines and hierarchy tables based on population growth size, not profile. Within Victoria, and Melbourne there is a layer between the State government policy and the Local Government level, and this is a group known as the Growth Area Authority, who interpret the State Government policy and provide an interpretation of how this policy should be implemented in the growth areas and corridors. This is then expected to be incorporated by the LGA planning policies and provision. It was found that LGA policies were narrow, specific, and designed to meet the needs of consumers generally. However, of key concern is that the planning does not necessarily align with the implementation, as implementation of the policy is shared between the LGA and developers of the urban areas. Consequently, leading to multiple stakeholders involved in the process, leading to ad hoc and often inadequate provision of facilities, and, commonly, any hard issues are moved back to 'planning' to deal with. The relationships between the stakeholders and their roles is described in Figure 1.

*Figure 1: UPSAR Model*



Source: Authors

Furthermore the research found that the LGA definitions changed substantially overtime, and furthermore the actual provision altered from being specific and prescriptive to rather vague based provision models. The examination of policy of the Wyndham City Council identified the change from a prescriptive model based on facility provision by population, which in 1996 included a range of facilities, to an adjusted model in 2000 where the ratios have been adjusted thus increasing the level of facilities required. As a result, facilities such as a multi-purpose stadium and indoor leisure centre have been removed, with golf courses and netball courts added instead. By 2007 only principles were identified in the provision of facilities, further clarified by subsequent documents relating to the Outdoor Sports Facility Development Guidelines, the Aquatic Strategy and the WSIP 2012 update. In those documents policy guidelines in regard to facilities were reduced to a static scale based loosely on population and also a percentage of developable land area. One could take the view that, by 2007, with the move away from prescriptive ratios so that measurement became more intangible and less measurable, getting the facilities required as identified in 2000 was near impossible to implement and achieve, as shown in Table 1.

*Table 1: Calculation of Point Cook Sport and Recreation requirements for the community based on 2012 population*

Facility	1996		2000		2009	
	Ratio of Population	Facilities Required	Ratio of Population	Facilities Required	Ratio of Population	Facilities Required
Football/cricket ovals	1:5000	8	1:2,900	14	Static scale	2 ovals
Soccer/hockey fields	1:5000	8	1:3,600	12	Static scale	Minimum 3
Tennis courts	1:2000	21	1:1,000	41	Static scale	Minimum 6
Netball/basketball			1:7,000	6	Static scale	Minimum 4
Bowling greens	1:10,000	4	1:5,000	8		
Aquatic centre	1:50,000	1	1:100,000	0		
Multi-purpose stadium	1:20,000	2				
Indoor leisure centre	1:20,000	2				

Source: Authors

Under rapid urbanisation and the increasing need to build sustainable communities that provide suitable amenities and living conditions for today's and future residents. As demonstrated in previous research the policy provisions are continually changing to a point whereby the actual provisions are becoming so vague so that it is near impossible to fail in terms of identifying the actual required provisions, due to the elusiveness of the policy. Consequently, this paper investigates and compares the actual provision of space in the Point Cook region to the prescribed policy provisions. Specifically, this research uses a case study of one growth suburb in Melbourne. Point Cook, in the City of Wyndham, Victoria, is used as a case study to investigate the disconnect between provisions of sport and recreation space and policy, highlighting future implications for sport development, community health and wellbeing.

## METHOD

Urban planning policies determine what facilities are provided and, therefore, what people play, and how they play it—yet, little research has explored the nexus between urban planning and sport and recreation. Provision of open space, sport and recreation facilities in urban areas, particularly those with limited private open space is imperative to health and well-being of the community. Little research has addressed the relationship between policy provisions and actual provisions. Previous research found serious discrepancies in the changes over time of the level of planned provision of open space, sport and recreation facilities. This research goes to the next level and examines what has actually been implemented within the community and compares it to the policies developed over time in the case study area of Point Cook.

Using the findings of previous research by Warren-Myers and Phillips [20], which identified the changes in policy provision overtime in the case study area, these will be compared to the actual provisions in the community at present. Data was collected via the Wyndham City Council and via Rapid Map who used spatial mapping to identify and measure the size and area of open space, sport and recreation facilities in the Point Cook area. The data was then combined and classifications were used to categorize the different facilities. This allowed the researchers to compare the actual provisions with the policy provisions.

The data presented in this research is part of a larger project. The first stage of the research found that policy provisions changed substantially over the past 10 – 15 years for this area. It identified key discrepancies in planned provisions and the development of increasingly vague statements regarding provision of open space, recreation and sporting facilities. This comparison and analysis of the planned provisions versus the actual provisions builds the argument for better policy and careful implementation of all open space, recreation and sporting facilities. This paper presents the preliminary findings of the comparative analysis of planned and actual provision of sport and recreation facilities, in the urban growth areas of Melbourne, Australia, namely the suburb of Point Cook.

## RESULTS AND DISCUSSION

The data collection comprised collecting information from Wyndham City Council and assistance from RapidData on aerial photography and measurement of open space in the Point Cook region. This information was then sorted in excel, classifying the open space land within the Point Cook region into three categories: park, linear park and sport reserve. There were further sub-classifications and delineation of uses for the space.

Summary analysis of the data collected identified a total amount of Open Space in the Point Cook area comprises 155 hectares. Using Wyndham City Council classifications this separated the 155 hectares into three key categories comprising Park, Linear Park and Sport Reserve, the breakdown of area is shown in Table 2.

*Table 2: Point Cook Open Space*

<b>Classification</b>	<b>No.</b>	<b>Square metres</b>	<b>Hectares</b>
Park	54	395,393	39.54
Linear Park	26	693,712	69.37
Sport Reserve	5	464,095	46.41
	<b>85</b>	<b>1,553,200</b>	<b>155.32</b>

On initial analysis, the provision of open space in Point Cook appears to be substantial, in the order of 155 hectares, which is approximately 17% of the total area of Point Cook (approximately 930 hectares). However, when areas like drainage reserves are taken into account, which by current standards at State and Local Government level, are not considered to be open space contributions, this reduces the overall levels substantially. By removing land used for drainage and wetlands purposes the overall open space is reduced by 55%, equating to 8% of the land in Point Cook is open space as shown in table 3.

*Table 3. Open space without land used for drainage or wetlands*

<b>Classification</b>	<b>Sqm</b>	<b>Ha</b>	<b>Difference</b>	<b>% Difference</b>
Park	374,585	37.46	2.08	5%
Linear Park	21,382	2.14	67.23	97%
Sport Reserve	309,053	30.91	15.50	33%
<b>Total open space</b>	<b>705,020</b>	<b>70.50</b>	84.82	55%

On further analysis of the data, it was found that when examining the secondary classifications, there were dual uses to a number of the parks which provided sporting facilities or areas available for certain types of space. This subsequently increased the overall provision of land for sport related purposes to 56 hectares. However, on further investigation what was also clarified was although the space was classified for sport use, a large proportion of the land in these areas was also utilised as parkland and playground. Consequently, as highlighted in Table 4, only 37 hectares is dedicated to actual sport related area, which is only 23% of the total open space is dedicated to sports area. Furthermore, there are only 14 actual locations for sports areas, and these are heavily weighted towards Basketball, Football and Cricket.

*Table 4. Areas for sports activities*

<b>Classification</b>	<b>Detailed Classification</b>	<b>Sport Use</b>	<b>Sport Area sqm</b>	<b>Park Area sqm</b>	<b>Playground Area sqm</b>	<b>Total Area sqm</b>	<b>Total Ha</b>
Park	Sport	Basketball	122	10,543	0	10,666	1.067
Park	Sport	Basketball	399	7,671	4,680	12,751	1.275
Park	Sport	Basketball	144	8,968	236	9,347	0.935

Park	Sport	Basketball	162	17,300	480	17,941	1.794
Park	Sport	Basketball	630	8,084	490	9,204	0.920
Park	Sport	Basketball	356	8,957	360	9,673	0.967
Park	Sport	Basketball	4,530	4,967	436	9,933	0.993
Park	Sport	Football	4,316	5,259	426	10,001	1.000
Sports Reserve	Sport	Football/Cricket	39,988	92,138	1,071	134,236	13.424
Sports Reserve	Sport	Football/Cricket	32,564	0	1,436	34,000	3.400
Sports Reserve	Sport	Football/Cricket	219,781	0	0	219,781	21.978
Sports Reserve	Sport	Football/Cricket	40,026	0	0	40,026	4.003
Sports Reserve	Sport	Football/Cricket, Basketball, Volleyball, Soccer	20,708	14,917	428	36,052	3.605
Park	Sport	Tennis	1,208	5,903	898	8,009	0.801
			<b>364,932</b>	<b>184,706</b>	<b>10,940</b>	<b>561,619</b>	<b>56</b>

It is highly apparent when considering the space and areas that have actually been implemented in the Point Cook area, that they are substantially below the proposed levels as set out in the policies. Table 5 depicts the comparisons drawn between required facilities and actual facilities that have been provided. Where clarification of actual playing fields can be verified this number has been used, however, where this is not possible an extrapolated figure has been used. To ascertain the approximate number of actual fields a calculation was utilised, by identifying the gross areas and dividing these by the areas of the prescribed playing field areas as stipulated by the different sporting associations. These figures are likely to slightly inflate the number of actual fields.

*Table 5. Comparison of planned facilities versus Actual facilities in 2013, based on 2012 population.*

Facility	1996	2000	2009	Actual 2013	Actual 2013	Comparison		
	Facilities Required	Facilities Required	Facilities Required	Primary Facilities	Secondary Optional Use	1996	2000	2009
Football/cricket ovals	8	14	2 ovals	14		Exceed	Meets	Exceed
Soccer/hoc key fields	8	12	Min 3		5	Beneath	Beneath	Beneath
Tennis courts	21	41	Min 6	8	2	Beneath	Beneath	Exceed
Netball (shared)	Nil	6	Min 4		1	N/C	Beneath	Beneath
Basketball (shared)	Nil	6	Min 4	8		Exceed	Exceed	Exceed
Bowling greens	4	8	Nil	0		Beneath	Beneath	N/C
Aquatic centre	1	0	Nil	0		Beneath	Beneath	N/C

Multi-purpose stadium	2	Nil	Nil	0		Beneath	N/C	N/C
Indoor leisure centre	2	Nil	Nil	0		Beneath	N/C	N/C
Golf course	Nil	2	Nil	0		N/C	Beneath	N/C

\*N/C stands for no comparison due to there being no provisions set in the policy.

This research has identified the substantial disconnect between planned provisions and the actual provisions. Overall the actual provisions still fall short even of the modified 2009 requirements which have demonstrated a significant drop off and vagueness in provision guidelines. Making it difficult for measurements to be made and compared to identify whether there is limited or sub-standard provision of facilities within the area. In some cases, it would appear that there has been an over development of certain sport facilities, whilst others have been completely ignored, and going by the change over time removed as a result of the unlikelihood of there being a facility developed. A prime example of this is the Aquatic Centre, which was identified as a requirement in the 2000 policy, and subsequent papers have identified this as a necessity for the area, however, recently rather than deciding to provide one, this has been outsourced to another suburb entirely [20]. Furthermore, the lack of facilities has been remedied somewhat by a large sporting facility known as the Point Cook Road Reserve which comprises a substantial provision of sport facilities including 3 AFL fields, 8 tennis courts and 3 soccer fields, which was completed in 2013. From a football and cricket perspective based on 2012 population this just exceeds the stipulated requirements, however, given the rapid growth of the Point Cook region this will soon be lacking.

The other concerning feature of the analysis, is that there is a substantial saturation of certain sporting facilities, whilst others are ignored. Does this ratio of facilities meet with the community demand for certain sports based on population demographic of ethnicity, age and interest? Furthermore, these facilities tend to be lumped together in one location, limiting broader access to the community, unless undertaking a purposeful visit to the sporting facilities. Consequently, transportation to and from these facilities limits and inhibits the broader population from actively participating in the sports that are played. This also limits the level of unstructured sporting and play activity by the community, further reducing the overall physical activity of the community.

## CONCLUSION

This research has found alarming results in terms of the substantial disconnect between planned and actual facility provision. Demonstrating that even under more prescribed frameworks of yesteryear based on population ratios the provisions across the board fall short for the Point Cook area. Additionally the research has unearthed other concerning attributes of centralised facilities, saturation of sporting types, and limited access to local facilities within the immediate vicinity of resident dwellings.

Furthermore it is clear that the provisions of sport and recreation facilities and areas within urban growth areas has declined over the past decade in the policies set down, however, at the same time these policies cry for a more sustainable and healthy lifestyle. When the planned provisions are compared against the actual provisions within this case study it is apparent that the space provisions fall alarmingly short of requirements. The research also highlights that the community bears the brunt of the lack of clear definitions, vague and constantly changing provision policy guidelines, and a lack of funding and integrated management of stakeholders throughout the system to achieve the required implementation levels to provide a healthy and interactive sport, recreation and open space areas within a community.

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# IDENTIFICATION OF MATERIALS FOR NEW SOLAR CELLS USING SYSTEMS ENGINEERING IN COMBINATION WITH MATERIALS SCIENCE

Anne Elisabeth Thorstensen<sup>1</sup>, Turid Worren Reenaas<sup>2</sup> and Annik Magerholm Fet<sup>3</sup>

<sup>1</sup> Department of Materials Science and Engineering, Norwegian University of Science and Technology (NTNU)

<sup>2</sup> Department of Physics, NTNU

<sup>3</sup> Department of Industrial Economics and Technology Management, NTNU

## ABSTRACT

In this work we have used systems engineering in combination with materials science to systemize the design of a potential sustainable intermediate band solar cell system, based on a particular starting material. By utilizing the combined approach, challenges of a promising IBSC material; cuprous oxide  $\text{Cu}_2\text{O}$ , were identified and analyzed. The purpose has been to evaluate if there are material related barriers or bottlenecks that can stop the realization of these devices. Two challenges, and potential solutions, have been identified. In addition, possible production techniques suitable for large scale production of the solar cells have been identified. The combined approach has facilitated the identification of challenges, solutions and production techniques. It has also identified areas where further materials and device research is needed.

*Keywords: Intermediate band solar cell, systems engineering, material analysis, photovoltaic efficiency*

## 1 INTRODUCTION

Extraction, refining and consumption of fossil fuels contribute to global warming and air pollution, and are harmful to the earth's ecosystem both on- and offshore. Photovoltaic (PV) energy conversion by the use of solar cells is one of the more promising renewable energy technologies, which has the potential to contribute significantly to a green and sustainable energy supply, and may mitigate greenhouse gas emissions.[1] As renewable energy supply is an important part in realizing sustainable buildings, solar cell panels are recognized as an important clean technology for local and regional energy generation in the building sector.

The first barrier for large scale use of solar cell panels in buildings is the cost of the generated electricity. Green [2] has defined three generations of solar cells, each with characteristic cell costs and conversion efficiencies. The first generation is crystalline cells, primarily made of silicon (Si), that have become commercially available over the last decades. These cells have been expensive to fabricate, and to reduce the solar cell electricity cost one can either develop cells with low production cost, or increase cell efficiency, i.e. amount of electricity generated per incoming solar power. The low cost approach resulted in so-called 2<sup>nd</sup> generation solar cells, and the high efficiency approach in so-called 3<sup>rd</sup> generation cells. Green predicted that 1<sup>st</sup> generation cells would be as cheap to fabricate as the 2<sup>nd</sup> generation cells (arguably this has already happened),[3] and thus that markedly higher efficiencies are needed. The high efficiency, 3<sup>rd</sup> generation, cells have fundamentally different designs than the 1<sup>st</sup> and 2<sup>nd</sup> generation, and Green predicts that these cells eventually will have low production costs. The intermediate band solar cell (IBSC) is one of the proposed high efficiency concepts, and is characterized by a simple design compared to other 3<sup>rd</sup> generation designs.[4] A simple design is a good starting point for achieving a low production cost, since this can limit the number of production steps. IBSCs have a theoretical efficiency of about 50 % higher than conventional (1<sup>st</sup> and 2<sup>nd</sup> generation) solar cell under the same operating conditions.[5] For a *sustainable* PV technology, however, high efficiency is not the only requirement that has to be fulfilled; environmental and social concerns must also be taken into account.

The current challenge in IBSC research is to identify and develop new solar cell materials and material combinations with suitable properties to obtain a high efficiency. Most of the materials

studied so far contain toxic and/or non-abundant materials, [6] and a new, more holistic, approach is needed to develop sustainable IBSCs. The work presented in this paper is the first attempt of such an approach. In a previous work, we performed a broad materials screening to identify new materials composed of abundant and non-toxic elements, that seem to have suitable optical and electrical properties for the intermediate band solar cells.[7] One of the materials identified is cuprous oxide ( $\text{Cu}_2\text{O}$ ), and recently the first attempt to synthesize an IBSC material based on it was reported.[8] To evaluate if the use of this material can result in *sustainable* IBSCs, we need to consider environmental, social and economic, as well as technological, aspects of the production, use and disposal of a PV system based on such solar cells. As a starting point for this evaluation process, we choose to use systems engineering in combination with materials science and technology.

Systems engineering (SE) is a holistic and interdisciplinary engineering field for designing or improving a system. The SE process (SEP) involves transformation of needs and requirements into a set of system products and process descriptions, generation of information for decision makers, and input for the next level of development.[9] In this work we use a customized SE approach to optimize the *solar cell* of an IBSC PV system. The customized approach was used to get an overview of the complete IBSC system, to better understand how to evaluate and solve the material challenges of sustainable  $\text{Cu}_2\text{O}$ -based IBSCs. The customized approach turned out to be useful for the identification of possible barriers and bottlenecks, and of possible large scale production routes, of the cells. In section 2 the customized method is presented, and in section 3 the complete IBSC PV system to be analyzed is described. The main results obtained when using the customized method are presented and discussed in section 4, and finally a summary and conclusion is found in section 5.

## 2 METHODOLOGY

To get an overview of the functions and relationships of a complete IBSC system, a SE process (SEP) can be used. The 6-step SEP, as illustrated in Figure 1, is used as a basis to first define the needs and requirements of the system that is investigated.[10] After the requirements are defined, a system feasibility analysis is performed according to Ref. [11], to evaluate different technological approaches. Next, the various possible design approaches should be identified, the most likely candidates regarding performance etc. should be considered and a preferred approach should be recommended. Finally the chosen design of the system or component can be verified and tested. Results from step 3 - 5 can be fed back into step 2 for further refinement.

A holistic SEP is challenging for an immature technology such as intermediate band solar cells, and in particular for the case studied here where not even a demonstrator device based on the selected host materials exists. Therefore, at this stage of the development of a sustainable technology, materials science *must be* combined with SE in a customized approach. The approach used in this paper is based on the 6-steps method mentioned above, with the whole IBSC system as a starting point, but with focus on only one system component: the solar cell. The main characteristics of this combined method are:

1. To describe requirements and specify the performance of a complete IBSC system, and to prepare for further investigation of IBSC development, e.g. by means of a life cycle assessment (LCA).
2. To analyze and evaluate material properties for all materials involved in a  $\text{Cu}_2\text{O}$ -based IBSC, and to suggest final material alternatives and suitable production routes.

The resulting method is a dynamic SEP for selection of materials, where mainly materials and production route choices, as well as some PV system aspects, are analyzed and discussed. In this paper we present only the main results from step 1-4. A more comprehensive study is found in Ref. [12].

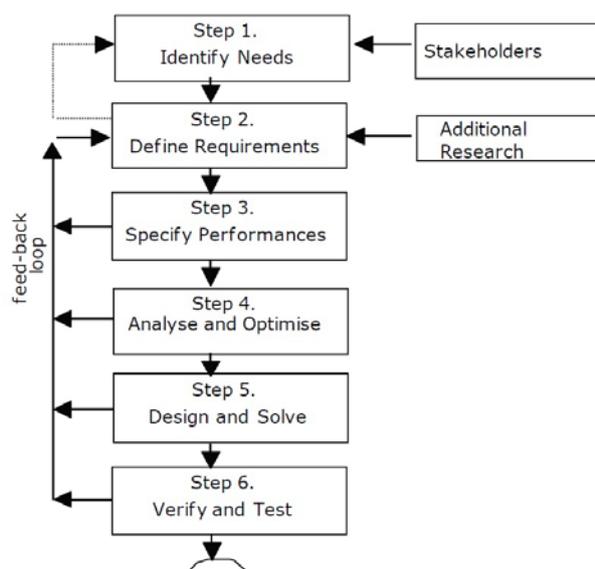


Figure 1. The 6-step systems engineering process [10].

### 3 THE INTERMEDIATE BAND SOLAR CELL SYSTEM

The core element of a PV system is the module where the sunlight is converted into electricity. An international standard for the cell and module size does not exist, but the most used sizes (in Norway) are modules of 1.6 x 1.0 m with 60 cells of 156 x 156 mm.[13] The module is mounted in a mounting structure and connected to various electronic components (power control systems, inverters, storage devices, etc.).[14, 15] All parts needed in addition to the PV module are called the balance of system (BOS). A PV system can either be grid-connected or stand-alone. In the latter system, the storage devices and charge controller store the generated electricity as long as needed, while in grid-connected systems these components are not needed.[16] At present, several different solar cell technologies are commercially available. Various applications of these technologies result in a variety of BOS components, such as different mounting and inverter systems. At this stage of the IBSC research and development, it is therefore reasonable to assume that existing BOS technology can be used for the IBSC system as well, or that it can easily be adapted. We also assume that the available processes for assembly and encapsulation of individual cells into a module are useable for IBSCs. Thus, the work presented in this paper focus only on the intermediate band *solar cell*.

The IBSC device structure is shown in Figure 2. It is rather simple compared to other third generation solar cells: The only additional layer needed compared to conventional cells is the intermediate band layer (IB-layer). A major difference is, however, that in conventional cells the p- and n-emitters function both as light absorbers and as selective collectors of the generated charge carriers (electron-hole pairs). In the IBSC, the light absorption should take place preferably only in the IB-layer, and the p- and n-emitters are for carrier collection and emission only; the carriers are “emitted” from the IB-layer into the contacts. In addition to the emitters and the IB-layer, the complete device consists of contacts covering the whole back surface, and a finger/grid contact on the front, see Figure 2. An anti-reflective coating (ARC) is also needed on the front surface, to reduce reflectance loss of sunlight.

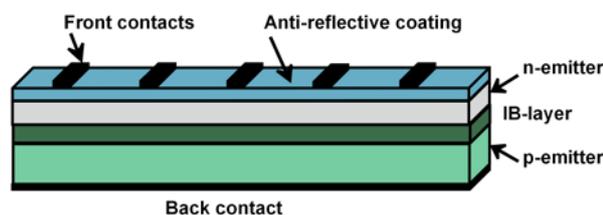


Figure 2. Schematic drawing of the IBSC device structure.

As mentioned earlier, we have chosen  $\text{Cu}_2\text{O}$  a case-material for the IBSC in this work. Since it is difficult to obtain n-emitters based on  $\text{Cu}_2\text{O}$ , our test solar cell consists of a *heterostructure* device with  $\text{Cu}_2\text{O}$ , for both the p-emitter and the IB-layer, and  $\text{ZnO}$  for the n-emitter. To obtain the desired IB and emitter properties of the  $\text{Cu}_2\text{O}$  and  $\text{ZnO}$  layers, suitable dopant elements must be incorporated into the materials. (Conventional cells are *homostructures*, in the sense that they use only one material, e.g. silicon, for the p- and n-emitters.) To evaluate if an IBSC based on p- $\text{Cu}_2\text{O}$ /IB- $\text{Cu}_2\text{O}$ /n- $\text{ZnO}$  can be a sustainable PV technology, the next step is to identify suitable materials for the dopants, buffer layer, electrodes and ARC. The p- $\text{Cu}_2\text{O}$ /n- $\text{ZnO}$  heterostructure, *without* the IB-layer, is already investigated in the solar cell materials research community as environmentally friendly and potentially cheap materials.[17] Data on potential materials for dopants, electrodes and ARC materials can therefore be found in literature, as well as information about potential materials challenges, bottlenecks and suitable production methods. It is important, however, to realize that the material properties and device performance, strongly depends on how the material or device is fabricated.

Two main material challenges were identified for p- $\text{Cu}_2\text{O}$ /n- $\text{ZnO}$  heterostructures; 1) the resistivity of p- $\text{Cu}_2\text{O}$  and 2) the interface quality between the  $\text{Cu}_2\text{O}$  and  $\text{ZnO}$  layers.[18] Increasing the crystalline quality of the  $\text{Cu}_2\text{O}$  layer might lead to better conductivity, and optimization of the IB- $\text{Cu}_2\text{O}$ /n- $\text{ZnO}$  interface can improve the carrier transport across the interface. In addition to the cell elements in Figure 2, a buffer layer might therefore be needed between the  $\text{Cu}_2\text{O}$  IB-layer and the  $\text{ZnO}$  n-emitter.

### 4 RESULTS AND DISCUSSION

The main results from using the 6-step SEP process on the IBSC PV system are presented in this section.

#### 4.1 Step 1&2: Needs and requirements to the system

The need for this system is rooted in the societal needs for more sustainable energy carriers. Instead of doing a stakeholder analysis, the choice of technology is based upon the expertise and insight held by the authors, and by a thorough literature search on material properties. The overall need for the system was through the discussions and feedback defined as “a grid-connected IBSC system made of sustainable materials and production routes, with approx. 50 % higher module efficiency than conventional Si- based modules”. As mentioned earlier, we assume that the only system component that will need to be analyzed and optimized is the solar cell. A grid-connected rooftop system is chosen because this is currently the solar cell systems with the highest growth rate in the market.

The second step of the SEP is to define the system and system component requirements based on the identified needs. For our case, the defined requirements for the solar cells are that they must only consist of non-toxic and abundant materials and fulfill certain requirements for the physical properties, such as; high transport properties of the emitters, suitable electro-optical properties of the IB-layer, high conductivity of the electrodes, etc. The materials must be compatible with each other, and in addition, it should be possible to produce the materials and devices by using techniques that are relevant and familiar to the existing solar cell industry.

#### 4.2 Step 3: IBSC system performance

Next, the requirements defined in step 2 were translated into performance criteria for the total IBSC system and subsystems. The most important parameter here is the conversion efficiency. Other performance parameters like lifetime, performance ratio, insolation and temperature were also addressed, as well as the specified production performance, and are presented elsewhere.[12] The efficiency of an ideal IBSC, i.e. an IBSC with optimum electronic and optical properties, is largely determined by the bandgap of the material it is made of. For the bandgap of  $\text{Cu}_2\text{O}$ , the maximum efficiency is estimated to 48 %, [19] compared to a maximum of 30 % for a silicon cell at similar operating conditions.[20] The best laboratory-scale Si-module efficiency reported is 22.4 %, [21, 22] i.e. at 74.6 % of the theoretical cell efficiency. Commercially available modules have lower efficiencies than this. For the IBSC system performance we assume that the lab-scale module can achieve the same efficiency relative to the theoretical cell efficiency as for conventional silicon cells, i.e. 74.6 % of 48 %, namely 35.8%.

#### 4.3 Step 4: IBSC material analysis and evaluation

The cell performance depends strongly on the material and device quality, which depends on the production methods. The best solar cells of today are based on single crystal materials/wafers.[21] Single crystals will be very challenging to achieve for the  $\text{Cu}_2\text{O}/\text{ZnO}$  heterostructure, but we believe a good starting point is single crystal p- $\text{Cu}_2\text{O}$  wafers. To optimize the system, a well-functioning  $\text{Cu}_2\text{O}$  IB-layer must be formed, and a high quality buffer layer and n-ZnO layer must be deposited. The p- $\text{Cu}_2\text{O}/\text{IB-Cu}_2\text{O}/\text{n-ZnO}$  stack must be further processed into solar cell devices, by deposition of the ARC and electrodes. A literature search has been performed on different materials with the purpose of finding the best design for meeting the identified need and defined requirements. A sustainable solar cell should have high material quality to obtain the highest conversion efficiency, but environmental and economic concerns must also be addressed in this step.

In the following, we present the results from the material analysis. Different fabrication and material alternatives are identified for each layer/material. As SEP is an iterative process with feedback loops, see Figure 1, final design solutions should be considered throughout this analysis and evaluation step. Thus, this step was performed with optimized cell design solutions, see section 4.4 for results from step 5, in mind:

1. The production method chosen for the single crystal  $\text{Cu}_2\text{O}$  wafers is the floating-zone (FZ) method.[23] This method is currently used for the highest quality single crystal Si wafers.[24] It has been reported that p-type FZ  $\text{Cu}_2\text{O}$  can be made by controlling the partial pressure of oxygen during single crystal formation.[23] The resistivity decreased by two orders of magnitude as a result.[25]
2. For the  $\text{Cu}_2\text{O}$ -based IB-layer, we chose nitrogen doped  $\text{Cu}_2\text{O}$  ( $\text{Cu}_2\text{O}:\text{N}$ ), since this has already been identified as a highly promising intermediate band material.[8] A suitable method for formation of the IB-layer might be ion implantation, where nitrogen ions are bombarded into the top layer of the  $\text{Cu}_2\text{O}$  wafer. An annealing step might be needed after the implantation.

3. The n-emitter is chosen to be Al-doped ZnO (AZO) based on the promising findings for heterojunction AZO/un-doped ZnO (ZO)/Cu<sub>2</sub>O cells by Minami *et al.* and Nishi *et al.* [17, 26]. A high quality deposition method should be used, that also is suitable for the preceding buffer layer and subsequent ARC layer. In that way, the three layers on top of the Cu<sub>2</sub>O/Cu<sub>2</sub>O:N wafer can be deposited in one production sequence.
4. A buffer layer between the Cu<sub>2</sub>O:N and the AZO and might minimize defect concentrations and band bending in an IBSC in a similar manner as for n-ZnO/p-Cu<sub>2</sub>O heterostructure cells. Undoped ZnO has been identified as a promising candidate.[17, 27] Another promising buffer layer material is amorphous zinc tin oxide (a-ZTO) deposited by atomic layer deposition (ALD).[28]
5. The refractive index of the anti-reflective coating (ARC) should be between the refractive indices of the surroundings (glass in this case) and underlying material. The refractive index of ZnO is 2.00-2.05 at wavelengths 5-600 nm at room temperature,[29] and most glasses have a refractive index around 1.5.[24] The appropriate refractive index for an ARC placed between ZnO and glass is about 1.75-1.76, and a suitable thickness is approximately 85 nm.[12] Several materials have the desired refractive index,[30] and we chose Al<sub>2</sub>O<sub>3</sub> since this material already has been used as ARC for other applications.[31]
6. The front electrode should form an ohmic contact with the n-emitter, and the back electrode should form an ohmic contact on the p-emitter. The work function of the back contact should thus be higher than that of cuprous oxide; 4.84 eV [32], and the front contact should have lower value than the work function of zinc oxide; 4.7 eV [33]. Many elements have work functions in ranges potentially suitable for both the front and back electrode.[26, 34-36] After considering toxicity and availability, the materials with suitable work functions for ohmic contact are:
  - Cu<sub>2</sub>O ( $\Phi_m > \Phi_p$ ): C, Re, Au, Cu<sub>2</sub>S
  - ZnO ( $\Phi_m < \Phi_n$ ): Al, Ti, V, Fe, Cu, Zn, Ag, Sn, ITO (indium tin oxide)

The high availability and low cost of graphite makes graphite paste a suitable electrode material for the back electrode.[37, 38] However, Cu<sub>2</sub>S and Au are used in the record efficiency Cu<sub>2</sub>O/ZnO cells.[17, 26] The high cost of Au should be taken into consideration. For the front electrodes, the materials showing best performance in literature are Al,[28] Ti-Al alloy,[39] and a combination of ITO and a copper grid.[18] Indium is however regarded as a critical element.[40]

#### 4.4 Step 5: Design of solution

From the findings in the materials analysis and evaluation of step 4, fabrication of the Cu<sub>2</sub>O p-emitter and IB-layer are chosen as the wafer described above. The buffer layer and electrodes are further discussed here in step 5, as the chosen materials for these components will influence the remaining cell manufacturing steps, and thus the final cell design and performance. For our test case we foresee two different approaches for the final cell design: an advanced cell, where the emphasis is on using methods and materials that are believed to result in the best material quality; and a low cost cell, where the focus is to use materials and processes that are believed to be of lower cost than those of the advanced approach.

##### **The low cost approach**

For the low cost approach, the front electrode is chosen to be aluminum, because it is a simple metal with long use as an electrode material for solar cells. Conventional screen printing used for Si-cells can be used to form an ohmic contact with aluminum.[41] For the back contact, both graphite paste and Cu<sub>2</sub>S can be low cost alternatives, and it is difficult to compare these electrodes from a sustainable perspective at this point. They are both non-toxic, but as Cu<sub>2</sub>S is a binary material, graphite is not, and the graphite electrode is thus potentially cheapest. However, the graphite paste may need careful doping, so its apparent simplicity may not be valid if the needed doping technique is complex. Also, the sulfur in Cu<sub>2</sub>S may not be compatible with the rest of the processing steps. Thus, both the back contact alternatives must be evaluated further for use in the IBSC device. When it comes to the production techniques, the graphite paste contact can be formed by conventional screen printing.[42] Un-doped ZnO can be a suitable buffer layer for the low cost IBSC case. A conventional, good quality deposition technique can be used to deposit this layer, and the subsequent AZO and ARC layers. Plasma-enhanced chemical vapor deposition (PECVD) can be a good choice, since this method is already used for deposition of ARC on conventional Si-cells.[43] With process steps that already exist

in the solar cell industry, this low cost approach could be considered for IBSC production if a material quality leading to competitive solar cell efficiency is obtainable.

### ***The advanced approach***

In contrast to the low cost approach, the advanced approach has technology, and especially high quality, in focus. The most important requirement for high efficiency IBSCs might be high material quality, i.e. high degree of crystallinity for the  $\text{Cu}_2\text{O}$  and  $\text{ZnO}$  layers, and high conductivity for the electrodes. To achieve this, the low cost  $\text{ZnO}$  buffer layer should be replaced by a more complex material. The best performing buffer layer for p- $\text{Cu}_2\text{O}$ /n- $\text{ZnO}$  heterostructures, a-ZTO, was deposited by ALD in a complex sequence to obtain the needed Zn:Sn ratio. ALD is an extremely accurate and high quality deposition technique, and can result in very high quality and performance of the AZO- and ARC-layers deposited on top of the buffer layer.[44] For the advanced approach we can choose the Ti/Al alloy deposited by electron-beam evaporator as the front electrode.[45] For the back electrode, gold could be used. This approach is likely to lead to higher cell efficiency than the low cost approach. However, for both Ti and Au, cost and availability is a potential barrier for large scale use.

### **4.5 Step 6: Test and verify**

According to the two different approaches for the final cell design; an advanced cell of the best material quality, and the low cost cell that can make the energy produced from this cell at competitive prices compared with conventional technology, the final decision on the materials and production methods that are most likely to result in a sustainable solar cell technology based on  $\text{Cu}_2\text{O}$ , is not possible to make at this stage. Further trade-offs between production costs and material/device properties should be performed since the materials and device processing resulting in the highest performance will most likely be too expensive for large scale production. The result so far is therefore a preliminary design not ready for testing and verification. However, a test and verification plan with the purpose of evaluation according to initial needs and more detailed specified requirements, is under development. This plan will further be used in the feedback-loop as indicated in Figure 1 to get more details into each of the steps in the SEP.

## **5 SUMMARY AND CONCLUSION**

This paper is an attempt to combine knowledge from different disciplines to design a product that is problematic to produce, according to the set requirements on environment, cost, production technology and material technology. A customized systems engineering approach was used in combination with materials science to match the detailed goals of this paper. A potential sustainable intermediate band solar cell (IBSC) system based on a particular starting material was planned, with focus on the IBSC device. By utilizing the combined approach, challenges of a promising IBSC material; cuprous oxide  $\text{Cu}_2\text{O}$ , were identified and analyzed. The purpose was to evaluate if there are material related barriers or bottlenecks that can stop the realization of the device. The main challenges were identified as poor conductivity of  $\text{Cu}_2\text{O}$  and defects at the  $\text{ZnO}/\text{IB-Cu}_2\text{O}$  interface, and potential solutions have been evaluated. Single crystal growth of  $\text{Cu}_2\text{O}$  and a tailored buffer layer at the interface can mitigate these challenges. In addition, a goal has been to identify possible production techniques suitable for large scale production of the solar cells. Two alternatives for the cell materials and production were identified; a low cost approach that can be fabricated by conventional, high quality methods, and an advanced approach with more complex materials and production processes. The SEP has facilitated the identification of challenges, solutions and production techniques. It has also identified areas where further materials and device research is needed. However, even if the research did not end up with a final product, the framework shown in Figure 1 has been helpful in the process of structuring the steps in the development process, and it will be utilized in the further research on this topic.

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# ECONOMETRIC ANALYSIS OF THE IMPACT OF CLIMATE-INDUCED PRODUCTION RISKS AND MITIGATION MEASURES ON AGRICULTURAL PRODUCTION IN NIGERIA

Olawale Emmanuel Olayide

Centre for Sustainable Development, University of Ibadan, Nigeria  
[waleolayide@yahoo.com](mailto:waleolayide@yahoo.com), [oe.olayide@ui.edu.ng](mailto:oe.olayide@ui.edu.ng)

## ABSTRACT

In recent years, high intensity of rainfall has resulted in some of the worst floods causing huge economic loss and damage to lives and properties. In the events of erratic rainfall, irrigated land area is insurance to rain-fed agriculture. Hence, land area under irrigation is a predictor of resilience to climate-induced vagaries. This study assesses the impact of production risks and mitigation measures on agricultural production in Nigeria. It employed econometric analysis to estimate the impact of production risks and mitigation measures on agricultural production, including staples, livestock, fisheries and forestry. The impact of production risks and mitigation measures was estimated using generalized method of moments (GMM). Test of stationarity (using Phillips Perron tests) and correlation matrix were also employed in the analysis of the time series dataset spanning a period of four decades and three years (1970-2012). It was found that mitigation measures proxied by proportion of arable land under irrigation have significant impact on aggregate agricultural production ( $\beta = 3.534$ ;  $p < 0.001$ ), crop production ( $\beta = 3.955$ ;  $p < 0.001$ ), staples production ( $\beta = 4.069$ ;  $p < 0.001$ ), livestock production ( $\beta = 5.349$ ;  $p < 0.001$ ), fishery production ( $\beta = 1.199$ ;  $p < 0.1$ ), and forestry production ( $\beta = 2.676$ ;  $p < 0.001$ ) in Nigeria. Climate-induced production risks (flood incidences) have positive but non-significant impact on agricultural production in Nigeria. Irrigation programs should be scaled up to enhance sustainable agricultural production in Nigeria with a view to mitigating climate-induced agricultural production risks. The study suggests the need to build disaster-resilient sustainable agricultural production systems through mitigation measures.

**Keywords:** Production risks, mitigation measures, sustainable agricultural production

## INTRODUCTION

The frequency of occurrence of climate-induced disasters in the last four decades has been on increase in Africa (Potschin, 2009; Douglas *et al.*, 2008; Satterthwaite *et al.*, 2007). This phenomenon has serious implication for sustainable agricultural production and food security for the most populous nation in Africa - Nigeria. The agricultural production system in Nigeria is largely rain-fed. In such a case, extreme rainfall pattern and or variability becomes a critical production risk. In recent years, high intensity of rainfall has resulted in some of the worst floods causing huge economic loss and damage to lives and agricultural livelihoods (Odufuwa *et al.*, 2012; Adeoti *et al.*, 2010). Climate shocks, such as flooding, lead not only to loss of life, but also long-term loss of livelihood through loss of productive assets, impaired health and destroyed infrastructure (Dercon, 2004; Carter *et al.*, 2007). Further, farmers and landless laborers dependent on rainfed agriculture are particularly vulnerable due to high seasonal variability in rainfall, and endemic poverty that forces them to avoid risks (Vermeulen *et al.* 2012). Changes in the mean and variability of climate will affect the hydrological cycle and agricultural production (Easterling *et al.*, 2007). In the events of erratic rainfall, irrigated land area is insurance to rain-fed agriculture. Hence, land area under irrigation is a predictor of resilience to climate-induced vagaries.

Further, some studies have identified long- or short-run adaptation among farmers (Schlenker and Lobell, 2010; Schlenker and Roberts, 2009; Guiteras, 2009; Seo and Mendelsohn, 2008; Kurukulasuriya *et al.*, 2006), but have been unable to assess the impact of climate-induced production

risks and mitigation measures (jointly) on agricultural production. Although, research at the community- and household-level have provided insight into particular adaptation strategies and impacts (Below *et al.*, 2012; Vermeulen *et al.*, 2011), empirical assessment of the impact of mitigation measures at sub-sectoral levels of agricultural production remains unclear, at least for Nigeria. Understanding the impact of climate-induced production risks and mitigation measures across the sub-sectors of agricultural production is important because policies aimed at resilience and food security given that mitigation strategies are typically implemented at scales greater than the individual household and community (Dell *et al.*, 2013; Easterling *et al.*, 2007). On methodological grounds, much of the research on climate effects/impacts on agriculture at national or international scales using statistical methods (Gourdji *et al.*, 2013; Lobell *et al.*, 2011a, b) have provided insight into impacts, but has been unable to address climate-induced production risks on agricultural production using econometric tools as undertaken in this study.

Farmers are now making changes and building resilience to vagaries of climate change (Woods *et al.*, 2014; Kristjanson *et al.*, 2012) as a result of climate-induced production risks. The risk imposed by climate variability may be an incentive or disincentive to investment in improved agricultural technology, including irrigation system. Projected increases in climate variability can be expected to intensify the cycle of poverty, vulnerability and dependence on external assistance. A comprehensive strategy for adapting agriculture and food systems to a changing climate must therefore exploit the full range of promising strategies for managing current climate-related risk (Vermeulen *et al.* 2012). Climate change has the potential to transform food production, especially the patterns and productivity of crop, livestock and fishery systems, and to reconfigure food distribution, markets and access (Liverman and Kapadia, 2010; Nelson *et al.*, 2009). Understanding the impact of climate change-induced productions risks and mitigation measures on agricultural production, and in which contexts (sub-sectors), will be needed for effective design and targeting of interventions, investments (including infrastructures) and policies aimed to facilitate mitigation and resilience to climate change.

## **MATERIALS AND METHODS**

### ***Coverage of the Study***

Nigeria is located approximately between Latitudes 4<sup>0</sup> and 14<sup>0</sup> north of the equator and between Longitude 2<sup>0</sup> 2' and 14<sup>0</sup> 30' east of the Greenwich Meridian. To the north, Nigeria is bordered by the Republic of Niger and Chad; to the east by the Republic of Cameroon, to the south by the Atlantic Ocean, and to the west by the Republic of Benin. Nigeria is located in sub-Sahara Africa (SSA) in the western part of Africa on the Gulf of Guinea. Nigeria has a total surface area of 923, 770 km<sup>2</sup>. About 35 percent of the land mass is believed to be arable while 15 percent is said to be used as pasture land, 10 percent as forest reserves, another 10 percent for settlements and the remaining 30 percent is composed of water bodies or are simply uncultivable (FGN, 2007). Nigeria has more than 60 percent of its population in the rural areas that largely practice rainfed agriculture (NBS, 2007 and 2008; World Bank, 2008).

### ***Type, Measurement and Sources of Data***

Time series data were extracted from many sources, including Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS), and the Food and Agriculture Organization (FAO) of the United Nations. The data extracted included: agricultural production indices (aggregate production, all crops, staples, livestock, fishery, and forestry), incidences or occurrence of flooding in a specific year, mean annual rainfall in millimetres, and value of agricultural (food) imports in billion naira.

The FAO indices of agricultural production show the relative level of the aggregate volume of agricultural production for all sub-sectors (all crops, staples, fishery, livestock and forestry) for each year in comparison with the base period 2004-2006. They are based on the sum of price-weighted quantities of different agricultural commodities produced after deductions of quantities used as seed and feed weighted in a similar manner. The resulting aggregate represents, therefore, disposable

production for any use except as seed and feed. Deductions for seed (in the case of eggs, for hatching) and for livestock and poultry feed apply to both domestically produced and imported commodities. They cover only primary agricultural products destined to animal feed (e.g. maize, potatoes, milk, etc.). Processed and semi-processed feed items such as bran, oilcakes, meals and molasses have been completely excluded from the calculations at all stages. All the indices are calculated by the Laspeyres formula (<http://faostat.fao.org/site/362/DesktopDefault.aspx?PageID=362>).

### *Analytical Methods*

The Generalized method of moments (GMM) involves the estimation technique which employs lagged variables in difference. The choice of GMM was informed because the ordinary least squares estimation technique may lead to a biased estimation. Another estimation issue that may cause spurious regressions is the possible existence of unit roots or nonstationarity of variables included in the analysis. This problem was overcome by differencing. Also, to avoid the potential endogeneity problem of the independent variable, the GMM instrumental variables approach was employed in the estimation procedure (Fan *et al.*, 2008).

Following Fan *et al.* (2008) and Arellano and Bond (1991), a GMM estimator as an estimation method was stated as:

$$\Delta y_{it} = \sum_{e=1}^m a_e \Delta y_{it-e} + \sum_{e=1}^n \beta_e \Delta x_{it-e} + \Delta \eta_{it} + \Delta u_{it} \quad \dots\dots\dots (1)$$

Where  $y$  is the dependent variable;  $x$  is a set of independent variables,  $i = 1, \dots, N$ ;  $m$  and  $n$  are the lag ( $\Delta$ ) lengths sufficient to ensure that  $u_{it}$  is a stochastic error and  $\eta_i$  are instrumental variables. In order to ensure efficiency gain in GMM model estimation, Blundell and Bond (1998) proposed an extended system estimator that used lagged differences as instruments for equations in levels, in addition to lagged levels as instruments for equations in first difference. If the simple autoregressive AR(1) model is mean-stationary, the first differences  $\Delta y_{it}$  will be uncorrelated with individual effects. Zhang and Fan (2004) applied a system GMM method to empirically test the causal relationship between production growth and infrastructure development using India district-level data from 1970 to 1994; and Fan *et al.* (2008) applied a system GMM method to assess the impact of public expenditure in developing countries.

The procedure for time series regression analysis involves examining the nature of the relevant variables for stationarity; and whether or not there exists a long-run relationship between the dependent variables and the independent variables. According to Engel and Granger (1987), homogenous non-stationary series, which can be transformed to a stationary series by differencing  $d$  times, is said to be integrated of order  $d$ . Thus,  $Y_t$ , a time series is integrated of order  $d$  [ $Y \sim I(d)$ ] if differencing  $d$  times induces stationarity in  $Y_t$ . If  $Y_t \sim I(0)$ , then no differencing is required as  $Y$  is stationary. The test proposed by Dickey-Fuller to determine the stationarity properties of a time series is called the Unit Root test denoted by DF. The regression equation for the DF class of unit root test is:

$$\Delta Y_t = \phi Y_{t-1} + \varepsilon_t; \quad \varepsilon_t \sim N(0, \sigma^2), \quad Y_0 = 0 \quad \dots\dots\dots (2)$$

The unit root test above is valid only if the series is an AR(1) process. If the series is correlated at higher order of lags, the assumption of white noise disturbance is violated. In such cases, the Augmented Dickey-Fuller (ADF) or the Phillips-Perron (PP) tests use a difference method to control for higher-order serial correlation in the series. The PP test allows for individual unit root process so that the autoregressive coefficient can vary across units (Ajetomobi, 2008). The tests make a parametric correction for higher-order correlation by assuming that the  $y$  series follows an AR( $p$ ) process and adjusting the test methodology. It is identical to the standard DF regression, but augmented by  $k$  lags of the first difference of the series as follows:

$$\Delta Y_t = \alpha Y_{t-1} + \sum_{i=1}^k \omega_i \Delta Y_{t-1} + \varepsilon_t \quad \dots\dots\dots(3)$$

Where the lag  $k$  is set so as to ensure that any autocorrelation in  $Y_t$  is absorbed and that a reasonable degree of freedom is preserved, while the error term is white noise.

### ***Variables Used for the Estimation of the GMM***

Agricultural production indices were used as dependent variables while incidence of flooding and proportion of arable land under irrigation were the independent variables. The instrumental variables were annual mean rainfall (in millilitres) and annual total value of agricultural (food) imports (in billion naira). The production risk (with probability of outcome) was operationalized as incidence of flooding instrumented by annual mean rainfall, while the proportion of arable land under irrigation was instrumented by annual total value of agricultural (food) imports. The level of significant of variables was determined at the threshold of five percent (Wood *et al.*, 2014).

## **RESULTS AND DISCUSSIONS**

Results in Table 1 show that the logarithm levels of all the variables (except incidence of flooding which was a dummy variable) used for the estimation of the GMM were both stationary at level and first difference. This result indicates that the variables are correlated at  $I(0)$ ; with or without differencing.

***Table 1. Phillips-Perron tests of stationarity of variable used for the estimation of the GMM***

	At Levels		At first difference	
	Test statistic	Probability	Test statistic	Probability
Index of aggregate production	-4.9442*	0.0002	-4.9685*	0.0000
Index of crops production	-5.7058*	0.0000	-5.7273*	0.0000
Index of staples production	-5.5634*	0.0000	-5.5803*	0.0000
Index of livestock production	-7.1128*	0.0000	-7.1488*	0.0000
Index of fishery production	-7.8234*	0.0000	-7.8234*	0.0000
Index of forestry production	-4.8763*	0.0003	-4.5717*	0.0000
Mean annual rainfall	-7.8071*	0.0000	-7.9561*	0.0000
Proportion of arable land under irrigation	-6.2699*	0.0000	-6.2699*	0.0000
Value of total agricultural (food) imports	-6.2825*	0.0000	-6.2370*	0.0000

Note: Test critical values (Mackinnon critical values) are -3.6268 and -2.9458 at 1% and 5%, respectively. \* indicates 1 percent level of significance.

Having confirmed the stationarity of the variables, the GMM was estimated for each sub-sector of agricultural production, including aggregate agricultural production. It was found that mitigation measures proxied by proportion of arable land under irrigation (that is, adoption of agrotechnology) have significant impact on aggregate agricultural production ( $\beta = 3.534$ ;  $p < 0.001$ ), crop production ( $\beta$

= 3.955;  $p < 0.001$ ), staples production ( $\beta = 4.069$ ;  $p < 0.001$ ), livestock production ( $\beta = 5.349$ ;  $p < 0.001$ ), fishery production ( $\beta = 1.199$ ;  $p < 0.1$ ), and forestry production ( $\beta = 2.676$ ;  $p < 0.001$ ) in Nigeria. Climate-induced production risks (incidences of flooding) have negative but non-significant impact on staples. This result suggests potential production risks that could be imposed by incidences of flooding on staples, and by extension agricultural production and food security in Nigeria. The impact of flooding could be exacerbated by climate change and inadequate policy on preparedness or mitigation measures. Other studies have revealed that the primary cause of flooding in many parts of the world is directly or indirectly related to rainfall. Climate change also works in an indirect way to aggravate flooding (ActionAid, 2006; Olanrewaju and Fadairo, 2003). It is therefore, important to provide resilient and adaptation measures that will mitigate incidences floods with a view to enhancing sustainable agricultural production and food security. Expansion of irrigation might be considered as a complementary strategy to enhance the resilience of agriculture (Cervigni *et al.*, 2013).

**Table 2. Impact of climate-induced production risks and mitigation measures on agricultural production**

Sub-Sector	Variable	Coefficient	t-value	Probability	R-squared
Aggregate agricultural production	Constant	5.3975*	56.9676	0.0000	0.8292
	Incidence of flooding	0.1947	0.2805	0.7806	
	Proportion of arable land under irrigation	3.5339*	8.1838	0.0000	
Crops production	Constant	5.5321*	54.7363	0.0000	0.8335
	Incidence of flooding	0.1295	0.1566	0.8763	
	Proportion of arable land under irrigation	3.9547*	9.8904	0.0000	
Staples production	Constant	5.6285*	48.0454	0.0000	0.8506
	Incidence of flooding	-0.1372	-0.1521	0.8799	
	Proportion of arable land under irrigation	4.0694*	10.3219	0.0000	
Livestock production	Constant	5.7695*	49.7509	0.0000	0.6862
	Incidence of flooding	0.7177	0.6983	0.4891	
	Proportion of arable land under irrigation	5.3487*	6.2942	0.0000	
Fishery production	Constant	5.1575*	40.6151	0.0000	0.1507
	Incidence of flooding	0.2609	0.3461	0.7311	
	Proportion of arable land under irrigation	1.1999	1.9586	0.0573	
Forestry production	Constant	5.1071*	77.1349	0.0000	0.4172
	Incidence of flooding	0.6069	1.1674	0.2501	
	Proportion of arable land under irrigation	2.6757*	5.7776	0.0000	

\* indicates 1 percent level of significance.

## CONCLUSION AND RECOMMENDATIONS

This study analyzed impact of production risks and mitigation measures on agricultural production in Nigeria. It used time series dataset that spanned from 1970 to 2012. It employed econometric analysis to estimate the impact of production risks and mitigation measures on agricultural production, including staples, livestock, fisheries and forestry. It was found that mitigation measures have significant impact on all sub-sectors of agriculture, especially the crops and staples sub-sectors. The findings suggest the need for the minimization of the impact of climate-induced production risks on

agricultural production through investments in agrotechnology in the form of irrigation system, especially for staples sub-sector category is mainly made up of roots and tuber crops (including, cassava, yam, potatoes and cocoyam), cereals (including, rice, maize, millet, sorghum and wheat), legumes (including, cowpea and soybean). The staples have implication for food security and poverty reduction especially for rural households in Nigeria. Therefore, irrigation programmes should be scaled up to enhance sustainable agricultural production with a view to mitigating climate-induced agricultural production risks while as the same time building disaster-resilient sustainable agricultural production systems.

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# CLOSING THE LOOP WITH AQUAPONIC SYSTEMS IN ENERGY-EFFICIENT GREENHOUSES

**Björn Oliviusson<sup>1</sup> Eva-Lotta Thunqvist<sup>2</sup>**

<sup>1</sup>KTH, Royal Institute of Technology; Marinens väg 30, SE13640 Haninge, Sweden, bjorn.oliviusson@haninge.se

<sup>2</sup>KTH, Royal Institute of Technology; Marinens väg 30, SE13640 Haninge, Sweden, eljt@kth.se

## ABSTRACT

In this paper some first results from an existing closed-loop food production system in temperate climate are presented. In a dome-shaped, energy-efficient greenhouse an aquaponic production system is used for the production of fish and vegetables. The only inputs are water and fish feed. The only outputs are fish and vegetables. The greenhouse is heated by biofuels from a nearby farm. All relevant production parameters, such as water consumption, water quality (ammonium, nitrite, nitrate, phosphate), production volumes of fish and plants have been measured and compared with conventionally produced fish and vegetables.

*Key words: aquaponic, greenhouse, energy efficiency, rainwater harvest, tilapia*

## 1 INTRODUCTION

In Sweden more than half of the food is imported. In the future climate change, which may cause water scarcity in many food producing areas, and decreasing oil reserves, which will increase costs for transport and production, will enhance the need for more local and sustainable food production. Sweden has a surplus of water of good quality but only a production season of 4-6 months, greenhouses with heating and lighting for food production during the cold months is required. Since imported vegetables have been inexpensive and available even in the winter, so far not much effort has been invested in methods for improving the energy efficiency or to adapt the constructions of the greenhouses to Swedish conditions. Very few innovative models for food production, where water and nutrient recirculation is tested, have actually been built.

## 2 BACKGROUND

Aquaculture has been identified as the fastest growing food production sector in the world. Half of all fish, shellfish and algae/seaweed being consumed comes from aquaculture production. Traditionally, aquaculture in Scandinavia has been cage-farming, with salmonid species being produced in flow-through net cages. Growth of aquaculture capacity in Sweden has been slow due to competition from abroad and rather strict environmental regulations. As few of the coastal areas surrounding Sweden meets the environmental standards set by the EU, the possibility to expand the aquaculture industry using traditional methods are very limited.

Landbased, recirculating aquaculture systems (RAS) has grown in acceptance as production techniques has improved and production data has become available. RAS systems were originally developed in order to reduce the water consumption as 90-99 % of the water in the system can be recycled. [1]. RAS systems enables the producer to have very good control of production parameters but high initial investment cost, need for highly trained staff, and sensitivity to technical failures are limiting factors. High operational costs as well as difficulties in treating diseases are other limitations [2]. In order to maintain acceptable water values nutrients must be removed, either as sludge, through water exchange or as gas. The necessity to remove sludge and to change water limits the possibility to locate RAS systems in urban settings.

In Aquaponic RAS systems the nutrient rich effluent from the fish production is treated by planted hydroponic units before being returned to the fish-tank. In a balanced aquaponic system no water exchange is necessary, only water losses through harvest or evaporation is compensated for, all nutrients being absorbed by the plants. By using rainwater to supplement losses, the system is more or

less disconnected from the environment. This enables aquaponic systems to be placed directly in urban settings, such as rooftops, very close to the consumers. This also makes it possible to utilize waste heat from ventilation systems and other sources, drastically reducing the energy cost.

Aquaponic systems have been used for food production since the 1980s in the US. The system is based on fish tanks from where the nutrient rich effluents are feeding different cultures of vegetables. The drainage from the vegetables units, often gravel filled bio-beds or floating raft systems, is collected and recirculated back to the fish-tanks. The only input is fish feed and water [3]. One study showed that 69% of nitrogen removal by the overall system could be converted into edible fruits in an aquaponic system [4].

The fish species most often used in the system are Tilapias (*Oreochromis* sp.) although a large number of species can be cultivated in the system. Tilapias may grow to approximately 1 kg in 8-9 months if reared at a temperature of 27-28 C and on a diet containing 30% of protein. Tilapias can, contrary to salmonid species, to a much higher degree utilize carbohydrates as energy source which makes it possible to use waste products from agriculture as sustainable feed components. Internationally, even though the Tilapias are omnivorous, fish meal is used as feed. As most fishing areas around the world are being over-utilized, the use of fishmeal is considered unsustainable. In this project, mussel meal, made from waste material from sustainable mussel production, is used as feed component.

The Tilapias are also considered relatively insensitive to low oxygen concentrations and are tolerant to elevated nitrogen levels and temperature variations. These traits increase the production safety, making them ideal for closed production systems [5]. There has been an increasing interest for rearing tilapia in the Nordic countries but no data for aquaponic production during Scandinavian conditions is available. There is currently no data available on production parameters on systems using a vegetable/mussel diet.

Most data available on aquaponic production come from production facilities placed at more southern latitudes with sunlight, cloud cover and temperature patterns significantly differing from higher latitudes. Energy use for lighting and heating, productivity of different crops and the balance between fish and vegetable production during year around conditions have not yet been evaluated. Energy data from greenhouses with alternative shapes and materials are also not yet available.

### 3 TEST SETUP AND RESULTS

An 80 m<sup>2</sup> dome-shaped greenhouse has been erected at an agricultural school outside Stockholm in 2012/13. Experiences from the first year of production, May – Nov 2013, are presented and discussed. The dome is 10 m in diameter and 4.5 meters high. The geodesic structure is made from wood and covered with poly-carbonate insulation sheets, 16 mm thick. During this first season the dome was heated with electrical fans.

The production system consists of a 4200 l fish tank with 2.3 m diameter, constructed from sheet metal and rubber lining. From this tank, water is pumped to 3 wooden, water-tight, gravel-filled grow-beds with a total length of 10.5 m. 44 tomato plants were planted in the beds. The system covers ca 16 m<sup>2</sup> including walkways. Groundwater were used for the fish tank and fish feed for the tilapia was produced of leguminous crops, grains and flour made from ecologically grown mussels. 200 Tilapia fry (*Oreochromis niloticus*) average weight 4 gr was used.

Due to a very long and severe winter the production season was started in late May. At this time cooling fans and artificial lighting was not in place. The following summer was very warm and sunny and temperatures sometimes reached over 45 degrees C in the greenhouse. Some technical difficulties like pump break downs also occurred. Feeding was suspended for a number of days as Ph-value increased (8.4) and feed composition was altered in order to stabilize water values. During this period conventional feeds were also used to supplement the diet. Despite these conditions approximately 100 kg tomato was harvested (6.25 Kg/m<sup>2</sup>) and a total increase in fish weight of ca 6 kg was observed.

Fishes were showing no signs of stress or malnutrition and plants showed no signs of any lack of nutrients. During the end of the season the plants were affected by spider mites which caused some production losses. The plants were also affected by the very high temperatures. This also caused some harvest losses. Water values (Ph, conductivity, temperature) were very stable during the summer and nutrient levels only slowly increased as the natural light intensity decreased. No water was changed

during the entire season, only evaporation and harvest losses were compensated for. Energy consumption was not measured during this period.

Despite start-up mistakes and technical shortcomings the system performed well and was very stable during the test period. Interruptions in feeding patterns and temperature variations are well known to affect the growth rate of fishes but did not seem to affect the growth of the plants. The high summer temperatures as well as the elevated Ph caused plant production to slow down but production quickly recovered as conditions improved.

#### 4 DISCUSSION

The results for this first season were very meagre compared to conventional commercial growers but important lessons were learnt which will be implemented during the next season. In an Aquaponic system in Härnösand in Sweden, production of more than 25 kilos/m<sup>2</sup>/year was reached when combined with rainbow trout farming [6]. This system also had low production at the start but production increased as the system got more stable. Conventional commercial producers often reach production volumes of 25 - 45 kilos/m<sup>2</sup>/year during optimized production conditions. The system proved to be very stable and, when technical errors had been corrected, requiring very little maintenance. The system can be built with standard components. Apart from keeping initial costs down, components are easily available making the system safer.

The production season 2014 has already started, in January, as the heating system and artificial lighting was installed. Cooling fans will be installed in April and energy use is now also being monitored. Gutters for collection of rainwater will also be installed. Water parameters are controlled continuously (temperature, conductivity, ph, nutrients) and automated feeding systems will be installed as well. Harvest has already started, increasing the likeliness for a substantially larger harvest. Hopefully the system will slowly reach production volumes similar to commercial systems as the system set-up is optimized and the staff gains more experience.

#### 5 CONCLUSIONS

Aquaponic production systems have a number of significant advantages compared to conventional RAS systems. The systems are technically less complicated and have shown very stable performance despite minor interruptions. As the system can be constructed with off-the-shelf components the initial cost can be kept low. The system, being largely biological is able to adjust to differences in flow and nutrient loads without technical changes. The possibility to use waste material and convert it to valuable products makes the system also economically as well as environmentally sound. The preliminary results indicates that this system can be integrated in Swedish urban setting, increasing urban food production and utilizing waste heat to lower productions costs.

#### 6 IMPLICATIONS FOR 'RESILIENCE THE NEW RESEARCH FRONTIER'

A preliminary comparison between the facility described above and conventional production shows that:

Fish farming in our facility avoid the problems of nutrient overload from fish farms. More than 80% of the fishing areas around the world are over-utilized or have collapsed and a large part of the catch is being used for production of fishmeal, the main component in commercial fish-feeds. Conventional fish-farms, often located in coastal waters are having large environmental impacts due to nutrient leakage. Land-based farming systems allow for total nutrient recovery and minimal environmental impact. As our fish is fed with mussel meal and cereals the problem with over-fishing is also further avoided. With our choice of fish, products with relatively low protein and fat contents can be used in a way that salmonid species have a very limited ability to do. Waste from agriculture and aquaculture (mussel meat) can be used, creating a market for materials that is normally thrown away.

Use of waste energy. As the Aquaponic systems are disconnected from the surroundings, the systems can be used in close proximity to sources of waste energy. This makes the production of heat-demanding fish- and plant species in temperate areas possible. It also makes it possible to place production facilities near attractive markets or in the cities. In our facility the energy use, both for

heating and electricity for pumps and lighting is monitored. By knowing the energy use, the production potential for various waste energy sources can be estimated.

In our facility only evaporative and harvest losses of water are compensated for while in most recirculating aquaculture systems (RAS) a daily exchange of 5-10 % of the total water volume is common. Compared to soil-based production of vegetables, Aquaponic systems use 10 % or less of the water volume normally needed. With the possibility to utilize stormwater from the greenhouse roof other demands on fresh water can be low, saving groundwater reserves.

With the location close to the market, products from our facility require less transport measured in ton/km than many other products on the market. However, in order for emissions for transport to be substantially lower than for other products it is important to also look at the energy efficiency of vehicles and this will be further explored in the next phase of the project. Also losses of products and lower product quality will be eliminated, resulting in higher profit margins for the companies. On-demand harvest will be possible also resulting in higher quality products.

With the plants, bacteria and the fishes closely connected, as in our facility, the use of chemical fertilizers and antibiotics are impossible. Chemical fertilizer might have a positive effect on plant growth but will, as different salts are being accumulated, have a toxic effect on the fishes and the bacteria. Antibiotics might save sick fishes but will kill the bacteria needed for the decomposition of fish wastes and the following release of plant nutrients. With the use of organic feed substances used in our facility no build-up of toxic components will occur.

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# CARGO BIKE POOL – A WAY TO FACILITATE A CAR-FREE LIFE?

Miriam Börjesson Rivera<sup>1</sup> and Greger Henriksson<sup>1</sup>

<sup>1</sup>KTH Royal Institute of Technology, Division of Environmental Strategies Research

miriamrg@kth.se

gregerh@kth.se

## ABSTRACT

In planning for sustainable cities, there is a need to take into consideration alternative transportation modes and facilitate the use of these, for the types of trips that people tend to use cars for. One way to mitigate car dependency in everyday life could be by using a cargo bike for these types of trips.

The purpose of this paper is to map in what ways a specific trial of providing access to a cargo bike pool in a housing association affected both people's travel habits and how they reimagined the types of trips that could be done at all or done in another way in order to find car-free travel and transportation modes. In this paper we focussed on the residents who actually used the cargo bikes.

This qualitative study shows that although many of the residents did indeed lead car-free everyday lives, they got the opportunity to do other types of trips that they had not even thought about beforehand or deemed too difficult to do without a car. The cargo bike proved to fit into the portfolio of sustainable travel modes that facilitate everyday transports. The way that trips are imagined has also changed, that is what a cargo bike can be used to in relation to car, regular bike and public transportation.

Having access to a cargo bike through a vehicle pool means that the possibilities to live a car-free everyday life are facilitated and in the long run a sustainable transportation pattern is being put in place.

*Keywords: cargo bike pool, mobility solution, behaviour change, sustainable transportation*

## 1 INTRODUCTION

Alternative transportation modes have been argued to have large potential to contribute to sustainable urban development. This means not only an accessible city in the terms of walkability, being able to ride a bike or good access to public transport but, perhaps more importantly a city where day to day transports can be done without the necessity of a car. Examples of the types of trips that today might require a car are those trips where people need to transport either things or children or both from one place to another. There are certain trends such as peak car (the trend of declining car use in developed cities) [1, 2] and that young people tend to wait longer nowadays before getting a driving license in comparison to 20 years ago [3, 4]. But there is still an expectation from a societal perspective that encourages having a car and barriers in the city's physical structure that hinder people from living a car-free life. If we are to be able to fulfil the targets set up to radically reduce GHG emissions and be able to mitigate climate change the role of the car in everyday life needs to be challenged fundamentally. This involves both city planning and the development of new mobility services. One such mobility service that enables a car-free life could be a cargo bike pool. In this paper we will look into a cargo bike pool trial that was made in a housing association in the south of the city of Stockholm, Sweden.

Cycling as a transportation mode has been put forward in Swedish policy documents and the government also stated in the goals for the Swedish Transport Administration that cycling is to increase its share of trips made, in order to meet the vision of a carbon neutral Sweden 2050 [5, 6]. It is however, not only climate arguments that are linked to the desire of increasing the share of bicycle trips but also arguments of accessibility, freedom of choice and health, as well to the image of the 'good city' [7]. The importance of policies in combination with infrastructural measures when it comes to encourage cycling is stressed by Pucher & Buehler [8] in their comparative study, whereas other studies have looked into the role life events could have on people's willingness to taking up

biking [9, 10]. Yet other studies have looked into how the local context shapes the culture of cycling on different places and the importance of taking this into consideration in policy-making [11].

Cargo bikes or freight bikes have been around for almost as long as ordinary bikes and were used by shopkeepers to make local deliveries [12]. These kinds of bikes were also used by the postal offices and still are to some extent. Cargo bikes have become popular for private use over the past couple of decades; here the Netherlands and Denmark stand out, and main uses are transportation of children and goods. Since cargo bikes have not had the same breakthrough in Sweden as in Denmark, for example, the barrier towards purchasing one for private use might be higher as the cargo bike is considered to be a niche bike. There is also the issue of where to park it when living in apartment buildings as a cargo bike takes up more space than a regular bike. A way to get around both the cost and parking issues is to set up a vehicle pool, where you share the vehicles, in this case cargo bikes, with your neighbours.

The purpose of this paper is to analyse how having access to a cargo bike pool affect both people's travel habits and how they reimagine the types of trips that could be done at all or done in another way in order to find car-free travel and transportation modes.

The aim of this paper is to explore how a mobility solution can contribute to change people's everyday travel behaviour in an environmentally sustainable direction.

## 2 METHODOLOGY

In this study, we have used a variety of methods, but always with an ethnographic approach. By ethnographic approach we mean that we wanted to see how the cargo bikes have been used in this specific context. This means that we describe and try to understand what it means to be a cargo bike rider in Bagarmossen 2013 as fully as we can. How we interpret and analyse material will thus be dependent on the specific conditions in this time and place. We interviewed 12 residents, both those who had not used the bikes as well as those who have actually used the bikes. We aimed at getting an as wide spread of informants as possible, and we managed to find our informants in slightly different ways, both through a pre-survey that we distributed in the houses and through meeting residents when visiting the housing association. We have also been in Bagarmossen and made observations on several different occasions to further provide a basis for our understanding of how the cargo bike pool trial worked.

Our in-depth interviews were semi-structured; this means that even when we followed a question guide, to get what we wanted to find out, there was opportunity for us to follow up on what the informant was saying even though this was a bit outside of what was in the question guide. As part of the in-depth interview, we also asked the informants to fill out a one-day travel diary. The purpose of the travel diary was partly to estimate how and how much the informant travelled in a day and also to be able to relate the questions in the interview to the specific trips written down in the travel diary [13].

We also had access to the booking lists the residents had to fill out in order to borrow the cargo bikes and were thus able to see when the bikes used, how long and how many residents actually used them. In this paper, however, we will focus on the residents that did use the bikes and their stories that we got from the interviews. We will in this paper use examples from the interviews to illustrate the way that the cargo bikes have been used and how some of the users have thought and reflected upon their usage.

In ethnographic research and analysis the point is not to let the empirical material falsify or verify a specific theory, but rather let the empirical material 'talk' to the theory, or as Pink & Morgan put it: "Ethnographic research evolves in dialog with theory rather than being led or structured by theory" [14:357]. The analytical process is an iterative where the data and the ideas are in a dialectical movement back and forth [15]. Thus we have analysed and interpreted the interviews in accordance with our anthropological and ethnological training and experience in order to find themes that are recurring and then tried to find reasonable theoretical arguments that are used as lenses to interpret our findings.

## 3 THE LOCATION OF THE TRIAL

The housing association is located in Bagarmossen, a city district in the south of Stockholm, and consists of 260 apartments in seven buildings. The association, which is one of the older housing cooperatives in Bagarmossen, has recently gone through a rejuvenation process and many younger people, both single and families with children have moved there. In addition to the rejuvenation

process, Bagarmossen, or at least parts of it, is also experiencing a gentrification process. Gentrification is a complex process that involves a change of residents and other land users in an area so that the new land users have higher socioeconomic status than the previous ones, while the built environment is altered by capital invested in the area [16]. In recent years, Bagarmossen has emerged as an increasingly attractive place to live, as the districts closest to the city centre have become increasingly expensive. Some of the reasons mentioned in the interviews that we have done are for example the proximity to nature, good communications, that they have friends living in the same area and that it is a safe area compared to other similar areas same distance from the inner city. The local context of a place impacts the way that cycling is perceived. Aldred and Jungnickel argue that “when everyone cycles, no one is ‘a cyclist’” [11:80] and this applies to the local cycle culture of Bagarmossen. Cycling is a natural part of the transport portfolio in Bagarmossen of both the cargo bike users and non-users that we interviewed.

## 4 RESULTS

### 4.1 Who used the bikes?

In common among the interviewees who used the bikes is that they were members of multi-person households. The interviewees all had children of different ages, however the most common was that they had children of school age or younger. Another common factor is that the interviewees in the interviews expressed a desire to live car-free lives. Most of the interviewees either had driving licenses or had a partner who had a driving license, but stated that they would prefer to manage their everyday transportation needs without a car as much as was possible. Many of the interviewees, though not all, were bike riders on a regular basis. Some biked to and from work, while others preferred to go by public transport.

A couple of our informants who also used the cargo bikes more often than average had had extensive discussions about acquiring cargo bike with their partners even before this project became known. Bill is such a person. Bill is 31 and has lived in the housing association for about 3 years. Bill is married to Olivia, 27, and together they have three children in the ages 3, 1 and a new-born baby. Bill started to work again in August after a period of parental leave. Bill rides his bike to and from work every day, a distance which is about 15 km there and back. Bill says that he had heard of cargo bikes before the project in his housing association. He mentions that there is a workshop nearby where they sell and make those kinds of bikes and that he and his wife had had their eyes on them for some time, discussing that ‘in a few years we’ll do this investment’. One of the neighbours also has a cargo bike of their own but a different model than the ones in the trial.

Bill and Olivia come from a small city in northern Sweden and have had driving licenses since they were 18-19 years old, something that is almost a requirement in that region because of long distances and poor public transportation possibilities. During his parental leave Bill estimates that he has used the cargo bikes about three times a week. He was at home with their two children and also took care of a third child who was two years old. Taking care of three small children limits where you can go if you don’t have a car, but thanks to the cargo bikes Bill could do outings to different playgrounds in the local area. He has also used the cargo bikes for family outings like going to the lake.

For Bill the cargo bike pool has facilitated extremely much, and Olivia fills in that particularly the electric cargo bike has been very useful during her pregnancy when you don’t have your usual strength or are as fit as normally. They have good friends with car, which they are free to borrow at any time, but it is not always it feels right to take that alternative.

One trip that Bill mentions is when he went and fetched furniture at a second hand store located about 7, 5 km from their home. Bill says that his reasoning was, "I might as well take the bike instead of calling a friend [with a car]." He goes on and says that all journeys "this side of the city which have demanded cargo space, he has been able to do with a cargo bike. Bill says that the cargo bike has provided a sort of emotional space, a kind of freedom and accessibility that a car could give, but without the negative. According to Bill, the cargo bike pool is also a fun thing, a community thing: "If you see a neighbour with one of the cargo bikes you stop and chat, 'you're out with the bike, we are in this together.'"

The Bergman family consists of father, mother and two daughters 8 and 12 years. The family moved to Bagarmossen and the housing association about 15 years ago. Before the move, the couple had a number of criteria that were important to meet, among other things, south of town, biking distance to

town and close to nature. Another important criterion was that there would be no through traffic. Because of that the two places where they previously lived were not viable options.

Bergman family can be characterized as habitual cyclists. When they need a car in Stockholm they can either borrow from a friend or they rent one. The default setting is, however, "never drive in town," and therefore a carpool membership has never been an option for this family. Everyone in the family bike and the kids either bike or walk to school. According to the mother you can let the kids ride bikes without worrying because Bagarmossen have such good bike paths.

When it comes to using the cargo bikes everyone in the Bergman family had tested the bikes and booked them on a few occasions during the month of May. The father says he tested the electric but felt that it almost went too fast. The last time they used a cargo bike was when they carried things to a flea market where the daughters were going to sell their old clothes. After that the mother had booked one of cargo bikes so the oldest daughter could use it for her field trip, but this was around the same time as one of the bikes stolen and the remaining cargo bikes moved to a new place indoors in a garage in the yard. Since the cargo bikes no longer stood on their "usual" place and it was not clear where they had gone the daughter had to cope without the cargo bike on her field trip. Both the mother and the father believe that using the cargo bikes was more spontaneous when the bikes were visible and they were reminded that they existed. They also say that they thought the bikes were removed for good until our interview.

The Nordlund family provides a third example of users. The Nordlund family consists of Peter 47, Helena 49, and their daughter Mira 10. Both Peter and Helena have driving licenses and Peter has also owned a car previously but they lead a car-free day to day life and have done so for quite many years, at least as long as they have been together. Peter says he loves to drive but that it is rather pointless. The family has used the cargo bikes for doing their weekly grocery shopping and also for transporting things to their boat for the summer. When the family does their grocery shopping with the bike then Peter rides the cargo bike and Mira and Helena ride on their ordinary bikes and they all go to a store located in the adjacent city district, Skarpnäck. The distance is about 2, 5 km one way. The trip to the boat is an example of how a car trip actually has been substituted. Usually Peter lends his father in law's car to do that trip but this time he wanted to try the cargo bike, and it went quite well. It has almost become a habit to look if the bike is in when passing by the garage. Yet another type of trip was when the family went to a garden shop located approximately 6 km from their home. All in all Peter and Helena conclude that cargo bike trips have indeed substituted many of the trips when they otherwise would have borrowed Helena's father's car. The cargo bike has proven to be a convenient way to manage the family's transportation needs on an everyday level.

The different families have thus explicit car-free everyday lives and for all the families the trial has also meant an opportunity to try one more alternative to the car for transportation. Yet the families' stories reflect rather different usage patterns. When Bill and his family used the bike on almost a daily basis during the summer, the Bergman family barely began to explore what the cargo bike could be used for. One reason for this could be how the information about what happened to the bikes reached the residents. While Bill and his wife knew what had happened to the bikes while the Bergman's had not received this information. Another reason, not linked to the first one, could be the way in which the families pictured cargo bikes before the trial. The theory of planned behaviour states that the decision to perform a particular action depends on three situational beliefs: i) beliefs about the likely consequences of the action / behaviour , ii) beliefs about others' normative expectations and iii) beliefs about what factors might facilitate or inhibit the behaviour/act itself [17]. This perspective fits well into Bill and Olivia, who already before the trial had given serious thought to acquire a cargo bike.

It becomes clear that the cargo bikes appeal to a particular segment of the residents. To live a car-free life in general, however, does not seem to be equated with needing a cargo bike to solve everyday transport in the local area. Rather, it is fair to assume that when there is a need to solve everyday transport in the local area along with a desire to live a car-free life the cargo bike is starting to emerge as a suitable mobility solution. In the Danish sociologist Miriam Godsken's dissertation [18] about families with children in Copenhagen and their travel habits, she writes how travel patterns may change during the life course; she refers to these changing times as breakpoints. Such a breakpoint, for example, is when you have children; another breakpoint can be when you move. It is fair to assume that access to a cargo bike could be a way to maintain a car-free life style when people face such breakpoints in their lives.

## 4.2 To ride a cargo bike – a new practice or a new habit?

To understand how habits and practices change, Social Practice Theory can be a useful theoretical lens. A practice can be understood as a bodily - mental cluster of activities that are linked together in a meaningful unit for the performer. Elizabeth Shove and Mika Pantzar [19] argue that what defines a social practice is that it actively integrates materials, meaning and types of skills, which together link the social and material aspects of change. According to Shove and Pantzar practices only exist when people perform them and practices also need to constantly be reproduced to not disappear. A practice can thus be said to be an ongoing process where the integrate parts are changing and the way also practice in full. A new practice is according to this view rarely completely "new" without building on one of its component parts, materials, sense or form, takes on a new guise.

If we look at riding cargo bikes from a social practice perspective then, it becomes very clear that riding on these bikes require new skills that are not necessarily based on previous knowledge. Riding a cargo bike differs a bit from riding a "normal" two-wheeler without a box. It takes some time to get accustomed to, and the fact that it does differ from riding an ordinary bike might put off certain people.

Another factor that may play role possibly is the "novelty" factor, having access to cargo bikes. That can help people to become aware and may for some be a trigger to test at least. This does not obviously guarantee that the users will continue to use these. However, it is important to address the visibility of the cargo bikes in this context. Actually seeing the bikes on a daily basis can work as a reminder of their existence and that we have access to them. Yet another factor, more connected to the social part of social practice is the social context in which the cargo bikes occurs influences people to use them. If a resident sees his neighbours and friends using the cargo bikes and talk about using them maybe this will make him more inclined trying?

When the housing association board was planning the introduction of the cargo bike pool they decided to build on the laundry room booking routines. The board also came with the proposal to have the same key that is used to open the gate and which is also the laundry room key to open the bike locks. The booking practices and using the same key can be seen as examples of how certain parts of a new practice, such as material parts and certain skill parts, are based already existing practices. There is also a sense of continuity in meaning as the sense of the cargo bikes being something that all residents in the housing association have equal access to, the same way as the laundry room is. These are also ways which may help to keep the threshold for a new practice down and good examples on how new practices seldom are entirely new, but rather built upon and integrated into already existing ones.

Another way to explain habits is by seeing them as more or less physically anchored routinized actions that do not require any special reflection. Tim Schwanen et al [20] define habits as tendencies or forces that are implicit in (routinized) practitioners. The habit is what connects the body and mind with artefacts, infrastructure, other people, rules, beliefs, and other agents encountered as part of everyday life [20]. The habit can then be said to be what makes everything runs on "as usual". Further, Schwanen et al. state that question about changing habits rather should work with the habits already in place and to do it on much broader way than it is done now. Habits are often established at an early age and by facilitating the kind of habits that are more sustainable, the more unsustainable habits could be left aside. One way to do this is by creating alternatives. The cargo bike trial did just that, an alternative means of transport was suddenly available for all the residents in the housing association and for the vast majority of the regular users, this became also a way to build on a habit that already existed, that is, regular cycling, to some extent. While it isn't exactly the same thing to ride a cargo bike as it is to ride a regular bike it might have required a period of getting accustomed.

## 4.3 Different types of trips

During the trial the residents have used the cargo bikes for different types of trips. For example trips to supermarkets for weekly shopping, when transporting bulky or heavy items such as a mattress, or going to the rehearsal room with electric guitar and other music gear, or transporting parts of the boat equipment for the summer season. The cargo bikes have also been used to transport (smaller) children to different places.

Many of the trips that the residents have done with the bikes have been leisure trips, e.g. outings. One possible interpretation is that since the cargo bike is a new thing the users have made trips of a type that they usually do not do during the exploratory phase, such as excursions to nearby suburbs, or to the adjacent nature reserve, i.e. the type of trips that are not part of the day to day travels. Once the users have grown accustomed to the bikes through these exploratory trips, it seems that the residents have started using the bikes for trips with a specific goal and purpose and linked to everyday travel in a different way than outing trips.

Meanwhile, one of the residents who most frequently used the bikes mainly used them to transport three young children (3 years and under) to the playgrounds outside the near vicinity during his parental leave. This would have been very difficult to do without a car otherwise and shows one way that access to cargo bikes have helped create transportation opportunities and trips that otherwise would not have been. For some residents it is also quite obvious that the cargo bikes have to a certain degree helped to substitute car trips.

## 5 CONCLUDING DISCUSSION

Our study shows that the cargo bike pool was seen positively by both non-users as well as the users among the residents of the housing association. In this paper we have focused on the residents that did use the cargo bikes. The interviews with them show that they have in common that they are members of multi-person households, and that they have expressed a desire to live car-free lives. Additionally, most of the cargo bike riders also rode on regular bike on a regular basis. Finally, at least a few of the most frequent users had had extensive discussions about acquiring a cargo bike of their own before the trial.

The residents used the cargo bikes for different types of trips, e.g. trips to supermarkets for larger purchases, and for transporting other bulky or heavy items. The cargo bikes have also been used to transport (smaller) children to different places. Many of the trips that the bikes have been used for can be characterized as outing trips for leisure. Our interviews also indicate that after the users have passed the first exploratory phase the bikes have also been used for a wider variant of errands, even though outing trips still remain popular.

The frequent occurrence of exploratory trips we believe, demonstrate that the access to cargo bikes can be seen as creating opportunities or opening new possibilities. That is, a lot of these trips would perhaps never have happened, because the possibility to make them was not yet available. Having access to a cargo bike pool has led residents to make trips that they might not previously known they were going to make. 'Possibility opening' has a dual connotation; it means both being able to make trips that otherwise would not have been made but also being able to make trips that would otherwise have required a car. In some cases perhaps these two types of trips blend together and are different aspects of the same type of trip such as Bill's trip to the second hand furniture store. Yet another way to express this is that the availability of a cargo bike provides the residents with a type of agency previously lacking. For the residents with an explicitly stated car-free lifestyle, access to cargo bikes definitely helped them to resolve their everyday transportation in a way that was consistent with how they want to live. This desired kind of lifestyle is also related to preferences of residence location.

Bagarmossen is an increasingly attractive place to live and we consider this as important to the outcome of the trial. Bagarmossen's popularity is related to the inner suburbs closest to the city center becoming increasingly expensive to obtain housing in. This is also something that is mentioned in the interviews that we've done. Bagarmossen is not a place people end up in for no reason but rather a place that people seek out a variety of reasons, including the proximity to nature, good communications, there is no through traffic and that it is a safe and secure place compared to other similar areas at the same distance from the inner city. The interviewees revealed choice of residence in relation to public transport and (to some extent) their workplace as very important aspects. The fact that Bagarmossen and its surroundings are relatively flat and 'bike-friendly' also contributes to giving the trial favorable prerequisites.

The cargo bike trial in Bagarmossen suggests that even though it may be difficult to change everyday habits it is not impossible. The booking statistics show that 5 % of the residents booked the cargo bikes at 10 or more occasions thus confirming this assumption. Meanwhile, it is a complex process and it is hard to single out isolated factors that influence a person to start doing something in a

different way than before. However, we believe the following factors or prerequisites to increase the chances for a mobility solution such as a cargo bike pool to succeed.

One factor that favored the cargo bike pool was the design of the booking system. Both booking the bike and locking the bike built on already existing practices of the housing association and are good examples of how a new practice is based on elements of existing ones, which may help to keep the threshold down for a trying and developing a new practice. From a social practice perspective we argue that in the practice of riding a cargo bike is included a variety of different and sometimes new elements. Apart from cycling in itself riding a cargo bike as a practice also comes with a series of new 'sub-practices', who also need to be getting accustomed to, such as booking the bike, how to lock it, how to park it, how to use the electric battery, remembering to cover the cargo box, etc. As new sub-practices could also be viewed outings, errands that the pool opened up for (see above). All these elements cover what constitutes a practice and once they are in place there is no problem and will be carried more or less unreflective and routine.

We also believe that the potential of a cargo bike pool would be enhanced if introduced as a part of a wider package of mobility services. Riding cargo bikes may not be a viable alternative for all residents, or in all situations, but access to a cargo bike pool seems at least in an area such as Bagarmossen to help create space for residents to live a car-free everyday life and as such also help to show sustainable alternatives for transportation in everyday life.

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# THE HISTORIC URBAN LANDSCAPE VALUE OF GEORGE TOWN PENANG UNESCO WHS

Shuhana SHAMSUDDIN<sup>1</sup>, Rohayah CHE AMAT<sup>2</sup>, Ahmad Bashri SULAIMAN<sup>3</sup>

<sup>1&3</sup>Universiti Teknologi Malaysia, [shuhana@ic.utm.my](mailto:shuhana@ic.utm.my), [bashrie@ic.utm.my](mailto:bashrie@ic.utm.my)

<sup>2</sup>Universiti Teknologi Malaysia, [c.rohayah@yahoo.co.uk](mailto:c.rohayah@yahoo.co.uk)

## ABSTRACT

Sustainable management of historical places involves identifying the extent historical and cultural heritage values are incorporated in the improvement of these places. Communicating the significance of historic places in the local community may influence their awareness of its values. Scholars posit that it is possible to assess the qualities that make people value a place. Historic urban landscape value tends to be the value being least considered in urban conservation. The incorporation of these values on the character of historical places in management strategies will be a sustainable approach to protect the heritage values of a place and its setting. This paper is to determine the significance and value of historic urban landscapes by the community (local people) of the case study George Town UNESCO World Heritage Site (WHS), which will influence the character of the place. The case study is approached by using a mixed method using questionnaire survinterview with the local residents. This paper also attempts to describe how the value attached to the historic urban landscape influence the character of a historic place.

*Keywords: Historic Urban Landscape, Value, Significance, Local Community and George Town*

## 1 INTRODUCTION

George Town, the capital city of Penang was inscribed as a UNESCO World Heritage Site alongside with Malacca as the Historic Cities of The Straits of Malacca. Ever since, its inscription, the challenges faced by the city is to ensure sustainable development to take place whilst retaining its Outstanding Universal Values that earned its status. Much focus was given on the tangible heritage that relates to the physical environment, especially on the heritage buildings. However, recently, a community design approach was adopted to encourage local community's participation in enhancing the place through many street enhancement projects. Thus, the social aspects of sustainable development are slowly being considered, although much is yet to be understood on the values of the urban heritage by the local residents. Understanding of their values is important in order for the local community to be actively involved in conserving the character of the place. This paper focusses on the historic urban landscape and the community's value of it, where the urban landscape is seen as one of the elements that creates the sense of place for the World Heritage Site.

Historic Urban Landscape (HUL) is the sensory perception of the urban system and its setting as the result of the process to link the tangible and intangible heritage components [1]. The term of HUL was formally adopted in the *UNESCO Declaration On The Conservation of Historic Urban Landscape* by 15<sup>th</sup> General Assembly of State Parties to The World Heritage Convention in Paris on October 2005 and *Xi'an Declaration On The Conservation of The Setting of Heritage Structures, Sites and Areas* in the 15<sup>th</sup> General Assembly of ICOMOS in 21<sup>st</sup> October 2005. In the simplest term historic urban landscape is an historic urban area and its urban structure (natural, physical or cultural features), which portrays the diversity and identity of a place. These features are also called the tangible and intangible features of a heritage site. The landscape is seen as a relationship between the people and its surrounding places, including cultural and natural elements that are perceived by the community [1]. The perception evokes the feelings, memories and associations between the people and their place. Landscape character is the result of the perception of people towards their surroundings [2,3,4,5], creating its 'sense of place'. Heritage landscape or cultural landscape represents a broad term for special places created by human interaction with the environment, which help to define the character

of the community and their past [4]. The heritage landscape is defined through the people (especially local) by understanding and appreciating the broad range of historic, cultural landscape (historic, scenic, environmental qualities) and natural landscape [6]. The significant value of the heritage landscape provides a lasting personal value in the form of memories for residents and visitors. Heritage landscape provides each community with its own sense of place through the meanings identified and valued by the people. The understanding of these values would ensure a more sustainable approach to be adopted in ensuring the protection of the sense of place and the cultural sustainability of the World Heritage Site.

## 2 METHODOLOGY

The methodology in this paper is a case study with the mixed method approach, where both qualitative and quantitative approaches were adopted. The visual survey, literature review a questionnaire survey of 405 respondents of George Town UNESCO WHS located in Penang Malaysia. The survey was conducted to assess the local community perception towards the value of historic urban landscapes in the case study. This research applied similar methods by previous researchers to measure theoretical dimensions of the meaning of place by developing the series of Likert-scaled statements, which is based on individuals feelings and experiences towards the place [7,8,9,10]. The majority of the respondents are between 21 years old and above with the highest participation from male residents. There are three main ethnic groups in the case study: dominated by Chinese, Malay (including Indian Muslim and Jawi Peranakan) and Indian. The range age group of the respondents (64%) from 31 years and above with an almost extreme gap of distribution between the Chinese (54.3%), Malay (19%), Indian (24.2%) and others (2.5%). The majority of the respondents are the local community who is staying in the case study for six years and above.

## 3 SIGNIFICANCE OF THE VALUE AND IT'S MEANING

This paper presents the findings of the data analysis associated with the meanings and the activities of the study area, namely George Town, Penang World Heritage Site. The source of data is derived from the local community response to the questionnaire survey and in depth interview and field observations of the activities conducted in the place. Discussions are based on the communal value that is derived from the meanings of a place by the people related to it, that is reflected in their collective experience or memories of the place. The term has been discussed by English Heritage [11,12] who defined the communal values as an additional aspect of history (associated) and aesthetic values, but tend to have additional an specific aspects. Whilst, the commemorative and symbolic values as part of communal value relate to the meanings of a place, which creates the identity of the place and has an emotional link to the people. They are important aspects of collective memory, identity and activities that occur on/at the places, which has long associations with the character of the place. The meanings of the place derive from the community (local people) association with the places through their description of the place and the stories associated with the place. According to Stedman [13] people's experiences with the place contributed to the place attachment. The people will describe the emotion or feelings of how much a place means to them. The meaning of the place as perceived by the respondents will be categorized into two categories: functional value and emotional value. The functional value relates to the physical appearances and activities of the place, which the respondents perceive themselves to be associated with the place. Whilst, the emotional value relates to emotions and feelings, which the respondents feel attached towards the place.

### 3.1 Degrees of Functional Value

The functional meaning in the context of George Town as a UNESCO World Heritage Site and historic town is taken from the response of the respondents during the in-depth interview and questionnaire survey. The analysis suggested that the meaning of place was expressed in the form of engagement and association, familiarity and historical significance. This indicates that the presence of the historical significance elements bring the memorable experiences of the history of the place. The

respondents (70.9 %) responded that “the place is incomparable with other places” (COMPARE), while 64 % agreed that the study area is “the best place that they liked most” (BEST) and at the same time they (64.7 %) are “happy with the improvements” (IMPROVE) that have been done in this historic place. The relation between the three variables of functional meaning was significant,  $X^2(12, N=405) = 26.6, p = 0.009$  (COMPARE);  $X^2(12, N=405) = 33.98, p = 0.001$  (BEST); and  $X^2(12, N=405) = 33.98, p = 0.004$  (IMPROVE). The significance level is less than 0.01, reaching very significant level of the data that revealed that the age of the respondents is associated with the functional meaning of place.

The functional meaning as described by the respondents in the form of association with the place relates to the meanings of attachment or bonding developed with the physical attributes of the place. For example, one of the most significant historic open spaces in GTWHS known as Esplanade or Padang Kota becomes a gathering spot or nodes for the older folks or pensioners. The breezy atmospheres (located at the edges of the sea) with the presence of green field (which they called ‘Padang’), seating areas, shaded trees and the newly introduced area of activity “Dataran Pidato” (Speakers’ Square, a public speaking platform for the local community to express their thoughts and ideas) influence their preference to gather there. They explained why they chose to be in this particular location through the following statements:

*“We will be gathering here every Wednesday and Sunday evening just to listen to the somebody’s thought and ideas, especially on the current issues, which sometimes relate to the political issue, they are free to express their thoughts., observing people’s behavior and how they interact with each other, it’s some sort of therapy to us especially to the people in our age....” (In-depth Interview)*

The above respondents who closely bound up with social value associated the place with social interaction with the local community and this view supported by English Heritage [11, 12] and Shuhana [14] who writes the activities of the place are associated with the social values that people perceive as a source of identity, distinctiveness and social interactions of the place. A series of Spearman rank-order correlations was also conducted in order to determine if there are any relationships between the age of respondents in the three functional meanings: COMPARE, BEST and IMPROVE. A two-tailed test of significance indicated that age of respondents was unrelated to the functional meaning of place  $r_s(405) = -.07, p > .05$  (BEST);  $r_s(405) = -.08, p > .05$  (IMPROVE); and  $r_s(400) = -.05, p > .05$  (COMPARE). Based on Table 1.1, the high Kruskal-Wallis statistic (21.422) and the small p value (<0.001) for each age group indicates highly significant differences in functional meaning of place towards the respondents. The age group of 31-40 years {mean rank:COMPARE - 22.72; BEST - 231.50; IMPROVE-253.83} contributed greatly to this difference. The lower their mean rating, the higher indication of a stronger agreement towards the value of the place. The Kruskal-Wallis analysis was used to compare the mean differences in the respondents ranking of stronger agreement towards the value of place either in the functional or emotional meanings. In these quantitative data, the evidence for a relationship between age group and functional value has an impact and the findings are consistent with the previous studies that ‘place meaning’ tends to be higher for older people and those who lived in the area longer than the rest.

**Table 1. Functional Value – Age of Respondents (Kruskall-Wallis Test)**

Functional/AGE MEAN RANK (N=405)	21-30	31-40	41-50	51-UP	KRUSKALL WALLIS	CHI- SQUARE, p
COMPARE	198.06	222.72	214.44	175.20	16.318	.001
BEST	185.19	231.50	215.37	175.44	21.422	.000
IMPROVE	191.75	235.83	194.00	187.17	16.767	.001

The relation between the three variables of functional meaning towards the length of engagement, which are:  $X^2(20, N=405) = 34.625, p = 0.022$  (COMPARE) is significant; whilst  $X^2(20, N=405) = 18.674, p = 0.545$  (BEST) has no relationship; and  $X^2(20, N=405) = 35.017, p = 0.020$  (BEST) shows

a strong significant relationship. The significance level for the data revealed that the length of engagement of the respondents is associated with the functional meanings of the place in COMPARE and BEST. The Spearman rank-order correlations were conducted in order to determine if there are any relationships between the length of engagement in the three functional meanings: COMPARE, BEST and IMPROVE. A two-tailed test of significance indicated that the age of respondents was unrelated to the functional meaning of place  $R_s(334) = -.042, p > .05$  (BEST);  $R_s(334) = .015, p > .05$  (IMPROVE); and  $R_s(334) = ., p > .05$  (COMPARE).

**Table 2. Functional Value – Length of Engagement (Kruskall-Wallis Test)**

Functional/AGE MEAN RANK (N=405)	01-05	06-10	11-15	15-UP	KRUSKALL WALLIS	CHI- SQUARE, p
COMPARE	152.23	132.46	156.35	126.79	8.802	.032
BEST	149.07	134.17	158.51	118.57	7.846	.049
IMPROVE	147.79	129.34	167.29	145.29	13.052	.005

Based on Table 2, when  $\alpha=0.05$ , the p value of COMPARE (0.032), BEST (0.049) and IMPROVE (0.005) indicates significant differences in the respondents' functional meanings towards the place. The group of 11-15 years duration of stay shows the highest mean rank; while the group of 15 years and above is the lowest for COMPARE and BEST. The lowest mean rank (group of 15 years and above), show an indication of a stronger agreement that the place has functional meaning and associated with their life. The respondents strongly agree that the study area is the best place that they had and cannot be compared with other places. This test shows that the longer a person stays in one place; the stronger is functional feelings associated with the place. There are important aspects of collective memory and identity, place of remembrance whose meaning should not be forgotten [11:31].

The respondents generally relate the place with the strong bonding of their childhood memories which are comparable to other places. As explained by Maliki [2] that the concept of homeland by Yi-Fu Tuan is that the home is an archive of the feeling that has a sense of belonging and security, while Rapport Dawson described the meaning of home as a movement of the home place to another. The following respondent valued the study area as a valuable place, where he shares his childhood memories and strong bonding towards the place:

*“I moved from Penang seven years ago with my heart set on new adventures. I convinced myself that if I ever thought about returning to live in Penang, it would only mean a step back in my life. Shut my eyes and saw myself racing my sisters to close the old style convertible roof canopy in the mid courtyard when it rained. I could hear the crisp call of “kuih” from our favourite Indian uncle on his bicycle. I could feel the wind on the back of my neck thinking about the ghost stories we exchanged in the back lane, in a mix of migrant languages that makes Penang so unique. When I opened my eyes, I looked through the rusted window sills and saw a silent, old house. I realized then that nothing can take away the many special stories for us who have lived or are still living in this old town. It was a privilege to grow up in historic George Town, breathing and experiencing a true myriad of cultural traditions we moved back to Penang to take a step back into the past, so we could learn about my family and my home.” (Blogger, capturingpeneng.com., September 2010)*

**Table 3. Functional Value – Ethnicity (Kruskall-Wallis Test)**

Functional/AGE MEAN RANK (N=405)	Malay	Chinese	Indian	Others	KRUSKALL WALLIS	CHI- SQUARE, p
COMPARE	191.90	203.93	215.65	144.00	7.002	.072
BEST	188.54	197.10	229.24	186.85	9.640	.022
IMPROVE	201.94	190.15	240.12	130.00	22.723	.000

Based on Table 3, when the level of significance is set at 0.05 (a), the small p value (0.00) for IMPROVE indicates significant differences in the respondents rating towards the functional meanings with the ethnicity. The Others ethnicity had the lowest rank, an indication of a greater agreement level in associating the place with the functional meanings. However, the Others only contributed 2.5% of the total respondents and the majority of them are foreigners. The highest rank is from the Indian group, which contributed only about 24 % of the total numbers of respondents.

### 3.2 Degrees of Emotional Value

An analysis of the relationship between the five variables of emotional meanings with the age group demonstrate a significant relationship where,  $X^2(12, N=405) = 67.59, p = 0.000$  (MEMORY);  $X^2(12, N=405) = 44.30, p = 0.000$  (MEANINGFUL); and  $X^2(12, N=405) = 57.17, p = 0.000$  (ENJOYMENT);  $X^2(12, N=405) = 49.24, p = 0.000$  (SECURE); and  $X^2(12, N=405) = 51.52, p = 0.000$  (SADNESS). The significance level is less than 0.01, reaching very significant level where the data revealed that the age of respondents is associated with the emotional meanings of the place. A series of Spearman rank-order correlations was also conducted in order to determine if there is any relationship between the age of respondents in the five emotional meanings: MEMORY, MEANINGFUL, ENJOYMENT, SECURE and SADNESS. A two-tailed test of significance indicated that the age of respondent was unrelated to the emotional meaning of place  $r_s(405) = -, p > .05$  (MEMORY);  $r_s(405) = -.094, p > .05$  (MEANINGFUL);  $r_s(405) = -.093, p > .05$  (ENJOYMENT);  $r_s(405) = -.126, p > .05$  (SECURE) and  $r_s(405) = -.032, p > .05$  (SADNESS).

**Table 4. Emotional Value– Age of Respondents (Kruskall-Wallis Test)**

Emotional/AGE MEAN RANK (N=405)	21-30	31-40	41-50	51-UP	KRUSKALL WALLIS	CHI- SQUARE, p
MEMORY	183.78	252.69	203.82	166.31	47.012	.000
MEANINGFUL	194.27	232.34	198.74	184.01	15.532	.001
ENJOYMENT	182.19	236.52	219.45	168.57	31.344	.000
SECURE	184.6	243.39	215.01	164.46	37.124	.000
SADNESS	171.42	244.21	203.47	185.18	31.939	.000

When the level of significance is set at 0.05 (a), the small p value (<0.001) indicates significant differences in the age of respondents. Surprisingly, the age group 51 years and above had the lowest mean rank for MEMORY (166.31); MEANINGFUL (184.01); ENJOYMENT (168.57); SECURE (168.46), meanwhile for SADNESS, the lowest mean rank comes from the age group of 21-30 years. An indication of the greater level of age group for emotional meaning is when the 31-40 years had the highest mean rank. Confirming the above findings, where the age group of 31-40 years had the highest score is possibly due to their positive sentiments towards the place.

The relation between the five variables of emotional meaning and length of engagement were significant,  $X^2(20, N=405) = 76.952, p = 0.000$  (ENJOYMENT),  $X^2(20, N=405) = 82.245, p = 0.000$  (SECURE) and  $X^2(20, N=405) = 86.223, p = 0.000$  (SADNESS), where the significance level is less than 0.01, reaching very significant level for the data which revealed that the length of engagement is

associated with the emotional meanings of a place. Whilst,  $X^2(20, N=405) = 34.399, p = 0.024$  (MEMORY); and  $X^2(20, N=405) = 35.395, p = 0.018$  (MEANINGFUL) show the significant level  $> 0.01$  of the association. The p value of emotional meaning for MEMORY, MEANINGFUL, ENJOYMENT, SECURE and SADNESS indicate significant differences towards the length of engagement (duration of stay). The majority of the highest mean rank is from the group of the 11-15 years and the lowest mean rank are from the 6-10 years duration of stay and contradicted with the test from Table 1. These two tests show that the meaning of place (functional + emotional) varies with the length of engagement. The group of 6-10 years (most of them are 2<sup>nd</sup> or 3<sup>rd</sup> generations who occupied the places) is more attached emotionally towards the study area because of their motivation towards maintaining and conserving the area as a UNESCO World Heritage Site. Since the inscription was done six years ago, there is already a threat of the inscription being revoked and thus the concern among residents of not wanting to lose the heritage quality of the place. This also gives negative implications to the respondents because they might lose their collective memories, identity and history of place and that is why they are attached emotionally to the study area. The result supports the idea by English Heritage [11] that the social values may only be articulated when the future of the place will be threatened.

**Table 5. Emotional Meaning – Length of Engagement (Kruskal-Wallis Test)**

Emotional/Duration MEAN RANK (N=282)	01-05	06-10	11-15	15-UP	KRUSKALL WALLIS	CHI- SQUARE, p
MEMORY	155.94	<b>127.56</b>	164.25	<b>130.57</b>	17.087	.001
MEANINGFUL	161.48	<b>125.92</b>	154.69	<b>150.64</b>	18.669	.000
ENJOYMENT	141.69	<b>120.99</b>	204.18	<b>138.07</b>	56.348	.000
SECURE	156.58	<b>121.33</b>	187.67	<b>111.29</b>	43.917	.000
SADNESS	<b>158.88</b>	<b>125.86</b>	160.74	144.39	19.044	.000

The good moments and pleasant memories accumulated to become enjoyable experiences of the past events that happened in this place as reflected by the following statements.

*“ I still remember vividly growing up in Argyll Road in Penang. There were 11 of us in the family, eight brothers and three sisters. There were so many of us, but we had good fun playing around the many lanes and alleys in the busy neighborhood” (David Arumugan “Alleycats” in The Star 27 December 2013).*

*“ All these memories (which he refers to his childhood memories of Campbell Street) and more are good enough reasons to still visit this historic rich street each time I am back in my hometown”. (Wong Chun Wai, The Star Metro, 12 January 2013).*

The in-depth interview indicates that the strongest influence of the individual's towards the meaning of the place is their length of engagement (length of residence) where the longer the engagement the more positive sentiments towards the place and its meaning exist. The five Kruskal-Wallis analyses on the survey items had revealed that there was a significant difference in the age group, length of engagement and ethnicity in rating the functional value and emotional value towards the meanings of the place. English Heritage [11] posits that different people may attach differently of the similar heritage values of a place at the same time. Experience shows that the perception of heritage values, as people's perceptions of a place evolve. It is therefore necessary to consider whether a place might be so valued in the future that it should be protected now. Some values can be appreciated simply as a spontaneous, although culturally influenced, response; but people's experience of all heritage values tends to be enhanced by specific knowledge about the place.

#### 4 CONCLUSION

The value of a place from the local community's perception is influenced by their familiarity of the place and cultural background. The study produced results, which corroborate and are consistent with those of English Heritage [11,12] and Wan Hashimah [15] who defined the communal value as the meanings of the place that is valued by the people who are related to it. The communal values are closely interrelated with historical (associational) and aesthetic values [11]. These values are then translated in the collective memories and meaning of places that are important aspects that influenced the character of the place. The qualities of the historic urban spaces within the place give a significant impact through three attributes that have been discussed by the previous researchers. The attributes include cultural, behavioural and physical [14]. Vahid [16] stated that the urban spaces are part of the city that is harmonious, continuous and enclosed spaces that contain the social environment (relationship between people). Activities are the most important aspect of character element and component of an urban space, where they create the characters and the spirit of the place. Sustainable management of a place is communicating that significance value of the place, emotional or functional meaning and value, which will act as an awareness of its heritage values. Only through understanding the significance of a place is it possible to assess how the qualities that people value are vulnerable to harm or loss. In terms of sustainability, the way people value, their behavior and actions had an influence on the sense of place and thus affects the sustainability of the place from social as well as environmental perspective. Thus, appreciating the values that the local community place on their historic landscape could help the authorities to protect these heritage assets and assist in strengthening the place attachment and social sustainability of this World Heritage Site.

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# A SUSTAINABLE APPROACH FOR POST-DISASTER REHABILITATION OF RURAL SETTLEMENT HERITAGE

YU WANG<sup>1</sup>, HANS SKOTTE<sup>2</sup>

<sup>1</sup>Yu Wang Ph.D. candidate, Dept. Urban Design and Planning, Norwegian University of Science and Technology; [wang.yu@ntnu.no](mailto:wang.yu@ntnu.no)

<sup>2</sup>Hans Skotte Professor, Dept. Urban Design and Planning, Norwegian University of Science and Technology; [hans.skotte@ntnu.no](mailto:hans.skotte@ntnu.no)

## ABSTRACT

Rural settlements emerged as a consequence of a long-term communication between nature and people. Agricultural activities as a sustainable livelihood were the means of this communication. Nowadays some of the remaining rural settlements are identified as cultural heritage as a demand from the development of modern society, which holds new and totally different relationship between nature and people. A change which tends to make different nations and cultures similar. Hence, a rural settlement heritage is a manifestation of a bygone traditional sustainable development model and a container of cultural identity.

Conservation of rural heritage settlements is also challenged by the extension of modern society and modernity, where the sustainable relationship between nature and the local community is being gradually replaced. In such circumstances, rural heritage settlements become ‘lived-in cultural heritage settlements’ rather ‘living heritage settlements’ in which the local community inherits the knowledge and skills of maintaining and preserving the built environment; whereas in the former modernity weakened that relationship not only towards their built environment, but also to nature.

Present-day post-disaster reconstruction of rural heritage settlements may not merely be about rescuing the damaged heritage artefacts and objects but also carries the mission of recovering the daily life of local communities. But in reality post-disaster reconstruction may also be an opportunity to accelerate the process towards modernity in which the relationship between nature, the traditional living environment and local community may be fundamentally altered during a very short period. However this new relationship needs time and cannot be predicted precisely and therefore becomes uncertain.

*Keywords: Rural Settlement, Modernity, Post-disaster Reconstruction, Local Community*

## 1 INTRODUCTION

The empirical evidence on which this paper is based, stems from the investigation of the reconstruction of the Taoping Village. Taoping is a traditional Qiang minority settlement in China destroyed by the 2008 Sichuan Earthquake. Those events eventually fundamentally altered Taoping both physically and socially. The arguments of this paper rest on these changes.<sup>1</sup>

Rural settlement, meaning “the totality of human society in rural areas with all the social material organizational, spiritual and cultural elements that sustain a community” (Mandal, 1979) was the mainstay of human living space in pre-modern society. Urban settlements, however gradually replaced rural settlements, and have by now become the prevailing mode of human habitation. In fact the UN Population Division proclaimed that as of 2008 more than half of the population on the planet would live in cities (UNFPA 2007). The trend continues. By 2030 more than 80% of the population in developed counties will be urban, and in the less developed counties this figure is predicted as 56% (ibid). Urbanization along with industrialization and capitalism etc. have nurtured a process of modernity. Globalization substantially accelerates it. Both the territorial expansion of cities and the urban migration the urban have caused a dramatic declined the prevalence and vitality of rural settlements. For instance, in the first decade of this century the number of villages in China dropped

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<sup>1</sup> Most of the data appears in ref. 9, 10, 11, see list of references

from 3.7 to 2.6 million, which means that more than 300 villages vanished every day during the past decade.<sup>2</sup>

However, rural settlements manifest the long-term conversation between the human and natural environment and thus hold the records of history and society from the pre-modern era. Hence rural settlements become linkages to the past, i.e. containers of cultural identity and remain vivid examples of how manmade environments sustainably coexisted with the natural environment. That is why rural settlements are worth preserving from the wave of urbanization. As matter of fact, traditional rural settlements have been recognized as a certain type of cultural heritage by ICOMOS already in 1999. ICOMOS commended the built vernacular heritage as occupying “a central place in the affection and pride of all people”. And apparently, traditional rural settlements compose the major part of this category. From the perspective of ICOMOS, rural settlement heritage, unlike monuments, hold characteristics such as ‘utilitarian’ and ‘imprints of contemporary life’ (ICOMS 1999,p1). This paper will try to extend these features in an attempt to explore concept of the rural settlement heritage further. We will do so in the context of post-disaster reconstruction as this will allow us to also uncover the factors that challenge the very idea of rebuilding a sustainable rural heritage settlement in the twenty-first century.

## 2 CHARACTERISTICS OF RURAL SETTLEMENT

### 2.1 The Livelihood-dominated Relationship between Nature and Built Environment

Rural settlements can be regarded as the outcome of a long-term, pre-modern communication between nature and human beings. This communication was realized through the livelihood activities of agriculture. This stable communication also embodied the process of establishing and maintaining a stable relationship between the natural environment and the built rural settlement, in line with the ICOMOS claim that the built vernacular heritage is ‘the fundamental expression of the culture of a community, of its relationship with its territory’ (ICOMOS 1999, P1).

Agricultural activities bridged the natural environment and the built rural environment because farming defined the how resources of nature was being utilizing as well as how the built environment best served this livelihood. For instance, the typical residential building of the Qiang people populating the West Sichuan Province in China, was that of a three-storey structure in which first floor was for cattle, the second was for human habitation, and the third floor was for harvest storage. Rural livelihoods, their physical features and social practices are all parts of what Yrjö Haila labels an ‘organismic community’ (Haila 2000) where ‘nature is shaped within social practices’. Farming as a means of livelihood for instance imbued the Qiang people with links to nature so strong that they affected their ontology: they held their surrounding mountains as sacred. Every year a festival was conducted to show respect to that mountain. In rural settlements, therefore, farming was not merely the linkage of communication between man and nature but also shaped their social practice to form the rural culture as well. Under such circumstances, human culture cannot be isolate from nature just as Haila explained through the ‘ecosocial complex’:

Nature consists of a hierarchically organized set of processes which are locally and temporarily stabilized. Human activities are in contact with a restricted set of such processes at any one time.

Culture, on the other hand, might be profitably broken into parts by drawing distinctions between ‘social practices’ (...) which have relatively independent connections with their natural background. (Haila 2000, p167)

The above discussion indicates that agricultural livelihood was not only a way for living but also the way of living. A stable relationship has been founded in which nature, livelihood, social practice, and the built rural settlement were tightly connected in rural settlements. This puts the rural settlement heritage into a ‘living context’ which leaves it impossible to separate the built rural environment from the other constituting parts. Mediated by agriculture we cannot separate nature and culture. To study vernacular settlement heritage needs to understand this relationship and the research of rural settlement heritage cannot separate the issues of livelihood, nature, and social practice as separate conceptual elements.

<sup>2</sup> The data is sourced from a report of New York Times, seeing [http://www.nytimes.com/2014/02/02/world/asia/once-the-villages-are-gone-the-culture-is-gone.html?\\_r=0](http://www.nytimes.com/2014/02/02/world/asia/once-the-villages-are-gone-the-culture-is-gone.html?_r=0)

## 2.2 Accumulating the Values of Rural Settlement Heritage

ICOMOS asserted that although the built vernacular heritage “is the work of man, it is also the creation of time.” (ICOMOS 1999, p1) This assertion also applies to rural settlement heritage. The historic and aesthetic values of rural settlement derived from local inhabitants leaving traces of their daily-life on their dwellings throughout time. However, time is not the only agent, so is the local community. It is thus the interaction between community and time and their impact on settlement buildings that create their historical and aesthetic value.

Time is thus an essential element in creating the values of architecture heritage. This derives from the efforts of time to enhance the appearance of works of art. The term ‘patina’ is applied to describe this phenomenon. For instance, people do appreciate the changing surface of a bronze sculpture as copper reacts with oxygen in the air and forms a layer of copper oxide with its matt greenish-grey color. The aesthetic values in works of art are primarily embedded in the initial objects. The other values are just added bonuses. Unlike works of art, buildings were constructed for utility reasons; they were not objects for mere appreciation. As Alois Riegl claimed, we turned many utility works into ‘monuments’ that was never intended as such by their creators, who were primarily concerned with practical tasks rather than aesthetic goals (Riegl 1928, p44-93). He therefore developed a series of values besides aesthetic value. They are such as ‘age value’, ‘use value’, ‘newness value’, and ‘contemporary value’. Among those values, ‘age value’ is directly linked to time and is thus recognized as ‘historical value’. But for buildings time not only contributed to their historical value but also deliberately empowered building to achieve its aesthetic value. Just as John Ruskin advocated ‘voicefulness’ in buildings as very important; he praised the work of time upon the building as:

(T)he great glory of a building is not in its stones, nor in its gold. Its glory is in its Age, and in that deep sense of voicefulness, of stern watching, of mysterious sympathy, nay, even of approval or condemnation, which we feel in walls that have been washed by the passing wave of humanity.

(Ruskin 1849, Chapter 6)

Hence, time in buildings generates both their aesthetic and their historical values in holding the traces everyone in each generation left behind.

Pertaining to rural settlements this linkage to time in particular highlights the traces of daily life, more so, the stability of daily life. The agricultural-livelihood-dominated relationship between nature and built environment assured the continuity and stability of this relationship throughout the pre-modern era. That is due to farming being the dominant agent of the relationship between nature and the permanent housing. This stable relationship secured the same form and function of their built environment for generation upon generation as it also corresponded to a set of stable set of social practices including that of maintaining their physical environment. Hence, the sustainability of their livelihood assured the stability whereby the rural settlements over time accumulated their historical and aesthetic value.

## 2.3 The Modernity Caused Dualism State

Those above achievements of accumulating values and maintaining a generically sustainable relationship between nature and man only exist under the umbrella of the pre-modern. That statement can by itself only be formulated from a present-day viewpoint – from that of a modern society. As matter of fact, post-tradition generations - standing on the shoulders of enlightenment and equipped with advanced science and technology – initiated a new relationship between nature and humankind. Progressively this new relationship shaped modern society; modernity featuring i.a. capitalism, industrialization, and secularization. Furthermore, through modernity the prevailing worldview converted into anthropocentrism as Heidegger pointed out in his essay of ‘The Age of the World Picture’:

The fundamental event of the modern age is the conquest of the world as picture. The word “picture” now means the structured image that is the creature of man’s producing which represents and sets before... Namely, the more extensively and the more effectually the world stands at man’s disposal as conquered, and the more objectively the object appears, all the more subjectively, i.e., the more importunately, does the subiectum rise up, and all the more impetuously, too, do observation of and teaching about the world change into a doctrine of man, into anthropology. (Heidegger 1977, p115)

The anthropocentric worldview of modern society has generated a dualistic understanding of the past. Modernity has molded a new sensibility and awareness of history and the values of antiquity which can only be fully realized under new and unsustainable relationship between nature and man. A

relationship lacking the reciprocity of old as a consequence modern society's sense and value of time is recognized through cultural heritage conservation, which is now universally pursued, re UNESCO's definition:

The cultural heritage may be defined as the entire corpus of material signs – either artistic or symbolic – handed on by the past to each culture and, therefore, to the whole of humankind. As a constituent part of the affirmation and enrichment of cultural identities as a legacy belonging to all humankind, the cultural heritage gives each particular place its recognizable features and is the storehouse of human experience. The preservation and the presentation of the cultural heritage are therefore a corner-stone of any cultural policy. (UNESCO 1989, p57)

On the other hand, the reason of extending the cultural heritage territory into built vernacular environment is as ICOMOS admitted that

Due to the homogenization of culture and of global social-economic transformation, vernacular structures all around the world are extremely vulnerable, facing serious problems of obsolescence, internal equilibrium and integration. (ICOMOS 1999, P2)

'Homogenization' of culture and internationalization of the built environment represents a serious threat to cultural identity for present-day people all over the globe and may be seen as the most direct and tangible expression of modernity. In this modernity-caused dualism conserving heritage is a logical necessity in order to protect the fragile and faltering linkage to the past and with traditions we now are able to identify and appreciate.

This is particularly highlighted when dealing with the built rural settlements. Rural settlements used to represent the common arrangement of living space in the pre-modern era, now being replaced by the urban-living model of modern society. Moreover, the traditional relationship between nature and the built rural settlement has been significantly challenged because the conventional agricultural activities might no longer be the dominant mode of livelihood any more. Residents of rural settlement might pursue more profitable and easier careers, livelihood options that would never emerge in the pre-modern society. When these new modes of livelihood took over from farming, a new relationship between nature and community were established in rural settlements. These new livelihood options therefore logically affected the built rural environment: they had to physically adjust in order to suit this new situation. Rural settlement's self-adjustment has been a critical feature throughout history in its response to the requirements of 'daily life'. But in the face of modernity those changes and adaptation might be fundamental and they might thus suspend the very process of value accumulation. Furthermore those modernity-oriented self-adjustments may deconstruct – and destroy - the achievements and values made by the pre-modern paradigm.

## **2.4 A critical and Controversial Role of Community**

Identifying the value of the built vernacular environment as a particular type of cultural heritage is a claim rooted in the modernity-caused dualism. However, to verify it as an independent category and highlight its unique features, the local community plays a critical role in vernacular heritage conservation. Just as ICOMOS advocates "the appreciation and successful protection of the vernacular heritage depend on the involvement and support of the community, continuing use and maintenance." (ICOMOS 1999, P1) The controversial dimension emerges when the local community is in the process of modernizing, i.e. is changing their social practices and thus their innate relationship to the environment they now are advocated to maintain and protect.

The community was the creator of the historical and aesthetic values attributed to rural settlements. Adapting farming as its livelihood is why a rural settlement emerged in the first place. Agricultural activities generated a sustainable relationship between man and nature in which embedded and stable social practices constantly left traces on the buildings. These marks slowly evolving over time make up the settlement's 'voicefulness' – and its value as heritage. Under the livelihood-dominated relationship, the community not only created those values but also maintained them for generations. These social practices protected and accumulated these values long before they were identified and labeled 'heritage'.

Local communities play an essential role in rural settlement heritage conservation. This follows the unique position the inhabitants hold by actually living in their heritage. This is a different position from any other heritage monument that have become mere physical and symbolic artefacts. Through the fact that the inhabitants are living in their 'physical and symbolic artefacts' is essential for preserving their own cultural identity. This places the community in the primary position of 'heritage user'. But this also makes the community in their capacity as inhabitants the principal 'heritage

keepers' along with the heritage administration. And finally, the community is 'teacher' to settlement heritage conservation. Local inhabitants are thoroughly familiar with their living environment and have learnt, or 'inherited' the skills and knowledge on how to build and repair their dwelling in a way experts cannot learn from books.

However, the community stands to play a controversial role in the rural settlement heritage conservation when the community finds itself progressing towards modernity as this process alters the very character of a community and its relationship to the environment. The new livelihood adaption and the ensuing self-adjustment of the community also leave their marks on the traditional rural dwelling. Those marks are unlike those emerging under the umbrella of a traditional society. Moreover those new traces may cover, even destroy the values of heritage generated by the former marks.

## **2.5 Lived-in Cultural Heritage**

The circumstance of modern society, have forced the rural settlements to detach from the traditional living model which made the local community the very creators of settlement heritage values as well as their principal protectors. Being detached from the mode of livelihood that generated the heritage values, they also lose their capacity to create and protect, and may ultimately represent a threat to the rural settlement heritage.

From this perspective, the 'policy of conservation' towards settlement heritage can be regarded as another approach to achieving modernity. Although the conservation-generated modernity is much 'milder' than urbanization, the activity of conservation has created a possibility to form the rural settlement heritage into a 'lived-in cultural heritage' showcases. These are places where people live and where their cultural properties are used to sustain their livelihood. "Lived-in cultural heritage" as a self-coined term is differs from a "living cultural heritage" as it refers to the specific situation experienced by traditional rural settlements today.

## **3 THE CHALLENGES IN POST-DISASTER RECONSTRUCTION OF RURAL SETTLEMENT HERITAGE**

Based on the understanding of the characteristics of rural settlement heritage, we can then try to identify the factors can challenge the aim of reconstructing and rehabilitating a sustainable and resilient rural settlement heritage site after natural disasters, and consequently be able to recommend the necessary tactics towards that aim.

### **3.1 The Complex Process of Reconstruction**

Unlike other types of heritage, in a rural settlement heritage site, heritage conservation is an activity that coexists with habitation due to the fundamental function of a rural settlement (heritage): that of living. This coexistence therefore requires that post-disaster reconstruction not merely to rescues the disaster-damaged heritage properties but also – in order to sustain its conservation into the future - to rehabilitate 'the function' of living.

Post disaster heritage reconstruction unlike other objects, cannot be reproduced or renewed during the reconstruction. Because of that, to recover cultural heritage requires the professionals' delicate and elaborate reparations. Due to irreplaceability of cultural heritage, post disaster reconstruction of cultural heritage can never achieve the aim of retrieving all the values which heritage holds before the disaster. Natural disaster-caused damage is permanent. What one can do is maintain its remained values. Moreover is can be the opportunity to find and then eliminate vulnerabilities by increasing its resilience in order to mitigate the risk from potential natural hazards in the future.

Regarding the community, post-disaster reconstruction means to bring the disaster-affected society back on 'track', which requires recovering or replacing the damaged parts.

Rebuilding damaged living spaces carry fewer restrictions than repairing heritage properties. In this the community may seize the opportunity of pursuing new models of living since the former dwellings were destroyed.

Heritage rescue-reparation is normally secondary to rebuilding dwellings in a post-disaster context. However, those two activities overlap in rural settlement heritage sites as these two missions focus on the very same object– the residential buildings. A challenge, a conflict actually, emerges between pursuing the ideal living space and adhering to the strictly rules-dominated heritage reparation.. Another challenge follows when it comes to appropriately preserving the rebuilt dwellings. Those

challenges stem from the complex coexistence of conservation and habitation in rural settlement heritage as they represent both heritage values and living, respectively.

### 3.2 Volatility of Community after Reconstruction

Post-disaster reconstruction is basically about normalizing the disaster-affected area. The reconstruction is primarily focused on the physical environment. For example, the post-earthquake reconstruction in Sichuan took only three years, from 2008 to 2011, to (re)construct more than 2.2 million new dwellings and repair approximately 4.4 million damaged dwellings<sup>3</sup>. These achievements of reconstruction ensure the return to some sort of normality for the disaster-affected society. But they create a different 'normalized society', unlike the society before the disaster. The people living there needs time to understand this 'new society' and respond to the alterations caused by reconstruction.

Likewise, the community of a rural settlement heritage site needs time to adjust to this reconstruction-altered society. For those in the process of modernizing this adjustment may be seen as an opportunity. When traditional livelihoods are declining along with their living environment, the reconstruction after may be a way of pursuing a modern life style. This way post-disaster reconstruction becomes an accelerated process of modernity. Under such circumstances the community's reactions to reconstruction are unpredictable, which makes the community volatile after reconstruction. In general terms the community may, in other words, utilize reconstruction to shift its livelihood from agricultural activities to something that can modernize the community. However, this renders the community volatile and future livelihood activities unpredictable as they enter into a new and unfamiliar relationship with nature.

Consequently, this volatility of the community challenges the official and predetermined aim of reconstruction: to recreate and thus conserve what was there before the disaster. In effect, the community may actually thwart this mission by altering the (official) reconstruction in order to pursue their strategy towards modernization.

### 3.3 Uncertain Reflection upon the Physical Environment

In a rural settlement heritage site, the reconstruction-caused alterations at first appear in the physical environment. Those alterations soon after impact the social dimension of the community. Furthermore, the impacts do not remain within the social dimension, but also 'rebound' back to the physical environment. This is the uncertain reflection from the rebuilt rural settlements.

This uncertain 'feedback' results from the volatility of a community in the process of modernity in which, the community experiences an accelerated decomposition of their traditional-structured system and hence respond to the opportunities to quickly accomplish their version of modernity. No matter what opportunities community selects, it alienates the rural settlement heritage from the tradition-structured system. Gradually a new relationship between nature and community is established as along with adapting a new means of livelihood. This new livelihood may rework the (re)built environment, i.e. readjusting the recent reconstruction.

The post-Sichuan earthquake reconstruction, for example, experts of heritage conservation repaired the traditional Qiang dwellings, 3-storey stone-timber structured buildings. After the reconstruction, however, the community opted for the opportunities in tourism as a new means of livelihood. This new livelihood no longer relied on nature's resources but on their living environment, the rural settlement heritage. Following the requirements of this new livelihood, local residents rearranged the detailed and professionally guided repaired old dwellings into family inns by converting the cattle-breeding place on the first floor and harvest storage space on the third floor into guestrooms. In As we see new livelihoods force alterations, readjustments to the (re)built living environment. What sort of 'feedback' the environment will give is impossible to state beforehand. The community has several strategic options after reconstruction. As a result, this reflexivity on the part of the community makes the rebuilding of a rural settlement heritage very difficult as the predetermined aim of reconstruction, may not correspond to what the inhabitants see possible after the reconstruction.

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<sup>3</sup> As per data from the National Audit Office of P.R China in its annual audit report of the Post Sichuan earthquake reconstruction, 2011.

### 3 CONCLUSION & RECOMMENDATIONS

This paper is an attempt to uncover the characteristics of rural settlement heritage, demonstrating that agricultural livelihood was the corner stone to a sustainable relationship between nature and the built environment in the rural world. This relationship is the precondition for a long-term stable collaboration between a community's daily life and time. , Time has left traces in and on the buildings for generations and these marks were recognized as the core values of heritage, as conceptualized by modern society. This social practice-time collaboration continued to accumulate values of heritage until modernity driven changes in livelihoods. These are in turn causing new alterations, new imprints that may be of a totally different nature and thus devalue the heritage. ; Such modernity-driven alterations may question the local community's capacity to maintain and conserve rural settlement heritage.

This exposes three issues which interfere with, and challenge the aim of rebuilding a sustainable and resilient rural settlement heritage site as 'per book'. Issue no. 1 is the complex process of reconstruction due to the coexistence of habitation and conservation in a rural settlement heritage site. That leaves the reconstruction balancing the requirements of preservation with that of contemporary living conditions. Issue no. 2 is the volatility of the community after reconstruction related to the aspirations of the community towards modernization, i.e. a perceived better life. And in their pursuit towards modernity, the local community may react unpredictably to the reconstruction-created new 'normalized' society because of the uncertainty of their new 'modernized' livelihoods. Humans are reflexive and may not respond 'as predicted' or 'expected'. Issue no. 3 is – for similar reasons - the uncertain response the community will have upon the 'new' physical environment. Again this points to the reflexive relationship man holds towards his built environment. The outcome is thus unpredictable – and may result in the community changing the 'correctly reconstructed' heritage settlement by alterations that they find more useful in their pursuit of a more modernized way of living.

The above discussion indicates that focusing only on the reconstruction is insufficient for achieving a sustainable and resilient built rural settlement heritage site. And it is also clear to accomplish this aim in a short term perspective, is impossible. The reconstruction itself seems to create a volatile situation in which the community's unpredictable reactions to reconstruction may cause alterations to the built environment again - after its reconstruction. That requires a constant monitoring and investigation after reconstructions in order to find out what reactions the local community actually has and what 'feedback' they send back to the rebuilt physical environment – by possibly altering it. During the monitoring and investigation, a non-stop communication and collaboration between heritage conservationists and community members is crucial in order to find a win-win solution. Such a collaboration will have to acknowledge the aspirations of the community for comfortable living. This is a requirement for (re)developing a sustainable and resilient built rural settlement heritage.

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# ECOLOGICAL NETWORKS: THEIR APPLICATION FOR BIODIVERSITY CONSERVATION IN AN URBANIZED ENVIRONMENT

**A.R.b. ABDUL HAMID<sup>1</sup>, P.Y. TAN<sup>2</sup>**

<sup>1</sup>Department of Architecture, School of Design and Environment, National University of Singapore, A0066455@nus.edu.sg, abdulrahim.71@gmail.com

<sup>2</sup>Department of Architecture, School of Design and Environment, National University of Singapore, akity@nus.edu.sg

## ABSTRACT

The aim of this doctoral research is to develop a conceptual and methodological framework for the application of ecological networks onto a densely populated tropical city such as Singapore. This involves studying the spatial configuration of its green areas, incorporating a species level study through an assessment of the habitat suitability and quality of these green areas, as well as the permeability of the urban matrix through species dispersal. The first key question is whether it is possible to apply the concept of ecological networks onto a highly developed and compact city such as Singapore using multiple species. The second key question is how the conservation and enhancement of Singapore's biodiversity could be best achieved through taking an ecological network approach. The use of Geographic Information Systems (GIS) in concert with an organism based approach is aimed at bridging the gap between scientific biological research with landscape planning. The synergy between the two methodologies is achieved via focusing on the advantages of GIS such as spatial analysis and a layered approach, with the advantages of a species level analysis such as greater precision as well as relevance for local planning authorities.

*Key words: ecological network, biodiversity conservation, landscape planning, ecosystem management approach, Geographic Information Systems, Analytic Hierarchy Process, Delphi Process*

## 1 INTRODUCTION

The concept of ecological networks has been around for more than a decade, parallel to the call for an ecosystem management approach to biological conservation and planning. The conceptual and methodological frameworks have been developed extensively by numerous researchers [1-3]. While attempts have been made to apply the concept onto purely scientific studies [4, 5], others seek to extend the findings and concepts into landscape planning [6, 7]. This paper explores the applicability of the ecological network concept to the context of cities, particularly those within a tropical biome, through a conceptual and methodological framework for Singapore. Although the concept is not new, applying it to a densely populated urban region while considering a multi-species and multi-taxon approach is a novel one. This necessitates a multidisciplinary approach that includes the fields of conservation biology, urban ecology, landscape ecology, landscape planning, and remote sensing. This paper also explores an alternative approach towards the conservation of biodiversity for Singapore from one of protected nature areas to an ecosystem management approach, via an integration of the spatial characterization of Singapore's green areas, an assessment of habitat quality and suitability, mapping of species interactions with the habitats, and other land use considerations.

## 2 CONCEPTS AND PRINCIPLES OF ECOLOGICAL NETWORKS

Jongman [8] proposed that there is a need to adopt an ecosystems management approach to conservation, which is to move up towards a national or regional scale of protecting and restoring 'ecological networks'. An ecosystem management approach is 'a broad, systems-based approach that looks at the overall structure and behaviour of a given area' which concerns with analysing areas of distinct ecological areas as well as managing them [9]. Such an approach takes away the focus from the components of an ecosystem to emphasizing the importance of the functional relationships between the components [10].

Opdam et al [2] defines ecological networks as ‘a set of ecosystems of one type, linked into a spatially coherent system through flows of organisms, and interacting with the landscape matrix in which it is embedded’. Unlike the concept of a habitat network which is meant for a single species, an ecological network is a multi-species concept that links ecosystems together. Ecological networks may vary in physical configurations but they serve the same goal of biodiversity conservation. Such networks may be characterised via four physical features namely total network area, network quality, network density and the permeability of the matrix. Opdam et al [11] further proposes a framework consisting of four components to integrate individual species requirements to multi-species indicators at the landscape level. These components are a system of *ecological profiles*, an index for *habitat network cohesion*, an index for *spatial cohesion*, and an index for *landscape cohesion*.

Opdam et al [2] concluded that ‘ecological sustainability of landscapes can only be achieved on the basis of large-scale cohesive patterns of ecosystems’, and as a corollary, ecological networks is an effective basis for ecological sustainability when planning multifunctional landscapes. A review of the literature in ecological networks has shown that studies in ecological networks for tropical biomes are limited and no studies have been done for highly transformed densely populated cities using multiple species. Therefore, a pertinent question would be to ask if it would be possible to apply the concept of ecological networks incorporating multiple species onto a highly developed and compact city such as Singapore.

### 3 BIODIVERSITY AND LANDSCAPES OF SINGAPORE

Singapore is a city-state located at the tip of the Malay Peninsula. Due to its limited land area of 716.1 sq. km and a population of 5,339.2, it is a densely populated city of 7,540 persons/sq. km [12]. The landscapes of Singapore are made up of different levels of ecological spatial quality with varying degrees of species richness and ecosystem integrity. Being a biodiversity hotspot, there is rich biodiversity found within its nature reserves and natural areas. Not only is Singapore situated in a region of a unique ecosystem with a high biodiversity of species, but there is also a degree of endemism to her distinct version of tropical biodiversity [13]. However, the felling of trees in primary rainforests for agricultural production during the colonial era followed by subsequent rapid urban development has led to habitat fragmentation and loss. Hanski et al. [14] argued that this isolation and loss of habitats prevents native plant and animal species from developing viable populations and hence the loss of biodiversity.

One of the basic strategies to counteract this loss of natural habitats in the early days of Singapore’s development was to protect nature reserves by legislation and by designating other areas as ‘Nature Areas’. More recently, the government released two documents that incorporates biodiversity conservation, namely the Singapore Green Plan 2012: Beyond Clean and Green Towards Environmental Sustainability [15] and a National Biodiversity Strategy and Action Plan called Conserving Our Biodiversity [16]. One of the actions proposed under the latter is to extend green corridors to counter fragmentation. Some of the spatial strategies under this plan is the Park Connector Network [17], the Kallang River-Bishan Park as part of ABC Waters Masterplan (Active, Beautiful and Clean Waters) [18], and the Eco-Link Bridge over Bukit Timah Expressway [19]. However, there is currently a lack of a holistic framework and methodology for ecological networks [20].

Therefore, the second key question is how the conservation and enhancement of Singapore’s biodiversity could be best achieved through taking an ecological network approach. The questions posed gives rise to three objectives. The first objective is to characterize the current distribution and configuration of green spaces in Singapore using remote sensing and spatial analysis as the basis for further investigation. The second objective is to formulate a potential ecological network through mapping out the interactions between selected species and potential habitats and their permeability through the urban matrix, as well as a habitat evaluation at selected sites, in order to characterize the four physical features of an ecological network. The third objective is to develop the conceptual and methodological framework for the planning of ecological networks for Singapore.

### 4 METHODOLOGY AND RESULTS

Figure 1 outlines the methodological framework for the doctoral research. There are three broad stages. Stage one (ST1) in blue corresponds to a top down analysis of vegetation structure from a landscape scale for the whole island of Singapore. Stage two (ST2) corresponds to the link between landscape patterns to ecological processes at an island-wide scale followed by further assessments of

habitat quality and permeability of the vegetation at two chosen sites. The latter is a bottom up analysis from an organism based perspective. Stage three (ST3) corresponds to a planning stage whereby the analysis from stages 1 and 2 are being put through an assessment by experts from the various fields of urban planning, landscape planning and conservation biology using an Analytic Hierarchy Process via a Delphi Approach.

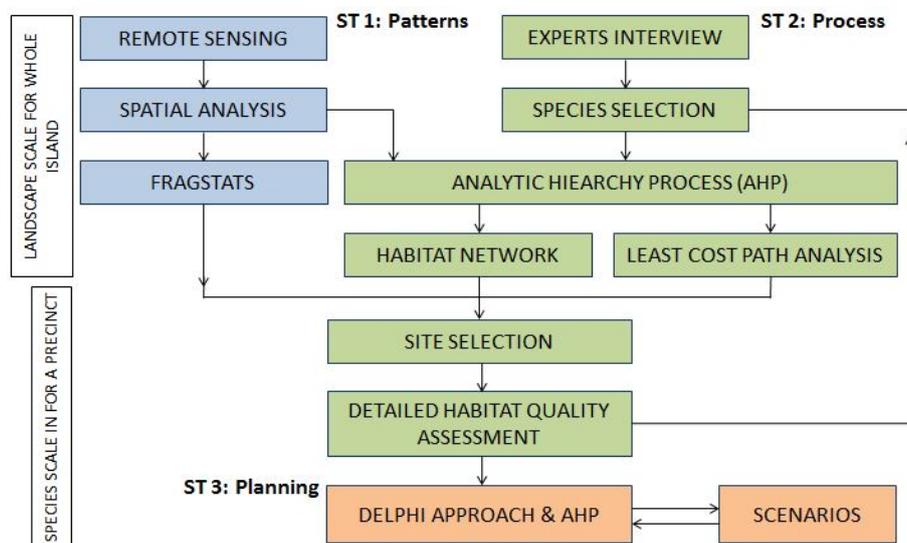


Figure 1. Overall Methodology for PhD Research

The methodology demonstrates how the concept of ecological networks can become a planning tool for landscape planning of a city while taking into account the both the ecological and social aspects of landscape provision. The flexibility of Geographic Information Systems which organise data into layers allows for the incorporation of as many species as required for consideration, and as many criteria and experts as required for the incorporation of ecology into the planning process [21]. The breadth of analysis is limited only to the extent of species and habitat networks that the planner wishes to incorporate. It is an iterative process whereby the outcome of the research may feedback into the formulation of new objectives or refining existing ones. Moreover, all four components of ecological networks by Opdam et al [11] are embedded within the methodology. This is important if the concept of ecological networks is to be effectively addressed within the planning framework.

There are both top-down and bottom-up approaches for this research, covering both an island-wide or regional scale, and a localised site scale for a detailed analysis. The first stage involves a top-down and island-wide approach via remote sensing, GIS spatial analysis functions and landscape metrics [22]. The derivation of the canopy map for Singapore is a fast method of obtaining the tree canopy cover versus open vegetation such as grasslands for Singapore whilst measuring the level of fragmentation of its overall greenery.

However, a top-down landscape level green vegetation structural analysis bears no connection with actual faunal species. It is important to consider the functional relationships and processes between landscape structure and the ecosystems within which are made up of species and their localised habitats. An organism based perspective also takes into account that landscapes are ecologically scaled which means that different species may perceive the landscape differently in terms of scale, distance or barriers [7, 11, 23]. Whilst many studies focus only on one species or taxon only, this research illustrates how the habitat networks for different taxon or species could be derived separately prior to their synthesis as a composite map. Only with the derivation of these separate habitat networks prior to their integration into an ecological network would the concept of *spatial cohesion* followed by *landscape cohesion* make sense [2, 11]. Taking a layered approach also implies that the analysis could incorporate a range of fauna with different home ranges from small to large. It is out of the scope of this research to incorporate the network of a wide range of species into the ecological network for Singapore but the modular structure of the tool linked to the layered approach of GIS enables the ecological network to be built upon over time as research in the various species progresses.

It is also important to zoom into the species scale of biodiversity in order to make the link from landscapes, which is predominantly within the realm of planners, to species, which is in the realm of ecologists, more tangible.

### Stage 1: Landscape patterns for the whole island of Singapore

The first stage involves two components, namely remote sensing and spatial analysis on an ArcGIS 10 platform in order to derive the canopy cover map for the whole of Singapore. A multi-spectral SPOT 5 satellite image with a 10 x 10m pixel resolution for the whole of Singapore was purchased in June 2012 via the Centre for Remote Imaging, Sensing and Processing (CRISP), National University of Singapore (NUS). A canopy cover map is derived from the SPOT Image via a supervised classification based on known areas of canopy cover and vegetated areas without canopy (Figure 2). Over 70 Regions of Interests (ROI) or training areas, verified by a drive through to various locations throughout Singapore with a GPS Tracking app called MotionX-GPS, were input into ArcGIS 10 as polygons.

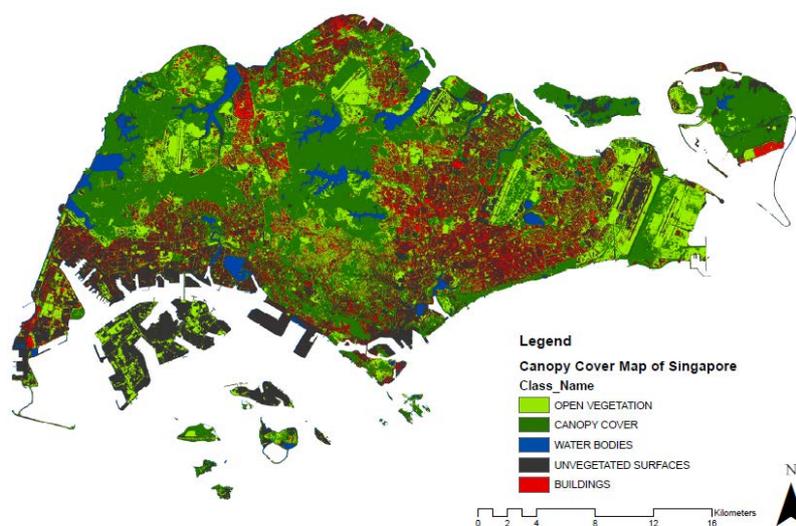


Figure 2. Canopy Cover Map of Singapore for June 2012

ArcGIS 10 is then used to visualise the results of a landscape structure study at a precinct scale using the values for the landscape metric called effective mesh size (MESH) derived from a freeware called FRAGSTATS 4.1 [24, 25]. Hexagons were created using a plug-in with a command 'Generate pattern of repeating shapes' [26]. The ideal size was determined following a study by Tian et al. [27] and another plug-in called Hawth's Tools [28]. This study leads to a selection of choices for further detailed site studies.

### Stage 2: Linking patterns to processes from landscape to species scales

The second stage of the research looks at the link between landscape patterns to ecological processes. Once the spatial pattern and structure of the landscape has been quantified, it is important to look at the species distribution data and ecological processes interacting with it in order to determine effects of structure on ecological processes and biodiversity [11]. The spatial characterisation of the greenery of Singapore derived from the spatial analysis of a remotely sensed image is further enhanced to include habitat networks. This is done by taking the canopy map as base layers for further inclusion into habitat suitability analysis and matrix permeability analysis for each key species considered in the next stage of the research.

Stage two consists of four components. In order to come up with an empirical rating scale for the habitat requirements and what constitutes habitat quality for each species, expert opinion is used as the main source of biological data collection [29]. Experts in the field of biological conservation and ecology were consulted in order to understand how the chosen species interact with their habitats, landscapes and urban elements. Thus, the first component features the interview of nine biological experts from academia, covering ten species; two each from five taxonomic orders namely butterflies, birds, amphibians, reptiles, and mammals.

For the second component, the expert approach is even further enhanced with the Analytic Hierarchy Process (AHP) [29, 30], and linked to a GIS analysis [31]. The AHP involves assigning relative values to pairwise comparisons on the importance of each layer of vegetation such as canopy, shrub, and ground cover, by using a rating scale developed by Saaty [32]. The resulting values are then set up in a matrix called the Overall Performance Matrix followed by the calculation of its eigenvector. The values of the eigenvector correspond to the relative weight assigned to the attributes considered earlier.

The third component involves the use of ArcGIS 10 to create a habitat potential map and a least cost paths map for each of the ten species identified by the experts for the whole island of Singapore [33]. Incorporating specific criteria for habitat requirements and AHP into the formulation of habitat patches enables the creation of a map of 'effective patch areas' weighted by habitat quality and becoming more ecologically relevant [30].

The habitat potential map for the Crimson Sunbird (*Aethopyga siparaja*) and the least cost paths from the Central Catchment Nature Reserve is shown below (Figure 3). The weights derived from the eigenvectors of the resulting matrix from the AHP were fed into an overlay analysis in ArcGIS 10 while incorporating relevant GIS base layers. The least cost paths map was derived using another set of variables as layers in which the expert was asked to rate them via the AHP for their ability to facilitate the dispersal of the species through the urban matrix, such as canopy cover and presence of water; as well as for their properties as barriers to dispersal, such as roads, canals and development intensity. The values derived from calculating the eigenvectors of the AHP matrix were then used to obtain a cost surface map which is the difficulty or 'cost' incurred by each species to move across the whole island. A cost distance map and a backlink map are then derived from a point at the Central Catchment Nature Reserve as a starting point. Finally, a least cost paths map is obtained which shows the paths of least cost for the Crimson Sunbird to disperse from the Central Catchment throughout the island. The habitat potential and least cost paths maps for each species represents its *spatial cohesion* in relation to the whole island of Singapore.

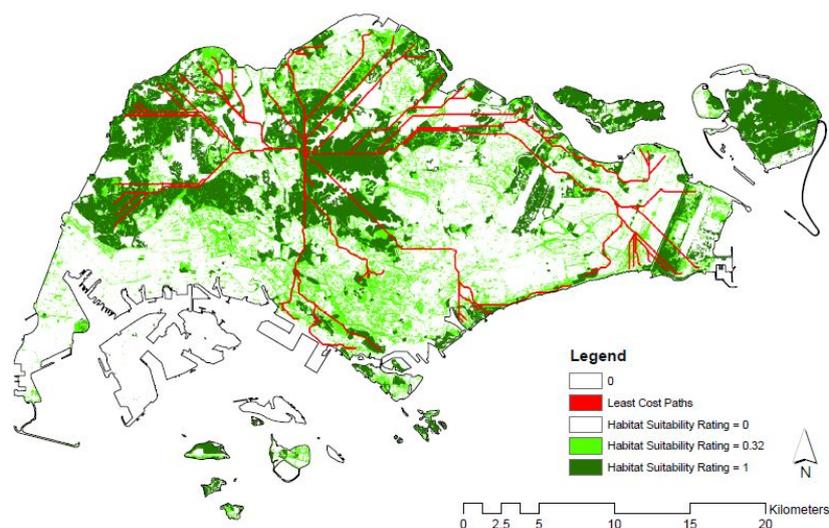


Figure 3. Habitat Potential map and Least Cost Paths for the Crimson Sunbird (*Aethopyga siparaja*) from the Central Catchment Nature Reserve to patches along the island perimeter

The fourth component entails a further assessment of habitat quality and permeability of the vegetation, and is a bottom up analysis from an organism based perspective [34]. Habitat quality is an important component which includes the specific vegetation characteristics and species required for every stage of the organism's life cycle as well as the multi-layered canopy structure of a tropical biome. In order to achieve a better assessment of habitat quality, the collation of the habitat potential and least cost path maps of the ten selected species into a composite map of *landscape cohesion* will assist in determining the key ecological patches and corridors for Singapore [11]. These maps will be further enhanced with an additional step involving a rapid biodiversity assessment of the patches *in situ*, adapted from Tzoulas and James [35], which links the landscape and ecosystem scale of the study to the species scale in a scientific, empirical manner as will be illustrated at two chosen sites. The results from this stage of the research is then presented to the biological experts for validation by

asking if their proposed key species are actually present in the patches and corridors of the chosen sites [36]. In return, the maps of the habitat potential and bottlenecks to species dispersal could be shared with them. This is indicated by the feedback loop in figure one in which more experts and species could be incorporated into further analysis in order to strengthen the *landscape cohesion* of the ecological network for Singapore. This process of sharing knowledge can engender further discourse between planners and biologists, hence bridging the gap between science and planning, which is the focus of Stage three of the research.

### **Stage 3: Linking science to planning at the precinct level**

The third stage of the doctoral research is to illustrate how the map of *landscape cohesion* formulated earlier could be incorporated into the planning process. This stage involves an overlay analysis of the maps derived from Stage two in relation to the adjacent land uses for two chosen sites in order to produce a composite map of different planning scenarios. Experts in the field of biological conservation, urban planning, and landscape planning will be interviewed via an iterative Delphi process, which is a useful technique to seek consensus amongst several experts or to extract key expert-based opinions via a structured communication process [37].

The expert panel will be asked to make pairwise comparisons between the conservation value of the habitat patch and corridor for each site in relation to the adjacent social values, such as housing, education or built heritage, and development values, such as industrial, commercial or transportation [38]. The weights derived out of this Analytic Hierarchy Process will then be fed into ArcGIS 10 to derive different scenarios as an outcome of the rating by each expert. The resulting scenarios will then be put forward to the same panel for discussion or re-weighting in order to come to a consensus as to the prioritized scenario for each site and the accompanying interventions, and mitigations or compensations.

## **5 DISCUSSION**

The doctoral research coincides with an exciting era whereby cities recognize the need to conserve biodiversity at the city scale. This parallels the growth of a relatively new field of urban ecology and refinements in the field of landscape ecology. This is further reinforced by using the case study of Singapore as a starting point for tropical cities whose outlook towards conserving urban biodiversity is a positive one with their new tagline of a 'City in a Garden'.

The significance of the proposed research is that firstly, the outcomes can be used to provide another approach to the conservation of biodiversity of cities, which may greatly enhance the traditional protected area approach, and hence its resilience for generations to come. Secondly, the research is to develop possible tools for use by land use planners to implement urban biodiversity conservation initiatives.

There is also an element of novelty to the proposed research both in terms of the theoretical foundations of ecological networks for dense urban areas and cities, as well as techniques and planning applications. The research attempts to look at the intersection of three disciplines of conservation biology, landscape ecology and urban ecology for a novel way of framing urban biodiversity conservation efforts for dense tropical cities such as Singapore.

## **6 CONCLUSION**

To reiterate, the above theoretical and methodological framework demonstrates how the concept of ecological networks can be applied onto a highly developed and compact city such as Singapore using multiple species, and how the conservation and enhancement of Singapore's biodiversity could be best achieved through taking an ecological network approach. The complete methodology is illustrated fully for two chosen sites due to the very detailed nature of the work in order to keep it within the scope of a doctoral dissertation. The methodology should be applied to more sites in Singapore in future depending on priority and development pressures. Furthermore, due to the limitations of a doctoral research, specific methods, species and consultations have been chosen based on the availability of data, experts and time. However, the flexibility of the methodology due to its modular and layered approach enables the incorporation of more species or experts in future as well as engaging both developers and the public in focus groups at the planning stage.

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# DESIGN THINKING FOR SUSTAINABILITY: A CASE STUDY OF A RESEARCH PROJECT BETWEEN HENNES & MAURITZ AND TEXTILES ENVIRONMENT DESIGN

**Kirsti Reitan Andersen<sup>1</sup> Rebecca Earley<sup>2</sup>**

<sup>1</sup>Copenhagen Business School

<sup>2</sup>University of the Arts London

## ABSTRACT

In this paper we fuse design thinking and the sociology of translation, particularly Callon's four moments of translation (1986), creating an analytical framework to explore organizational barriers to change towards sustainability in the textile and fashion industry. Drawing on design thinking we propose to add a fifth moment to Callon's framework to highlight the value of iterations or "overlaps" (Callon, 1986) in processes of change. The paper, which is co-written by a textile design researcher and a PhD student with a background in cultural studies, is based on a case study of a workshop series developed and delivered by Textiles Environment Design (TED) at Hennes & Mauritz (H&M). Based on an analysis and discussion of the workshop series, we argue that design thinking, especially through its use of design tools, has the potential to make the challenges and opportunities related to processes of sustainability change tangible and thus more actionable at individual and organizational level. We further argue that the framework established could facilitate a more nuanced understanding of organizational barriers to change towards sustainability and also bestow the field of design thinking with additional analytical concepts to explore its methods and communicate its potential value to processes of change.

*Keywords: The Sociology of Translation, Actor-Network-Theory, Design Thinking, Sustainability*

## 1 INTRODUCTION

The textile and fashion industry causes more pollution than most other industries and continues to face social challenges (Deloitte, 2013; Greenpeace, 2011). It is a highly globalized industry characterized by complex, global production networks, involving many different actors, with a modern history of migrating from one region to another. Most of this migration has been driven by one factor: the need to cut costs (Mosley & Uno, 2007). While a substantial part of the total environmental impact of a garment is to be found in the use phase, through laundry and premature disposal (Fletcher, 2008), the production phase is essential to the overall sustainability of textiles and garments. Normally it is the brand that triggers the product development process and thus also has the opportunity to impact the sustainability of the garment. While there is considerable research within the field of organizational change (i.e. Håkansson et al., 2012; Quattrone & Hopper, 2001) and sustainability and Corporate Social Responsibility (CSR) (i.e. Scherer & Palazzo, 2011; Banerjee, 2008), fashion companies at large still struggle to create change towards sustainability demonstrating a need for an analytical framework that can support a deeper understanding of organizational barriers to sustainability.

The empirical foundation of the paper is a collaborative research project between Textiles Environment Design (TED) and the Swedish multinational retail-clothing company Hennes & Mauritz (H&M), henceforth The Project. For the analysis, we draw on two streams of literature: design thinking (Brown, 2008) and the sociology of translation, particularly Callon's four moments of translation (1986), to explore the ways in which a fusion of the two approaches could bring forth new nuances to our understanding of organizational barriers to sustainability. We propose to add a fifth moment to Callon's

four moments of translation to bridge the practice-based approach of design thinking and Callon's analytical framework. This framework could then inform new practice-based research to organizational change towards sustainability in the textile and fashion industry. In this way, the paper builds upon recent impulses from Latour (2013; 2008), who argues that design is a key resource to extend more traditional social research and a means to support social intervention. For the analysis we use a broad definition of sustainability, mapped through design approaches, as outlined in The TEN (Earley & Politowicz, 2010) (Figure 1).



Figure 1. 'The TEN', buttons from the TED website (left), and in playing card format (right)

The paper is co-written by the practice-based textile design researcher who led The Project (Rebecca) and a PhD student with a background in cultural studies who followed The Project as part of her studies (Kirsti).

## 2 THEORY

In the following we introduce design thinking and the sociology of translation. Through the introduction of a fifth moment of translation we create a framework that draws both on a practice-based and an analytical approach to research.

### 2.1 Design Thinking

The history of design thinking is complex because definitions are being proposed by practitioners and scientists alike (Norman, 2013 & 2002; Kimbell, 2011; Brown, 2008; Cross, 2001; Simon, 1982). For the purposes of the paper, the authors adopt the understanding of design thinking tied to the design consultancy IDEO. In this view, design thinking is a formal, explicit method for practical, creative resolution of challenges or issues, with the intent of creating an improved result. Design thinking includes three overall stages: inspiration, ideation, and implementation (Brown, 2008; Moggridge, 2007). Any given project will jump back and forth between these stages, in particular those of inspiration and ideation, and is characterized by iterative cycles of prototyping (Houde & Hill, 1997) (Figure 2).

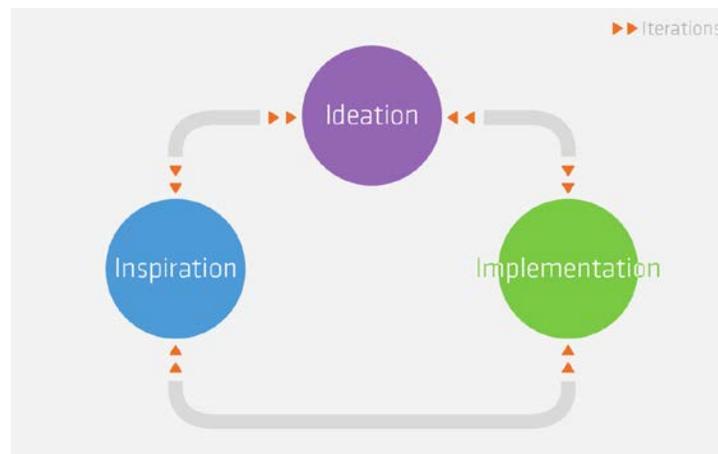


Figure 2. Design Thinking (Illustrations courtesy of Francesco Mondelli)

At TED the researchers recognize that design thinking is embedded in their practice-based projects - workshops are a key research method - yet the specific terms are not part of their every day language. A three-stage design thinking approach with iterative cycles can be found in all their research projects, and underpins the design of The Project work with H&M (Figure 3). Thus it provides a useful framework to discuss the development of The Project as well as design thinking's potential contribution to processes of change toward sustainability (Coughlan et al., 2007).

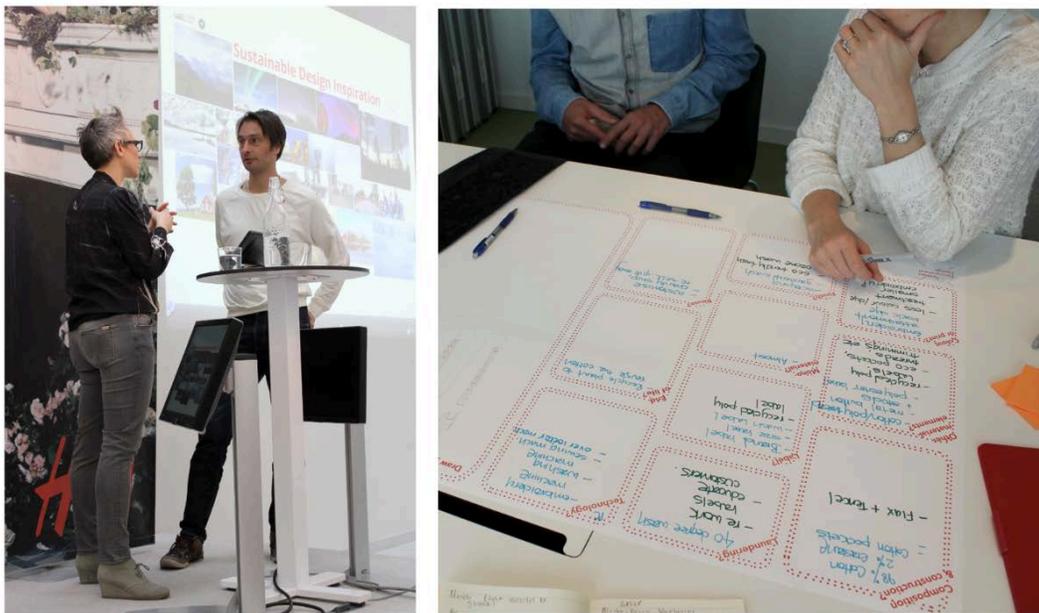


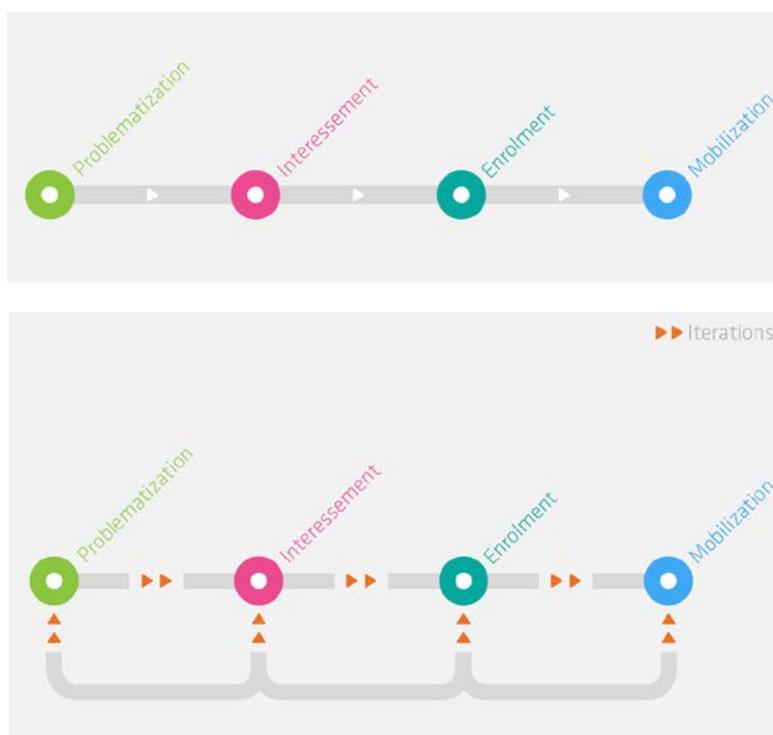
Figure 3. Two of The Project's Design Thinking approaches: (left) inspiration, the lecture series 'Sustainable Design Inspiration'; and (right) ideation, the redesign of existing H&M garments

## 2.2 The Sociology of Translation

In his seminal text from 1986 Callon investigates the process of translation, presenting it as a new approach to the study of power. The sociology of translation belongs within the broader theoretical framework of Actor-Network-Theory (ANT) (Latour, 2013, 2005, 1987; Law, 1992, Callon, 1986, 1980). At the core of the sociology of translation is the idea that change can be interpreted as a process consisting of four moments of translation: problematization, interessement, enrolment, and mobilization (Callon, 1986) (Figure 4). Problematization is the first moment and relates to the identification of actors in a network and the definition of the problem or question, also referred to as the obligatory passage point

(OPP). The second moment of translation, *interessement*, relates to the group of actions that an entity attempts to impose to stabilize the other actors' identity, which has been defined through *problematization*. If the *interessement* succeeds, then *enrolment*, the third moment, could take place. *Enrolment* refers to the moment that another actor accepts the interests as defined by the representatives. The last mode of translation is that of *mobilization of allies*. In this phase the crucial question to ask is whether the masses follow their representatives, their spokesperson (Latour, 2005; Akrich et al., 2002). *Mobilization* is the point at which the network of alliances can operate by itself and be represented to the outside as a unique entity. Callon highlights that this general agreement and the network of allies that it depends upon can be challenged at any given moment (1986: 15).

Establishing an analytical framework that draws on design thinking and the sociology of translation we propose to add a fifth moment to Callon's framework to better capture the cyclical process that characterizes both approaches, but is less outspoken in Callon's model. While Callon notes that the individual moments can "... in reality overlap" (1986: 6), the manner in which he outlines these, show translation as a rather linear process (Figure 4). Giving emphasis to the iterative process of translation through a fifth moment of translation bridges the two approaches and provides an analytical framework that has the potential to bring forth a more nuanced understanding of barriers to sustainability (Figure 5).



Figures 4 and 5. Callon's four modes of translation (above), and The Fifth Moment: Iterations (below)

### 3 METHOD: PARTICIPANTS AND DATA COLLECTION

This paper is based on empirical data gathered through fieldwork and our reflections on the analytical framework. The aim of The Project, which falls under MISTRA Future Fashion,<sup>1</sup> was to provide sustainable design education to H&M design teams and explore if this could generate ideas for new products and processes. TED designed a T-shaped training program for the H&M buying office. The program included six inspirational one-hour lectures that targeted the buying office at large and three workshops targeting a smaller group of people over a longer period of time. Here we focus on the

<sup>1</sup> For further information, please visit: <http://www.mistrafuturefashion.com/en/about/Sidor/default.aspx>

workshops, as they allowed a deeper engagement with actors and a setting to explore the role of design thinking in the facilitation of change towards sustainability.

### 3.1 Participants

TED consists of a team of practice-based textile design researchers based at Chelsea College of Arts, part of the University of the Arts in London. TED's work centers on The TEN, a set of design strategies spanning from approaches that rely on material, process, and technological solutions, captured in strategies 1-5, to more conceptual strategies encouraging radical innovation, captured in strategies 6-10. TED is engaged in education, research, and consultancy. The work with H&M was new in that it demanded that they apply their framework in a particularly restrictive environment, with a specific design team (Rebecca, April14).

The main actors involved from H&M were the Head of The New Development Team (JW), a representative from The White Room (UJ), and The New Development Team (ND Team). Hereafter, individual actors in the ND Team are referred to by "ndtINITIALS," i.e. "ndtMM." Both departments belong within the H&M Buying Office, which is located in Stockholm, employing approximately 1,200 people. The ND Team is, amongst other activities, responsible for the design of H&M's Conscious Collection. The White Room's main function is to support the design teams with color, fabric, trim and design expertise. Other actors, who were not directly involved in The Project but proved to play an indirect role, were H&M's production offices, responsible for decisions regarding manufacture sources, and the CSR department that set the overall sustainability agenda.

When quoting participants, we use the coding system established above followed by month and year, i.e. "ndtMM, Oct13." Thus, focus is on individual positions and the time of the statements to show how actors' roles and the goal of The Project change over time.

### 3.1 Data Collection

Kirsti took an ethnographic approach to the study, using participant observation and informal and semi-structured interviews to gather data. Participant observation rests on the principle of interaction between actors (Spradley, 1980; Atkinson & Hammersley, 1994), which enables the collection of a wider range of data than, for example, can be gathered using interviews only. The fieldwork was mainly documented through field notes and sound recordings. Participant observation was supported by informal and semi-structured interviews (Bernard, 2006; Kvale, 1996). A framework of themes to be explored was prepared in advance of the semi-structured interviews, but the conversation was kept open (Bernard, 2006). Furthermore, photos were taken to support field notes and our discussion. While Kirsti adopted an ethnographic approach, she aimed to facilitate a more dialogic form, allowing for multiple voices, as opposed to the "monologic" mode of much ethnographic writing (Atkinson & Hammersley, 1994: 256), through a conversational style in fieldwork and writing.

The empirical foundation of the study consists of three workshops and a re-cap with the ND team. The workshops were developed and conducted by TED, with the assistance of JW and UJ. The fieldwork was comprised of participant observation at the TED studio in the period June through November 2013, participant observation of the three workshops (April, 2013; May, 2013, and October, 2013), the re-cap session (June, 2013), as well as mid-way meetings and the final evaluation meeting between TED and H&M, ten semi-structured interviews with TED and H&M employees respectively, four semi-structured interviews with groups of workshop participants, and participant observation of TED's development and evaluation sessions before and after each workshop and the re-cap.

The software DEVONthink was used to manage field data. While the full data set inform the analysis and discussion we draw on selected parts based on the importance given to the issue by the involved actors (recurrent topics of discussion) and situations that highlight and contextualize TED's development and use of tools to facilitate translation.

## 4 AN EXPERIMENT IN TRANSLATION

In the following we draw on design thinking and the sociology of translation in an analysis of The Project. While the empirical data is based on design thinking, Callon's four moments of translation is the starting point of analysis. This then leads us to propose a fifth moment of translation and a discussion of the potential value of an analytical framework that fuses the two approaches.

### 4.1 Problematization

Inspired by TED's research on the ways in which designers can contribute to the sustainability of the textile and fashion industry, H&M invited the researchers to explore this question with the company. Early on in the process it was decided that The Project content should focus on TED's strategies 1-5, as opposed to strategies 1-10. According to JW: "Those are the ones most relevant to the buying office. We wanted to take away those that we cannot really effect, because we were afraid that this was just going to frustrate people." (May13). The delivery of the workshop was preceded by 18 months of negotiations and development, or problematization (Callon, 1986). During problematization The Project defined the role of individual actors and their identities. Key actors were agreed to be TED, JW, UJ, and the ND team. Their individual roles however, remained rather vague. For example, promoted by JW, TED was established as the spokesperson of the translation process. But, as the analysis will show, they were not given the organizational support to take on this position. Likewise The Project struggled to define the content and goal of the workshop series. The initial idea was to build on the educational model of an H&M training course in sustainable materials, but focusing on sustainable design methods: "In the beginning we discussed whether this should be a lecture and workshop within sustainable product development." (JW, May13). However, it soon became clear that this was not a risk H&M was willing to take:

"But the way we product develop within H&M is very structured today, there is a certain method that we use. We are so dependent on this method and how things work from sales to production. If we then start to say that we want to change this method, everyone gets pretty scared and we couldn't really get through with this. So therefore we had to put the whole direction of this course, lectures and workshops, towards a more inspirational angle, saying that this is about sustainable design inspiration rather than changing the method, how we work." (JW, May13)

Law uses the term punctualization to describe networks that run wide and deep, such as H&M's design method. He highlights that: "Punctualization is always precarious, it faces resistance, and may degenerate into a failing network." (1992: 385). As stakeholders within H&M learned that a workshop within sustainable product development had the potential (or risk) to train their designers to approach the design task in new ways, it was decided that the workshops should focus on inspiration, rather than education and training.

The actors failed to define a goal that successfully integrated their different agendas. JW, in an attempt to do so, appointed a key role to "the garment" – either as a whole piece, or new fabrics, finishes or processes embedded within: "But the goal we set up was that if we could get just one garment from TED into the H&M store, then that'll be success." (Dec13). TED did not object to this; but for them The Project was about education and inspiration at a more holistic level (Rebecca, Apr14). Being part of MFF, this was an opportunity for TED to investigate how The TEN would work in a large organization: "You see, in my mind the workshops are about product change but the ideas and the conversations that came about that implied cultural change or organizational change were a byproduct, and a very important byproduct ..." (Rebecca, Dec13). Meanwhile, UJ, as a representative of The White Room, was not particularly interested in exploring to what extent the creativeness of designers could add to the sustainability of the company's products, but was more interested in the case studies, as a resource for the White Room. While these diverging interests are brought up in discussions, the key actors never seemed to agree on what would constitute successful translation.

## 4.2 Interessement

Throughout the project, TED developed devices of interessement in the form of tools to guide and inspire the ND team. The tools had the additional function of being prototypes, developed to support TED's design process. For the purposes of this discussion, we focus on the TED RED BOX, which, in some ways, became the epitome of the project (Figure 6). The box contained a number of industry case studies that TED had selected and developed for H&M. What had been a small-scale, bespoke set of examples were transformed into industrial-level, actionable case studies and, in collaboration with H&M, divided into groups of "now," "near" and "far" (Rebecca, Apr14). In a meeting with H&M Rebecca introduces the box and its purpose:

"An important tool used throughout the three sessions will be the TED RED BOX. This contains a collection of industry innovations to illustrate how sustainable design is evolving across the globe. By editing and adding to these key ideas and case studies throughout the duration, the designers will build an invaluable resource - designed to be taken back to the studio and even used beyond the life of the course." (Feb13)



Figure 6. (Top left) The TEN RED BOX with case study cards; (top right) a time coded case study card; (bottom left) the NOW WALL; (bottom right) the untended box left on the shelf at H&M's White Room

The box was introduced to the ND team in the first workshop in March 2013. The participants were asked to divide the cases in 'now,' 'near,' and 'far,' as a way to take ownership. However, as the workshop rolls out, TED soon realized that the box, in its current form, could not extract the ND team from current practices (Callon, 1986). Using this constraint as a creative springboard (Brown, 2008), the cards in the box became the "Now Wall." Thus, the industry cases that the workshop participants found the most relevant to their work were hung on the wall, in the workshop space. It was then agreed to move the Now Wall to the ND team studio, as the workshop participants were to use the cases for their homework in preparation for the second workshop. On TED's return to H&M, for the delivery of the second workshop, the Now Wall was in the ND team studio. The box however, containing the cases that had been categorized near and far, was left in the corner, clearly not in use. Reflecting on the Now Wall JW says: "We can take a look at the cards, they're at the center of the department. But then again, it's a company, everyone have a full agenda. People do get inspired when they see the cards, but still everyone has more than a full agenda, especially this time a year. Well, it's like that every time." (May13). H&M's dismissal

of the near and far cases was a challenge to TED as it inhibited their aim to create an inspiring setting for the workshops and spur the ND team's creativeness. TED's selection and development of the industry cases, first for the box and then the creation of the Now Wall illustrates the iterative process of negotiations and adaptation that they went through in order to create suitable devices of interest for H&M: "To interest other actors is to build devices which can be placed between them and all other entities who want to define their identity otherwise." (Callon, 1986: 9). However, whilst there was a lot of focus on the individual cases and the design of the box, Rebecca recognizes that not enough consideration was put towards understanding the context that the tool was going to inhabit (Apr14).

### 4.3 Enrolment

On several occasions the workshop participants expressed their excitement about the workshops and TED's tools, or, in the words of Callon, the trapping devices (ndtMM, May13; ndtHN, May13; ndtMM, Dec13; ndtSM, Dec13). However, no matter how convincing, success is never guaranteed (Callon, 1986; 1991). Thus, though not made explicit, as The Project progressed it began to meet resistance from The White Room and the production offices, departments that currently carry considerable decision power in terms of H&M's sustainability agenda. The Project's success criteria of one garment/idea on the shop floor became a challenge, as the garment is the one actor that travels the entire organization and its supply chain. The Project's negotiation with the ND team became a negotiation with the company's organizational culture and structure. With the decision to shift the workshops' focus from design training to design inspiration, TED was also limited to work with the ND team only, not the production offices or other departments responsible for the company's sustainability agenda. In light of this, getting one product/idea through to the shop floor seemed an unrealistic goal.

Organizational resistance got a tangible expression in the limited turn up for the second workshop. Expecting about 30 participants only 12 showed up, due to internal deadlines (ndtHN, ndtMM, UJ, JW). Turnout for the Re-Cap session and the third and final workshop was good, but H&M's difficulty in allocating time for the workshops indicates failure of enrolment at organizational level. For TED, the fate of the TED RED BOX came to illustrate the struggles of The Project. But it also provided them with insights that led to new opportunities:

"But we made a very quick jump, we went from case studies to, ooh, tool box, let's see if this works, very quickly. It didn't work. It actually didn't work because nobody could own it and it would take more time to use it. And it was never meant to happen that there was a Now Wall. The Now Wall got invented in the moment as it worked better as a wall than it did as a box, and that immediately led to the insight that things need to be digitized in this company." (Rebecca, Dec13)

### 4.4 Mobilization

Following the 3<sup>rd</sup> and final workshop, JW announced that he had accepted a new job within H&M and was to leave his position as Head of the ND team. Now The Project was left without a key stakeholder. Mobilization seemed to have failed. As expressed by a TED researcher: "At H&M the workshop almost became something like ticking the box of what you have to do." (Oct13). According to Friedman, there are many causes of design failure including: "... lack of will, ability, or method. Designers also fail due to context or client, lack of proper training or a failure to understand the design process." (2003: 509). It seems as if The Project never came beyond problematization. The role of individual actors was unclear and it was never agreed what would constitute the "preferred" situation: "Being brought in to be educators and then sort of being re-packaged to be something else. What were we doing? Inspiration? Yes. Product idea for the shop floor? No – because we weren't allowed to, because they already had 'a way of working.'" (Rebecca, Apr14). However, as Callon underlines, translation is always a process. JW: "For me inspiration is the first key to making a change. First you have to get inspired, then you have to get knowledge, and then you base your decisions upon your new knowledge." (Dec13).

#### 4.5 Fifth Moment: Iterations

Based on the analysis of The Project, we propose to support Callon's framework with a fifth moment that we call: *Iterations*, as illustrated in Figure 5. This has two benefits. First, giving emphasis to the cyclical nature of change, organizational barriers, otherwise difficult to pinpoint, one gets a more tangible expression. Second, the proposed framework provides the spokesperson with concepts to recognize and work with the power games and resistance that characterize processes of change. Reflecting on The Project, Rebecca says: "In this case we had to really get involved in their circumstances and try to understand more about how The TEN could be applied and used, and would or wouldn't work. And of course what we kept coming up against was just this mass of informational and organizational infrastructure that prevented the designers from pursuing ideas." (Apr14). TED's response to these barriers was to continuously develop new tools, based on the behavior and feedback of participants. Supporting this process with the adaption of Callon's framework, over time, helped establish a more nuanced understanding of the barriers to the attempted translation. Tsoukas and Chia (2002) also highlight the iterative nature of change, arguing that change programs triggers ongoing change, "...It must first be experienced before the possibilities it opens up are appreciated and taken up (if they are taken up)." (578). We argue that the analytical framework proposed here supports a more thorough exploration of this process, than either of the two on their own.

## 5 DISCUSSION

As TED and H&M embarked upon The Project, they voluntarily entered a moment of redefinition, discussion, and negotiation - a moment of conflict (Latour, 2005), providing a unique case to explore processes of change towards sustainability. In the following we first discuss the ways in which design thinking could facilitate such change and how the proposed framework might support a more nuanced understanding of organizational barriers as well as provide the spokesperson with concepts to better act on these.

### 5.1 Design Thinking for Sustainability

In a keynote lecture given at the *Networks of Design* meeting Latour argues that to design something allows us to raise the normative question of good and bad design (2008: 11). Applying this to The Project, we can ask: is the garment well or badly designed? With The TEN at the core of the design process, the question of whether a garment is well or badly designed concerns more than aesthetics, fit, and cost. It concerns questions of social and environmental sustainability. While it is agreed that The Project should take an inspirational nature to prevent internal opposition, it nevertheless keeps running into organizational barriers, especially the question of who "owns" sustainability. While it is stated that it is everyone's responsibility (UJ, Jun13), in effect, the ND team has limited decision power (JW, Dec13).

One of the biggest challenges in sustainability is perspective: how to tackle big systemic problems such as poverty, water scarcity, and climate change? The Project demonstrates that design thinking can help make these massive challenges more accessible, at an organizational as well as at an individual level. For example, H&M could choose to work with strategies 1-5, keeping it actionable within the buying office. Similarly The TEN allows individual designers to start with one or two strategies and then, through layered thinking (TED, 2013), add more strategies (Figure 7).

The tools made the intangible topic of sustainability actionable: "That's what was so good about this course, it was more focused on - I mean, it was also about the big picture, but also about here and now. What you can do in your daily work." (ndtHN, May13). While The Project failed mobilization, TED's tools enabled the ND team to better overcome the challenges of perspective, drawing together human and non-human actors in 16 re-designs, celebrating the changes they could do within their part of the organization. As Latour argues, "To imagine that a political ecology of the magnitude being anticipated by all of the experts can be carried out without new innovative tools is to court disaster." (2008: 13). TED's tools also teased out internal power games, that otherwise could have gone unnoticed or not discussed. For

example, following the workshop, it turned out that no one took ownership of the Now Wall, both indicating lack of mobilization, but also a lack of communication:

“Kirsti: So I know the Now Wall was hung in the kitchen space in the ND team’s studio. Is it still there or has it been taken down?

JW: I haven’t been there for a couple of weeks so I have to say I don’t know.

UJ: I don’t think they’re up, to be honest, because we took them down for the last session and then I don’t think we put it up.

JW: [to UJ] You were supposed to be the ones owning them, right? We discussed that the most relevant spot to keep them would be with you and ... (Dec13)



Figure 7. One of the sixteen redesigned product worksheets that were created during The Project

## 5.1 Sociology of Translation

While the literature on design thinking pays close attention to the cyclical nature of design and the value of prototypes and design tools (Coughlan et al., 2007; Buchenau and Suri, 2000) we asked ourselves if Callon’s four modes of translation could bring out nuances that empower the designer in facilitating processes of translation. Does it, as Callon argues, support a better understanding of a “... network of relationships in which social and natural entities mutually control who they are and what they want.” (1986: 6). And if this is the case, does this knowledge bring any added value to design thinking?

The sociology of translation highlights the power games core to the translation process. TED, more than once, return to the perceived lack of collaboration from parts of the organization. Thus, while TED time and again is positively surprised by the creative atmosphere characterizing the buying office, the H&M production offices is perceived as the business reality: “... this whole other beast.” (Rebecca, Apr14), and they experience a lack of collaboration from The White Room. While TED’s tools tease out organizational barriers that might otherwise be overlooked, design thinking seems to lack the concrete focus and vocabulary to discuss the power games related to some of these barriers, provided by Callon’s framework.

## 6 CONCLUSION

As we demonstrate in our analysis of The Project, Callon's four moments of translation supports an investigation and deeper understanding of the agency of different actor groups in the context of transition processes, humans and non-humans (Latour, 2005, Callon, 1986). It helps us retrace parts of the translation and provides us with a framework to acknowledge and discuss actors' struggles to mutually control who they are and what they want (Callon, 1986: 6). However, it does not provide any answers as to how to overcome resistance to transition or learn from the "overlaps" or iterations. Based on the analysis and discussion of The Project we argue that design thinking, through its use of design tools and prototypes, learning from iterations, give shape to power games and structural challenges and thus make them more actionable. TED's approach to the challenge was to try to empower the ND team to build the environment they want, more so than designing an environment for them - building tools that could be locally adapted and elaborated by human agents (Tsoukas and Chia, 2002).

We argue that a fusion of design thinking and the sociology of translation could support a more nuanced understanding of barriers to change towards sustainability. The analytical framework also has the potential to help designers engage in the process of translation at a more conceptual level, providing a vocabulary to describe the complex settings they design for. Further, we suggest that the framework encourage reflections on design processes and practices themselves, with the potential of bigger impact: "The insight you give us from your angle as social scientists – reflection from your angle grows us, the reflective practitioner. It changes our overarching view of what is taking place creatively." (Rebecca, Apr13).

Due to limited access to the ND team and H&M, the study is short of data on the actual use (or non-use) of TED's tools in between workshops. Also, the suggested analytical fusion grew out of The Project, which is why we in this paper have only been able to explore its analytical potential. We therefore encourage research that further explores this fusion to inform more practice-based research on change towards sustainability in the textile and fashion industry in specific and/or in business at large.

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# WASTEWATER TREATMENT AND RECYCLING WITH MICROALGAE IN COLD CLIMATE

**Erik GRÖNLUND<sup>1</sup>, Morgan FRÖLING<sup>1</sup>**

<sup>1</sup> Ecotechnology and Sustainable Building Engineering, Mid Sweden University, Östersund, Sweden, [erik.gronlund@miun.se](mailto:erik.gronlund@miun.se), [morgan.froling@miun.se](mailto:morgan.froling@miun.se)

## **ABSTRACT (250 WORDS MAX)**

Resilient societies need technology with high recycling possibilities, as well as possibilities to treat wastewater with local ecosystem services as dominating driving forces.

Modern wastewater treatment often suffers from the problem of being a linear system, rather than a recycling system. From a recycling point of view the nutrients in the wastewater is of highest interest.

The use of microalgae has been proposed as collection systems for the nutrients, with several potential advantages: 1) they treat the wastewater further from a pathogenic point of view, 2) they produce a sludge of interesting biochemical quality depending on the species present in the treatment ponds, 3) they use the naturally occurring ecosystem services available at the wastewater treatment site in the form of sunlight, wind, and regional biodiversity of phytoplankton.

The academic focus regarding microalgae use for wastewater treatment has to a large extent been on the “sunbelt”, between latitudes 35 North and South, respectively. However, a few investigations have been performed on northern and southern latitudes. This paper summarizes experiences from using microalgae for waste water treatment at northern latitudes in Sweden and present suggestions for further research.

*Keywords: subarctic climates, phytoplankton, HRAP, ecological engineering, fellingsdams*

## 1 INTRODUCTION

This paper presents experiences regarding the use of microalgae in wastewater treatment in rural areas in northern Sweden. Based on these experiences we discuss potential development of sustainable wastewater treatment in rural areas based on high rate algae ponds (HRAPs) or improved fellingsdams.

Resilient societies need technology with high recycling possibilities, as well as possibilities to treat wastewater using local ecosystem services as dominating driving force. The latter is often accompanied with the need of large land areas, and therefore possible to realize mainly where land is readily available and cost of land is low. This is generally not the case in cities, but often the situation in rural areas. Ponds of different types are used for wastewater treatment in many places from Alaska in the north to New Zealand in the south. In such ponds, microalgae play an important role for the treatment process as long as light is sufficient and temperature high enough. At low temperatures the major function of the ponds are only as sedimentation chambers.

When light and temperature are sufficient microalgae take an active part of the ecosystem function in ponds. Their presence impact pond functions in several ways, for example is oxygen produced through the photosynthesis process, pH increases due to the bicarbonate depletion and giving a shift in the carbon dioxide/carbonic acid balance, etc. [1]. A sunny day, pond water can reach a pH above 10 due to microalgae activity, which have an impact on pathogenic organisms in the wastewater. In traditional oxidation or stabilization ponds the microalgae show a natural stochastic development pattern, with blooms followed by crashes. A more controlled type of ponds for microalgae growth is the so called HRAPs (High Rate Algae Ponds) or HRAPs (High Rate Oxidation Ponds). These ponds are shallow, 0.3-0.5 m, and the wastewater is put to continuous movement, most often by paddle wheels.

The above mentioned situation is well known microalgal behavior from ponds situated within the so called “sunbelt” area, which is defined by Oswald [2] as below latitudes 35 North and South. Further north and south the number of investigations on microalgae behavior and potential is much more limited, but there are some references also for these climates. Investigations in the south of New Zealand have been made by e.g. Park, et al. [3], [4-6], Craggs, et al. [7], [8, 9], and investigations in the north have been made in Canada by Abdelaziz, et al. [10], Chevalier, et al. [11], Dumas, et al. [12], Tang, et al. [13], Laliberte, et al. [14], De la Noüe and de Pauw [15] and in Sweden by Grönlund, et al. [1], Grönlund [16], [17], Hanæus, et al. [18].

In the following section experiences regarding the use of microalgae in wastewater treatment in the northern parts of Sweden are presented, and in section 3 suggestions for development will be discussed.

## 2 EXPERIENCES FROM THE NORTH OF SWEDEN

The pioneer in the field of wastewater treatment with microalgae, William J. Oswald [19-22], reported that this practice was appropriate to use in the “sunbelt” area, not further north than latitude 35 [2] due to restrictions in light and temperature. However, in a literature review by Grönlund, et al. [1] it was found that from a cold climate perspective the role of light and temperature was not very clear. In laboratory experiments Grönlund, et al. [23] could show that microalgae collected in the Mid Sweden region could grow readily in wastewater also under cold climatic conditions. During spring and autumn conditions—with temperatures between 5 and 10°C—the fastest growing cultures in the experiments had doubling times shorter than two days. These doubling times were possible to repeat also in field experiments [24], but could not be proved possible to maintain over longer periods of time. Even though the microalgal growth was slower, Grönlund, et al. [24] concluded that the HRAP technology may be possible to apply successfully from April to October in subarctic climate at latitude 63°N. These conclusions were based on experiments with high-rate algal ponds (HRAPs) during two seasons, with focus on spring and autumn function.

Grönlund, et al. [25] also investigated the sustainability of a modeled wastewater treatment plant based on HRAP functions, designed for 60°N. Sustainability was evaluated with a socio-ecological method [26], and with emergy evaluation [27]. The results indicated that the microalgal treatment plant model could be considered having a better position for future sustainable development, compared to a conventional three-step wastewater treatment plant and to a mechanical-chemical plant complemented with a constructed wetland.

So called “fellingdams” [28], i.e. wastewater stabilization ponds complemented with chemical precipitation and a common wastewater treatment method in northern Sweden, were also investigated from a microalgae perspective. In a case study, two fellingdam systems were modified by turning off the precipitation during the productive season and the effluent quality measured [18]. In one of the two fellingdams, the organic matter and phosphorus concentration in the effluent was just slightly above the values that had been reached when using chemical precipitation during previous years. In the second fellingdam, the performance was not as good. The investigated seasons were characterized by extremely high and low precipitation, respectively, which influenced the flow rates to the fellingdams significantly and complicated the evaluation. The potential of the biological component replacing the chemical component during the productive period was, however, demonstrated in the experiments. At one of the fellingdams (Orrviken fellingdams) a special study was done regarding the microalgal species and genera [29]. This study found that the stabilization ponds did not convert “sewage COD” into “algal COD” to the extent expected. Microalgae were dominant in the effluent COD for only 3-4 weeks out of 12 weeks investigated. The investigation confirmed the traditional “boom and bust” behavior of algae in stabilization ponds, and that species and genera composition varied over the season.

### 3 DISCUSSION

The experiences described in section 2 above indicate that pond treatment systems based on microalgae have the potential to be a resilient waste water treatment solution in rural areas also in the cold climate of Mid Sweden. The pond treatment systems can be seen as an ecological engineering solution. Ecological engineering is a branch of engineering characterized by an aim to use the available local renewable energies, self-organization and self-design to a large extent, compared to traditional engineering which is still most of the time characterized by imported goods and services as well as engineering design of the components [30, 31]. Wastewater treatment with microalgae fits well into the tradition of ecological engineering with its utilization of the natural occurring ecosystem services available in the form of sunlight, wind, and the regional biodiversity of phytoplankton [17]. We will now discuss potentials for development of pond treatment systems for use in rural communities in northern Sweden.

#### 3.1 Test of more wastewater types

In closed system microalgae cultivation it is possible to choose and decide what species should be cultivated. In open ponds this is almost never possible. The reason is the varying conditions regarding light regime, temperature, nutrient availability and other abiotic factors that occur over the day, the season, and the year. Therefore, the species composition in wastewater ponds will most likely not be stable. The combination of variations in wastewater composition, light, temperature etc. will also be slightly different also between ponds in the same region, which means that every wastewater treatment plant will have its own “fingerprint” of microalgae community. This species composition cannot easily be predicted or modeled but needs to be tested. Therefore, several types of wastewater should be investigated in a region where research is conducted.

#### 3.2 Ponds with storage capacity

From an ecological point of view cold climates are characterized by a bilateral pulse pattern over the year. During the winter time most organisms try to keep their activity as low as possible to survive until the summer period when activity levels in the ecosystems are very high. This pattern is highly relevant for the microalgal growth. Making use of the natural energies available in a northern region therefore suggests mimicking the natural pattern. An approach to do this can be to store the wastewater during the winter season and treat it during the summer season when the biological activity is very high. Grönlund, et al. [24] estimated that HRAPs would function properly from April to October in the mid Sweden region, meaning 5-6 months of operation and 6-7 months of storage. Grönlund (unpublished data) made estimations of the storage capacity needed for a system designed for 5800 m<sup>3</sup> of wastewater per day; see Figure 1, 2 and 3. Interestingly, the calculations showed that the area needed for the HRAP was approximately the same as the area needed for the storage pond. With floating HRAPs, described in the next section, the total area demand could be substantially decreased.

#### 3.2 Decreased area use by floating HRAPs

The HRAPs (raceways) used for microalgae culture are area demanding in order to capture the amount of sunlight needed. In most wastewater pond treatment systems, there are often several types of ponds, as for example a collection pond to even out periods of higher loads, and maturation ponds to prolong the detention time in the wastewater treatment plant and ensure pathogen die-off. In theory, it should be possible to have the HRAP floating in another pond (Figure 4). Two positive effects of such a design would be that the pond surface gives the “flat ground” that is needed for the shallow HRAPs and that very little piping will be needed. In mid and northern parts of Sweden, and similar places where ice will cover the ponds during winter time, the HRAPs can be lowered down into the water to avoid freezing problems that could occur if they were located on land. A problem area for this design may be how to balance the paddle wheel, which put an uneven weight to the HRAP. It is intended to further investigate pros and cons of this design.

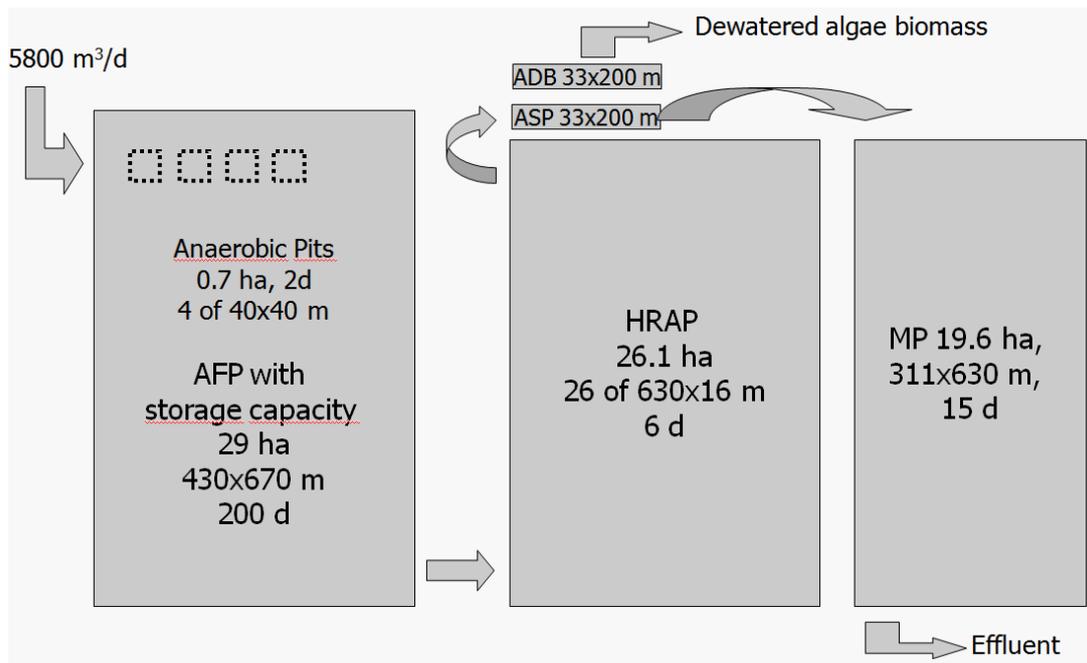


Figure 1. A pond system designed for 5800 m<sup>3</sup>/d load of wastewater. First an Advanced Facultative Pond (AFP) with storage capacity for 6,5 months (200 days) with a depth of 4 m. During the 5,5 months of summer season the wastewater proceeds to a High Rate Algae Pond (HRAP) with channels of 16 m width and a depth of 0.3 m. The wastewater is set to motion with a series of paddle wheels. The detention time in the HRAP is 6 days. After that the wastewater enters an Algal Settling Pond (ASP), 3 m deep with a detention time of 1.5 days, and finally a Maturation Pond (MP) of 1 m depth and a detention time of 15 days. The algae sludge from the ASP is dewatered on an Algal Dewatering Bed (ADB).

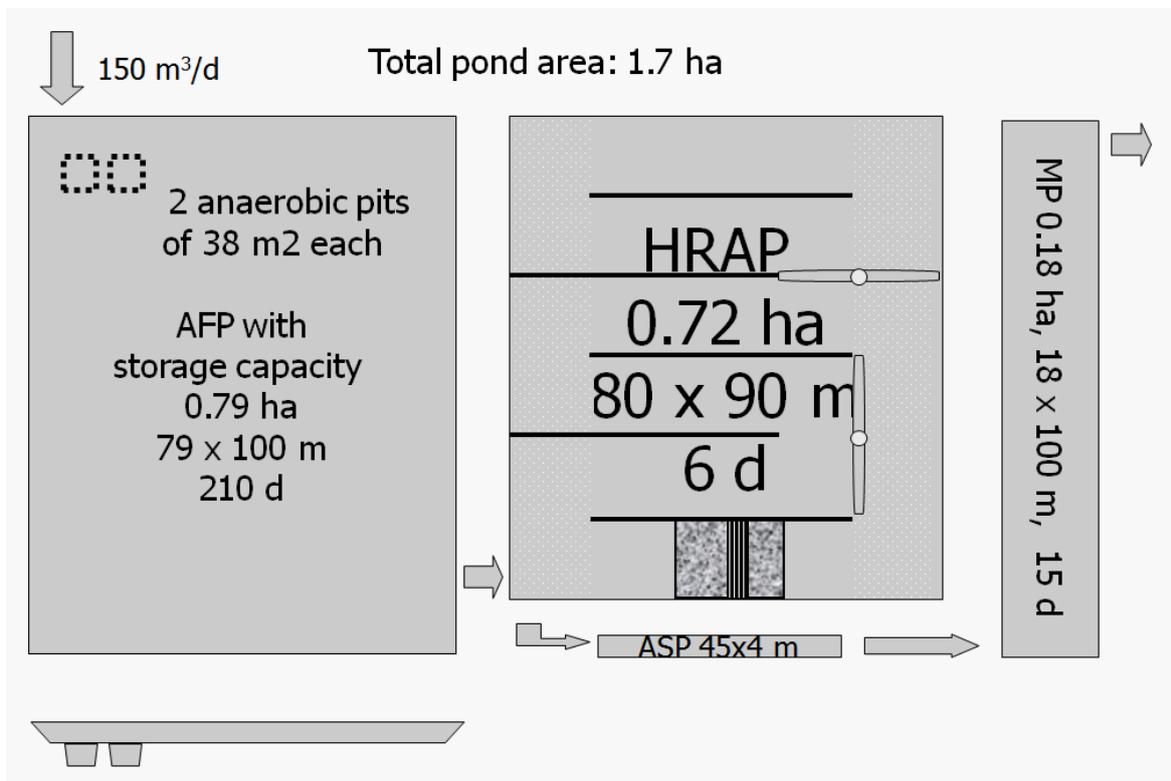


Figure 2. A pond system designed for 150 m<sup>3</sup>/d load of wastewater, and a storage time of 7 months, 210 days, meaning that the High Rate Algae Pond (HRAP) is only active for 5 months during the summer period. The HRAP has a paddlewheel with concrete reinforcement in the bottom down in the picture. To the right it also has swinging walls, enabling flexibility in the HRP volume. Other abbreviations, see Figure 1.

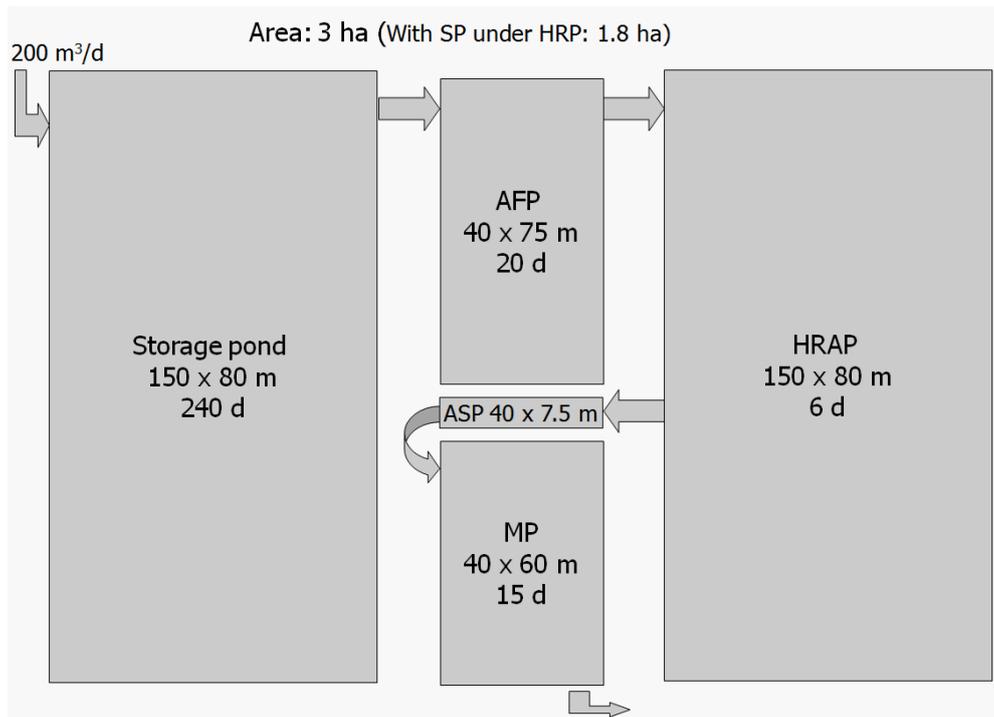


Figure 3. A pond system designed for 200 m<sup>3</sup>/d load of wastewater, and a storage time of 8 months, 240 days, meaning that the High Rate Algae Pond (HRAP) is only active for 4 months during the summer period. Other abbreviations, see Figure 1.

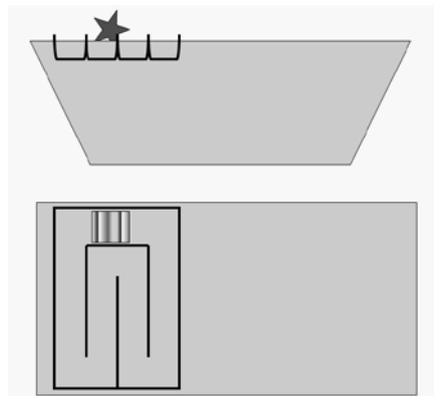


Figure 4. Floating HRAPs (raceways) in top of a stabilization pond or maturation pond.

### 3.2 Anaerobic tank

In a series of ponds for waste water treatment, an anaerobic pond is often the first pond [32]. Problems connected with this pond are frequent occasions of bad smell and that methane can escape to the atmosphere contributing to climate change. Oswald and co-workers developed and patented a series of ponds, which they called AIWPS (Advanced Integrated Ponding System) [33]. The first pond in this system contain anaerobic pits; for example [34, 35] addressed the design of this part of the system. The idea with this design is that any bad smelling gases coming from the anaerobic pits should be captured in oxygen rich layers of water above the pit and oxidized into other, less smelling compounds. It would also be possible to recirculate oxygen rich water from the HRAP pond to ensure a favorable oxygen condition in this top layer water. Instead of the pit design it would be interesting to investigate what can be achieved with a submerged anaerobic tank, see Figure 5. It must be mentioned though, that anaerobic bacteria are well-known for their low activity during cold conditions.

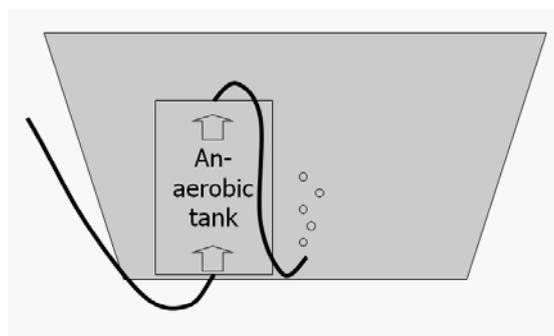


Figure 5. An anaerobic tank submerged in a facultative pond.

### 3.5 Microalgae for Bio-CCS

Another approach for utilization of microalgae and waste water could be to use the algae to absorb CO<sub>2</sub> from flue gases with the waste water having the function of nutrient source for the algae growth (and being treated at the same time). The latest IPCC report points out a need to capture CO<sub>2</sub> also from biofueled power plants to be able to minimize climate impacts in future. The HRAP technology is probably not best suited for this since the flue gases from the chimney are supposed to pass the water column. Instead vertical cylinders will perform better. Experiments with such systems have been made primarily in areas with more evenly distributed yearly sunlight compared to the short period of daylight wintertime in the Mid Sweden region; performance should be tested also in this region.

### 3.6 Use of the microalgae sludge

Above has been described how microalgae contribute to the treatment of wastewater or flue gases. A secondary effect (or a first effect depending on your initial intentions) is that microalgae produce a sludge of interesting biochemical quality depending on the species present in the treatment facility and how the wastewater treatment plant is designed. Possible products from the microalgae can for example be feed for aquaculture or in feedlots, extraction of pigments, enzymes, and oils of different kinds for fuel or industrial use. Grönlund, et al. [1] noted that less than one per mille of the world algal species are sufficiently explored concerning biochemical contents.

In HRAPs the sludge constitute almost fully of microalgae. In fellingsdams the chemical precipitation constitute a major part of the sludge.

For a Bio-CCS facility it would be beneficial if the sludge or product from the sludge retained the captured CO<sub>2</sub> for a substantial time. One possible use of the microalgae for carbon storage purposes can be as insulation material. It should be investigated further what are beneficial use of the generated algae biomass in different situations.

Sludge from waste water treatment contains resources in form of both nutrients and energy. Some studies have investigated if it is more interesting to utilize the energy contents or the nutrient contents of such sludge [36, 37]. If it is possible to utilize the energy in the sludge to efficiently replaces fossil fuels, the energy resource value of the sludge was shown to be of the same magnitude or even larger compared to the nutrient recourse value when replacing artificial fertilizers. In situations where available technologies for energy utilization are not feasible, e.g. due to small scale, or when renewable energy sources have become dominant so it is not fossil fuels that can be replaced, the nutrients gain higher value as recourse. The most interesting situation would of course be to simultaneously utilize both the energy and the nutrient resource value while decomposing harmful substances and polish the water from pathogenic micro organisms.

## 4 CONCLUSIONS

Resilient societies need technology with high recycling possibilities, as well as possibilities to treat wastewater with local ecosystem services as dominating driving forces.

Modern wastewater treatment often suffers from the problem of being a linear system, rather than a recycling system. From a recycling point of view the nutrients in the wastewater is of highest interest.

Using microalgae as a collection system for the nutrients has several advantages: 1) they treat the wastewater further from a pathogenic point of view, 2) they produce a sludge of interesting biochemical quality depending on the species present in the treatment facility, 3) they use the natural occurring ecosystem services available in the form of sunlight, wind, and regional biodiversity of phytoplankton.

Experiences from the mid Sweden mountain regions suggests that an microalgae based type of ponds, so called HRAPs (High Rate Algae Ponds), can be used 5-6 month during the summer period. The rest of the year a storage pond is used. For coming research it is suggested to test more types of wastewater, since the species composition is depending on this; to test floating HRAPs, preferably located on the storage ponds; to test if anaerobic tanks is a possible way forward; and to use microalgae for Bio-CCS, collecting flue gases from a biofuel based power plant in the region.

## ACKNOWLEDGEMENTS

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# LIFE CYCLE ASSESSMENT INTEGRATED IN THE DESIGN OF A NEW NANO INSULATION MATERIAL

Reidun Dahl Schlanbusch<sup>1</sup>, Bjørn Petter Jelle<sup>2,3</sup>, Linn Ingunn Sandberg<sup>3</sup>, Selamawit Mamo Fufa<sup>2</sup> and Tao Gao<sup>4</sup>

<sup>1</sup> SINTEF Building and Infrastructure, Department of Energy and Architecture, NO-0314 Oslo, Norway.

<sup>2</sup> SINTEF Building and Infrastructure, Department of Materials and Structures, NO-7465 Trondheim, Norway.

<sup>3</sup> Norwegian University of Science and Technology (NTNU), Department of Civil and Transport Engineering, NO-7491 Trondheim, Norway.

<sup>4</sup> Norwegian University of Science and Technology (NTNU), Department of Architectural Design, History and Technology, NO-7491 Trondheim, Norway.

## ABSTRACT

Buildings are responsible for about a quarter of the global energy-related CO<sub>2</sub> emissions. New materials represent a part of the strategy for reducing emissions in the building industry. The embodied energy and carbon footprint from the material production in building life cycle assessment must be considered in this context. However, there is a lack of tools to integrate environmental assessment in the early stages of material research. This study summarizes a life cycle assessment (LCA) of a new nano insulation material (NIM), based on hollow silica nanospheres. The purpose of this analysis is to investigate how the different activities in the production of the nano insulation material contribute to global warming and energy demand in order to find how the environmental impacts may be minimized. The main outcome of the LCA is therefore recommendations for a greener production of the nano insulation material. In addition, this study may serve as suggestion on how to integrate LCA in the design of other new materials.

*Keywords: Hollow silica nanosphere; Life cycle assessment; Material design; Nano insulation material; Sustainable building material*

## 1 INTRODUCTION

This study summarizes a life cycle assessment (LCA) of a new nano insulation material (NIM) [1, 2, 7], based on hollow silica nanospheres (HSNS) [8, 9, 16, 17, 18], recently developed in The Research Centre on Zero Emission Buildings (ZEB) [3], Norway. Life cycle assessment was used to calculate greenhouse gas emissions and energy consumption for the production scenarios close to the current synthesis procedure of the NIM. The life cycle assessment model was constructed with flexibility and can be used for further research.

Buildings are responsible for about a quarter of the global energy-related carbon dioxide (CO<sub>2</sub>) emissions [4]. In Norway, despite the large availability of hydropower, energy use in the building sector represented 5% of the country's total greenhouse gas (GHG) emissions in 2010 [5]. New materials represent an important part of the strategy towards reducing emissions in the building industry. Advanced thermal insulation materials is a prior research goal at The Research Centre on Zero Emission Buildings (ZEB) in Norway, because it is believed that better insulation is a cost effective way to substantially reduce GHG emissions [5, 6].

The multiple benefits of a thinner, superinsulating material for building applications, like e.g. nano insulation materials (NIM), were described by Jelle et al. [2, 7, 8]. The possibility of achieving a satisfactory NIM by using hollow silica nanospheres (HSNS) was discussed by Gao et al. [9, 16] and Jelle et al. [7].

The relative importance of the embodied energy and carbon footprint from the material production in building life cycle assessment (LCA) is a topic of growing interest [10]. There is a recurrent lack of

tools to integrate environmental assessment in the early stages of material research and development (R&D) [11-13], i.e. within nanotechnology and other material research fields. Some of the main reasons include data scarcity, lack of specific LCA framework for nanotechnology and poor coverage of the relevant raw materials and methods by the LCA databases [13].

In a recent article, Hetherington et al. [14] summarized many of the challenges and issues with LCA when used as a tool within early research. Nanotechnology was one of three sectors that Hetherington et al. treated in the article. The results coincide to a large degree with the issues and challenges identified within the study presented herein. The main problem is that LCA traditionally has been undertaken retrospectively, using data from existing large scale processes. Attempting to use LCA as a development tool therefore raises problems of comparability, scaling, data and uncertainty [14]. Hetherington et al. [14] strongly encourages publishing of early stage LCA process and results in order to increase understanding.

Hischier and Walser [12] critically reviewed the current available life cycle assessment publications on engineered nanomaterials.

The review insightfully [12] problematize the compliance of the publications to the conventional LCA framework and the standard ISO 14044, especially in terms of the life cycle inventories. Most of the available studies on engineered nanomaterials had missing, or very variable, energy input data and emission data. In fact, the reported energy consumption was so variable that Hischier and Walser [12] had to question asked if some of the data were calculation mistakes. However, the study does not couple this variability to the lack of industrial energy consumption data due to the early design phase in which much of the engineered nanomaterial products are situated.

Two other LCA studies are of special relevance to HSNS. Dowson et al. [13] reported a LCA on silica aerogels made in a laboratory. The inventory step in this methodology is limited to a laboratory recipe that produces a small amount of product. Gao et al. [9] recently reported a LCA on HSNS for thermal insulation applications, following Dowson's methodology. Although the LCA performed by Gao et al. [9] is important as a first step towards a cleaner production of the NIM, the study was carried out by a simplified LCA approach. Direct emissions to air and water, transport and also materials for which LCA data were not found in the literature were omitted.

In the study presented herein, we aspire to improve the challenging life cycle inventorying for products which are still at the pilot or laboratory stage. The objective of the work presented here is to develop a model applying LCA as a sustainability tool in the early design phase of hollow silica nanospheres (HSNS). The new model is constructed in order to calculate the environmental impact of a material for which only a limited dataset is available, by filling data gaps according to a suggested procedure, inspired by, inter alia, literature on LCA for chemicals [11, 14]. Data on all raw materials, emissions and infrastructure needed for an industrial HSNS production are included. As many of the characteristics of the NIM still are under development, the model is built as flexible as possible. The model can therefore be reused and sharpened as the product development of the material proceeds.

The method on how to model a system under development and predict its environmental impact may be of interest for future assessments of other new materials.

## 2 MATERIALS

The material is produced by a three-step synthesis procedure, summed in Figure 1. The experimental details of the synthesis and characterization of the hollow silica nanospheres are given in the studies by Gao et al. [9, 16, 18], Jelle et al. [8] and Sandberg et al. [17]. The HSNS was synthesized in three steps. Figure 1 shows scanning electron microscope (SEM) pictures of the steps. Synthesis of polystyrene templates is the first. The templates were created by employing a simple styrene/polyvinylpyrrolidone/potassium persulfate/H<sub>2</sub>O-system. In the following coating step, the as-synthesized template solution is mixed with ethanol and ammonium hydroxide. Then, the silica precursor (TEOS) is added to the solution and nanoparticles of silica slowly cover the polystyrene templates. After the coating step is completed, the silica-coated templates are extracted by centrifugation. The third and final step consists of removing the polystyrene templates to obtain hollow silica nanospheres. The polystyrene cores are melted/burnt away at elevated temperatures with hollow silica nanospheres as the result.

The new nano insulation material is founded on the known principle of confining air in extremely small pores within the structure. This is in order to lower the gas thermal conductivity of the material through, inter alia, the Knudsen effect. The idea of the hollow silica nanosphere type NIM is to try to

create a superinsulation nanoporous material bottom-up from the spheres. Gao et al. [9] points out that turning the conceptual HSNS into a practical thermal insulation material will require substantial research efforts. This is a representative example of a nanotechnology product case, where it is preferable to do an LCA to ensure clean production while many characteristics of the system is still under study.

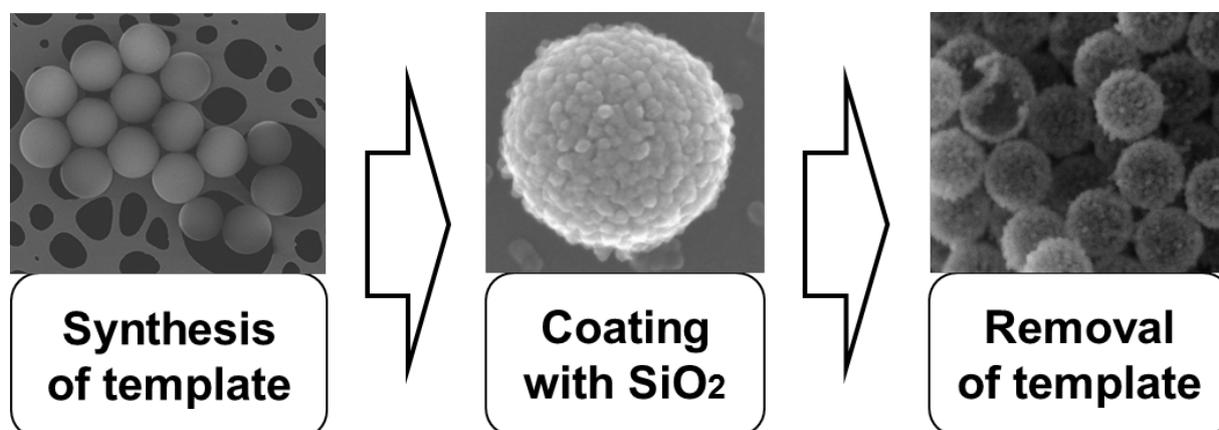


Figure 1: SEM pictures showing the three main steps of the template assisted synthesis of HSNS [17].

### 3 METHOD

#### 3.1 General

Attempting to use LCA as a development tool therefore raises problems of comparability, scaling, data and uncertainty [14]. This study presents a suggestion on how to solve these problems.

Life cycle assessment is used to calculate greenhouse gas emissions and energy consumption for production scenarios close to the current synthesis procedure of the HSNS. The LCA addresses all the GHG emissions and energy consumption caused directly and indirectly throughout production of the HSNS, from the extraction of raw materials, the manufacturing of the chemicals and the material production up to the factory gate. All material and energy flows, as well as wastes and emissions are accounted for.

This LCA complies with the ISO 14044 [19] standard. Accordingly, the LCA is carried out in four main steps: 1) goal and scope definition, which define the main aim of the study and its target audience, the functional unit and the system boundaries, 2) inventory assessment, where all required data on input and output of energy, material and emissions are collected, 3) impact assessment, which classifies emissions according to their environmental impact categories (e.g. climate change impact) and characterizes them by their significance to the reference unit (e.g. kg CO<sub>2</sub>-equivalents per functional unit) and 4) interpretation.

#### 3.2 Goal and scope

##### 3.2.1 Goal of this study

The goal of this analysis is to investigate how the different activities in the production of the HSNS contribute to global warming and energy demand, in order to find how the environmental impacts may be minimized. The analysis will be used by the scientists to optimize the production process and choice of raw materials with regard to the environment. The main outcome of the LCA is therefore recommendations for a greener production of the HSNS. In addition, this study can serve as suggestion on how to integrate LCA in the design of other research and development (R&D) materials.

##### 3.2.2 Functional unit

The functional unit of this analysis is set to 1 kg of hollow silica nanospheres. The choice of functional unit depends solely on the goal of the study. A mass based unit does not reflect the actual service delivered by the finalized nano insulation material and can therefore not be directly applied in a comparative LCA. Such a LCA is not possible before the physical characteristics, like thermal

conductivity and density, of the material as a finished building element is revealed. However, the mass unit is perfectly adapted to analyse the environmental impact of the production in order to optimize this. Hischer and Walser [12] put it this way: "If the objective of a study is to examine the impact of the production of a specific engineered material, a functional unit of 1 kg of this material is appropriate; as soon as the objective of the study goes beyond this objective – a simple weight-based functional unit is no longer reasonable." A functional unit of 1 kg material therefore allows for a transparent analysis and reflects the goal of this specific study. Furthermore, the mass unit is the necessary basis for any other functional unit that might be applied in the future.

### 3.2.3 System boundaries

Figure two is a flow diagram which explains the LCA study presented here. Figure 2 also shows the system boundaries of the model. The system includes the raw materials, energy, infrastructure, transport and emissions associated with the production process. Direct material input accounting for less than 1% of the total weight of raw materials are cut off.

The centre box in Figure 2 is basically a chemical production plant. It is assumed that the production facilities are placed in a central part of Western Europe. The properties of the plant are assumed to be representative for the average chemical plants in that geographical area. The model reflects a future production scenario for the HSNS NIM.

By reference to the synthesis route described in Figure 1, the model consists of a three step production system of template-assisted synthesis of hollow silica nanospheres, and the subsequent removal of the template in a furnace. The fabrication of the template requires water, styrene and polyvinylpyrrolidone (PVP). The silica coating process requires ethanol, TEOS and ammonia hydroxide. 80% reuse of ethanol is assumed in the model. The removal of the template requires a furnace. All steps require energy and capital investments. These activities require raw materials, a certain amount of processing energy and capital investments.

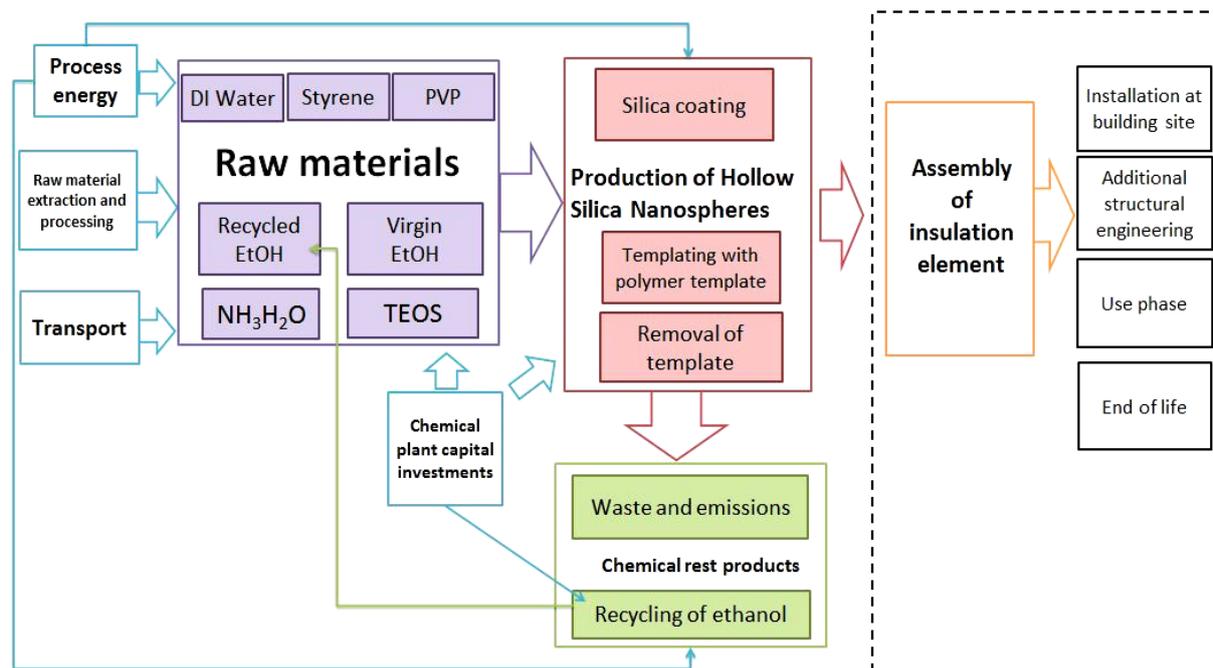


Figure 2: Figure illustrating the system model with system boundaries.

It is assumed to be no solid waste flow from the production system, only emissions to air and emissions to water, stemming from rest products of the chemical processes. It can be seen in that the recycling process also requires energy and capital investments. The dotted box to the right in Figure 2 shows the point where the system boundaries end. This is a cradle-to-gate LCA, so the use phase and end-of-life phase are placed outside the system boundaries. The assembly stage is placed outside the system borders.

### 3.3 Inventory analysis

#### 3.3.1 Data

The inventory analysis is challenging, especially for R & D cases, due to different sources of uncertainties including data inaccuracy, lack of specific data (data gaps or unrepresentative data) and uncertainty due to choices and assumptions taken [20]. The inventory analysis of HSNS is based on the data collected directly from the synthesis procedure of Gao et al. [9], and new data collected and modeled within this study. A set of assumptions was constructed in order to overcome the problems of LCA for a product in the early stage of development and design. The main assumptions are listed here. Figure two and this list is the backbone of the method presented.

Industry data for the embodied energy and emissions of the raw materials were applied when available. Ecoinvent unit processes [21] were applied to replace missing industry data. Processes that could not be found in the Ecoinvent v.2 database [21] were modeled according to a procedure published in Hirschier et al. [11]. This procedure consists of using stoichiometric equations from technical literature along with a set of assumptions and estimations.

#### 3.3.2 Main assumptions

##### Raw materials

LCA data are unavailable for some of the raw materials, and the scaling of the amounts needed to produce 1 kg of HSNS had to be assessed. Most of the direct raw material consumption is scaled linearly from the laboratory data. This is an acceptable assumption because the reactants have a high conversion rate. However, as production volumes grow, the efficiency of ethanol will have to increase; it takes 162 g ethanol to produce 1g of HSNS, but it does not take 1620 kg of ethanol to produce 10 kg HSNS. The upscaling problem is one of the most important challenges for LCAs on R&D products [14], and can be one of the reasons why Hirschier and Walser [12] found so large variability in the published life cycle inventories of engineered nanomaterials. In the study herein, it was assumed that, on an industrial scale, the ethanol use would go down with at least 50%. Therefore, a scenario with 81:1 kg ethanol to HSNS was set as a reference. All results and discussion will refer to this assumption in the following text.

Process modeling based on technical literature was carried out for missing data. The risk of using basic stoichiometric and thermodynamic calculations is that these might underestimate the energy requirement as the real systems are less efficient than theory. This was to some extent corrected by assuming efficiencies of 0.95 over the stoichiometric reaction [11].

##### Energy

Applying the laboratory energy consumption data based on the production of such a small amount of HSNS leads to serious overestimations of the energy consumption compared to a full-scale production system. This is because the efficiencies will be much higher in full scale. Hirschier and Walser [12] reported that in the nanotechnology LCA studies they reviewed, the production energies varied a lot. Some studies avoid this problem by simply ignoring the direct energy consumption. In the study presented herein, the most energy intensive processes were modelled by basic thermodynamic data according to the nature of the process (e.g. heat of vaporization, enthalpy of formation, enthalpy of combustion), is applied here. The less energy intensive processes (i.e. exothermic reactions, room temperature processes) were modelled with generic energy values for European chemical productions[11].

Because the production system under study is assumed to be situated in Europe, the electricity process applied is the Union of Co-ordination of Transmission of Electricity (UCTE) medium voltage production mix.

##### Transport

Because all the raw materials can be found in the portfolio of European suppliers, it is assumed that these are preferred over Asian brands and transport distances are therefore accordingly short. Standard distances by rail and road, to be found in Frischknecht et al. [24], are applied.

##### Other data

Capital investments, waste and stressors are modeled according to the method suggested by Hirschier et al. [11], which essentially implements generic data. This is mainly ethanol and ammonium hydroxide. It is assumed that 2% of the liquid waste stream is evaporated as emissions to air.

### 3.3 Impact Assessment

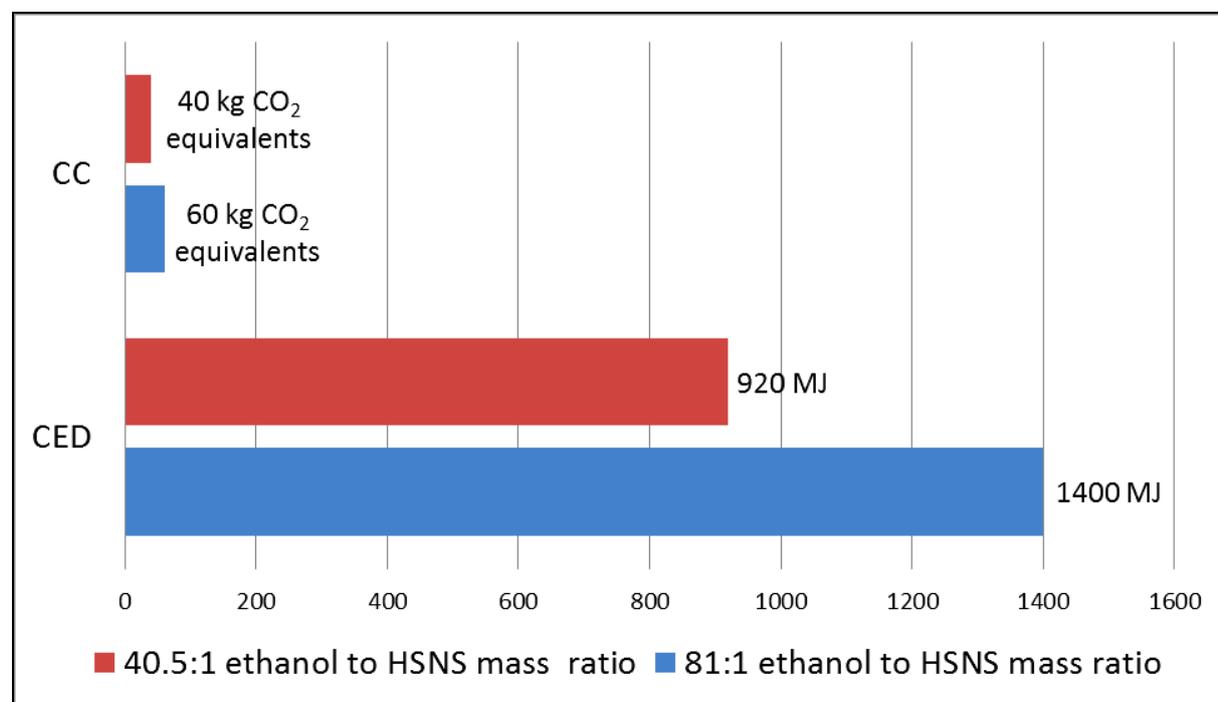
In this work, ReCiPe midpoint impact assessment method based on the Hierarchist perspective [25] was applied. This is a much used LCA methodology. In this methodology, there are unfortunately no indicators for release of nanoparticles, and no specific characterization factors for nanotechnology are currently developed [12].

Two of the most widely used impact categories, the climate change (CC, expressed in CO<sub>2</sub> equivalents) and the cumulated energy demand (CED, expressed in MJ) were applied. The calculations were performed with the LCA software SimaPro 7.3.1 [25].

## 4 RESULTS AND INTERPRETATION

### 4.1 Energy use and carbon footprint of HSNS

The total climate change (CC) and cumulated energy demand (CED) scores for the functional unit, 1 kg HSNS at factory gate are given in Figure 3. The results are rounded to the nearest 10 kg of CO<sub>2</sub> equivalents and MJ. By reference to the goal of the study, the following sensitivity analysis reveals how the results change when the assumptions are modified.



**Figure 3: Climate Change impact and Cumulated Energy Demand for two scenarios of hollow silica nanosphere production.**

In Figure 3, the reference scenario is as explained the scenario in which the ethanol use to the HSNS product is 81:1 mass ratio (i.e. 50% reduction of ethanol relative to the laboratory recipe). This reference scenario is juxtapositioned to a scenario in which the ethanol use is further reduced by half in Figure 3. The difference is quite noticeable, and it can be concluded that the environmental impact of the hollow silica nanospheres is strongly dependent on the amount of ethanol required.

In the production of hollow silica nanospheres, ethanol is used for cleaning and as a solvent. When tetraethyl orthosilicate (TEOS) hydrolyses as to form the silica shell, it is necessary to use ethanol as the solvent in order to control this process and create well-defined spheres. As long as TEOS is used as the precursor, ethanol is therefore essential. However, the usage of energy intensive solvents is not optimized in the process and this has a considerable impact on the results.

## 4.2 Contribution from the process steps

Figure 4 shows the relative contribution from template formation, template removal, silica synthesis, direct energy consumption and capital investments on the cumulated energy demand and the climate change impact of 1 kg HSNS. The table underneath the bar chart gives the total values in Figure 4. The scenario in which the ethanol use to the HSNS product is 81:1 mass ratio is still the reference to which all the following figures refer.

From Figure 4, it is clear that the indirect energy consumption is dominating, especially the consumption of the silica coating. Less than 4 % of the CC impact stem from the polystyrene template. Gao et al. [9] had a hypothesis that it would be environmentally preferable to wash out or dissolve the template instead of combustion. From a cradle-to-grave point of view the polymer rest product most probably will be incinerated too, or landfilled, at its end-of-life phase. The emission reduction potential in changing the template is, considering the results in Figure 4, low relative to measures targeting the silica coating.

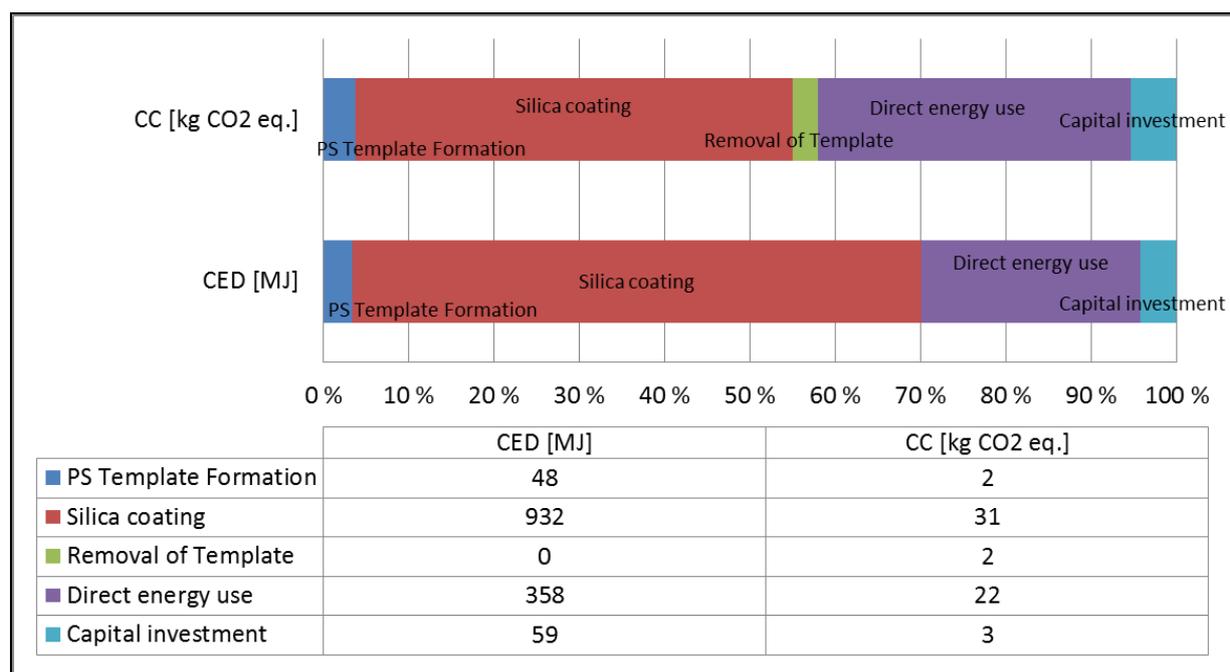
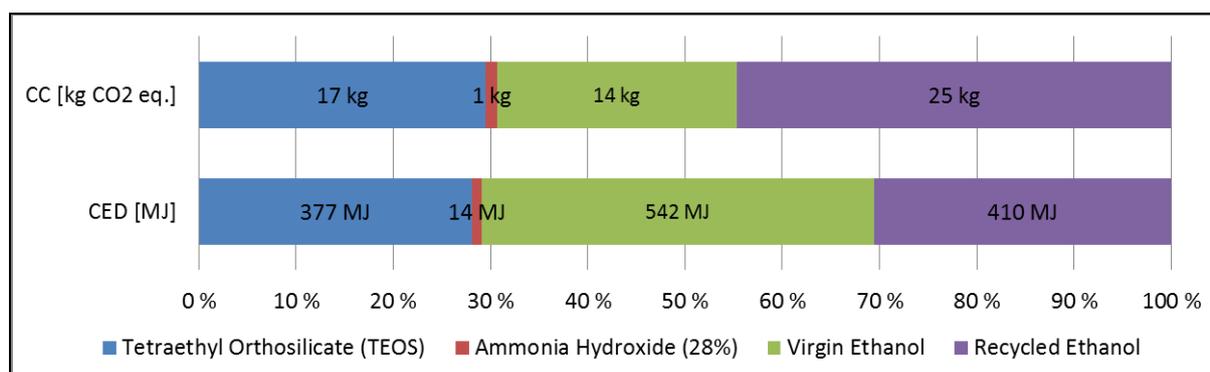


Figure 4: Bar chart displaying the contribution analysis results for the functional unit.

### 4.2.1 Contribution from silica coating

The silica coating contributes with more than 90% of the energy and climate change impact. The most important reason is that use of ethanol takes place in the coating process. A contribution analysis of the silica coating process is projected in Figure 5.

Figure 5 is clearly showing the dominance of the ethanol on the results. The virgin ethanol chosen here (ethanol, 95% in H<sub>2</sub>O, from sugar beet molasses, at distillery, Ecoinvent v2.0 [21], November 2012) has an embodied energy of 34 MJ/kg. When recycled, only 6 MJ/kg is required according to calculations. Furthermore, the climate change impact is 0.54 kg CO<sub>2</sub> equivalents for virgin ethanol and 0.36 kg CO<sub>2</sub> equivalents for recycled ethanol. Recycling lower the environmental impacts, but it is not entirely free of charge.



**Figure 5: Bar chart displaying the disaggregated contribution from the silica coating process step.**

The recycling process model was basically modelled as a distillation process assuming 1 kg steam per liter ethanol [27]. The vapor production is modelled based on data from Boustead et al. [28] where an arithmetic average of 215 European steam plants was used. The emission intensity of that fuel mix explains CC contribution from the recycled ethanol. The sensitivity of the results to these data is shown in the following sensitivity analysis.

Figure 5 shows that the material precursor, tetraethyl orthosilicate (TEOS), is relatively important. It contributes with about 28% of the embodied energy and 30% of the embodied emissions of the silica coating process. TEOS is a silica alkoxide commonly used as a precursor in the silica coating process. It is prepared by alcoholysis of silicon tetrachloride (see equation 1), a compound which is associated with ultrapure silicon production [29]. The main driver for the environmental impacts of TEOS is therefore the embodied energy of silicon tetrachloride.

### 4.3 Sensitivity analysis

A sensitivity analysis is provided to show additional scenarios and to investigate how the system reacts on changes in different input parameters. Table 1 shows the sensitivity to four different scenarios of ethanol consumption. The two first scenarios show the sensitivity to a 10% change in the internal recycling rate for ethanol in the system. Increased recycling does lower the impact, but the CC savings are limited to 8%. However, ethanol can have several harmful effects if emitted directly to nature in large amounts. Table 1 also displays the sensitivity to the energy requirement for the recycling process, which is strong. This was expected as the recycled ethanol is the most important raw material in terms of mass.

**Table 1: Sensitivity to four scenarios of ethanol consumption. The values are rounded off to the nearest 5 kg CO<sub>2</sub> equivalents and the nearest 10 MJ.**

Scenario	Final CED [MJ]	Final CC [kg CO <sub>2</sub> equiv.]	Change of CED impact [%]	Change of CC impact [%]
Baseline	1400	60	-	-
10% more recycling of ethanol	1180	55	-16	-8
10% less recycling of ethanol	1620	65	+16	+8
Halved energy consumption in the ethanol recycling	1220	50	-12	-17
Doubled energy consumption in the ethanol recycling	1750	85	+25	+42

The recycling energy was included in the sensitivity analysis because it was modeled on the basis of assumptions. It was assumed that the ethanol is purified through distillation. Table 1 shows that the impact from the recycling process is sensitive to this assumption and the data associated with it. A

more energy-friendly purification process may exist. With more environmentally friendly purification technology, the benefit from recycling of ethanol could be more significant.

### 4.3 Model validity and further work

The model of the system, on which the LCA is performed, is based on a laboratory recipe. Even though modifications and modelling have been done in order to reflect a production on an industrial scale, this is not a real industrial system.

As already stated, a substantial amount of research is needed to turn the conceptual HSNS NIM into a practical thermal insulation material. With the help of early stage LCA screening, a clean production process can be developed. This will minimize the environmental footprint of the finalized insulation element. The final environmental footprint of the future commercial product would depend also on other characteristics, like insulation performance, mass and means of installation in the building. Further work should include the assessment of the durability of the new material. To investigate the durability of building materials and components, also newly developed ones, e.g. by carrying out accelerated climate ageing in the laboratory, is of major importance [30]. If a building element must be changed halfway through the buildings life time its environmental footprint of that element must be doubled in the LCA. Thus, performing a robustness assessment of these materials and components may also be found to be beneficial [31].

## 5 CONCLUSIONS

This study has investigated the integration of LCA in the design of a new thermal insulation material. The objective of this was to screen the environmental impact of a new nano insulation material (NIM), based on hollow silica nanospheres (HSNS), at an early stage in order to optimize the process. A model was constructed for HSNS which was used to calculate cradle-to-gate climate change impact and cumulated energy demands for production scenarios close to the current synthesis procedure.

The LCA results gave insight on how the process can be optimized for a greener production. First of all, it is the indirect emissions and embodied energy of the chemicals that must be addressed in order to reduce the environmental impact of the production. The silica coating process is the most energy and emission intensive step, due to the indirect impact from ethanol and TEOS. Direct energy consumption and CO<sub>2</sub> emissions from the combustion of the template is less important, and the fabrication of the template is insignificant in comparison.

The ethanol consumption is accountable for the majority of the emissions. The most important recommendation is to reduce the amounts of ethanol consumption by increasing ethanol reuse rate. In addition, reuse and responsible waste handling should be ensured to minimize direct and indirect emissions to nature. However, as shown in the sensitivity analysis, as long as the recycling of ethanol is based on purification by distillation, it will not reduce the overall climate change impact as much as one would desire. It is therefore recommended to search for another purification technology, for instance based on membrane separation.

TEOS has an almost 100% conversion rate to SiO<sub>2</sub>. Consequently, it does not make sense to reduce the consumption of TEOS in the system. It is therefore recommended to search for substitutes that avoid the energy and emission intensive silicon tetrachloride in its formation.

The impact assessment presented here affirms a typical LCA result: It is, essentially, the indirect emissions from the final demand on non-renewable energy sources that pull the strings in the environmental impact of the production of a good or a service. All the industrial processes in today's society place a substantial demand on fossil resources. The shift towards low carbon energy sources is therefore an important part of the recommendations, even if this is normally outside the control of the producers.

The model presented here is based on a laboratory recipe, in which a substantial amount of research is needed to turn the conceptual HSNS NIM into a practical thermal insulation material. The cradle-to-gate LCA can help to minimize the environmental footprint of the finalized insulation element at the early stage development. The cradle-to-gate LCA presented here can also provide a basis for a cradle-to-grave LCA that can evaluate the environmental performance of NIM in a building once these characteristics are in place.

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# UNDERSTANDING HOW SOCIAL ENTERPRISES CAN BENEFIT FROM SUPPORTIVE LEGAL FRAMEWORKS

## CASE STUDY REPORT ON SOCIAL ENTREPRENEURIAL MODELS IN GREECE (Implementation of specific legal characteristics that typify social enterprises in their organisational models)

Aikaterini Argyrou<sup>1</sup>, Tineke Lambooy<sup>2</sup>, Henk Kievit<sup>3</sup>, Robert Blomme<sup>4</sup>

<sup>1</sup> PhD student at Utrecht University and Nyenrode Business University, A.V.Argyrou@gmail.com

<sup>2</sup> Associate Professor at Utrecht University and Associate Professor at the Center for Sustainability of Nyenrode Business University, T.E. Lambooy@uu.nl, T.Lambooy@nyenrode.nl

<sup>3</sup> Director of the Center for Entrepreneurship (NCE) and Assistant Professor of Social Venturing Entrepreneurship & Strategic Entrepreneurial Philanthropy at the Netherlands Institute for Social Venturing Entrepreneurship (NSVE) at Nyenrode Business University, H.Kievit@nyenrode.nl

<sup>4</sup> Associate Professor of Management and Organisation at Nyenrode Business University, r.blomme@nyenrode.nl

### ABSTRACT

In the last two decades, various countries have developed innovative legal frameworks and adopted encouraging tax regimes for social enterprises. In a recent study, we analysed various legal regimes in order to test whether they offer a special business form/model/structure that could invigorate the development of social entrepreneurship in a framework of sustainable development and innovation. This article is a follow-up to the previous study. As a follow-up to the previous study, this study aims to test how the identified legal factors in the first study exert influence on the organisational structure of a social enterprise. The paper focuses on the legal factor of governance as the decision-making power of stakeholders within the social enterprise. In this respect we elaborate on the special legal structure of the Greek Social Cooperative Enterprise (Koinsep). We selected a significant social enterprise in Greece i.e. Koinsep EKATI and we conducted a case study which will be presented in this paper. Our research employs the following methodology: i) collecting empirical data from EKATI Koinsep (ii) a qualitative study to acquire empirical data with regard to the case. The data were collected primarily by (I) relevant documents, which were accompanied by (II) semi-structure interviews (semi-structure interviews with four respondents); Our article falls within the scope of track 5c which elaborates on sustainability in supply chains, CSR and sustainable entrepreneurship. Our empirical research has resulted in conclusions which promote sustainable and innovative legal and entrepreneurial structures for social entrepreneurship. Therefore, they support sustainable innovation while enhancing resilience thinking in the science of sustainability.

*Key words: social entrepreneurship, governance, social cooperative enterprise, Greece, stakeholders, qualitative analysis, case study, employee participation*

### 1. Introduction

Legislation is a key factor for the stimulation and legitimisation of new entrepreneurial initiatives (economic and social).[1] Legislation can provide a legal structure for new organisational models and governance styles,[2] thereby enhancing legal certainty for the entrepreneur.[3]

Currently, the emergence of social enterprises is attracting a great deal of attention.[4] In that context, the following question has emerged: to what extent do national corporate laws support this interesting phenomenon? We identified that there is a gap in the literature as regards whether national corporate laws support social enterprises by offering a specialised legal structure, and in particular concerning the

question of in which way any existing national laws on social entrepreneurship support the new organisational models of social enterprises.

Social enterprises adhere to various legal forms which are available under local, civil and corporate law, such as associations, foundations, limited liability companies, and cooperatives. Several European countries have regulated social enterprises in their national jurisdictions.[6]The very existence of legislation on this topic has contributed to the clarification of the concept of social entrepreneurship.[5] Among the legal forms of social enterprises in Europe, three prevailing legal trends and corresponding organisational models have been identified by us[7]:

- (i) the *cooperative type* of social enterprises (mostly in Southern European countries, i.e. Greece, Italy, Spain and Finland);
- (ii) the *corporate type* of social enterprises, i.e. a limited liability company form (UK); and
- (iii) the *label-oriented type* of social enterprises that transcend existing legal forms of companies and entrepreneurs. The label can be adopted by various types of organisations if they satisfy certain social purpose requirements (Belgium).

A theoretical preliminary study was undertaken by the authors in order to investigate in which way each of these trends have been implemented in the company acts of respectively Greece, the UK and Belgium. We examined the Belgian ‘*Vennootschap met Sociaal Oogmerk*’ (VSO; i.e. the company with a social purpose), the British ‘Community Interest Company’ (CIC) and the Greek ‘*Κοινωνική Συνεταιριστική Επιχείρηση*’ (Koinsep; i.e. the Social Cooperative Enterprise).[8]The research aim of the preliminary study was to detect if there are apparent indicators/variables/characteristics in the legal forms which were introduced in these jurisdictions to accommodate social entrepreneurship.

The preliminary study revealed that in all three countries certain legal factors/variables could be identified that correlate with the characteristics of social enterprises in the definition of social enterprises as introduced by the European Commission.[9]These legal factors/variables are:

- aiming for a *social purpose and the generation of social impact*;
- organising the *governance of the organisation* in such a way that various stakeholders can influence the decision-making process;
- *accountability and transparency* include measuring and reporting on the fulfilment of the social purpose; and
- the *financial structure* is organised in a different way than in mainstream companies such as limited liability companies. Depending on the structure, often stakeholders such as employees also become financial stakeholders.[10]

The research results encouraged the authors to develop further research in order to test, in an empirical way, how these legal factors/variables in practice exert an influence on the organisational structure of a social enterprise that has adopted one of the three legal forms (i.e. VSO, CIC, Koinsep).

As a follow-up to the preliminary study, this present study aims to test how the legal factors that stem from the theoretical preliminary research are implemented in practice by social entrepreneurs.[11]In this paper, the research is limited to the second legal factor/variable, i.e. the governance structure of a social enterprise. The authors consider that the legal factor of governance is crucial because the governing bodies in social enterprises are the custodians of the social purpose/mission and oppose the multiple interests of the stakeholders. For the purpose of this article, the legal factor of governance is the starting and the end-point.

The preliminary research revealed that governance has a twofold meaning in the prevailing models of social enterprises in Europe.[12]Primarily, it showcases the role of the different stakeholders within the selected organisation. For a social enterprise it is common to have ‘multi-stakeholder ownership’, i.e. including beneficiaries, employees, consumers etc.[13]Therefore, governance also concerns the decision-

making power of stakeholders within the social enterprise. Furthermore, the European ‘EMES research network’ definition concerning social enterprises highlights the fact that a characteristic of a social enterprise is that the element of the decision-making power is not *per se* based on capital ownership (which, for example, is the case in the situation where every member has one vote), and not that the power is distributed according to capital shares.[14]

It can be seen from the participatory character of governance that the concept of stakeholder participation in decision making is relevant. Stakeholder theory elaborates on the definition of stakeholders but also on the prioritisation of the enterprise’s stakeholders by the organisation.[15] Although stakeholder participation in decision making for social enterprises is a concept that can be broadly translated according to the meaning that anyone would give to the term ‘stakeholder’ for social enterprises, the concept in theory can be narrowly interpreted i.e. as the participation of employees in decision making.[16] The concept stems originally from the cooperatives’ tradition showcasing the decision-making power of employees as it is expressed through the principle of ‘one man, one vote’.[17] The ‘one man, one vote’ principle requires that every member has only one vote regardless of his/her capital contribution in the cooperative transcending the classical correlation between shares/capital that the prevailing model of corporate capitalism of the last two centuries requires.

In order to understand and include stakeholders’ interest in decision making, social enterprises need to understand how the legal structure impacts the organisational set-up and outcome of decisions. It means that not only the legal aspects of employees’ participation in decision-making need to be understood but also how other types of stakeholders can be involved in decision making. These variations have not been included in the law and they need to be understood. In this respect, we have examined how selected national laws enable the organisational structure of social enterprises to involve stakeholders. Our research focuses mainly on the rights that three national laws provide for stakeholders in order to participate in decision making and their implementation by providing equal, inclusive and transparent (i) property rights, equal voting rights and supervising rights (e.g. employee members, the nomination of directors representing employees, the establishment of a supervising board) (ii) profit rights (e.g. adopting a profit policy or dividend policy, or a remuneration policy for workers and employees) (iii) the right to information (to acquire and share information within the enterprise). This article starts with exploring the situation in the Greek system. Our research on governance and stakeholder participation in social enterprises that have been established on the basis of the UK CIC regulation and the Belgian VSO regulation will be presented in a next article.

## 2. Brief Introduction to the Greek Koinsep

Law 4019/2011 on Social Economy and Social Enterprises defines the cooperative model for social enterprises, i.e. Social Cooperative Enterprises (hereinafter ‘Koinsep’). Article 2 paragraph 1 introduces the new form of Koinsep. According to Article 2 “the Social Cooperative Enterprise is established as an entity of Social Economy. It is a civil cooperative with a social purpose possessing entrepreneurial capacity by law.”[18]

Koinsep is a new entity which differs from existing civil cooperatives regulated in Greek legislation in Law 1667/1986 regarding Civil Cooperatives. Even though Law 4019/2011 stipulates that the Koinsep emulates the ordinary civil cooperative in terms of company formation and governance, the relationship between the members, the set-up of the administration, its operation and its dissolution, the law however recognises that the two entities do differ, among other things, in terms of their definition and purpose.[19] The civil cooperative is an association of persons with a commercial purpose which has been particularly designed to promote cooperation among its members aiming at the promotion of the economic, social and cultural development of its members and the improvement of their quality of life within the joint enterprise.[20] Koinsep is a civil cooperative with a social purpose which has been designed to promote the benefit of the community as opposed to the ordinary civil cooperative whose purpose can only be

commercial and only for the benefit of its members (i.e. productive, supplying, consuming, transportation, tourism).

Koinsep's social purpose varies within the three types of Koinsep that are laid down in Law 4019/2011 on Social Economy and Social Entrepreneurship; (i) the *Integration Koinsep* can have a purpose which aims exclusively at the integration of individuals belonging to a volatile and vulnerable population in economic and social life; (ii) the *Care Koinsep* can have a purpose which aims exclusively at the production and provision of goods and services related to social care for the benefit of vulnerable population groups such as the elderly, infants, children, the disabled and the chronically sick; and (iii) the *Collective and Productive Purpose Koinsep* can have a purpose which aims at the production of goods and the provision of services that meet the needs of society in terms of culture, the environment, ecology, education, social benefit services, the promotion of local products, traditional activities and arts and crafts which at the same time promote (1) local and collective interest, (2) the development of employment, (3) the enhancement of social cohesion and (4) the strengthening of local or regional development.[21]

The civil cooperative and the Koinsep also differ in terms of external accountability. Koinsep is subject to the audits undertaken by the Registry of Social Economy and Social Entrepreneurship which is the responsible administrative authority for mapping, coordinating and supervising all Koinseps in Greece. According to Article 11 of Law 4019/2011 the Registry of Social Economy and Social Entrepreneurship can request that any Koinsep provides, on an annual basis, documentation and/or information regarding the implementation of the Koinsep's social purpose. This requirement does not apply to civil cooperatives which are not accountable to the Registry of Social Economy and Social Entrepreneurship.

The Greek Koinsep also differs substantially from the European Cooperative Society (SCE) which was introduced in Greece by Council Regulation (EC) No. 1435/2003.[22]The SCE is a for-profit cooperative which aims primarily to satisfy its members' needs and/or the development of their economic and/or social activities. Its purpose is not social. Instead it aims at the promotion of the mutual benefit of its members. SCE profits are distributed to the members according to the needs of those members.

## 2.1. Property rights, representation rights and supervising rights for stakeholders

In principle, the research required a critical examination of the essential elements of the law related to the topic. In this case in order to examine how national laws in Greece enable social enterprises to involve stakeholders, we examined the acquisition and the exercise of (1) the property rights (including representation rights and supervising rights), (2) the profit rights (including distribution rights, dividend rights), and (3) the right of stakeholders to information.

According to the Greek Law on Social Economy and Social Entrepreneurship (Law. 4019/2011) as well as the Law on civil cooperatives and other provisions applicable to Koinsep, the Koinsep is a democratic model of representation which requires the equal representation of all Koinsep members.[23] It means that the democratic principle of 'one man, one vote' will apply. This principle is laid down in Article 4 (2) of Law 1667/1986 concerning Civil Cooperatives which is also a law that is applicable to the Koinsep according to Article 5 (1) of Law 4019/2011.

Article 4 (6) of Law 4019/2011 provides the legal right for workers/employees to become members of a Koinsep without any explicit limitation. Thus, workers and employees of the Greek Koinsep can acquire property rights without being subject to time or contractual constraints. Furthermore, according to Article 7 (1) of the Law concerning Civil Cooperatives, if a Koinsep has more than 20 employees who are not Koinsep members (this can also be stipulated in the articles of association) the law gives a right to the employees/non-members to appoint/elect one of the members of the Management Board/Committee. Article 4(6) of Law 4019/2011 and Article 7 (1) of the Law concerning Civil Cooperatives are complementary. Together they form an inclusive legal framework as regards the participation of stakeholders/employees in decision making. Within this framework, the law forbids public, governmental, administrative bodies or legal entities from the public sector to become members of a Koinsep under the principle of organisation autonomy. According to Article 3 (3) regional administrative organisations or

other legal entities which belong to the public sector are not allowed to become Koinsep members. As elaborated above together with the right to become members of the Koinsep, employees/workers also acquire the rights attached to the shares. Finally, in a Koinsep with more than 25 members, the establishment of a mandatory supervisory board is required upon election from the general assembly. The supervisory board audits and supervises the activity of the Managing Committee. Additionally, Article 7 (1) also applies according to which employees/non-members have the right to appoint/elect one of the members of the supervisory board.

## **2.2 Profit rights, distributions rights, dividend rights**

In the Koinsep stakeholders/employees only enjoy profit rights, distribution and dividend rights if they have been registered as Koinsep members. However, according to Article 7 a Koinsep does not distribute profits or dividends to Koinsep members. Instead, in the Koinsep profits are distributed to the employees/workers; they receive an annual 35 per cent of the enterprise's profits as remuneration for their productivity. Furthermore, an amount that equals 60 per cent of the revenues is reinvested in the enterprise for the generation of new vacancies and job creation for new employees in the Koinsep.

## **2.3. Right to information**

The Greek legislation provides that Koinsep members should receive and acquire information on the enterprise's operation. This is neither stipulated in Law 4019/2011 nor in Law 1667/1986, but it occurs as a right that stems from the provisions of ordinary corporate law. According to Law 4019/2011 there is no stipulated obligation for the enterprise's decision-making bodies to provide a specific amount of information to the enterprise's workers or employees. At the end of the accounting period a financial balance sheet and a profit-loss account are prepared by the Management Board/Committee. The Management Board/Committee submits the financial statements to the general assembly.

## **3. Methodology of the empirical examination**

The research addresses the following question: how does the Greek law on Koinsep enable the organisational structure of social enterprises to involve stakeholders in practice? In other words: how can the applicable Greek law accommodate the involvement of stakeholders in the governance structures of the Koinsep?

In essence this chapter explores how the organisational structure can improve the practical functioning of social enterprises in Greece by involving stakeholders in the decision-making process. In the authors' view, a case study is the most appropriate research method to be employed, because it will enhance the understanding of the legal provisions on the Koinsep by contextualising the contemporary phenomenon of social enterprises in Greece.

By developing a case study, this paper aims to generate theoretical statements about the practical application of the legal factor of governance in the Koinsep as well as a comprehensive understanding of the involvement of stakeholders in the organisational structure of the Koinsep in Greece. In this way the case study will showcase the relevance of the Greek legal provisions on the Koinsep with their implementation in the organisational structure when stakeholders are involved in the decision-making process. The case study will demonstrate ways for improving their organisational functioning.

The research required an empirical examination of the identified legal elements by means of a case study of a Greek Koinsep, i.e. Koinsep EKATI. Koinsep EKATI was selected because in its contribution to the general understanding of the main topics of the research it demonstrates important additional information about the Koinsep in Greece. The empirical examination was undertaken by (i) collecting empirical data from Koinsep EKATI (ii) a qualitative study to acquire empirical data with regard to the case. The data

were collected primarily by (I) relevant documents, which were accompanied by (II) semi-structure interviews.

The *relevant documents* that have been examined are EKATI's articles of association, EKATI's contracts, and online reports about the social economy in Greece.

*Respondents' background:* For the completion of the case study, four interviews were conducted:

- The first respondent is a Koinsep technical expert/advisor who was employed for the purpose of establishing Koinsep EKATI. He is the founder and the manager of the biggest and unique information portal about Koinsep in Greece i.e. Koinsep.org. He also participates in a formal steering body which represents numerous Koinsep in Greece. He was employed by EKATI and he collaborated with EKATI aiming at the promotion and development of social entrepreneurship and social economy in Greece. Therefore, he has a valid and concrete opinion as a third/external expert party.
- The second respondent is the President and the co-founder of Koinsep EKATI. He is an agriculturalist. Prior to the initiation of EKATI he was working as a civil servant in a public hospital in the city centre of Athens preserving and looking after the gardens of the hospital.
- The third respondent is EKATI's co-founder and EKATI's Managing Committee Secretary. She has 12 years of experience in the field of social entrepreneurship and social economy and today she works in various civil associations. As of now she is a trainer and a consultant in many publicly funded programs for social reintegration into the labour market via the use of social enterprises. She is an expert in environmental and ecological engineering and a geo-technician.
- The fourth respondent was, at the time of the interview, an official at the Registry of Social Economy and Social Entrepreneurship.

*Interview topics and the approach which was used:* The interviews were conducted over a one-year period. Interview reports were created including the interview questions prior to the interviews. The questions were formulated as having a broad nature and were semi-structured. The authors drafted reports to track methodological, observational and theoretical notes during the data collection. All the interviews and the notes were transcribed by the authors. The main interview topics covered in the interviews were: (1) background information about Koinsep EKATI i.e. start-up experiences, (2) its social purpose, (3) EKATI's provision of goods and services, (4) information about the governance structure, representation and decision making, (5) stakeholder and employee participation in the decision making, (6) the provision of property rights to employees, profit distribution to employees as remuneration for their productivity, (6) EKATI's stakeholder participation policy.

Grounded theory was the main analytical tool for understanding how the Greek legal provisions on employee participation in the governance of Koinsep enable the organisational structure of social enterprises to involve stakeholders in practice and to develop particular conclusions. The process consisted of creating codes and categories as well as hypotheses which are directly related to the research question of this paper. Additionally, the opinions of the first respondent as an expert on the issues at stake were integrated into the collected data.

*Procedure:* In the exploratory phase of the data analysis open in vivo coding was applied via ATLAS. The collected data were coded with codes which are important to the research question. The codes reflected the content of the text from the interview reports, the most important topics of the interviews and the issues identified in the literature. The used codes were: decision-making, governance structure, profit rights for employees, property rights for employees, access to information for employees, stakeholder policy, enabling legal environment, social purpose, challenges, entrepreneurial opportunities, financing. In the following phase of the data analysis, the authors reflected on the selected codes by classifying the existing codes into categories upon the identification of the ties and connections between the codes of the first phase. The dominant codes in this phase were EKATI's governance, employee participation in EKATI, enabling legal framework, EKATI's challenges, EKATI's advantages and opportunities. In the third phase of the data analysis the coded data were connected to the main themes and the concepts of the theory.

## 4. Case study

### 4.1. EKATI - introduction

Koinsep EKATI was established in August 2012.[24]It initiated its activity in June 2013. EKATI aims at the provision of goods and services for the preservation of the urban environment, the maintenance of green areas, the promotion of recycling, the promotion of the use of renewable energy and the protection, care and nursing of pets and stray animals. [25]It has a social and productive purpose which aspires towards the creation of jobs in the areas of recycling, renewable energy, environmental preservation and also in areas where EKATI could cooperate with public authorities for the exploitation of public resources and for the provision of services that the private sector is not interested in providing, i.e. using unused public facilities for the protection of stray animals in Athens. [26]The protection of stray animals and pets is a very important problem in Greece especially during the economic crisis. Greek people abandon their pets because they cannot afford to keep them. Stray animals can be seen everywhere in Athens. This has become a very common problem in Athens and a major problem throughout Greece.

### 4.2. EKATI governance

EKATI has eight members. A member who is an agriculturalist, five members who are geo-technicians, a retired army aviation officer and one member who chairs the Association for Homeless People in Greece named 'the Shelter'. Every natural or legal person who aspires towards EKATI's social purpose and social activity can become an EKATI member except for local administrative authorities and legal public law entities. [27]The General Assembly of the Members is EKATI's supreme administrative body. It has the right to decide on all matters concerning EKATI and it has exclusive competence to decide on the most important topics of the enterprise according to the articles of association and the applicable laws. It also undertakes the supervision and the auditing of the Managing Committee. EKATI's members of the General Assembly vote after discussions on the issues at stake. To date, all EKATI decisions have been taken unanimously by the members. The principle of 'one man, one vote' applies, which is characterised by the democratic participation of all the members in voting and the trust between the parties.

The management of Koinsep EKATI is undertaken by the Managing Committee which consists of three members: the President, the Secretary and the Treasurer who are directly elected by the General Assembly of the members. EKATI's Managing Committee manages and represents the enterprise according to its articles of association and the applicable laws. The Managing Committee also decides on all matters relating to the administration and management of the enterprise, apart from those which are within the exclusive competence of the General Assembly. Board meetings are held once a month or at the request of one third of the members. The Managing Committee's meetings are open to all the members but not to third parties or employees.[28]EKATI's members are informed by the Board about all the business activities and decisions taken by the Managing Committee. The Managing Committee is responsible for updating the rest of the members. Even though the dynamic character of EKATI's operation may give rise to opposition and disagreements between the members, especially considering that EKATI is a new enterprise without clear guidance from the competent public authorities, the members of EKATI are very keen to support the enterprise with their trust and confidence.

To date, EKATI cooperates closely with many animal welfare organisations especially aiming at enhancing its expertise and knowledge in the field of nursing and protecting stray animals. Some of EKATI's actions and decisions have been decided upon after consultation with animal welfare organisations. Furthermore, EKATI's members encourage consultation and cooperation with Koinseps from other fields in order to assist EKATI with the provision of complementary services that EKATI cannot provide.[29]

EKATI's General Assembly of the Members has an annual obligation to submit to the Registry of Social Economy and Social Entrepreneurship the following statements: 1) EKATI's annual balance sheet, 2) EKATI's explanations and information concerning its social activities 3) EKATI's annual plan regarding

the enterprise's social activities. The reports are not publicly available to employees or third parties but only to the members of the Koinsep.[30]

### 4.3. Employee participation in EKATI

In EKATI's management the roles are distinct.[31] In this case, the employees are not involved in the decision-making process concerning the managerial decisions. However, a consultation process may be followed in the decision making when technical matters are addressed and an employee may contribute with his/her technical expertise in the decision making.[32]

In EKATI during its initiation phase employees were occasionally replaced with others due to the financial instability of the enterprise e.g. bad payment, the lack of a social security status and poor information regarding the way in which Koinseps work. In the last four months the necessary balances have been found with the enterprise's employees. However, employees are not involved in the decision making.[33]

As of today none of EKATI's employees has become a member of the enterprise even though all employees in EKATI can by law become members upon confirmation by the General Assembly. According to Mr. Stratakos it is necessary for EKATI to balance the relationship between employees and members. [34] Koinsep as a legal structure allows for a relationship between the members and the employees which does not emulate the classical relationship between employer and employee in for-profit enterprises. The employees of EKATI are the core of the enterprise and the reason for EKATI's existence. They receive a large part of the enterprise's profits as a reward for their productivity. The employees' productivity is a characteristic feature of the importance of Koinsep and it generates a motivation for other individuals to initiate a Koinsep. The distribution of EKATI's profits to EKATI's employees as a productivity bonus is at the discretion of the Managing Committee which subjects the decision to a General Assembly vote. The distribution of profits to the employees is analogous and proportional to the employees' annual productivity. The current position is that EKATI's limited profits have not allowed for the distribution of profits to the enterprise's employees.

In EKATI there are also some volunteers. However, there is no legal framework in Greece for the provision of voluntary services in a Koinsep and in general. This is a major loophole according to Mr. Stratakos. According to Mr. Fiskilis employees should be employed with contracts because there is no room for volunteers in EKATI; this is because the purpose of Koinsep is the creation of new vacancies and job positions.[35] The contribution of volunteers is a negative development for EKATI. Voluntary positions can only be created for non-productive positions within Koinsep, for example secretaries.[36] EKATI's books and statements are accessible to all members of the enterprise but not to employees. There are no statutory requirements for the public disclosure of EKATI's annual financial statements to employees.[37]

### 4.4. Enabling legal framework

The legal framework for Koinsep in Greece is still primitive. The existence of the economic crisis does not help Koinsep's development. However, there is room for the development of Koinsep even within the economic crisis in Greece. Koinsep is a hybrid model which does not aim primarily at the generation or distribution of profits. The overarching goal of Koinsep is to create revenues to provide services which benefit society and to generate new employment so as to alleviate unemployment.

The entrepreneurial structure of Koinsep may be a solution for the economic crisis in Greece if the structure of Koinsep will be institutionally strengthened and financially aided by the state.

Furthermore, the public sector is functionally suffering in Greece. The current public deficit and the inability of the public authorities to be substantially financed have undermined the quality of the provision of public services. Improving the quality of public services is necessary. The structure of Koinsep in Greece can play a substantial role in the alleviation of the economic crisis by improving the

quality of the services provided by the public sector.

According to the existing legal framework for Koinseps in Greece, municipal authorities can enter into public contracts with Koinseps within the framework of local action plans for enhancing employment at a local level as well as for assisting the public sector in improving the quality of public services. The existing legal framework allows a Koinsep to participate in local open, restricted or negotiated public procurement procedures.[38]The contracts between Koinseps and public/municipal bodies aim to exploit public resources in industrial areas where mainstream/ordinary companies are not interested in offering services due to the low opportunities for profit; thus the use of public property for the benefit of society leads to job creation and to strengthening the public economy.[39]

EKATI was awarded a public contract by the Municipality of Athens for the protection of stray animals in the city.[40] In the framework of cooperation with the Municipality of Athens EKATI has created five new job positions. It has employed a veterinarian and four other employees. Simultaneously, more than 120 stray animals are being protected and nursed by EKATI.[41]

EKATI, in cooperation with the city of Athens, also exploits unused facilities that belong to the Municipality of Athens for the care of stray animals such as old buildings and shelters. EKATI provides full care, nursing and veterinary services to stray animals. In this field EKATI has developed experience and expertise. Members of EKATI have already invited other municipalities in Greece to work and cooperate with EKATI especially considering that in 2014 a European Directive on the protection of stray animals will come into force. Another factor that needs to be taken into consideration is protection against the spread of rabies among animals and the people.

EKATI's activity has benefited society by reducing unemployment and creating five new jobs, raising society's and the public sector's awareness regarding the protection of stray animals, protecting public health, the nursing of stray and unprotected animals, raising public awareness and effectively providing solutions concerning the problem of deserted animals.

EKATI has a continuous and sustainable activity. Although the concept of sustainability is not included in EKATI's articles of association, sustainable development is reflected in its practice. EKATI's economic, social and environmental footprint is evident. By definition, sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. EKATI expects to meet the present needs of society via job creation and the exploitation of unused resources without compromising future generations. EKATI's purpose is to satisfy those needs of society that the public authorities cannot satisfy due to the economic crisis as well as to cover the needs of society that the private sector cannot cover because there are no opportunities for profit.

#### **4.5. EKATI's challenges**

EKATI's experience with local authorities has illustrated that in the awarding of public contracts the local contracting authorities should take into consideration Koinseps' special characteristics, such as (1) the special character of a Koinsep and the fact that its profits are returned to society to serve the social purpose and to create jobs while for-profit companies distribute their profits for the benefit of individuals, (2) the fact that the use of public resources will benefit society because a Koinsep does not aim at profit generation but at benefiting society, (3) the fact that a Koinsep is accountable to the Registry of Social Economy as part of the Ministry of Labour, Social Security and Welfare compared with for-profit enterprises which are not accountable to anybody, (4) the fact that a Koinsep is vulnerable to institutional and legal instabilities because it is a new legal structure compared to the classical types of private companies, (5) the fact that the legal framework for social enterprises is vague and should be supported, for example with the introduction of Law 4019/2011, by tax exemptions for Koinseps.

Furthermore, bureaucracy, administrative burdens and the lack of public funding generates problems for the development of a Koinsep. At the same time the lack of information provided by the administrative authorities for developing a Koinsep and their weakness in understanding and implementing Koinseps' legislative framework generate barriers and problems for the development of Koinseps, thereby keeping

them at a primitive level. For example, the administrative processes for establishing and initiating EKATI were problematic. Upon its incorporation EKATI used the sample template of articles of association which is provided by the Registry of Social Economy and Entrepreneurship. This template which is commonly used by many start-up Koinseps suffers from ambiguities that created initial problems and additional costs for EKATI. Furthermore, there is no harmonisation and guidance regarding the tax and social security regime for Koinseps in Greece. The Greek government constantly changes the tax regime for Koinseps by gradually removing tax exemptions for Koinseps. Due to this problematic and vague legislative framework EKATI was subjected to several fines upon its initiation that generated extra costs for the enterprise's initial limited capital.

EKATI's members have initiated a public discussion/consultation concerning this problem with the administration. They have requested the involvement of the Registry of Social Economy and the Ministry of Labour, Social Security and Welfare in order to clarify the existing legal ambiguities for Koinseps in Greece. The discussion resulted in the issuance of Ministerial decrees with clarifications as to tax and social security aspects.[42]

Furthermore, there is no financial support for Koinsep either from the private or the public sector. The Greek state could use indirect forms to finance social enterprises (via public contracts) thus the state would become an important partner for Koinseps. Koinsep EKATI was initially financed by contributions from the founding members. When the public contract with the Municipality of Athens entered into force, there were delays in financing from the side of the Municipality. Many Koinseps delay their start-up due to a lack of the necessary initial capital. Even though there is no minimum capital requirement for Koinseps the members cannot provide the necessary minimum capital for the initiation of the enterprises.

Future social entrepreneurs/initiators have not been trained in managing a Koinsep. There is no academic institution for providing support and the necessary training and education in the field of the social economy and the management of Koinseps. The existing universities do not offer courses on the social economy and the management of Koinseps.

Society itself is not aware of the opportunities that the entrepreneurial structure of Koinseps can offer. In the beginning EKATI's activities encountered negative reactions and opposition from existing animal welfare organisations in Athens. However, the negativity of these organisations disappeared soon after EKATI began to offer its professional activities to the Municipality of Athens.

Finally, the establishment of Koinseps takes place in a disorderly fashion without any guidance and instruction from stakeholders, experts and public authorities. Therefore, they do not fully meet the needs of the market. The majority of Koinsep initiators aspire to attain either public or private financing in order to proceed with the Koinsep's activities or to obtain a future contract with local or public authorities.

## 5. Discussion

To conclude, our research examined stakeholders' and employees' participation in the Greek Koinsep. In our research we identified that even though the legal framework is conducive to employees' participation in decision making, EKATI's employees have not become EKATI members. Therefore, EKATI's employees do not enjoy property rights or access to EKATI's decision making and information. Furthermore, employees' profit rights from the distribution of EKATI's profits have not yet been realised. The limited willingness of employees to become EKATI members can be justified by the fact that there is no information being provided about the topic of employee participation for EKATI's employees from EKATI's members. EKATI's members are focused on creating new job opportunities to alleviate the major problem of unemployment in Greece instead of enlarging stakeholder participation in EKATI's governance. The considerable amount of financial and administrative problems caused to EKATI either due to the lack of financing or due to the vague administrative, tax and welfare framework is not conducive to EKATI focusing on improving its organisational structure.

Furthermore, the information provided to society regarding the institutional and legal framework of Koinseps in Greece is limited. This is evident by the fact that the initial employees who were employed by EKATI were not aware of how Koinseps work. The current role of employees and members in Koinseps is considered to be distinct to Koinseps. Participation and democracy applies only to the enterprise's members. Every natural or legal entity (including also employees) which wishes to become a member needs to purchase and acquire a cooperative share. In Koinseps the members currently finance the initiation and the operation of the enterprise by means of their own contributions due to the lack of financial assistance either from the private or the public sector. Considering that the majority of EKATI's employees were unemployed people they do not have the financial means to meet the financial obligations/contributions which apply to Koinsep members.

Stakeholder theory as well as the definition embraced by the EU Regulation on Social Entrepreneurship Funds address additional types of stakeholders for social enterprises i.e. beneficiaries, consumers, the local community or the people affected. Therefore, not only the legal aspects of employees' participation in decision making need to be examined but also the legal and practical implication of other types of stakeholders who are involved in a Koinsep's decision making. This topic will be the subject of the authors' further research.

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Ibid, Lambooy & Argyrou 2014, pp. 70–75

[10] For an elaboration of the meaning of each of these factors/variables see supra Lambooy T.E., Argyrou A., Hordijk R. 2013, supra note 8. See also Lambooy & Argyrou 2014, supra note 8.

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# SUSTAINABLE CSR FOR MICRO, SMALL AND MEDIUM ENTERPRISES

Ruchi Tewari<sup>1</sup> and Taral Pathak<sup>2</sup>

<sup>1</sup> Ahmedabad University; ruchi.tewari@ahduni.edu.in

<sup>2</sup> Ahmedabad University; taral.pathak@ahduni.edu.in

## ABSTRACT

Corporate Social Responsibility (CSR) is engaged as a competitive tool in developing economies and it is a reality which faces strong criticism from the Micro, Small and Medium Enterprises (MSME's)-business units of small net worth with two striking characteristics - supported and managed by single individuals or his family members and operate in a 'cluster'. MSME's grow and flourish in a unique business environment while parameters for effective CSR remains the same for MSME's and large corporations. Since MSME's need to compete with the large corporations, CSR adoption is not a choice and therefore the current paper argues that policy makers should consider and create provisions to support, 'collective corporate social responsibilities, (CCSR) through which a group of MSME's with similar sustainability needs support and take up socially responsible activities, as a unit.

The clusters provide a conducive opportunity to MSME's to adopt social responsibilities collectively, which will serve the needs of the various stakeholders like workers, community, environment, customers etc. This concept of 'CCSR' adheres and corroborates to all the Carroll's (1991) [1], 4 stages of CSR Pyramid. The results substantiate the earlier work suggesting that the western institutional and management models exported to other regions of the world are not always very successful (Wohlgemuth, Carlsson & Kifle ed, 1998) [2] and understanding and practice of CSR should be socio-culturally framed (Sundar 2000) [3].

*Keywords: Micro Small and Medium Enterprises (MSME's); Clusters of MSME's; Corporate Social Responsibility (CSR); Cluster Social Responsibility; India.*

## 1 INTRODUCTION

The business world is inter-linked along with a clear distinction between the developed and the developing economic structures with the standards and norms being set by the former and the tireless attempts made by the latter to cope up and meet the established norms leading to a state of flux. Changes observed in the organizational structure of the developed western economies and societies affect the developing countries as well. The new form of development marked since mid-1970s represents a transition for a new phase of capitalist development where organization of production is changing from mass consumption to customized products, employment in the services sector is becoming increasingly important, management of firms is becoming less hierarchical, the welfare state is being redefined and national states are increasingly taking decisions in a context of globalization (Amin 1994) [4]. The hold of governing agencies and policies has been decreasing giving way to business to contribute in the process of development. This leads to a number of issues and dilemmas which throw up challenges and opportunities for business both in the developing and the developed world.

Therefore, the development process which involves activities by government or business units need to be in sync with the historical and cultural make-up of the country. The current paper attempts to look at corporate social responsibility (CSR), as a developmental activity by businesses in India in light with the manners and ways in which business activities are run and managed in India. It proposes a conceptual model through which CSR can be better engaged by micro, small and medium enterprises (MSMEs) in India.

## 2 THEORITICAL FOUNDATION

### 2.1 SME Contribution to Indian Economy

Post deregulation, India has three broad categories of business establishments - state firms, Multinational Companies (MNCs) and family-managed Indian business. Issues of coping up and

matching the governance patterns of the three are considerably unique and necessary to understand before their role in the process of economic development can be defined. Among the family-owned business a large segment is occupied by the small and medium scale enterprises (SMEs). SMEs are increasingly playing a significant role in the economic and social development of the nation. As compared to corporate enterprises, SME's contribute more extensively as they have a share of 40% in terms of volume, 80% in terms of employment, 60% in terms of exports and 92% in terms of number of enterprises. These figures are indicative of the economic significance of SME's. (OECD) [5]

The Small and Medium Enterprises (SME's) alone contribute 7% to India's GDP. As per the Third All India Census of Small Scale industries conducted in 2004, the SME's have increased from about 80,000 units in the 1940's to about 10.52 million units. Their total employment is about 25 million and they produce about 7500 products including high technology products. In the sports goods and garments sector their contribution to exports is as high as 90% to 100%. They constitute 90% of the industrial units in the country and also contribute to about 35% of India's exports (Pandey, 2007) [6]. The performance of the Indian small scale sector in terms of critical economic parameters such as number of units, production, employment and export during the last decade is indicated in the table below.

Table 1. Performance of Small Scale Sector

Year	No of Units (Million Nos)	Production (Billion Rs) (at current prices)	Employment (Million nos)	Exports (Billion Rs) (at current prices)
2000 – 01	3.37	6454.96	18.56	599.78
2001 – 02	3.46	6905.22	19.22	712.44
2002 – 03	3.67	8243.63	20.07	861.03
2003 – 04	3.83	9323.54	20.9	N.A.
2004 – 05	4	10600.87	21.78	N.A.
2005 – 06	4.18	1213.8	22.78	N.A.
2006 – 07	4.37	14019.39	22.17	N.A.

(Source: Pandey 2007) [6]

The SME category has a typical competitive advantage in the Indian industry in terms of the market it controls globally and its ability to make customized goods even in a small volume and yet maintain low fixed and overhead costs. The SMEs have thus over a period of time developed a specialization and have evolved as 'clusters'.

## 2.2 SME and Cluster Development

Globalization has led to the influx of large corporations in developing nations and small and medium enterprises which are integral to the nature of local economies often find it difficult to survive against the large firms due to their size (UNIDO, 2001). Individual SME's find it hard to achieve economies of scale in procurement of raw material and other resources, adoption of internal functions like technology adoption or up-dation, training programmes for skill enhancement or division of labour. But UNIDO (2004) [7] asserts that SME's needn't be looked as individual units as that is isolation of the firm. Cooperation among SME's offers a solution to their diminutive size. Porter (1998) [8], defines clusters as 'geographic concentrations of interconnected companies and institutions in a similar field. It extends downstream to channels and customers and laterally to manufacturers of complementary products ad to companies in industries related by skills, technologies or common inputs.' Literature offers several evidences of successful working of SME's as clusters from both the developed and developing world (Goodman, Bamford, and Saynor, 1989 [9]; Pyke, Beccattini and Sengenberger, 1990 [10]; Sengenberger, Loveman, and Piore, 1990 [11]; UNCTAD, 1994 [12]).

## 2.3 Understanding CSR

CSR as a concept has undergone drastic changes in nomenclature, varying orientation of the term and has also undergone significant evolutionary development. CSR in theory and practice falls within the

realms of various fields of study like sociology, social work, economics public administration, environmental studies and academics. The diverse and prolific contributions from the various fields has not only enriched but has also led to controversies and confusions. As Votaw and Sethi (1973) [13] puts it, “the term (social responsibility) is a brilliant one, it something but not always the same thing, to everybody. To some it means socially responsible behavior in an ethical sense; to still others the meaning transmitted is that of ‘responsible for’ in a casual mode; many simply equate it with ‘charitable contributions’, some take it to mean socially conscious or ‘aware’, many of those who embrace it most fervently see it as a mere synonym for ‘legitimacy’, in the context of ‘belonging’ or being proper or valid, a few see it as a sort of fiduciary duty imposing higher standards of behavior on businessmen at large”.

The term CSR has been defined differently and variedly over a period of time and has had various shades of understanding across commercial activities in different geographic locations. Therefore, CSR lacks any definitive and tight definition primarily because this concept has evolved differently and has had varied forms of existence in different places and business activities. Carroll (1999, 1998) [14]; [15] was a seminal contributor to “modern” CSR theory with later contributors including authors such as Jenkins (2006, 2004) [16]; [17], Fuller and Tian (2006) [18], Maignan, Ferrell, and Ferrell (2005) [19], Matten and Crane (2005) [20], Maignan and Ferrell (2001) [21]. The broad understanding is that it is the scope and the kind of social and environmental obligations which corporations may consider while executing and operating their routine business practices (Shamir, 2005) [22].

The following definition by Lord Holme and Richard Watts, is most widely accepted and suits the context of our study most appropriately, "Corporate Social Responsibility is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large", in ‘Making Good Business Sense’ report at the World Business Council for Sustainable Development website.

For the purpose of this study the understanding of the concept of CSR will be based on the Carroll’s pyramid of Social Responsibility where he elaborates of four distinct stages of business – Economic, Legal, Ethical and Philanthropy. (Carroll, A. 1991) Economic component included the responsibility that the business should perform in such a manner that it maximizes earning per share and remains as profitable as possible so as to maintain its competitive position and high level of operating efficiency. The legal responsibility demands that the conduct of business be such that it conforms to the expectations of the government and law, comply with the federal, state and local regulations, be a law abiding corporate citizen such it the firm fulfills its legal obligations. The responsibilities at the ethical stage is adherence to normative rules of justice and fairness which may not have been codified as law but are yet expected or prohibited by society. This would include an ethical treatment of the various stakeholders. The philanthropic responsibilities include being a good corporate citizen such that the business gives back to society and the various stakeholders. This incorporates engagement into activities and programmes that include and lead to human welfare and goodwill. Philanthropy is the most discretionary function of business though the expectations from society are always there.

Through this model, we shall understand the business activities and strategies of the SMEs operating in India and explain our model of Collective Corporate Social Responsibility (CCSR) as applicable to SME’s in India.

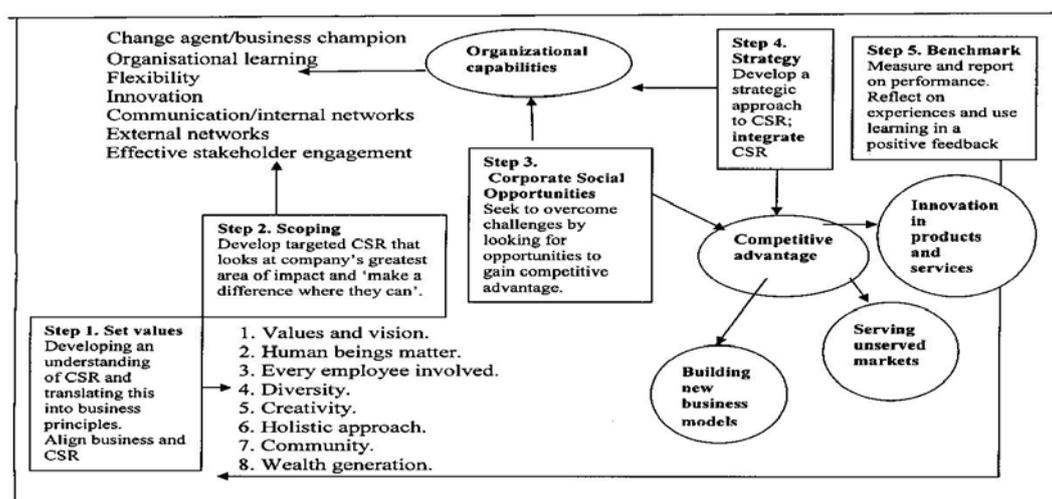


Source: Carroll (1991, p. 42)

Figure 1. Carroll's (1991). Pyramid of Corporate Social Responsibility

## 2.4 CSR – the SME Way.

The core of CSR is managing the triple bottom line and be able to integrate and balance between economic, environmental and social issues going above legal requirements. It is interesting to note that SMEs operate and function with very limited resources and most often have limited vision in terms of organizational goals which is primarily focused upon profit generation. They are generally believed to heavily emphasize economic imperatives rather than social goals mainly because of their survival strategy and their relatively limited financial base and are competing against the fund-rich well established MNCs making the standing fairly lop-sided and unequal. But today, corporate responsibility is not merely an issue for large MNCs but also for SMEs with limited resources and less market power. The reason why CSR becomes pressing for the SMEs is also because it is well accepted as a tool for competitive advantage leading to sustainable development and poverty reduction in the world. From the management side, the corporate responsibility can be seen as a market requirement and used as a marketing tool for competitive advantage. A strategic approach to corporate responsibility which makes it helpful is the fact that it increases the accountability of positions which is well demanded in SMEs. The idea of corporate responsibility development is demonstrated by a model showing the steps towards an integrated triple bottom line (Jenkins, 2006). Through his study, he provides an insight into corporate responsibility in a SME and links it to value-based management and quality management to the process of developing a sustainable business approach.



Model 1. A 'business opportunity' model of CSR for SMEs (Jenkins, 2006)

Figure 2. 'Business Opportunity' model for CSR and SMEs (Jenkins, 2006)

## 3 RESEARCH GAP

The large body of knowledge on CSR so far developed has improved our understanding of the integration of CSR with other corporate strategies; further necessary work is still being done by both academics and practitioners. In particular, SMEs' CSR has received relatively little attention and there is a small body of literature on SME experiences in industrialized countries and a very limited amount of literature in developing countries (Spence, 1999 [23]; Spence et al., 2000 [24]; Spence and Schmidpeter, 2003 [25]; Spence and Lozano, 2000[26]; Spence and Rutherford, 2003 [27]). Such a knowledge gap is critical, as small businesses remain the dominant organizational form within the member countries of the OECD – Organisation for Economic Co operation and Development (Spence and Rutherford, 2003). According to several authors, research on the relationship between CSR and SMEs differs significantly from the research on enterprises: "Business ethicists must acknowledge that the large multinational firm is not a standard business form against which other types are benchmarked" (Spence and Rutherford, 2003). Obviously a number of characteristics distinguish SMEs from their larger counterparts. Size represents but one criterion; others include legal form, sector, orientation towards profit, national context, historical development and institutional structures (Spence, 1999; Spence and Rutherford, 2003). Therefore, given the above differences between large

firms and SMEs, further research is required to define whether or not also a different theoretical perspective should be embraced to explain the CSR and SMEs relationship and to address future empirical research. Recent research focuses on social capital. “Whereas physical capital refers to physical objects and human capital refers to the properties of individuals, social capital refers to connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them” (Putnam, 2000) [28], “that can improve the efficiency of society by facilitating coordinated actions” (Putnam, 1993)[29]. Moreover, “stocks of social capital, such as trusts, norms, and networks, tend to be self-reinforcing and cumulative. Virtuous circles result in social equilibria with high levels of co-operation, trust, reciprocity, civic engagement, and collective well-being. These traits define the civic community. Conversely, the absence of these traits in the uncivic community is also self reinforcing” (Putnam, 1993). The intangible assets of reputation, trust, legitimacy and consensus are all aspects of social capital (Spence et al., 2003, 2004), the basis of the long-term performance of SMEs and especially SMEs embedded into the local community in which they operate. This literature provides a clear direction for further research in CSR: to provide SMEs with guidance and tools to implement and report on their CSR policies, processes and performance effectively, based on their social capital.

#### 4 RESULTS AND CONCLUSIONS

What needs to be scrutinized closely is the suitability of CSR models developed in the west and their implementation in other parts of the world, especially the developing eastern nations? There are studies providing links that the western institutional and management models exported to other regions of the world are not always very successful (Wohlgemuth, Carlsson & Kifle ed, 1998). Research also indicates that the understanding and practice of CSR is socio-culturally framed (Sundar 2000).

At one extreme CSR participation by SMEs has been viewed as an extension of profit-making activities and, at the other extreme, involvement in CSR with community stakeholders, has been understood as a purely altruistic activity. Despite this varying and conflicting conclusions very little of mainstream literature and research focused upon how regions other than the west engage in CSR.

It is important to note that Jenkins (2006), ‘business opportunity’ model fits the existence and operation of the SME in the west as it operates in an environment where the focus of small-scale business has elevated to quality management and value-based management. In India the SMEs operate in an environment where the notion of quality management is still distant except to the ones catering to the export demand where emphasis on quality is stringent but due price competitive advantage and lack of competition, involving into CSR as a competitive tool the motivation for involving in CSR is absent. The majority of the SMEs caters to the local market and can make a difference to the development process in case they take up social responsibilities.

Since the growth and development of SMEs indicate that cluster making is the key which provides a unique sectoral advantage, involvement in CSR will also be more effective if the SMEs take up collective and group CSR leading to what may probably be an innovation in CSR and get to known as ‘*Cluster Social Responsibility*’ or “*Collective Corporate Social Responsibility*’ (CCSR). We’d employ Carroll’s Model to explain the stage-wise rationale for ‘*Cluster Social Responsibility*’ or “*Collective Corporate Social Responsibility*’ (CCSR).

##### 4.1 Understanding CCSR through Carroll’s Stages of CSR

**Stage 1:** The economic responsibility of business in case of SMEs is met and fulfilled because they operate as a group and are therefore able to employ and utilize the resources most efficiently. They tap local and indigenous resources from the immediate environment where they flourish and adapt to the demands and the needs to the local environment as well. Therefore with such heavy dependence and utilization of the local resources, the cause for giving back to society gets further strengthened. So, the entire cluster operating in a region must contribute for the basic cause of sustenance and the individual unit (a single SME) may not be able to do much.

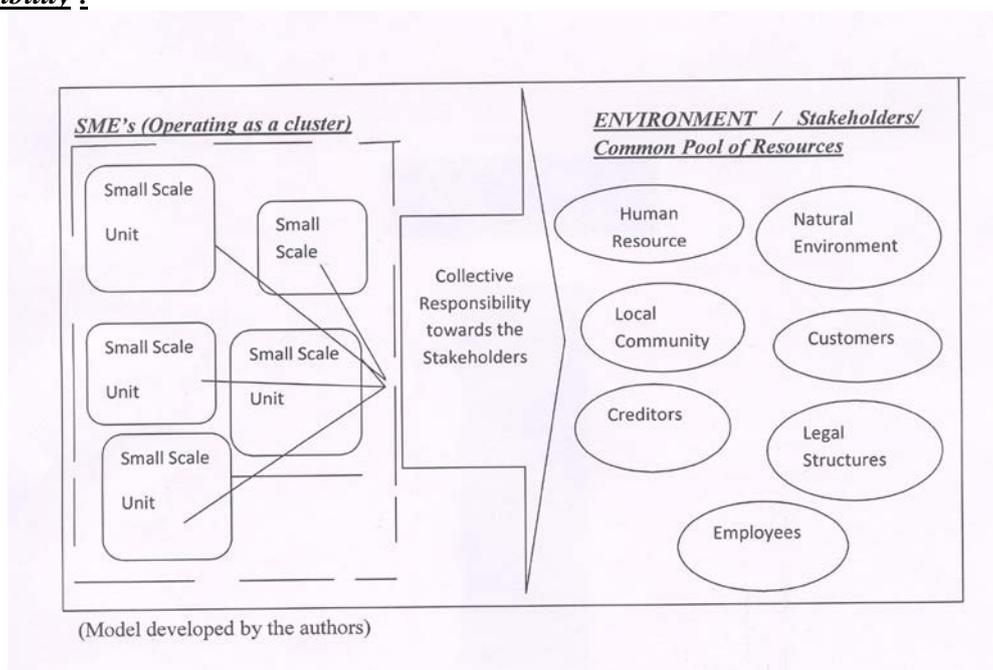
**Stage 2:** The legal demands and the laws of the land apply equally and have a similar impact on all the units operating in the region because they belong to a similar type. The legal structure and policies need to be adhered to ensure smooth business operations. Therefore, as a cluster the SMEs would hold a stronger position in ensuring that the laws and policies designed and enforced are conducive for the development of the cluster in the region.

**Stage 3:** The ethical stage of social responsibility holds the faith that business should be conducted ethically and the policies and codes of the enterprise should be ‘*fair and just*’ (Crane and Mathen,

2007)[30]. The internal and external CSR aimed at direct stakeholders like employees, suppliers etc. would hold consequence when the entire cluster as a whole evolves and adopts socially responsible behavior. The impact of the stakeholder would be more effective and sustainable because a collective decision to be socially responsible towards direct stakeholders would lead to evolution of an ethical environment which would soon be normative leading to a better and healthy work environment.

Stage 4: An individual small scale unit may find it difficult to turn into a good corporate citizen and match the performance by the MNCs. But if all the SMEs operating as a cluster join hands to work for socially beneficial causes, it shall in the long run result into collective good which will provide growth and development opportunities.

We propose the following model for *Cluster Social Responsibility or Collective Corporate Social Responsibility*.



(Figure 3: Model Developed by the Taruchi, 2014)

CSR as a concept is relatively new in developing countries like India where philanthropy and donations were considered as an extension of the business activity and were not a part of strategy and competitive survival for most business establishments. This form of CSR started off as a response by multinationals to remedy the effects of their extraction activities on the local communities. In countries like India where business activities have a long historical and cultural traditions, welfare activities are often informal and linked to cultural local traits. Traditional values such as people/employees being treated as ends in them, as well as values like sharing and consensus are still strongly manifested in business life. While many systems and practices which have a historical ethical existence are embedded in the daily activities and are loosely in use but have not been consciously evolved due to which the capacity to benchmark them is still at very early stages.

Analysis of the role and positioning of welfare activities conducted by SMEs in India and the manner in which CSR is understood and followed internationally by the large corporations around the world reflects a huge variance. The MNC's generally hold a stakeholder view while considering and implementing their CSR strategies while the SMEs may consider a social capital view while working on their CSR plans. A dialogue between the SMEs and the MNCs would cultivate better opportunities and environment for furthering the CSR activities in the developing world mitigating challenges both.

## 5 IMPLICATIONS OF THE STUDY

MSME's need to be sustainable and with CSR turning into a competitive tool and the focus of Indian policy makers shifting towards a mandatory CSR compliance, *Cluster Social Responsibility or Collective Corporate Social Responsibility* may help MSME's make a mark stand up the pressures from policy and industry quarters.

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# IS THE GREEN KEY STANDARD THE GOLDEN KEY FOR SUSTAINABILITY MEASUREMENT IN THE HOSPITALITY SECTOR?

**Arjan van Rheede<sup>1</sup>, Martijn Rietbergen<sup>2</sup>**

<sup>1</sup> Hotelschool The Hague, [a.v.rheede@hotelschool.nl](mailto:a.v.rheede@hotelschool.nl)

<sup>2</sup> Institute for Engineering & Design, Utrecht University of Applied Science, [martijn.rietbergen@hu.nl](mailto:martijn.rietbergen@hu.nl)

## ABSTRACT

The Green Key is an eco-rating program that aims at promoting sustainable business practices in the hospitality sector. The Green Key assesses amongst others the sustainable management of energy, water and waste within hotels and other hospitality firms. The Green Key standard awards points if specific sustainable practices or environmental measures have been implemented, but does however not assess the actual environmental performance of hospitality firms. Therefore, the interesting question arises to what extent the Green Key certification levels relates to the actual environmental performance of hospitality firm This paper focussed on energy usage in hotel, because this is the biggest impact hotels have on the environment and this is the topic that is high on the political agenda because of global warming.

A quantitative study was designed to test the statistical relationship between the energy usage per square meter in Dutch hotels and their level of certification. We conclude that the Green Key certification levels do not relate to actual energy performance of the hotels. The two variables are not correlated. Also the high percentage of gold certified hotels is suggesting that the label shows appliance with the standards, and not highest performance on minimized impact on the environment.

The findings of this pilot will be used to further develop this research to set up a longitudinal research to find the actual impact of eco-labels on actual environmental performance.

*Keywords: Hotels, energy efficiency, eco-labels, certification, sustainability performance*

## 1 INTRODUCTION

Sustainability is an important topic in the hospitality sector; this can be achieved amongst others by implementing certification schemes, such as the Green Key. The Green Key is an eco-rating program that aims at promoting sustainable business practices in the hospitality sector. The Green Key assesses amongst others the sustainable management of energy, water and waste within hotels, restaurants, camp-sites, etc. The Green Key standard awards points if specific sustainable practices or environmental measures have been implemented, but does however not assess the actual environmental performance of hospitality firms. Therefore, the interesting question arises to what extent the eco-rating programme reflects the actual environmental performance of hospitality firm. The outline of this paper is as follows, the theoretical framework discusses energy usage in hotels as a measure for actual environmental performance of a hotel and the eco certification scheme of Green Key. Next, the methodology is discussed and the results are presented. Finally in the discussion and conclusion further improvement of the measurement of the relationship is discussed and first directions will be proposed to better align the Green Key standard with the actual environmental performance of hotels.

## 2 THEORETICAL FRAMEWORK

In this study we will particularly focus on hotel firms, because of the high participation of hotels in the Green Key label and the relative high environmental impacts of hotels compared to other firms in this sector. This study is going to build upon research by e.g. Grosbois [1], Myung, McClaren [2], Rheede and Blomme [3], Sloan, Legrand [4] about the various sustainability initiatives currently undertaken in the hospitality industry, e.g. eco-labels, sustainability programs and sustainability reporting. This paper will contribute to the debate within the hospitality on which instruments can stimulate the sustainable development in companies effectively.

Black and Crabtree [5] define environmental certification as a “.. voluntary procedure that sets, assesses, monitors, and gives written assurance that a business, product, process, service, or management system conforms to a specific requirement. A marketable logo (sometimes called an eco-label) is awarded to those that conform or meet the criteria, with the standard at least meeting, but generally being above, any regulatory requirements”.

This definition also addresses the three objectives of certification: (1) promote the implementation of sustainability practices in the hospitality industry; (2) increase profitability; and (3) provide more accurate information to guests [6]. In the literature the discussion has been on the recognisability labels, and whether it attracted more guests, or guests are willing to pay a premium price for a more sustainable hotels room (e.g. [3, 4]). The question about whether labels reflect the actual impact on the environmental or the social environment has not been discussed so far. Eco-labels that are better capable to represent the real impact of a firm on the environment can potentially lead to a selection by hotel guests of the sustainable hospitality operations, similar to variance and selection in evolutionary processes [7].

In other sectors than the hospitality branch, there is also a rich experience with eco-labelling schemes, eco-rating or environmental certification programmes and benchmarking, see e.g. energy labels for buildings [8], the CO<sub>2</sub> performance ladder for the construction sector [9], ISO 14001 certification and energy efficiency benchmarking. Several studies show that impact of these certification schemes is questionable and that labelling does not coincide with the actual performance [8]. This study will also contribute to existing knowledge about the effectiveness of this type of public and private policies and measures.

### 2.1 Energy usage in hotels

Depending on the location, facilities and comfort level of the hotel, energy consumption represents a major part of the utility costs incurred by a hotel. According to Stipanuk [10] energy costs usually amount to four to six percent of the revenue achieved by a hotel and have been driving upwards over the last few years. These costs are amongst the highest non-staff costs applicable for hotel operation [11]. According to Budeanu [12] the average final energy use in a hotel room per guest night ranges from 15 to 90 kWh (comparable with 54 to 324 MJ) in North America. Compared to an average household energy usage per day of 9,5 kWh (comparable with 34 MJ) in the Netherlands<sup>1</sup> [13] the average energy use in a hotel is rather high.

In this research the energy usage is registered as MJ/m<sup>2</sup> (serviced space). For the climate region of The Netherlands the following energy performance benchmarks are established for luxury hotels:

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<sup>1</sup> Based on an energy usage of an average household of 2,2 person of 3500kWh (12600MJ) per year in the Netherlands

excellent performance < 1026 MJ/m<sup>2</sup>; satisfactory between 1026 – 1242 MJ/m<sup>2</sup>; high between 1242 – 1467 MJ/m<sup>2</sup> and excessive: > 1467 MJ/m<sup>2</sup> [14].

Webster [15] proposes five initiatives designed to enhance energy efficiency: (1) installation of a computer-controlled air conditioning system, (2) installation of double glazing, (3) installation of an energy efficient kitchen, (4) the purchase of fuel efficient refrigeration, and (5) buying fuel efficient transport [16]. Other factors to be considered are heating, ventilation and air-conditioning systems (HVAC). These above mentioned factors can constitute 20% of the energy consumption applicable for a hotel. Depending on the climate region (the Mediterranean versus Northern Europe), this figure can reach 50% of the energy consumption. It will come as no surprise that this fact leads to the expectation that hospitality industry might focus on energy-efficiency, particularly because actions of this nature may result in money being saved.

In pilot studies [3] it was found that chain hotels in the higher star segments are much more active in their approach to environmental sustainability issues than are privately owned hotels. Almost all of the four and five star hotels interviewed pointed out that they were focusing on energy-related measures, as these yielded the greatest cost-savings. However, many also mentioned that saving energy helps the environment as much as it helps reduce costs. Increasing numbers of chain hotels have developed systems to benchmark their own properties and report the results of their sustainability policy in a sustainability report [1].

## 2.2 Eco certification program

The most widely used eco certification program in the Netherlands among hotels is the Green Key. The goals of this program are: ‘..(1) Environmental and Education for sustainable development of the owner, the staff the stakeholders (suppliers etc) and the client; reduction of the impacts of the facility; (2) Economical management as a reduction of consumption induces a reduction of costs; and (3) Marketing strategy with the promotion of the label and the facilities awarded.’ [17]. This is in line with previously mentioned goals of certification systems in general. The certification program works with criteria that are divided into two categories: (1) Imperative to be fulfilled in every Green Key hotel (26 criteria in The Netherlands) and (2) Guideline criteria: designed to be part of the point system. The point system is used to make a distinction between different levels of certification: bronze (17 points), silver (26 points) and gold (33 points) [17]. Concerning energy efficiency the Dutch Green Key certification has 4 imperative criteria and 15 guideline criteria.

The imperative criteria consist of (1) having energy efficient lightning in and around the hotel, (2) inventory of equipment that usage energy or gas (above 150 Watt). In case of replacement, the hotel chooses a energy efficient version. (3) Refrigerators and cold stores are well maintained. (4) prevent lose off heat by outside doors.

The guideline criteria are: daylight systems; light sensors, 100% led; locally controlled climate control systems; climate neutral operation; centralized cooling; heat recovery system; 100% green energy for electricity; green Gas (base on biomass); generates renewable energy; usage of sustainable technics such as Cogeneration; building control system for air and temperature, performs energy scan and takes measures or energy label for building. Additional energy reduction via movement detection and timers etc. [18].

The Green Key does not assess the actual environmental performance of hospitality firms. Therefore, the interesting question arises to what extent the eco-rating programme reflects the actual environmental performance of hospitality firms. Since energy is an important factor in this respect, we will focus our research on the actual energy performance only. The energy performance is defined as the total final energy usage in the hotel per m<sup>2</sup>.

Hypothesis: there is no significant relationship between the energy performance of a hotel and the level of certification in an eco-rating programme for that hotel.

### 3 METHODOLOGY

In this study we used a convenience sample 80 Dutch hotels<sup>2</sup> that provided energy use data from 2012. The hotels were mainly holding a 4 star rating according to the Dutch classification scheme. In table 2 the actual amount of Green Key hotels per certification level for the population and the sample are shown. This data set includes several self reported numbers taken from CSR reports and reporting obligations for the Green key certificate (see table 1). Basic numbers to compare and assess the actual energy performance are the level of Green key certification (bronze, silver or gold), the star rating (according the Dutch classification scheme), the amount of hotel rooms, the total area of hotel rooms (in m<sup>2</sup>), the total area of conference facilities (in m<sup>2</sup>), the total final energy usage (MJ/m<sup>2</sup>: both electricity and gas). Factors that influence the total energy use such as restaurants, bars, pools, gyms, casino's will also be included in the analysis.

Table 1. Descriptive Analysis

	N	Valid %	Mean	SD
<b>GREEN KEY level</b>				
Gold	52	75		
Silver	16	22		
Bronze	2	3		
missing	10	-		
<b>STAR CLASSIFICATION</b>				
3 ***	2	4		
4****	74	96		
missing	1	-		
<b>YEAR BUILD</b>				
	52	100	1973	96
missing	25	-		
<b>HOTEL</b>				
rooms	58	76	143	67
total area rooms (m <sup>2</sup> )	59	76	4502	2280
conference facilities	59	76	12	5
total area conf. (m <sup>2</sup> )	59	76	1270	867
missing	19	-		
<b>FACILITIES</b>				
Restaurant	58	100		
Bar	58	95		
Pool	16	27		
Gym	34	56		
Casino	4	7		
Cogeneration (CHP)	33	54		
missing	19	-		
<b>ENERGY</b>				
Energy performance (MJ/m <sup>2</sup> )	75	98	2024	735

<sup>2</sup> Three cases are excluded from the analyses because essential data on total energy use was not correct.

missing	2	-		
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To test the hypothesis a Spearman's Rank Order correlation was run to determine the relationship between energy performance (MJ/m<sup>2</sup>) and the level of Green Key certification. IBM SPSS Statistics 19 was used for analyzing the data.

#### 4 RESULTS

The sample shows that the majority of hotels, 74%, have achieved the highest level of certification. Within the population of Green Key certified hotels in the Netherlands, this percentage is 65%.

In Netherland there are 3183 hotels [19]. 75% of all rooms are within 3 and 4 star hotels, a total of 905 hotels. 403 hotels are Green Key certified (see Table 2) and a lot of these hotels are 3 or 4 star hotels. We assume that a quarter or one third of all the 3 to 4 star hotels in the Netherlands are certified Green Key hotels.

*Table 2. amount of Green Key certificates Population (2014) versus samples*

	Population[20]	%	Sample	%
GREEN KEY level	403	100	80	100
Gold	262	65	52	74
Silver	117	29	16	23
Bronze	24	5	2	3
Missing	-	-	10	-

A Spearman's Rank Order correlation was run to determine the relationship between energy performance and the certification level of Green Key of a hotel. The total energy use was not correlated with the level of Green Key certification ( $r_s(66) = 0,048$ ,  $p = .697$ ), meaning that the data did not show a higher actual environmental performance in hotels with a higher level of Green Key.

Next to this correlation the variables mentioned in Table 1 where included in a regression analyses where we controlled for size of the hotel (in total area of rooms and conference facilities) and for additional facilities such as restaurants and pools. This did not provide us with additional insights on the correlation between energy performance and level of certification.

#### 5 DISCUSSION AND CONCLUSION

The authors assume a sort of normal distribution in the level of sustainable performance among businesses. The fact that 65% of all hotels has the gold certificate, suggests that the label shows conformation to standards, and not highest performance on minimized impacts on the environment. In addition the sample has also some limitations. First of all the amount of gold certified hotels is over represented by 9% in the sample (see Table 2). Another issue is the little amount of silver and bronze Green Key hotels. The relative small size of the sample makes it difficult to find a significant relationship if sub groups are small.

Second, energy performance was calculated per m<sup>2</sup>. Data on the energy use per guest was not available. This is an indicator the Green Key uses and it is especially important to control the effect of occupancy on the energy performance in a hotel. Longitudinal data on the energy usage before (zero measurement) and since joining the label – corrected for degree days [21] –

would give more insights in the actual effect of the Green Key certification on actual energy performance.

The conclusion of the research however stays intact: the eco-rating programme does not reflect the actual environmental performance of a hospitality firm: there is not a significant relationship between the energy performance of hotels and the level of certification in an eco-rating programme.

Based on the result it is too early to make judgement on the certification system of Green Key. We suggest the following routes for continuation of the research. We will use the findings of this pilot to collect a bigger sample – with additional variables to find stronger evidence whether the certification system of the Green Key represents the actual impact on the environment. It would also be interesting to evaluate the Green Key's effect from a different perspective by studying the type and impact of implemented energy efficiency measures.

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# SUSTAINABLE FLOWERS ARE SPROUTING IN AFRICA. THE ROLE OF CODES OF CONDUCT IN THE CUT-FLOWER SUPPLY CHAIN

Inma Borrella - presenting<sup>1</sup>, Ruth Carrasco-Gallego<sup>1</sup>, Carlos Mataix<sup>1</sup>

<sup>1</sup> Innovation and Technology for Development Centre (itdUPM). Technical University of Madrid (UPM); [inma.borrella@upm.es](mailto:inma.borrella@upm.es)  
[ruth.carrasco@upm.es](mailto:ruth.carrasco@upm.es)

## ABSTRACT

The global cut-flower industry has undergone significant changes during the last two decades. The most relevant one has been the relocation of production to developing regions of Latin America and Africa. African countries – such as Kenya, Ethiopia and Uganda – have become the main exporters of cut flowers to the European Union. Flower growers have thrived and cut flowers have become an important source of foreign income and job creation in South and Eastern Africa. However, the social and environmental risks associated to flower exploitations are high. European clients are already demanding sustainable flowers and asking their African suppliers to comply with certain standards and certifications. But for the producers to be able to meet these requirements, a bridge needs to be built: adapted codes of conduct. In this paper, we present the story of the Ethiopian cut-flower industry and how it has developed and implemented successfully its own code of conduct.

*Keywords: sustainability, supply chain governance, standards, codes of conduct, cut-flower industry, cross-sectorial partnership, Africa.*

## 1 INTRODUCTION

The global business outlook has been profoundly reshaped during the last two decades. Many companies have expanded their operations and supply chains to developing countries in Latin America, Asia and Africa, boosting economic growth and creating jobs but also introducing new social and environmental risks in vulnerable regions with fragile institutions. In these complex global production networks, the responsibilities of each agent are diluted, whereas multinational corporations and brand-owners have usually been appointed by society as the entities accountable for the negative impacts their supply chains can produce. Transnational firms are now urged to monitor and control business operations throughout their entire supply chain [1], since a scandal can seriously harm buying firms' reputation, sales and market share [2].

Sustainability requirements are usually communicated and monitored by lead companies through codes of conduct. Voluntary codes of conduct range from vague declarations of business ethical principles to more serious self-regulatory efforts. These codes tend to focus on business impacts in two main areas: social conditions and the environment. They often derive from local legislation, and international standards and conventions such as: ISO14000, ISO26000, AA1000, SA8000, UN Global Compact, Global Reporting Initiative Guidelines, ILO Declaration on Fundamental Principles and Rights at Work, OECD Guidelines for Multinational Enterprises. A variety of stakeholders including trade associations, NGOs and the corporate sector itself have played a role in the elaboration of these codes [3]. The number of codes of conduct has grown exponentially since the early 1990s, nevertheless many difficulties are found when trying to implement them throughout global supply chains [4]–[7].

During the last decade, the academic community has analysed these and other related challenges by increasing research on supply chain sustainability [8]–[13]. However there is a lack of research contributions for and from developing countries in the supply chain sustainability arena [14], [15]. In particular, among all the emerging economies, African countries seem to be particularly understudied, when compared with other continents such as Asia or Latin America [16], [17]. This paper addresses this gap by presenting a case study on the cut-flower supply chain with origin in Ethiopia. The case

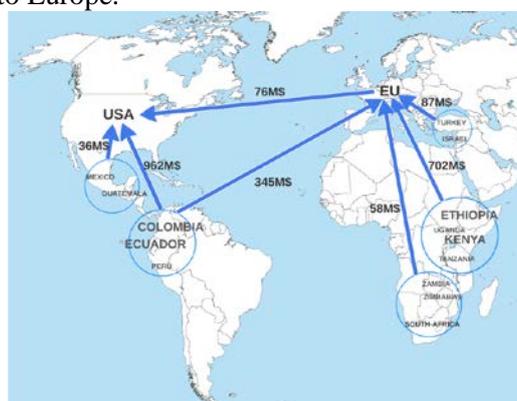
explores the design and implementation of a sectorial code of conduct in the blooming Ethiopian floriculture industry, as well as the circumstances that led to it.

The structure of the paper is as follows. In the second section, we introduce the main features of global supply chains in the floriculture sector, where growers are increasingly located in developing countries while the consumption centres still remain mainly in the North. In the third section, we briefly present the methodology used to build the EHPEA case study, which is based on the empirical data collected in the field during a two-week research stay carried out by the authors in Ethiopia and commissioned by the Spanish Agency for International Cooperation for Development (AECID) within its program “Business and Development”. In section four, we present the details of the case study and its results. In section five, we identify and discuss the factors that drive the emergence of a code of conduct in the cut-flower industry in Ethiopia and which are the features (or wise choices) that make this initiative interesting to be replicated in other regions or other industries besides floriculture. Finally, we present the conclusions and implications of this case study and propose potential avenues for future research.

## 2. GLOBAL SUPPLY CHAINS IN THE FLORICULTURE SECTOR

The floriculture industry contains a wide variety of products which can be classified as follows: cut flowers & foliage, potted plants, garden plants, nursery stock (trees), flowering leafy, annuals & perennials, and bulbs & tubers. The worldwide market for floriculture products has been growing consistently over the last decades, with an average yearly growth between 6 and 9 % [18]. This industry accounted for 20 billion dollars exports in 2012 (UNcomtrade, 2013). Due to its potential and its low entry barriers, floriculture production is increasing in volume and in geographical spread, turning into a very globalized and competitive industry.

The study we are presenting in this paper focuses in the cut-flower industry, only one part of the wider floriculture industry. World trade in cut flowers and foliage represents more than 8 billion dollars per year (UNcomtrade, 2013). The largest markets for cut flowers are the European Union and the USA. Traditionally, the production of flowers was concentrated in the aforementioned consumer countries, but new producing areas have emerged during the last two decades in developing regions – Latin America and Africa – challenging the sector’s dynamics. The main drivers of this relocation of production have been lower labour costs and better agro-climatic conditions. Another reason is the lightness of cut flowers, which makes long distance transportation possible at a relatively cheap price; on the contrary the cost of potted plants transportation (much heavier) represents no incentive for the growers to relocate production. The main exporters of cut flowers in Latin America are Colombia (1.3 billion dollars in 2012) and Ecuador (771 million dollars in 2012); and in Africa, Kenya (480 million dollars in 2012) and Ethiopia (180 million dollars in 2012). Within these regions the domestic market is negligible, so their cut-flower businesses are export-oriented and depend highly on foreign markets. As shown in Figure 1, the main cut-flower market flows go from South to North: from Latin America to the USA and from Africa to Europe.



Data from UNcomtrade (2013)

Figure 1: Cut flowers main import-export flows in 2012 (not considering the Asian region).

The Netherlands plays a leading role in the cut-flower industry. It stands for more than a half of all world floriculture exports and it is the main hub in the cut-flower global supply chain, since the majority of cut flowers are sold through Dutch clock auctions. The biggest auction is FloraHolland in

Aalsmeer, located only 11km away from the Schiphol International Airport of Amsterdam. Some factors that determined Dutch businesses success in the global floriculture market are: well-organized supply chains and clusters where all industry actors work closely together with the auctions as the central marketplace, numerous highly specialized research institutions, efficient packaging and shipment, strong home demand, highly efficient supporting services (such as infrastructure and logistics), and decided support from their government.

## 2.1 African-European cut-flower supply chains

Europe is the biggest importer of cut flowers in the world, a market of around 1300 million dollars a year, and more than half of these flowers are produced in East- and South-African countries.

African flower production – mainly roses – has increased rapidly during the last few decades in countries like Kenya, Ethiopia, Uganda, Zambia, Tanzania, South Africa or Zimbabwe. Despite the risky and unstable institutional and business environment of some of these countries, their flower production has shown rapid growth. The success of this industry is due to its good agro-climatic conditions for flower growing; its low labour cost, very relevant in this labour intensive industry; and its proximity to the European market.

African governments have usually supported the development of the floriculture sector in order to reduce unemployment and generate foreign currency. It has been estimated that high value agricultural export products, such as flowers, provides employment for 25 people per hectare [20]. In Ethiopia and Kenya cut flowers are listed as one of the top 5 export products.

However, this promising industry presents several challenges for African producers. The key competitive features of cut flowers are price, quality, variety and freshness. First, regarding price, the African cut flower industry is highly dependent on foreign markets. The local consumption of flowers is almost inexistent; therefore fluctuation of prices in global markets affects the industry severely. Secondly, in order to achieve high quality and variety, the producers depend on imports from developed countries. Netherlands and Israel are the main providers of agricultural inputs, market information, new flower varieties, equipment, new production techniques, and technology. Finally, freshness is a key issue because cut flowers are a highly perishable product and lose 15% of their value every day. The speed of delivery to the final consumption point is extremely important, consequently very efficient packaging and logistics systems – air cargo capacity at reasonable prices and with daily frequency – are required to maintain competitiveness.

All these challenges faced by producers lead to power imbalances in the African-European cut-flower supply chains. African producers need agricultural and technical inputs, foreign market information and extremely efficient logistics systems they usually don't possess. Therefore, they are highly dependent on foreign investors and trade partners.

As most trade is done through auctions, it would be easy for both suppliers and buyers to switch partners across the chain. However, there is a lot of cooperation in the industry, and a tendency to vertical integration has been observed. This increasing collaboration is driven by big buyers – large florists, supermarkets, garden centres –, who wish to control the quality and sustainability of the product from seed to final customer. Following this trend, wholesalers are becoming service providers and are cooperating with growers very closely. Their goal is to copy the demands of big buyers with labels, certificates and quality audits in order to prove they produce high quality products in a sustainable way. In short, we are observing a transformation in the way floriculture businesses compete, switching from a competition among firms to a competition among supply chains.

In this new and highly competitive environment, sustainability is an area in which achieving competitive advantage can make a difference. Social and environmental impacts of flower farming can be highly damaging if the businesses involved don't identify the risks associated to the exploitations and establish a suitable management system that minimizes them. Prado [21] goes even further and says that “for a number of interest groups within the flower industry, environmental and labour standards constituted a mechanism to counteract strong competition in other product dimensions, such as price and quality”. There is no doubt that trading according to international standards – regarding quality and sustainability – is important to make the delivery accepted, especially when most of the cut flowers are sold through auctions. A growing demand for sustainable certified products has been observed, due to better informed and socially conscious consumers. The market has responded with a proliferation of standards such as Flower Labelling Programme (FLP), Fair Flower and Fair Plant label (FFP), EurepGAP, and MPS-Florimark label, just to mention a few of them.

All these different codes of conducts, standards and labels have created confusion among African producers. Sustainability standards are usually created and imposed by buying companies, which in this case are European businesses. Many producers complain about these imposed requirements, claiming that they should be adapted to the context of each country. Prado [21] indicates that when standards are launched by developing countries' floriculture industries, they tend to be motivated by anticolonialist sentiments. However, in the case study we present in this paper, it will be shown that standards developed with the participation of the actors who are supposed to enforce them suit better the reality of the farms, and their acceptance by producers is usually wider.

### 3. METHODOLOGY

In order to understand the dynamics present in a specific setting: the application of a code of conduct to a particularly risky sector (the cut flower industry) in an East African country (Ethiopia), we used in this study the inductive approach principles of case study research. This is a research methodology oriented towards theory building, grounded on a variety of empirical data sources [22]. The unit of analysis used in the case is the global floriculture supply chain beginning in Ethiopia and ending in Northern countries, being the European Union the main importer.

Case study research is one of the most appropriate methodological strategies for addressing a phenomenon that has undergone little research up to the present [23], [24]. Sustainability in supply chains in general, and standard setting for sustainable flower cultivation, in particular, is still a domain under development. In addition, as pointed out in the Introduction section, research with a focus on or using data from the African continent is scarce, so this case study has the potential to bring new empirical insights on the role of business in African countries and the specific environmental, social and governance challenges that arise in this context.

The data collection methods used in this research are summarised in Table 1. We used a variety of data sources and methods (data triangulation) including documentation, interviews and direct observation. Investigator triangulation is ensured in this case study by the participation of various researchers on the data collection and data analysis phase, which generally reduces bias and provides complementary insights, enhancing the confidence on the findings [23], [25].

*Table 1 – Sources of information and data collection methods used in this study.*

		DATA COLLECTION METHODS		
		Documents	Semi-structured interviews	Direct observation and informal interviews
SOURCES OF INFORMATION	Ethiopian Horticulture Producer Exporters Association (EHPEA)	Code of practice for sustainable flower production etFresh magazine	Manager Coordinator of the training program	Presentation of the organization and staff
	Ethiopian farms			Genesis Farm Ethio-Veg Fru Meki-Batu cooperative union
	Ethiopian Investment Agency (EIA)	Ethiopian Investment Agency Brochure	Agency Representative	
	Agricultural Ministry of Ethiopia		Head of the Department of Agricultural Investment Support	
	Dutch Embassy	PSI brochure	Head of the Private Sector Investment Program (PSI) in Ethiopia	
	Wageningen University	Ethiopian-Netherlands Horticulture Partnership. Report on Agenda Setting Mission.		

## 4. A CODE OF CONDUCT FOR THE ETHIOPIAN CUT-FLOWER INDUSTRY

### 4.1 The context: the origin of the Ethiopian floriculture industry

Ethiopia's approach to the floriculture industry was late compared to neighbouring countries but quite successful. In fact, it has overtaken most of its competitors, becoming the world fifth non-European exporter and the third from the African region. Its potential for flower farming is high thanks to agro-climatic conditions that allow production for all-year-round, abundant and cheap labour force, and proximity to the European and Middle East markets. For these and other reasons explored throughout this paper, Ethiopia has been able to develop a floriculture sector from nearly no production in the year 2000 to a volume of exports worth 159 million dollars in 2010. In this period, the sector has created 50 thousand direct jobs and an estimated 200 thousand people have benefited indirectly.

Around the year 2000, several businesses pioneered in flower farming oriented to the export market. Some of them failed but other ones succeeded. Golden Rose Ltd., Summit Agro Industry,

Ethio Dreams, SIET Agro Plc. and Ethio Rose were some of the companies that successfully launched floriculture businesses between the years 1999 and 2002 [26]. These five enterprises formed in 2002 a trade association: the Ethiopian Horticulture Producer Exporters Association (EHPEA). The goals of this association were representing the members' interests in front of the government and other stakeholders, as well as promoting the Ethiopian floriculture sector and strengthening commercial links in the exports market. From its constitution, EHPEA worked to sensitize the public authorities about the great potential of the floriculture sector for the Ethiopian economy, seeking government's support for this nascent industry.

Flower farmers identified many barriers for the development of their industry, being the main ones: access to credit, cost of land rental, poor infrastructures and air freight availability and price. In 2003, the Ethiopian government was already committed to promote the cut flower industry. It worked to eliminate the barriers and offered fiscal advantages to the businesses operating in the sector. Some of the measures were: long lease land (25 to 45 years) at very affordable prices (\$4 to \$20/hectare/year); long term credits with no endorsement requirements from the Ethiopian Development Bank; and the coordination of multiple farms' air cargo shipments through Ethiopian Airlines. All these measures, plus the fiscal advantages, created a favourable business environment that attracted local entrepreneurs as well as foreign investors, and the sector grew exponentially.

#### **4.2 How to overcome an unexpected barrier? Facing social and environmental sustainability demands**

In 2004, the opposition launched a very critical campaign against the floriculture industry, accusing the government of supporting an unsustainable and harmful business. They denounced the environmental risks associated to intensive flower farming, based on the negative impacts observed in other countries with more experience in the sector, such as Kenya, the African leader in cut flowers exports. In this country, the massive use of pesticides and the intensive use of hydrological resources led the region of the Naivasha Lake to an alarming environmental crisis that affected the lake ecosystem as well as farm workers' health and people living in the surrounding areas [27].

The Ethiopian population and other national and foreign stakeholders began to worry and the sector came under close scrutiny. Poor labour conditions and child labour were reported, as well as the use of chemicals that could seriously harm the environment and workers' health [28]. This growing concern about the social and environmental impacts of flower farming was a threat for the investments on the sector. The floriculture sector was in the spotlight, and EHPEA was aware of the need of taking action to protect the interests of the industry. They got to the conclusion that a code of conduct had to be developed to address the social and environmental risks linked to flower farming and to improve the public image of the sector.

The main foreign investors of the industry were from The Netherlands. In 2007, 37% of the total production of flowers for export in Ethiopia came from Dutch farms, and two thirds of the Ethiopian flowers were exported through the Dutch market – in auctions like Flora Holland [29]. Flora Holland is a Dutch firm operating flower auctions in the Netherlands. Given the predominant role the Netherlands play in the horticultural sector at an international level, Flora Holland has become the leading matchmaker and intermediary between worldwide demand and supply of cut flowers and plants. Therefore, the involvement of Dutch actors into the code of conduct design and implementation process came as no surprise.

The “Ethiopian-Netherlands Horticulture Partnership” was created in 2006. This cross-sector partnership intended to “contribute to a balanced growth of the horticulture sector in Ethiopia” (Helder & Jager, 2006). The partnership's priorities were capacity building and helping to develop and implement a sectorial code of practice for sustainable floriculture. As shown in Figure X, the partnership included organisations from the public sector, the private sector and the third sector. Notable participants were the Dutch Embassy, the Ethiopian Government and EHPEA. From the beginning, the partnership considered very important that the Ethiopian flower growers, through EHPEA, take the lead in the design of the code of conduct, as at the end of the day, they would be the ones implementing and enforcing the code. The presence of civil society organisations in the partnership also ensured that all the relevant issues were included in the agenda of the partnership.

#### **4.3 The code of conduct**

In the course of 2006 and 2007, the code of conduct was designed by a team composed of EHPEA members and different Ethiopian stakeholders. Business, civil society and government were all represented. During the whole process, Dutch experts were advising the team.

The practices of the Ethiopian floriculture sector were characterised, a benchmark study of other codes of conduct was carried out, and the potential linkage with international standards was analysed. Several workshops with farmers were celebrated to review and validate the contents and define the implementation strategy.

The code was finally launched in 2007. This first version of the code was quite basic and defined the minimum standards a flower farm in Ethiopia should accomplish to avoid social or environmental harm: it was called the “Bronze level”. The code approached different issues that were classified in three categories: management of the farm, good agricultural practices and protection of the environment, and workers’ and local communities’ wellbeing. Figure 5 shows the contents of the code in a schematic way. The code points out the importance of considering the three aforementioned categories throughout the whole production process: from site selection to post-harvest, including seed nursery, cultivation/production and harvest. In any of these phases, negative impacts or outcomes can occur, therefore is very relevant to develop and implement a practical management system that identifies and minimizes social, environmental and economical risks. This management system should incorporate issues related to workers, environment and production, as well as relations with other stakeholders (market actors, local communities, the Ethiopian government, EHPEA, and external auditors).

In 2010, the code was revised and the Silver and Gold levels were introduced. These new levels were perfected evolutions of the Bronze level. These new levels sought to show the path for improvement to the farms that wished to increase their commitment with sustainability.

The implementation strategy for the code of conduct was based on a cyclic process of continuous improvement. EHPEA provided capacity building and support services to its associates during the whole process, through a team composed of an expert – an English expatriate – and six Ethiopian graduates. The process of implementation, grounded on the classic Deming’s circle “Plan, Do, Check, Act” (Deming, 1986), allowed to introduce improvements step by step, facilitating a gradual evolution to the different levels without affecting too much the farm’s regular activities. Once the farm was ready, it had to contact the certifying entity approved by EHPEA. Farms must be audited annually to keep the certification.

#### **4.4 Results**

In 2010, fifty flower farms – accounting for 80% of the total land dedicated to floriculture crops – were certified with the Bronze level, eighty-five farms had participated in workshops related to the code, and over three thousand farm workers had received training on sustainable practices. The code of conduct improved the working conditions in the sector and reduced the environmental risks associated to the farms. The assistance of a specialized training team entailed an important knowledge transfer in managerial, organizational and technical terms. Finally, the implementation strategy has led some farms to adopt a culture of continuous improvement and pursuit of quality. These positive effects and spillovers were recognised by the Ethiopian government, who decided that the Bronze level of the code should be obligatory for all flower growers in the country. This legislation came into effect in 2010. EHPEA keeps working for this code to be recognised internationally, hoping that the Silver and Gold levels will be one day considered equivalent to other international certifications.

### **5. CASE ANALYSIS: INSIGHTS DISCUSSION**

Once presented the EHPEA case study, we analyse in this section the factors (or wise choices) that make the adoption of this code of conduct among flower growers in Ethiopia a successful example with a high replication potential.

The first factor is related to the goals of the code of conduct. The Dutch government – seeking to protect the interests of the numerous Dutch investors in the sector – and the industry’s trade union, EHPEA, decided to develop this instrument. The objectives set for the code were to strengthen the sector by reducing social and environmental risks, and improving quality and business management capacities. Using the code not only to avoid hazards but also to improve managerial and technical practices was the first wise choice.

The design and validation of the code was based on multi-stakeholder participation: Ethiopian civil society, businesses and government agencies were all represented. Therefore, this code of conduct was written for Ethiopia from Ethiopia, counting with the opinion and approval of all the different actors involved in the industry. This was the second wise choice, since it facilitated a wide acceptance of the code.

The third wise choice was to implement the code through a cyclic process based on the continuous improvement philosophy, and to support it with a capacity building program.

The intervention of EHPEA was decisive for the promotion of the sector. EHPEA strengthened local farmers' capacities and led the design and implementation of the code of conduct. The code had a very positive impact, minimizing environmental and social risks associated with the cultivation of flowering plants, improving the image of the sector, and generating a competitive advantage for Ethiopian flowers in the international market.

Moreover, the code of conduct evolved from a self-regulating initiative to a government legislation, which supports the idea that codes of conduct can be a useful complement to national laws [30], [31].

## 6. CONCLUSIONS AND FURTHER RESEARCH

Ethiopia has become the third African exporter of cut flowers. The floriculture industry has exponentially grown in this country during the last decade, generating important economic activity and creating thousands of jobs. The main catalysts of this success have been the continuous flow of foreign investment and the determined support of the Ethiopian government through fiscal advantages, cheap credits and long-term land leases. However, the floriculture sector has not been free of controversy.

The denunciation of some unsustainable practices and the mistrust of local and foreign stakeholders towards the industry jeopardised the floriculture sector's growth. As an export-oriented sector, sustainability issues were very important due to end customers' concerns about social and environmental impacts.

The insights obtained through the EHPEA case study have enabled us to conclude that three relevant elements should be considered when analysing if the adoption of a code of conduct in African business can drive real, positive change in the operations of local agents.

First element is the motivation. In the EHPEA case study, the design of the code is not only driven by a need of mitigating or reducing social and environmental hazards, but also by a desire of investors and public administrations of building on the capacity of local business. By means of carrying out a suppliers' development program aiming at the improvement of the managerial and technical skills of the Ethiopian flower producers, the ends of ensuring environmentally and socially sustainable practices in the Ethiopian cut-flower sector could be better achieved.

The second element is the trigger. Which are the factors that activate the response of the relevant stakeholders for designing and implementing a code of conduct? In the EHPEA case study, the triggering factors are both local and global. On the one hand, the Ethiopian civil society denounce constitute the local trigger. The experience in neighbouring countries, such as Kenya, had made the local population increasingly aware of the negative impacts of intensive flower farming on the environment (water use, pesticides) and on the workers' health. On the other hand, the global trigger comes from the demands of end consumers' of cut flowers in the North for ethical and responsible sourcing in global supply chains.

The third element is the ability. Which distinct features of its implementation process have made of the EHPEA code a successful experience? We conclude that its focus on suppliers' capacity building, together with the incremental nature of the implementation process (following the principles continuous improvement represented in Deming's PDCA cycle) are relevant aspects to be considered for driving effective change on local business practices.

In addition to those three elements (the motivation, the trigger, the ability) we suggest considering in any further replication experience some of the issues raised in the insights we have extracted from the case study, namely:

- Wider acceptance is facilitated when diverse actors (multi-stakeholder approach) are involved in the definition of the code.
- Codes of conduct can be a source of competitive advantage in global markets.
- Codes of conduct can be a useful complement to national laws and/or can even drive the development of new legislation in countries with fragile political institutions.

Finally, we would like to remark that the results we present in this paper are based on the analysis of the dynamics of one sector in one region and one global supply chain. Further case studies in other sectors and geographical areas should be carried out in order to get to generalizable conclusions about the motivations, the benefits and the processes associated to the development and implementation of sectorial codes of conduct.

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# FACILITATING SUSTAINABLE BUSINESS MODEL INNOVATION IN FIRMS

G Heyes - presenting<sup>1</sup>

<sup>1</sup> Manchester Metropolitan University; g.hey@mmu.ac.uk

## ABSTRACT

This paper presents the methods used in a research project focused on facilitating the design and implementation of new business models that internalise the environmental impacts that arise from the operations of a large multi-national airport retailer. New business models will be developed following Osterwalder's Business Model Canvas and through an adapted version of this tool known as the Strongly Sustainability Business Model Canvas, a nascent research method that is currently under development. By using these tools, the paper will assess the ability of these tools to facilitate sustainable business model innovation in firms, making recommendations to their development as drivers of 'sustainable development'. A methodology has been developed leveraging the underlying methods behind the two tools, using Action Research to test the models in-situ at an organisation. The first initial stage of this research methodology has been completed, with the remainder of the research phases to be completed by summer 2014.

*Keywords: Sustainable Business Model Innovation, Retail, Sustainable Retailing, Sustainable Aviation, Sustainable Business Model Canvas, Corporate Engagement, Business Model Innovation*

## 1 INTRODUCTION

This paper sets the agenda for research in the field of sustainable business model innovation and details the methodology and initial results of a research project that sets out to address this field. Preliminary results are presented, with the research process to be completed in the summer of 2014.

Business models refer to how an organisation, creates and captures value, and offers a high level overview of how an organisation can implement its vision, mission and strategy. For firms who are looking to embed sustainability into such organisational concepts, the business model allows managers to understand how such an approach may fit into their incumbent way of doing business, and how their current approach may be innovated for 'sustainability' to flourish. Tools designed to help businesses understand their business model and how it may be innovated are relatively nascent, however one, the "Business Model Canvas" by [1] has gained academic and commercial success. This tool has however been critiqued from a sustainability perspective. This paper looks to assess the ability of the business model canvas to drive sustainability, and that of a modified version of the canvas called the Strong Sustainability Business Model Canvas. In doing so it will assess the validity of critiques of the canvas, and make practical recommendation on how each may be improved.

## 2. BACKGROUND

### 2.1 The Challenge of Sustainable Development

The idea that anthropogenic influences are the dominant force behind climate change (CC) has been made beyond any reasonable doubt [2],[3],[4], with a study of 12,000 academic climate papers published between 1991-2011 finding 97% were of the position that the Earth's climate is changing as a result of human activity [5]. Governments have responded by agreeing to limit the impact of CC to no more than 2°C degrees more than pre-industrial levels to stop potentially catastrophic changes to the Earth's climate [6]. In order to meet such targets, transformative changes are required from all actors in society, from the individual actions of the public, to the activities conducted by businesses. The scale of the challenge is great, with recent analysis conducted by PricewaterhouseCoopers finding that an annual decarbonisation rate of 5.1% is required to limit average global temperature increase to

2°C, but that the global average since the year 2000 has been just 0.8% [7]. Clearly, there is much to do and all members of society will be required to act.

Whilst often referred to as an environmental issue, the issues at the heart of CC can very much be seen as social issues in that its roots are anthropogenic in nature, and will require societal action in order to be overcome [8]. As a result of continued economic growth based on a consumerist, take-make-waste system [8], the biophysical carrying capacity of the Earth has been overshoot (Meadows et al., 1974). This raises questions over the feasibility of the necessary economic growth required to bring the world out of poverty as a requirement of sustainable development (SD) [9], [10]. SD describes the challenge of achieving intra- and inter-generational equality, on a planet of limited biophysical carrying capacity, on a long-term basis [11] and is often cited as being one of the key challenges facing civil society in the 21st century, for example; [12]. It is about solving complex societal problems, and is not a passive consequence of consuming less [13]. All actors within society will be required to act, from individuals, to Governments, and in particular businesses.

## **2.2 Business as a cause and solution to the SD challenge**

The existing capitalist economic system prevalent throughout most of the world largely does not conform to the principles required of a sustainable society in that it operates under a ‘productionist’ paradigm in which the manufacture and consumption or use of goods has been the dominant force behind government strategy [14]. Under this paradigm, businesses seek profit as a main priority, operating as ‘externalising machines’ in which they are free from value judgements or external influence [15] leaving the consequences of their actions to be dealt with by other institutions, be it governments, non-governmental organisations, or even other businesses. This neo-classical, ‘short-term profit maximising’ relationship [16] has led to a consumerist ‘take – make – waste’ economic system that “neglects to assign any value to the largest stocks of capital it employs – the natural resources and living systems, as well as the social and cultural systems that are the basis of human capital” [17: p5)].

As a result, a number of environmental limits have been reached; the Earth’s store of natural resources has been diminished, the capacity of the atmosphere to deal with anthropogenic changes to its composition has resulted in dangerous changes to the global climate, and all against the backdrop of even greater resource demands of a growing, wealthier global population. The unrelenting pursuit of economic growth in its current form is directly at odds with these issues and that this approach cannot continue in perpetuity is an increasingly espoused belief [8],[9],[10]. Indeed, in early 2014 a NASA funded study went so far as to suggest that the activities of the World’s wealthiest nations have brought civilisation to the point of collapse [18]. Similarly, Tainter [13] has posited that the increasing complexity of society has left it liable to collapse should any of the pillars on which it relies fail; he cites the issues surrounding sustainability as such a threat.

In the context of SD and CC, the current economic model is not fit for purpose, and the need for change is clear. New, transformative ways of doing business are required that are able to both meet the social obligations of SD (that require a strong economy), but in a way that is environmentally ‘sustainable’ [8],[9],[10]. Sustainability centric ways of doing business offer the opportunity for a ‘Green Wave’[19] in how firms create and capture value in new low carbon, resource efficient ways [17],[20]. Such transformative change will give rise to new infrastructure, technologies, operational practices and business models that could represent a new wave of economic activity that is able to deliver economic growth at least environmental harm, or even on a remedial basis [21]. Those organisations who do not adapt may struggle or even disappear, whilst those who innovate and react fastest will be gain competitive advantage and be able to flourish from a new ‘techno-ecological’ paradigm [21]. It is as such that the process of organisational change, particularly towards sustainability, is central to the challenge of SD, and it is to this area that we now turn.

## **3. LITERATURE REVIEW**

### **3.1 Innovation as a Transformative Agent**

In a business context, innovation can be described as the process by which firms look to do something new or something different, that will make a positive difference to the way they do business. It can be

defined on a number of continuums; between radical and incremental innovation; from an organisational, to a global systems; and on the object of change, be it product, process or service innovation [22].

The power of innovation as a transformative tool is well documented, the process perhaps best described using Kondratiev's theory of economic long waves [23]. This theory posits that step change innovations can give rise to waves of prosperity as a result of increased economic activity; each 'era' of growth resulting some major innovation that has enabled a reconfiguration of economies based on new, more productive, ways of doing things, that result in a period of economic [23]. It is generally acknowledged that there have been five such Kondratiev waves since the industrial revolution of the late 1700s [19], [23] and each of these eras have resulted in noteworthy changes across the whole of society.

As can be seen from these cycles, the innovations of each wave have not directly provided for economic growth, rather they have enabled such growth to be generated by society as a whole. The railway for example did not directly deliver economic growth, but it enabled people and goods to be transported further and in greater numbers, and thus facilitated new business possibilities that were previously not possible.

### **3.2 Business Models and Business Model Innovation**

The business model (BM) is a relatively nascent concept [22] traditionally focused on the application of technological innovations within a business [24] but increasingly accepted to go beyond this limited context. Essentially a BM describes the rationale of how a firm creates, delivers and captures value [1] or how customers are encouraged to pay for the value created by a firm through the services it provides or the products it sells, and how this money is converted into profit. Value is typically considered in exclusively financial terms, as one would expect from theory developed under the neo-classical concept of the firm [24].

BMs act as an "important locus of innovation and a crucial source of value creation for the firm and its suppliers, partners, and customers" [25]. They are a "a system of activities that depict the way a company 'does business' with its customers, partners and vendors", detailing "the bundle of specific activities that are conducted to satisfy the perceived needs of the market, including the specification of the parties that conduct these activities, and how these activities are linked to each other [25]. Further, the more comprehensive the links between the different components of a BM, the more likely it is to be effective in the short and long term [1]. Thus, a well thought out BM that considers all aspects (both internal and external) related to a given firm, the more likely said firm is to be profitable.

BM theory has been criticised for being frequently mentioned but rarely analysed and thus poorly understood [26]. This has changed in recent years due to increased academic focus, typified by the academic and commercial success achieved by [1] Business Model Canvas (BMC). This profit-centric canvas defines BMs in a visual way that clearly shows the different components of a BM, and how they interact with each other to create financial value for the incumbent firm. The publication has had great commercial success, helping established businesses and new ventures to understand their business and to innovate more profitable BMs for their given marketplace. For example, the model has been used to illustrate the business model of airports [27]. Yet, despite the success of the BMC, BMs have been critiqued from a sustainability perspective [22]. Whilst tools such as the canvas include externalities, they remain profit centric in nature; that is, they only pertain to issues that directly result in the ability of the given business model to generate financial value. Consequently, its use as a tool for sustainability can be called into question, particularly towards the transitional concepts surrounding the idea of sustainability that are required to avoid catastrophic CC. If one was looking design a business model that had issues of sustainability at its core, the BMC does not appear to be appropriate.

### **3.3 Business Model Innovation**

In a review of the academic literature, [22] found two roles of the business model; to support the strategic marketing of innovative processes, products and services [26], and to provide competitive

advantage by changing the terms of competition, through business model innovation (BMI) [24]. New products may open up new markets for businesses and pave the way to new profit streams, however, as Chesbrough [24] explains, technology alone has no objective value; any potential that a technology may hold lies dormant until a business model enables it to be commercialised in some way. As such, the value an innovation may provide a firm will vary depending on how it is applied through the firm's BM. A potentially lucrative innovation may offer only small financial gains if it is built around an inefficient business model, whilst a 'lesser' innovation may provide more value than a greater innovation, if it is implemented by a 'better' business model [24]. An often-cited example of this is the dominance of the VHS video system over the BETA system.

BMs can be a source of innovation in themselves, for example when it "connects previously unconnected parties, links transaction participants in new ways or new transaction mechanisms [25]. In doing so it may complement innovation in a number of ways, be it through products and services, production, distribution, or marketing methods. An example of this is the growth of the 'Low Cost Carrier' or 'No Frills' airline in the aviation sector, which since the 1990s, has gone through substantial growth as a result of its ability to operate highly efficient, low cost services for passengers. This was achieved through new business models offering essentially the same service of traditional airlines (airborne mobility), but in a more cost effective way. The growth of the sector has proven to be so great that airports must now compete against each other to attract such airlines to use their facilities. This has seen the traditional fees charged to airlines stagnate, leading to alternative sources of income for airports (such as airport retailing) to become more important [28].

Business model innovation (BMI) involves changing 'the way you do business', rather than 'what you do' and hence must go beyond basic process and product innovation [25]. BMI is a process of modifying the existing activity systems of a firm, in such a way that the BM is able to create and capture value in new, novel ways. For example, this may include changing the activities that are performed, the links of activities and the order in which they may occur, and the governance that surrounds such activities [25]. The power of BMI as a transformative tool is so great that it has been recognized as a means in which established markets may be reshaped, and new markets and industries may be created [26].

The field of transitions recognises sustainability as a process of continuous adaptation, addressing new or ongoing problems and securing the resources to do so [13]. Given that BMI regards the radical or incremental adoption of new ways of doing business to suit a changing world, in a way that is forward thinking and aware of externalities suggests that it is the ideal tool for which such transformative changes may be facilitated.

### **3.4 Sustainable Business Models**

There has been a great deal of academic interest in the field of sustainable innovation [22]; Hall and Clark, 2003, and in the transition towards a sustainable society [20]. There is however something of a gap in terms of the relationship between sustainable innovation and the business model [22]. The business response to environmental concerns is an evolving concept with a number of approaches that can be placed on a continuum from "weak" to "strongly" sustainability [29].

Weak Sustainability (WS) describes a system in which natural capital is viewed as 'non-declining' in as much as human made capital can substitute for natural capital. That is to say that the intrinsic value of, for example, ecosystem services can be substituted by human capital such as wealth. There is no focus on equity across generations, and the use of resources to create wealth is deemed an acceptable pursuit. Based on this definition it can be argued that businesses are today operating within a WS framework. Such approaches are typically implemented in pursuit of bottom-line benefits in which businesses look to quantify their activities in social and environmental terms as a performance indicator, as would traditionally be done with financial accounting. Such focus has provided financial bottom line cost savings to firms, whilst at the same time resulting in environmental savings. This can be very much seen as taking an 'efficiency' approach to business in which the SD challenge may be met through implementation of new technologies and new ways of doing business that are able to deliver greater levels of productivity at lower resource intensity [10]. This approach to business has

given rise to the concept of Corporate Social Responsibility (CSR), effectively an extension of TBL reporting in which firms typically present their social and environmental accounts in a CSR Report, detailing, whilst giving the opportunity to showcase their pro-social and environmental efforts. CSR has proven so successful that an international reporting body has been set up with the aim of standardising reporting globally, and providing guidance to organisations looking to conduct their own CSR activities [30]. Such approaches are clearly of some pro-social value in that they encourage businesses to take ownership and stewardship of issues that have traditionally been considered as externalities, however they are not without critique, with Stubbs and Cocklin [31] stating how such behavior legitimises the very structures that have been responsible for the societal and environmental issues business activity has resulted in. CSR activities provide firms who have caused an environmental harm with evidence that they are undertaking remedial activity to make amends for such harms, and thus providing them with a license to operate under their incumbent business models. The ability of such activity to address the wider issues surrounding SD can thus be drawn into question.

WS can perhaps be considered as current practice in the business community. It enables businesses to tackle environmental issues in a largely ‘business as usual’ way; that is, they are able to embed some level of environmental concern within their operations, whilst being largely able to deliver the same products and services using established business models. For the transformative changes in business activity necessary to mitigate the challenges of SD and CC, it can be argued that WS does not go far enough, and that “Strong Sustainability” (SS) is a more applicable concept. SS is based on the idea of ‘non-declining natural capital’ [32], as opposed to the WS notion of ‘non-declining total capital’ in which human-made capital can act as a substitute for natural capital. SS acknowledges that natural resources are vital inputs in terms of the global economy that cannot be substituted. Furthermore, it regards environmental components as unique, irreplaceable, and their depletion as being irreversible [32]. A SS stance would not advocate CSR activities alone as going far enough to combat the issue of SD as it would not advocate replacing an environmental harm with an environmental or societal ‘good’ in another area.

This approach is very much in line with the transformative changes required from businesses to meet the challenge of SD, and increasingly businesses can be seen taking this approach to their operations, and represents the converse of the WS ‘efficiency’ approach, with SS having more of a ‘sufficiency’ mindset. Such thinking has led to theories on the economies such as The Circular Economy [20]. A growing number of businesses are able to find value a place in the marketplace from such concepts and are performing well as a result; for example the Patagonia and Whole Foods chains in the United States.

The movement required for more transformative ways of doing business, towards a more strongly sustainable vision of business, can be a difficult process beset by a number of barriers [22 p13]. Overcoming such barriers represents the journey businesses must face so as to move towards sustainability. This process has evolved over time with Natrass and Altomare [33] espousing a sustainability learning curve that businesses have had to pass through. Businesses today are at different stages of this learning curve with some further along than others, largely governed by the business model employed, which itself is influenced by a number of factors, from available resources to the abilities of a given firms workforce.

### **3.5 Business Model Design**

As a continually developing field, and one that is deeply interdisciplinary in nature, there are a number of concepts of what a sustainable firm should look like, and these will largely depend on whether one is inclined to follow the WS or SS path. Whatever path is chosen, business model design and innovation is an essential process. Tools such as the BMC (as introduced in Section 3.2) have been developed to help facilitate business model design and innovation. These have however been critiqued from a sustainability perspective [34]. The canvas has been designed with a profit-centric and internalizing approach, that is more aligned to the idea of WS focused businesses. Environmental and social issues are not considered as embedded business concerns, they are merely considered as passing consequences of the BM design process. For example, the model does not explicitly consider the

impacts to its stakeholders (for example the local community, or the well-being of its workforce), it merely considers issues such as supply chain, and customer base; that is issues that have a direct impact on the short term profitability of the firm in question. It's use as a tool for Sustainable BMI can thus be called into question, particularly as a tool for SS BMI. Recognising this, Antony Upward [34] developed the Strongly Sustainable Business Model Canvas (SSBMC). This tool is largely inspired by the BMC, however it has been designed with SS as a key concern and as such differs from Osterwalders canvas in a number of ways:

- The Context for the organization whose business model is being described is included
- The boundary of the organization whose business model is being described is included
- There are nine additional boxes to the nine included on the BMC

The tool is currently under development for publication in 2015 with a large working group of academics and business leaders aiding this process.

#### 4. METHODOLOGY

This paper has thus far illustrated something of an agenda for research in the field of sustainable business models, and it is from these issues that research objectives have been identified (see Table 2).

*Table 2; Research objectives and underpinning gaps in the literature*

	Area requiring investigation	Research Objective
1	The BMC has been critiqued for its ability to drive strong sustainability in firms. This belief is currently untested.	Analyse the BMC as a tool for weak and strong sustainable business model generation. Make practical recommendations on how the tool may be improved so as to best encourage sustainable business model innovation.
2	The SSBMC has been put forward as a tool that may be better suited to drive Strong Sustainability in firms, however it is as yet untested.	Analyse the SSBMC as a tool for weak and strong sustainable business model generation. Make practical recommendations on how the tool may be improved so as to best encourage sustainable business model innovation.

In order to answer these objectives a methodology has been developed around a real world organization on which the BMC and SSBMC may be tested. The company in question is World Duty Free Group (WDFG), a leading airport retailer, specializing the sale of duty free goods. Such retailers operate in a sector that is increasingly constrained by the issues surrounding CC, yet the environmental impacts that accrue from such activities are presently unknown [35]. The organization thus acts as an ideal testing ground for both the BMC and SSBMC methods in that the company does not currently confirm to any ideas of sustainable operations, but that it maybe forced to in the future, to overcome the carbon threat [35]. The full methodological approach to be taken can be seen in Figure 1.

#### 5. RESULTS

The methodological approach described above is to be completed in the summer of 2014. At the time of writing work on Objective 1 is in the early stages of completion, but is not ready for dissemination. Full research findings will be presented at the 20th Annual International Sustainable Development Research Conference in Trondheim 2014.

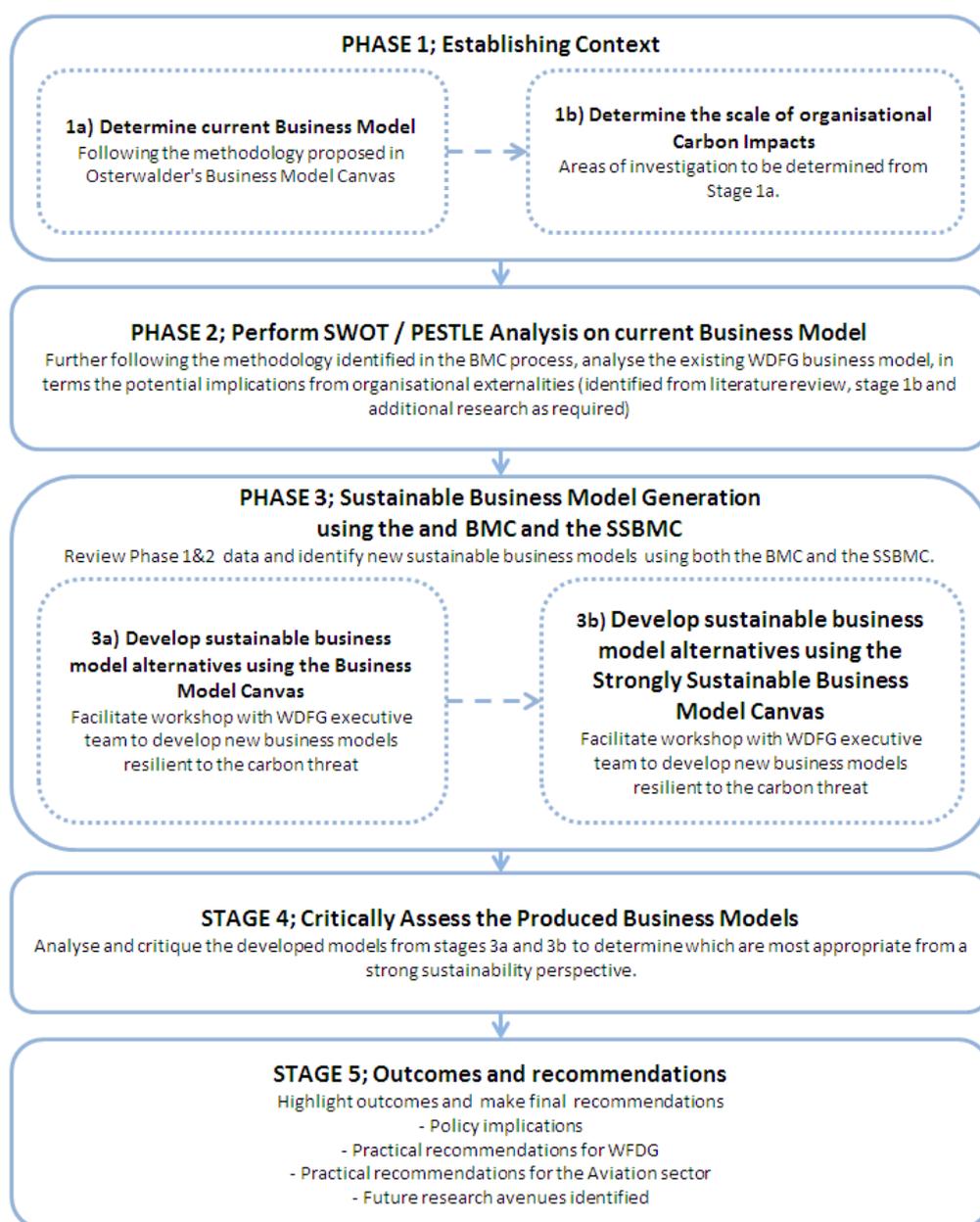


Figure 1; Overarching research methodology.

## 6. CONCLUSION

This paper has outlined the importance of BMI in society being able to meet the challenges of SD and CC. It is through such innovation that firms are able to change the way they do business; being able to avoid risk and take advantage from opportunities in the process. With the concept of business models being relatively nascent, and tools that can facilitate such organisational change being even more so, there is much scope and necessity for academic research into how existing models (such as the BMC) can be applied in organisations, how they may be developed to meet the needs of sustainability.

From a SS perspective, the boundaries of a BM go far beyond the firm in question, and BMs can act as useful tools for internalising such external concerns. Despite this, tools such as Osterwalder and Pigneurs Business Model Canvas [1] remain profit focused in their orientation with such externalities only considered in terms of how they can deliver financial benefit to the business in question. The growing popularity of such tools and this gap in their use acts as something of a barrier to sustainability in the business community, whilst at the same time, potentially holding the key to a sustainable future, if said models are able to embed sustainability.

At a time when innovation is strongly linked to the economic growth that is vital for SD, business models offer the opportunity for firms to remain profitable both in the long and short term. “Executives behave as though they have to choose between the largely social benefits of developing sustainable products or processes and the financial costs of doing so. But that’s simply not true... Our research shows that sustainability is a mother lode of organizational and technological innovations that yield both bottom-line and top-line results.” [36; p.3].

A number of barriers exist that can impede an organisations move towards sustainability, however it is through tools such as the BMC and the SSBMC that such barriers can be overcome. They offer firms the ability to understand their organisation, the role their business can play in the future world, and to lay the foundations of how a firm may successfully move towards such a vision.

Sustainable BMI offers the opportunity for a new wave of economic growth that may ensure the future of our planet in a profitable way where firms are able to act in transformative ways, by both ‘doing good’ and ‘doing well’. The successful development and dissemination of a tool that is able to fulfil facilitate this move could have far reaching impacts for all, and as such is an area that should be of great academic focus.

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# SECOND-HAND ELECTRICAL AND ELECTRONIC EQUIPMENT (EEE) TRANSBOUNDARY TRADE FROM THE EUROPEAN UNION (EU) COUNTRIES TO DEVELOPING COUNTRIES: A TWOFOLD ISSUE

Isabelle Amorim<sup>1</sup>

<sup>1</sup>BANGKOK UNIVERSITY, ISABELLE.S@BU.AC.TH

## ABSTRACT

The trade of second-hand electrical and electronic equipment (EEE) from the European Union (EU) countries to developing countries can be considered a twofold issue. On one hand, it represents a threat to humans and the environment since most of the recipient countries lack an adequate system of collection and recycling, easily becoming a dumping ground for toxic waste (According to UNEP, some 220,000 tonnes of second-hand EEE were shipped from the EU to West Africa in 2009), while on the other hand it represents a considerable source of revenue to developing countries and actors involved in the process. In order to tackle the transboundary flows of e-waste, directives and regulations were implemented and enforced within the EU. However, significant challenges lie ahead when considering the numerous stakeholders involved in the trade. Are these EEE directives and regulations considering the different actors, both in North and South, involved in the process? This paper intends to highlight the importance of a more comprehensive approach based on a resilience framework. By framing the issue of the second-hand EEE trade into a resilience framework, it is posited that there is a possibility to introduce alternatives that do not represent an 'either-or' solution (as a total ban of second-hand EEE exports or its unrestricted transboundary movement), that ignores the interdependence that exists between the actors involved in the process. The target audience for this paper includes researchers and practitioners.

**Key words:** *(Second-hand Electrical and Electronic Equipment, Waste Electrical and Electronic Equipment, European Union, Transboundary Shipments, Directives, Developing countries)*

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## 1 INTRODUCTION

The transboundary movement of second-hand EEE from EU countries to developing countries has increased remarkably in the last years. According to the United Nations Environment Programme (UNEP), some 220,000 tonnes of second-hand EEE were shipped from the EU to West Africa in 2009 [1]. In addition to the second-hand EEE that have been exported, the domestic generation of e-waste in developing countries, as for example in China and India, will increase considerably. In order to tackle the transboundary flows of second-hand EEE and to prevent electronic waste being dumped in landfills, directives were implemented and enforced within the EU from 2006 to 2012, as the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal, 22 March 1989 (the Basel Convention).

While significant progress is being made in the EU countries due to directives on Waste of Electrical and Electronic Equipment (WEEE), important challenges lie ahead. The WEEE directives are intended to decrease the export of WEEE to developing countries, although little attention is being paid regarding the responsibility of governments to allocate resources to improve the technology or capacity of countries, such as China, India and Ghana for the recycling and disposal of WEEE that have already been dumped in their landfills. In addition, definitions related to what can be defined as re-usable, hazardous and non-hazardous waste are still ambiguous in those directives.

This article presents an exploratory study on the transboundary movement of second-hand EEE from developed to developing countries and its implications. In order to capture the various dimensions of this process, qualitative secondary data were used as the main source, mainly documentation made by International Non-governmental Organizations (INGO's) and recent studies including reports on the global route of second-hand electrical and electronic equipment. The analysis of the transboundary movement of second-hand EEE is not a straightforward one. Because it is a process, it is difficult to grasp, observe and evaluate. Therefore, this paper does not look for clear-cut answers based on quantitative measurement of outcomes.

In addition to the trade flow of second-hand EEE, the article also discusses the importance of investing in a more comprehensive approach including, the allocation of resources to ensure the adequate disposal and recycling of second-hand EEE as well as the provision of modern technology to the recipient countries which could also generate revenue to the population in those countries.

Furthermore, this article proposes a resilience framework that is conceptualized beyond its 'technical' role as the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner' [2]. The concept of resilience, as described herein, reflects a broader approach which has the ability, not only to adapt, but also to transform [3]. Moreover, the concept of resilience might thus act as an enabler that promotes bridges and communication between the different actors involved and affected by the trade of second-hand EEE.

## 2 EUROPEAN UNION MAIN DIRECTIVES CONCERNING EXPORT OF SECOND HAND EEE

International environmental policies concerning the trade in hazardous waste were initiated in the early 1980s, when North-South regulations on hazardous waste trade were viewed as necessary. There are a number of directives and regulations within the EU that have been instituted to address the transboundary movement of hazardous waste from OECD countries to Non- OECD countries. They vary through several levels, from strict measures such as a total ban on sending or receiving waste, for example, the Basel Ban Amendment [4], to less stringent ones, such as, requirements for notification, informed consents or guarantee of environmentally sound management, as found in the Basel Convention [5].

Moreover, as the Basel Convention, other regulations including the Organization for Economic Co-operation and Development's Waste Agreement (OECD Waste Agreement), the European Waste Shipment Regulation (WSR) and the WEEE Directive, aims to address the waste stream of both second-hand EEE and end-of-life electronics in their provisions.

The Basel Convention, one of the main multilateral environmental agreements, was created to 'correct' an environmental problem the international community had 'considered unfair': the shipment of hazardous wastes from OECD to Non-OECD countries. The Basel Convention has been signed by 181 parties [6] and it has entered into force in 1992, with later addendums in 2006 (Nairobi Declaration) and 2011 (Cartagena Decisions), after several agreements and meetings of the United Nations Environment Programme (UNEP) expert working groups. The main goal of the Basel Convention is to prevent or minimize the generation of waste at their source, to minimize the quantities of hazardous waste that are shipped across borders and to treat and dispose of wastes as close as possible to their place of generation. Moreover, in order to ship any second-hand EEE a notification document is required, specifying the details of the proposed movement to be sent to the competent authorities in the countries of export, import and transit for their authorization.

The Basel Convention has clear restrictions related to the export of hazardous waste intended for disposal. The convention classifies hazardous waste in terms of substances present in the waste materials, thus depending on the chemical properties of the waste and on the threshold limit for each hazardous substance. The measure of those thresholds is quite complex and can only be efficient if there are specific guidelines and competent technical organizations involved in the process. Moreover,

the definition of re-use is not always clear with respect to certain types of waste and the Convention is at times ambiguous in its use of terms with regard to the meaning of hazardous or non-hazardous waste.

Furthermore, the Basel Convention 'ensures' that waste may be exported where it is intended for recycling and recovery, thus any waste exchanged across borders should be managed and disposed of in an environmentally sound manner in the importing country [5], in addition, the Convention establishes that the wastes may only be exported if the exporting state lacks Environmentally Sound Management (ESM) capacity.

In order to address challenges with the Basel Convention, a movement towards the total banning of all transboundary hazardous waste shipments was initiated by the Danish Environment Ministry in 1993, along with Sweden, Finland and Norway, which reinforced the moral imperative to keep waste out of developing countries. They argued that the Basel Convention was not strict enough on the control of the transboundary movement of hazardous waste from OECD countries to Non- OECD countries. Furthermore, they submitted a proposal to the Basel Convention Secretariat for a complete end to disposal waste shipments between OECD and non-OECD countries, known as the Basel Ban Amendment (Decision III/1) [7]. However, by the end of the negotiations, the compromise reached by EU countries concerning the shipments of and the prohibiting of export of wastes classified as hazardous, was less stringent. It allowed the shipment of wastes destined for recycling, as long as a bilateral agreement was in place. The reasoning in favour of that decision, may be attributed to the fact that it would involve the loss of revenue to developing countries specialized in waste handling as well as creating restrictions on the access to recyclables and raw materials in those countries. In October 2011, the 181 Parties of the Basel Convention agreed to allow an early entry into force of the BAN Amendment [5].

In 2006 a new law called the European Waste Shipment Regulation (WSR), created as a result of the transposition of the Basel Convention and the Organization for Economic Co-operation and Development (OECD) Waste Agreement (1992), came into effect in the European Union. The WSR is mainly concerned with the simplification and strengthening of waste movement systems in order to enforce the disposal of wastes in an environmentally sound manner and improve control over the type of wastes that are exported, however, as in the Basel Convention, the procedures as well as the definitions related to re-usable, hazardous or non-hazardous EEE still remain complicated<sup>1</sup>.

### 3 TRANSBOUNDARY MOVEMENT OF SECONDHAND EEE: A TWOFOLD ISSUE

When the issue of the e-waste began to gain attention, it was China and India who were the main receivers [8]. For instance, the town of Guiyu in China can probably be considered 'the largest e-waste recycling site in the world; it employs about 100,000 people, representing about 80% of the town's population' [9]. The e-waste sent to China is also diverted to remote rural villages, Vietnam, Cambodia and other countries of South-East Asia. These types of movement aim to circumvent the stricter environmental policies being implemented by local governments in southern China [9].

Furthermore, although re-usable second hand EEE exports are legal, exports of e-waste are not under international legislation. For instance, China signed the Basel Convention and was one of the first global proponents of a total ban on the hazardous waste trade [9]. However, the number of continuous shipments to China has not ceased with those agreements, an indication that the issue not only concerns the lack of laws, but also the unsuccessful enforcement of the law, as pointed out by Ni & Zeng (2009) [10]. Besides the ineffective enforcement of directives by Governments, other significant drivers could be enumerated as influencing the increasing transboundary movement of second-hand EEE. The main one is that the trade is primarily driven by profit. From the perspective of non OECD countries, e-waste contains valuable components. There is a strong electronic re-use market in these

<sup>1</sup> For a detailed explanation of the definitions see: [http://ec.europa.eu/environment/waste/shipments/pdf/correspondents\\_guidelines\\_en.pdf](http://ec.europa.eu/environment/waste/shipments/pdf/correspondents_guidelines_en.pdf)

countries, combined with low labour costs for reparation and scarce precious metals (such as gold) found on computers and other electronics, further, it is relatively cheap to ship and the risk of being caught is generally low [9]. For OECD countries the recycling of e-waste is very costly due to the strict requirements to observe environmental and social standards [11]. Consequently, such factors intentionally or ‘unintentionally’ ‘stimulate the export and imports of second-hand EEE’ [12].

As early as 2005, studies began to reveal that shipments of e-waste were being exported beyond Asia to some African countries [13], mainly to Ghana and Nigeria [14]. Most of the second-hand EEE that are exported from developed countries to Africa arrived in an unusable condition, i.e. between 25% and 75% [15]. One important issue concerning the differentiation between second-hand EEE and WEEE is related to the difficulty in defining the boundary between waste and commodity. How can a computer that has been used in a certain country be classified as re-usable in another one? For instance, a used computer in Germany would not be as valuable a commodity it would be in Nigeria, for example. Furthermore, the definitions of e-waste contain nuanced differences in the EU’s Waste Directive and in the Basel Convention [16], thus compromising how the e-waste shipments have been regulated.

The requirements concerning the distinction between what is defined as second-hand EEE destined for direct re-use and WEEE is unrealistic, since the tests to be applied on the item being shipped requires knowledge and expertise that is only possible to find in certain places in the world. Many products can only be properly tested in very specialized repair centers. For instance, in Nigeria estimates of the number of computer imports found to be non-functioning range from 75% to 95% of each shipment [17].

Moreover, issues concerning the export of second-hand EEE to developing countries could be considered twofold. On one hand there are those in favour of the trade, who justify the transboundary shipment of second-hand EEE using economic and social arguments while on the other hand there are those in favour of the total ban of the export, including, for example, the organization Greenpeace who emphasize the damage the mechanical disassembling of e-waste can generate to the environment and human health [18].

Those in favour of the trade advance the following arguments:

- There are many NGO’s as well as cooperatives in developing countries engaged in secondhand EEE take-back, for example NGOs involved in projects that aim to bridge the digital divide by delivering EEE restored.
- There is potential importance in the re-use of EEE from an environmentally sustainable perspective, thus the emphasis on the re-use product stream.
- The export of secondhand EEE implies an extended life-time period, thus impacting on the environmental burden.
- Re-use may lead to a reduction in overall global recycling because producers would then be focused on ensuring their products are re-used.
- Improves the competitiveness of developing countries by providing them with access to raw materials needed by their economies.

Those against the trade advance the following arguments:

- The re-use of EEE in non-OECD countries is of serious concern, since those countries lack a system of collection with a pre-processing and end-processing infrastructure. Thus such products do not end up being recycled at the product’s final end-of-life.
- Reports of NGO’s have suggested that the export of e-waste to developing countries is in reality a new form of toxic waste dumping from the rich to the poor that are now paying the price for the affluent, high-tech lifestyles of the North [19].

The debate between those in favour and those against the export of second-hand EEE evokes the complexity of the transboundary movements of EEE. What should not be overlooked is the actual value of discarded electronic equipment to developing countries, the numerous stakeholders involved in that process and their influence on the increasing of exports.

Consequently, several issues arise that have not yet been addressed by EU regulations, including the Basel Convention, in their attempt to address the complexity of the transboundary waste stream. The complexity involved in achieving a systemic approach that considers both perspectives as well as the various actors involved in the transboundary waste movement will be examined in the following sections.

## 4 SHARING RESPONSIBILITIES

### 4.1 THE TRANSFER OF RESPONSIBILITY FROM TAXPAYERS TO PRODUCERS AND ITS IMPLICATIONS

The new directive concerning WEEE, enacted by the European Parliament and Council on July 4, 2012 and transitioning to an 'open scope' legislation [20], imposes the responsibility for the disposal of waste electrical and electronic equipment on the producers that will 'take full ownership of the WEEE collection'. This proposal aims to harmonize producer financing across the EU, to shift payment for the collection of this waste from general tax payers to the consumers of EEE. According to the new directive EU Member States will be able to fight illegal export of waste more effectively, since the Directive forces exporters to test and provide documents on the nature of their shipments where such shipments could potentially be waste [21].

What are the implications of these new measures? Transferring responsibility from governments and taxpayers (consumers) to the hands of producers raises significant issues. First, before this shift takes place governments had applied taxes in the form of disposal fees to ensure that the waste is disposed in an environmentally manner. For example, in the Netherlands for the 'period of 1998 to 2007' approximately 425 million Euros was collected in disposal fees for only electronic products, of these, 223 million were spent on recycling costs, retailers fees and overhead [22]. However, some millions of Euros still remain in the fund, how will this be spent? More precisely, how will this fund, related directly to the disposal of electronics, be used, since probably many of these products have already been exported to developing countries?

Secondly, the new system enables producers to register a product in one country and then report products placed on the market in other EU countries, however, putting all the responsibility of the collection and financing process in the hand of producers, makes it more difficult to track the second-hand EEE that are exported to developing countries, as well as coordinating the allocation of funds to invest in technology and recycling. Additionally reporting the products that are within the EU states is already a challenging task due to the high amount of data transfer required. Further, considering those products that have already been shipped to developing countries, it would be unlikely that a system would be implemented that would be operationalized and effective. Furthermore, there is a lack of accurate information on how much second-hand EEE is exported and where they are moved to. Thus, the system, if well managed, could enable the tracking and transferring of data within the EU, but would not predict the amount of e-waste that has been exported. Therefore, who would be responsible for the disposal and recycling of products that are exported? In this case, the producers do not have any responsibilities concerning these procedures; neither do the member states where the electronics were produced.

Under the new directive, producers are encouraged by Member States to take full responsibility for the financing of WEEE collection. One of the consequences resulting from this is the ignoring of the waste brokers who are taking advantage of lower recycling costs in developing countries as well as avoiding disposal responsibilities at the points where the E-waste is produced. Thus, a major challenge resulting from the transfer of responsibility from member states to producers is the removal of accountability from the main actors.

### 4.2 THE RESPONSIBILITY OF GOVERNMENTS: NORTH AND SOUTH

According to a report released by The International Labour Organization (ILO) 80% of the e-waste sent by developed countries for recycling ends up being shipped illegally to developing countries to be

recycled most of the times by informal workers using rudimentary techniques. It is estimated that 70% of electronic waste discarded and exported ended up in China with further exportation to neighbouring countries such as Cambodia and Vietnam. The report highlighted that many of those countries lack adequate regulations to implement the new waste stream and lack effective enforcement of e-waste regulations [23]. According to the study, the developing countries are dealing with the burden of a global problem, without the adequate technology to deal with it. In addition, developing countries are also generating a large amount of e-waste. “It is predicted that, by 2020, in both China and South Africa, there will be 200-400 per cent more e-waste from old computers than in 2007, and a staggering 500 per cent more in India. The volume of e-waste from mobile phones will be about seven times higher in China and 18 times higher in India” [24]. Counting also the e-waste that is still being imported to those countries, the problem is gaining an immeasurable dimension.

A major problem regarding the facilitation of the trade in e-waste also relates to the absence of regulations to ensure the safety of those who deal with the discarded waste and the lack of financial incentives to recycle the waste in an environmental manner (as highlighted in the Basel Convention). The manipulation of second-hand EEE poses several health risks due to the high presence of toxic materials. One of the recommendations proposed by ILO (2013) is the adoption of appropriate legislation and enforcement mechanisms, the regularization of the informal sector that handles the recycling of e-waste and the organization of workers into cooperatives. The promotion of cooperatives should be an imperative for governments, in order to provide legal and financial support to workers that are working in the informal sector of e-waste, as ILO (2013) suggests: “A balanced society necessitates the existence of strong public and private sectors, as well as a strong cooperative, mutual and other social and non-governmental sectors. It is in this context that Governments should provide a supportive policy and legal framework consistent with the nature and function of cooperatives and guided by the cooperative values and promote the important role of cooperatives in transforming what are often marginal survival activities (sometimes referred to as the “informal economy”) into legally protected work, fully integrated into main-stream economic life” [25].

Furthermore, E-waste management involves local government actions integrated with global initiatives and community participation. It is therefore important that policies and regulations provide some sort of direction beyond traditional waste streams, in order to address the complexity in the transnational flow of EEE; this could be proposed through a comprehensive approach based on the resilience concept, which will be discussed in the following section.

## 5 RESILIENCE FRAMEWORK/COMPREHENSIVE APPROACH

It is considered here that the resilience framework is one that could help frame the issues under consideration through a systemic approach, bearing in mind the variety of the involved dynamics currently affecting humans and their environment due to the trade of second-hand EEE.

An increasing number of academics now recognize the concept of resilience more as an ‘ability to resist, recover from, or adapt to the effects of a shock or a change’ [26] than as an outcome. The shift in this approach goes from a narrow focus, the attempt to control or create stability, towards a systemic perspective that embraces the capacity to adapt and transform [27]. Furthermore, resilience is conceptualized here beyond its ‘technical’ role as the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner [28], reflecting therefore a broader approach which has the ability, not only to adapt, but also to transform [29].

Thereby, to enhance resilience is to recognize the strength of a group that goes beyond vulnerability. Although there are risk factors in situations of adversity, there are simultaneously protective factors that help the person or community to perceive the situation in a different way and overcome problems. The emphasis on protective factors can generate a positive perception of the environment and the feeling that one can take action in the situation [30]. As pointed out by P.Borbeau, resilience as renewal is characterized by responses that transform basic policy assumptions and ways societies understand and interpret a particular set of issues, thus, potentially remodel social structures [31].

Thereby, by framing the issue of second-hand EEE trade into a resilience framework, it is posited that there is a possibility to introduce alternatives that do not represent an ‘either-or’ solution (as the total ban of second-hand EEE export or the unrestricted transboundary movement), that ignores the interdependence that exists between the actors (Producers, manufacturers, businesses, governments, consumers, traders, exporters and importers, scrap dealers, smelters and recyclers).

It is important to point out that this approach avoids the ‘aggressor or victim’ trap. We acknowledge the ‘moral responsibility’ EU member states have for the waste generated within its borders, however when considering the complexity of that trade, all actors involved herein North and South are responsible to address the problem in a more efficient way. Furthermore, a resilient systemic approach should consider regulations to ensure the safety and social security of those dealing with the discarded waste, financial incentives and provision of modern technology to cooperatives to recycle waste in an environmental manner and the enforcement of laws. Furthermore, both north and south governments and civil society are responsible to not only adapt, mitigate negative impacts caused by the transboundary movements of e-waste, but mainly to take action to transform their situations. This transformative process would require the involvement, participation and responsibilities of the different actors involved in the second-hand EEE transboundary movement, thus requiring, a combination of technological innovations, institutional reforms, behavioural shifts and cultural changes. The integration of discourses under the banner of resilience would enable a platform of actions, where dialogue could be initiated between north and south governments promoting bridges and communication between the actors involved and affected by the trade of second-hand EEE.

## 6 CONCLUSION

As highlighted above, the solution to the problem of the second-hand EEE transboundary movement and its implications is not as straight forward as implementing the total ban. Second-hand EEE accounts for a significant portion of the economic revenue of developing countries. It cannot be ignored, that this informal sector employs thousands of people in developing countries, where, for a significant number, the process of dealing with e-waste is their main revenue. Hence, what appears to be required is intervention where synergy and complementarity between the involved and affected actors are fostered and not intervention where only local measures are favoured to the detriment of others.

The role resilience plays in different arenas, as applied here in a systemic way, emphasizes the system components’ of interdependency. Moreover, the numerous actors with different priorities (labour, technology, value and sustainable development) involved in the second-hand EEE trade should be recognized when directives are implemented since their lives are more dependent on these mechanisms. In this sense the resilience of such communities should be weighed when local and global policies are designed.

It is also fundamental to propose a contextual analysis of the different receptors of e-waste in order to establish the appropriate measures in each situation. The reality of each country may vary as well as their policies and technological abilities. Moreover, it is important to comprehend each receptor country’s e-waste reality and dimensions in order to develop a sound understanding of the key issues and to avoid single-sector approaches. The strengthening of dialogue and links among all actors in both north and south governments, could considerably improve the scenario under which the trade operates.

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# THE CARBON FOOTPRINT OF MUNICIPALITIES IN OPPLAND

Hogne Nersund Larsen<sup>1</sup>, Christofer Skaar<sup>1</sup> Christen Ness<sup>2</sup>

<sup>1</sup> MiSA AS – a subsidiary of Asplan Viak AS

<sup>2</sup> Oppland county

## ABSTRACT

This paper describes the development of a consumption-based carbon footprint inventory for the provision of municipality services in the 26 municipalities in Oppland County. Per capita carbon footprints indicate fairly large variations between municipalities. Some variations are explained by differences in investment rates in new buildings and infrastructure, and; since Oppland is a very popular holiday destination, some municipalities have significant amounts of cabin users not registered as inhabitants of the specific municipality, or as in many cases, not in the county of Oppland at all. In total, energy- and building/infrastructure-related carbon footprints are identified as the two largest input contributors to the carbon footprint of municipal service provision, while “education” (provision of kindergartens and schools) and “water, wastewater and renovation” are the two most significant service areas. The per capita importance of the latter is far higher than national averages and can be explained by two phenomena, the first being the significant numbers of cabin users who are more likely to use water and waste services compared to most other services. The second is restrictions on waste water because of the Mjøsa lake, which introduce energy-intensive wastewater treatment for the municipalities surrounding the lake.

*Keywords: Carbon footprint, Environmentally extended input-output analysis, Local climate action*

## 1 INTRODUCTION

Local climate action at the sub-national level has increasingly filled the void of the national focus limited to mainly post-Kyoto agreements and financial instruments. Decision makers at the local level have also been more open for using life cycle perspectives in consumption-based accounting of carbon and other environmental footprints compared to the national level. One reason for this could be the use of geographical boundaries used in the production-based perspective the indicated agreements and instruments at the national level are built upon. Therefore, despite consumption-based accounting being available at the national level [1, 2], they have had limited impact on national commitments and mitigation actions. At the product level, however, the introduction of life cycle assessment (LCA) [3] has made the life cycle perspective a clear preference. Also at the organizational level, consumption-based accounting covering complete footprints are now becoming the preferred choice [4, 5].

In Norway, counties have started to both calculate greenhouse gas (GHG) emissions from their own organization [6], and support municipalities in their need for better data on which to base their GHG mitigation actions. The latter was the motivation for the present work on municipalities in Oppland. Most municipalities in Oppland have fewer than 10 000 inhabitants, and the county of Oppland initiated a project to support them in developing a standardized, comparable GHG inventory to support municipalities in GHG mitigating strategies. Furthermore, the life cycle perspective will provide additional information on the carbon footprint (CF) of the wide range of consumables, equipment, materials, and services purchased, giving municipalities a new set of possibilities for GHG mitigation through green purchasing strategies, compared to the more traditional production-based focus limited to energy and transport related GHG emissions. In addition to the system boundary limitations indicated in the production-based perspective, some uncertainties have been identified in the energy and GHG accounts at the municipal level reported by Statistics Norway (SSB) [7, 8]. These uncertainties were the main reason for SSB to cease municipal GHG reporting in 2012, and

municipalities have since been looking for alternatives and supplements to this. The Klimakost model [9, 10] has proved to be a valuable supplement to the lack of municipal GHG inventories. It has been applied to several large cities in Norway such as Trondheim [11], Tromsø [12] and Oslo [13]. In addition, the model has proven useful for effectively deriving footprints of smaller municipalities since the consumption-based nature of the model enables Norwegian municipalities to use standardized financial data that are already available [14].

In addition to expanding the GHG inventory scope to include the emissions related to consumption of all goods and services, efforts have been made to allocate GHG emissions to the responsible departments of the municipalities. Previous work on the CF of municipal services indicate large differences in the size and structure [15], hence investigating the CF structure of the different types of service provision will help to better aim the GHG mitigation strategies effectively. Since the financial expenditure data used as input to the Klimakost model already is divided into several service areas, the CF structure according to these different service areas is easily calculated. Furthermore, by introducing time series analysis of the municipal CF, the analysis provides tools to measure the development and future progress of the CF. Again, using financial data on the purchase of goods and services to municipalities have proven valuable. These data are available from 2001, and enable time-efficient derivation of carbon footprint time series. Also, once the model is linked to the municipal financial accounts, it is fairly easy to update the GHG inventory in future years.

The purpose of this paper is to describe the development of a carbon footprint-based GHG inventory developed for municipalities in Oppland. The focus is on the CF resulting for the provision of services of the municipalities. We aim to identify important target areas, the most important service areas, and to track the development over time. Municipalities will also be compared to each other and national averages using per capita normalization.

## 2 METHODS

GHG accounting at the corporate level has existed for several years. The first generation of GHG inventories were often limited to accounting for direct GHG emissions from fossil fuel combustion (scope 1) and the use of energy (scope 2). However, research shows that, for most sectors, indirect GHG emissions caused by the consumption of goods and services, form the largest part of the carbon footprint [16]. These indirect GHG emissions, termed as Scope 3 emissions by WRI and WBCSD [17], were initially often classified as voluntary to report, and therefore often excluded. New developments within life cycle assessment (LCA) and environmentally extended input-output analysis (EEIOA) have, however, made more complete footprint analysis possible. Therefore, more recent standards [4] focus specifically on the inclusions of such scope 3 emissions. The scope classification of GHG emissions is illustrated in Figure 1.

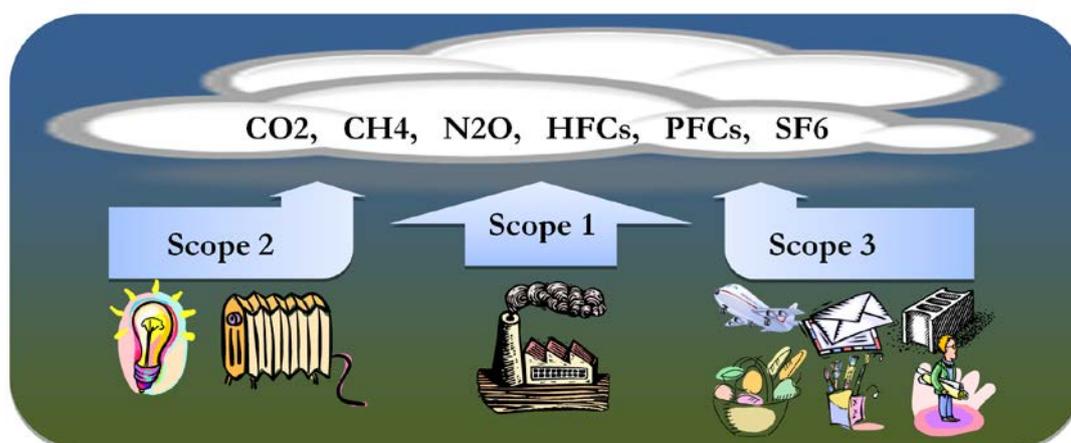


Figure 1. Scope classification according the GHG protocol [17]

The Carbon Footprint (CF) [18-20] has become a popular term referring to the measure of all direct and indirect GHG emissions resulting from an activity or organization. Its popularity is probably partly inherited from its predecessor, the Ecological Footprint (EF) [21, 22], which became popular for communication purposes due to its measure of (un)sustainability in terms of land use necessary to satisfy human demands. Results indicated that several developed countries exceeded the maximum capacity of the Earth (2.1 hectares per person) by 3-4 times, initiating news stories such as “we need x number of Earths to support the consumption of this population”. Despite the popularity of EF, it had some methodological weaknesses, and other footprint perspectives have increasingly substituted the use of EF. The CF indicator is clearly related to the EF indicator, but uses the stronger methodological foundation of LCA [3, 23] and EEIOA [24-27].

The CF analysis of the municipalities in Oppland is derived using an EEIO based model developed by MiSA [9, 15]. The model applies a Norwegian 2007 IO table for domestic production matched to an EU27 IO table used as import technology assumption. A key part of the analysis is then to match the standardized set of 34 municipal purchasing categories (KOSTRA) to the 58 IO sectors. The EEIO model is then used to derive GHG intensities for each IO sector. Using this procedure, schematically illustrated in Figure 2, we are able to generate a GHG emission inventory resulting from the initial KOSTRA-purchase. Note that in some cases, also physical data is applied to improve the accuracy of the emission intensities.

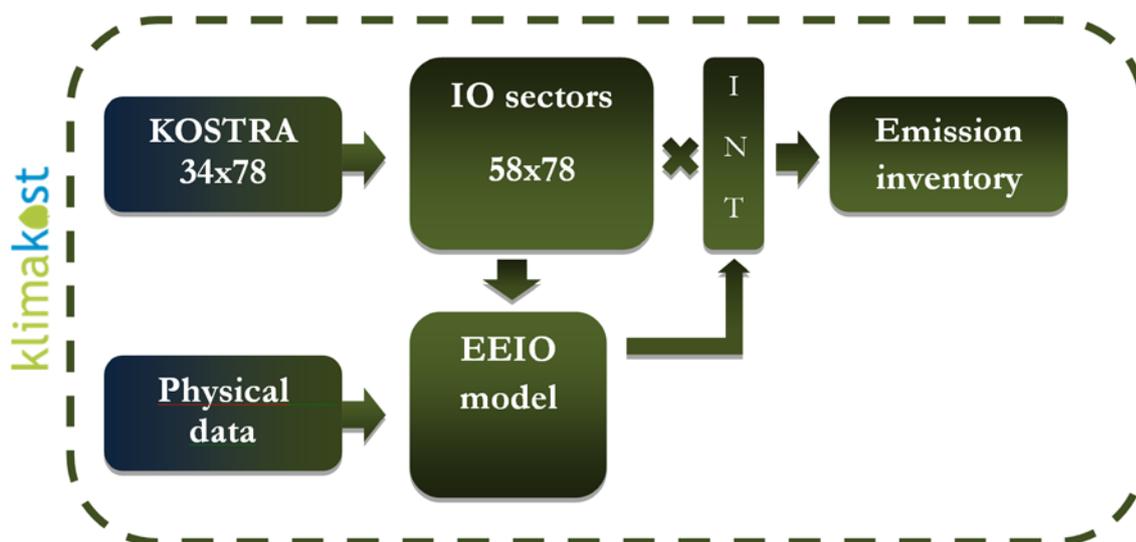


Figure 2. Overview of the EEIO model used

The KOSTRA purchases are further divided into 78 different municipal service areas creating a standardized two dimensional GHG inventory that can be normalized per capita and compared to the other municipalities in the county to identify potential municipal-specific target areas. Data on municipal purchases have been tracked since 2001, thereby enabling us to derive a CF time series to track the development of the CF resulting from municipal service provision. Also, an update of the inventory in 2015 is planned to help municipalities measure the effect of potential actions.

### 3 RESULTS

The results indicate fairly large variations between municipalities in the per capita carbon footprint resulting from the provision of municipal services, ranging from less than 0.8 tonnes to more than 2 tonnes of CO<sub>2</sub> equivalents per capita. One reason for this was identified as the significant amount of cabins in some of the municipalities. This increases the demand of some municipal services, although the users in most cases do not count as inhabitants of the municipality. Therefore, the summary of results in Table 1 also includes a column with # of cabins adjusted results. These results assume 50 %

of cabins are inhabited by 2 persons from outside the municipality, and consume 25 % of the average service provision. As indicated in Table 1, such adjustments lower the carbon footprint significantly for some municipalities where high numbers of cabins are found (e.g. Etnedal), whereas for larger cities (e.g. Lillehammer and Gjøvik) with insignificant numbers of cabins, results are not influenced.

*Table 1. Summary of results. Table indicate (from left): name, population, number of cabins, carbon footprint, per capita carbon footprint, % difference in per capita carbon footprint compared to 2001 and 2005, average yearly difference in per capita carbon footprint, per capita carbon footprint adjusted for # of cabins, and average carbon footprint 2001-2011*

Municipalities Oppland	Popul. 2011	# of cabins	CF [t CO2e]	Kg CO2e. /capita	% diff 2001	% diff 2005	yearly % diff linear trend	kg CO2e./cap. # cabins adj.	kg CO2e./cap. avg. 2001-2011
Lillehammer	26571	1382	27233	1025	8,0	-6,3	-0,34	1012	1066
Gjøvik	28974	905	29201	1008	40,4	3,5	2,46	1000	913
Dovre	2748	703	3272	1191	-1,9	20,8	2,02	1119	1212
Lesja	2197	1877	4246	1933	105,4	59,0	9,56	1593	1433
Skjåk	2299	641	3411	1484	30,4	81,4	3,24	1387	1068
Lom	2401	262	3154	1314	42,4	0,8	2,43	1279	1216
Vågå	3718	965	4617	1242	39,5	15,2	8,54	1166	1166
Nord-Fron	5834	2364	9247	1585	84,3	69,1	7,61	1439	1123
Sel	6004	1991	7473	1245	42,0	14,2	4,52	1149	1203
Sør-Fron	3212	1659	3601	1121	-7,1	13,5	2,32	993	1113
Ringebu	4556	3597	6787	1490	75,2	18,9	3,74	1244	1138
Øyer	5092	2210	6249	1227	20,0	29,7	3,97	1107	1144
Gausdal	6141	2355	7446	1213	17,5	29,2	4,54	1106	1157
Østre Toten	14604	1134	14011	959	73,9	54,9	7,28	941	774
Vestre Toten	12803	313	10961	856	30,4	25,1	2,78	851	728
Jevnaker	6359	342	4692	738	-3,2	-13,9	-0,98	728	771
Lunner	8654	1165	7871	910	43,2	22,2	4,3	880	772
Gran	13434	1412	13861	1032	62,6	40,3	5,62	1005	829
Søndre Land	5837	1079	5884	1008	1,9	-5,0	-0,22	964	1013
Nordre Land	6716	2390	7071	1053	14,4	14,2	1,36	967	962
Sør-Aurdal	3164	3423	2961	936	24,4	-20,3	0,45	736	987
Etnedal	1388	2190	2677	1929	72,9	26,5	4,6	1383	1197
Nord-Aurdal	6402	4188	7814	1221	69,2	51,6	4,53	1049	975
Vestre Slidre	2217	2480	3795	1712	47,9	17,7	3,97	1338	1462
Øystre Slidre	3171	3305	6618	2087	83,7	97,4	9,57	1656	1393
Vang	1591	1593	2781	1748	31,3	17,9	1,59	1398	1682
Oppland	186k	-	207k	1112	34,7	18,2	3,11	1047	987
<b>Norway</b>	<b>4920k</b>	-	<b>4872 k</b>	<b>990</b>	<b>19,1</b>	<b>17,1</b>	<b>2</b>	<b>970</b>	<b>904</b>

Previous studies indicate a correlation of municipal population and per capita carbon footprint of municipalities in Norway [14] as illustrated in Figure 3. The correlation is most significant in the range of 1000 to 10000 inhabitants. The main reason for this is that for more highly populated municipalities, public services can be performed more efficiently compared to more sparsely populated municipalities. This is also the case for the municipalities in Oppland. Most municipalities with a population less than 5000 have a higher carbon footprint compared to the Oppland average, whereas most municipalities with over 5000 inhabitants have a lower per capita carbon footprint.

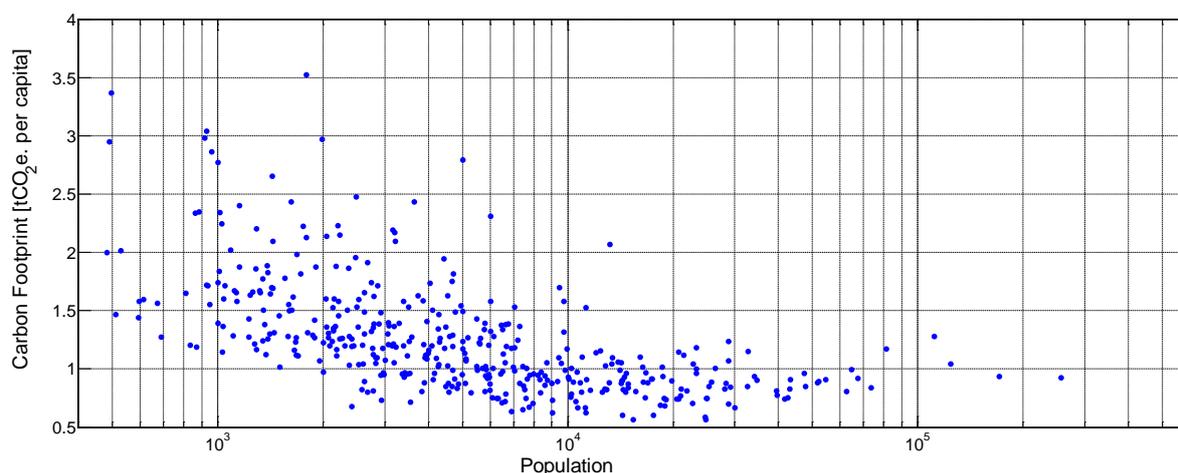


Figure 3. CF versus population, all municipalities in Norway

Table 1 also includes some results regarding the year-to-year development, as 2011 results are compared to both 2001 and 2005. Large variations are found, and are mainly connected to investment rates in new buildings etc. All CF from constructing new municipal buildings are allocated to the specific year the investment is made. Because most municipalities and hence absolute emissions levels here are quite small, this causes some large year-to-year variations. Because of this, the results also include a column indicating the average yearly development of the CF assuming a linear trend of the time series results. This reduces some of the fluctuations, however results still differ from a -1 % decrease per year to almost + 10 % increase per year. Finally, Table 1 also includes a column indicating the average per capita CF for all years analysed, with results ranging from 728 kg CO<sub>2</sub>e/capita (Jevnaker) to 1682 CO<sub>2</sub>e/capita (Vang).

In total, results from Oppland indicated an average CF of approximately 1.1 tonnes CO<sub>2</sub>e per capita. This is about 10 % higher than the Norwegian average. As indicated, cabins and the high fraction of smaller municipalities are two explanations for this. The overall structure of the results indicates a fairly similar carbon footprint composition as the national average. However, one significant difference was the importance of the service “water provision, wastewater treatment”. For Oppland, this was found to be significantly more important compared to national averages. Energy-intensive wastewater treatment of the municipalities surrounding Mjøsa lake was identified as one of the reasons for this. In Figure 4, the CF structure of the municipalities in Oppland is illustrated. Schools (20 %), water/waste (19 %) and healthcare (17 %) are the greatest contributing services whereas energy- (29 %) and building and infrastructure-related CF (30 %) are the highest contributing activities/purchases. Regarding energy use, a Nordic average electricity mix at 186 g/kWh is used in deriving the CF.

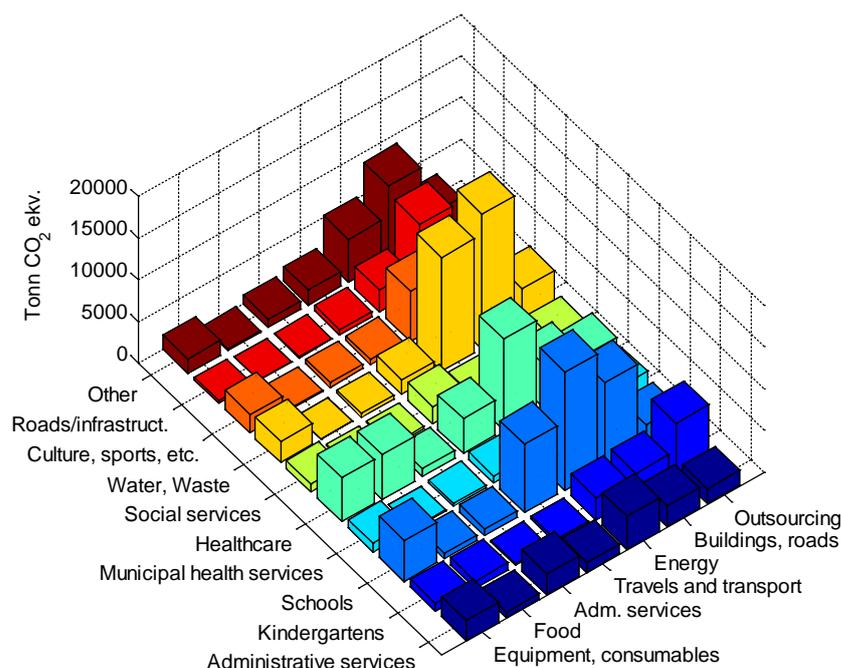


Figure 4. CF structure of municipalities in Oppland

#### 4 DISCUSSION AND CONCLUSION

This paper aims to illustrate the strength of consumption-based accounting as a vital supplement to more traditional production-based accounting. Regarding municipal service provision, a surprisingly small fraction of the CF consists of direct GHG emissions. This is due to heating oil being substituted by renewable energy sources in buildings, and reduced fuel purchases as transport services are outsourced to private companies. The latter example illustrates very well the importance of including scope 3 emissions resulting from the purchase of services. Therefore, for most municipalities, direct GHG emissions count for less than 5 % of the total CF. Including energy use (scope 2) increases this to approximately 25%, still leaving the vast majority of the CF to be counted as indirect, or scope 3 GHG emissions.

The klimakost model was developed specifically to include scope 3 emissions in an effective and standardized manner using EEIOA. Financial data available at a standardized format enable us to generate CF of all municipalities classified into municipal purchases and service areas. This provides municipalities with an excellent starting point in developing action plans and refining the GHG inventory. Note that the klimakost model is not intended to be used as a direct measure of climate performance, but rather acts as an indicator of emissions. Instead, robust indicators must be developed in order to develop specific action plans targeting climate emissions. The aim of the klimakost model is mainly to intensify target areas for mitigation action strategies and to refine these important contributions in the GHG account by using more specific LCA data. The role of the klimakost model is illustrated in Figure 5.

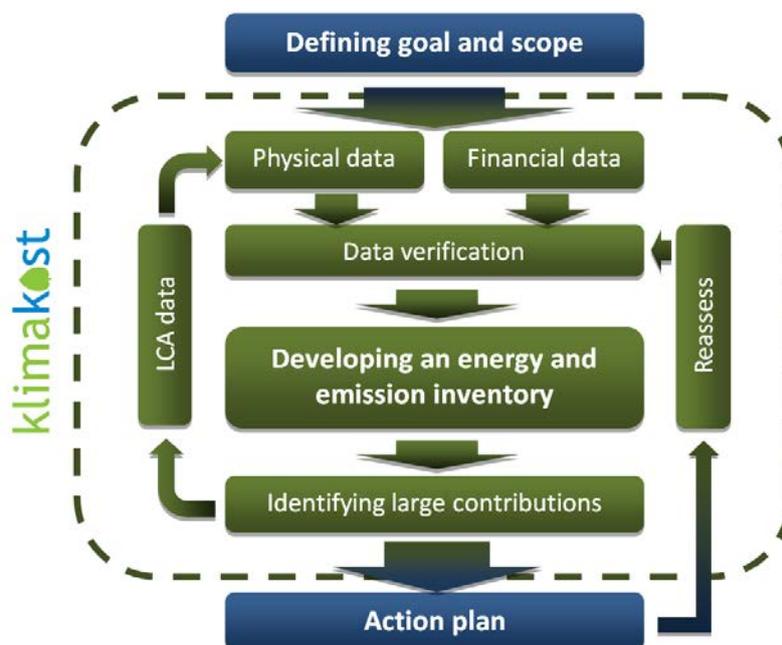


Figure 5. The intended role of the Klimakost model in local climate action

Results show that the per capita CF of municipalities in Oppland is slightly higher than the Norwegian average. However, this is due to factors such as population, which is obviously difficult to alter. Figure 3 clearly shows that a low and disperse population on the average have a higher carbon footprint per capita resulting from providing local services. The number of cabins in especially some municipalities is also found to potentially influence the results. This is because many of the users are not counted as inhabitants of the municipality, however still requiring elements of local service provision. The effect of this, and other elements – such as local tourism – , should be investigated in more detail in further analysis. The structure of the CF reveals a few interesting findings. Water provision and waste water treatment are significantly more important than national average. This could indicate a potential focus area; this sector has significant potential in reducing its carbon footprint in terms of use of biogas and energy generation.

In total, municipalities in Oppland have increased their CF by 3 % each year (assuming a linear trend). Some of this increase is attributable to investments in newer and more energy efficient buildings that in the future could help reduce the CF. Still, this shows the significant effort that is required of the municipalities in taking their share of responsibility to turn things around and reducing the per capita footprint by a factor of 2-3, in order to meet the 2-degree target. A good starting point is obviously a complete GHG inventory illustrating all available GHG mitigation potential.

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# UN GLOBAL COMPACT AS MEANS FOR SUSTAINABLE VALUE CREATION

**Sigurd Sagen Vildåsen<sup>1</sup>, Annik Magerholm Fet<sup>2</sup> and Kristoffer Magerøy<sup>3</sup>**

<sup>1,2</sup>Norwegian University of Science and Technology

<sup>3</sup> SINTEF Technology and Society

## ABSTRACT

Organizational barriers to sustainable value creation are analysed and discussed in this paper. Furthermore, a central objective is to present managerial recommendations on how to increase sustainability performance. The internal implementation process related to strategic objectives within sustainability is chosen as unit of analysis, and thus theoretical concepts within change management are emphasized. A case study conducted in the maritime sector show that organizational resistance is a substantial risk when implementing sustainability initiatives such as UN Global Compact. One explanation could be that relations between strategic objectives such as market growth and profit optimization become unclear. Furthermore, there will most likely be different attitudes and behavioural traits between different employee groups. It seems reasonable that people working with external stakeholders perceive relevance for their own tasks differently than people working closely with production-oriented activities. An efficient way of reducing barriers can be to relate new initiatives to existing policies and routines within Health, Safety and Environment (HSE), quality management, and general work on legal compliance. In addition, managers should involve employees actively and early in the process of developing performance targets and establishing new guidelines in order to establish ownership and local anchoring.

*Keywords: UN Global Compact, sustainability, organizational innovation, change management, strategic sustainability management, corporate social responsibility (CSR)*

## 1 INTRODUCTION

Sustainability is a term being used by most actors and grows in usage. In the business sector it often reflects being profitable in the long term, while the public sector, NGOs and many scholars emphasize environmental and social aspects as equally important. The latter would be in accordance with the concept of sustainable development as defined by the Brundtland commission, and is also the understanding of the authors. Furthermore, Porter and Kramer (2011) argue that it is possible to create maximum economic value through creation of social and environmental value, e.g. shared value creation, which is one way of conceptualizing sustainable value creation. In other words, a company could achieve long-term competitiveness and sustainability by addressing societal needs strategically.

The literature gives few clear answers for managers on how to achieve wanted results from strategic sustainability management. Company-specific factors are of great importance, and generic solutions are therefore challenging to deduce. However, given a set of objectives one could argue that the *transition process* towards a more sustainable organization would reflect generic traits and therefore being applicable for research. Theoretical concepts within change management and organizational innovations are believed to be valid in this context. Thus, the framework of Krüger (1996) is applied as the analytical model.

The purpose of this paper is to analyze how managers can achieve sustainable value creation. The analysis is done through a case study on the sustainability initiative UN Global Compact, and the results are illustrated by empirical findings from a case company in the maritime sector. Value creation in this context can be in terms financial, environmental and social factors, but also intangible values such as stakeholder collaboration, communications and awareness within an organization.

The overall research question is:

i. How can organizational barriers to sustainable value creation be reduced?

In order to answer this, a theoretical background is presented and empirical data from a case study are analyzed. Furthermore, the results are discussed and constitute the basis for managerial recommendations.

## 2 THEORETICAL BACKGROUND

In this section UN GC as means for sustainable value creation is conceptualized through literature findings. Furthermore, a change management framework is presented in order to lay the foundation for empirical and theoretical analysis based on empirical results.

### 2.1 Impact from UN Global Compact on organizational change processes

The UN Global Compact comprises ten principles within areas of human rights, labor, environment and anti-corruption, and covers many aspects related to corporate social responsibility (CSR). Furthermore, the ten principles are based on the logic of sustainable development and put emphasis on stakeholder involvement. Signing UN Global Compact require top-management commitment, as the chief executive has to prepare a Letter of Commitment to the Secretary-General of the United Nations. By this the firm express commitment to (i) the ten principles; (ii) engagement in partnerships to advance broad UN goals; and (iii) the annual compilation of the Communication on Progress (COP) report. UN GC can in general be regarded as strategic policy framework for achieving sustainable value creation.

Cetindamar and Husoy (2007) argue that GC could facilitate value creation both in the short and long run, especially because of network opportunities which could be an important source of knowledge and new ideas. However, this conclusion is not supported by Runhaar and Lafferty (2009), who address how industry specific factors influences the contribution of UN GC. Their study shows that GC has a marginal beneficial effect, and their main criticism is that “*GC does not provide industry-specific input or resources (in terms of either knowledge or partners)*” (Runhaar and Lafferty, 2009, p.492). In other words, the argument of beneficial network seems ambiguous because companies seem to regard other networks better suited for addressing industry specific issues.

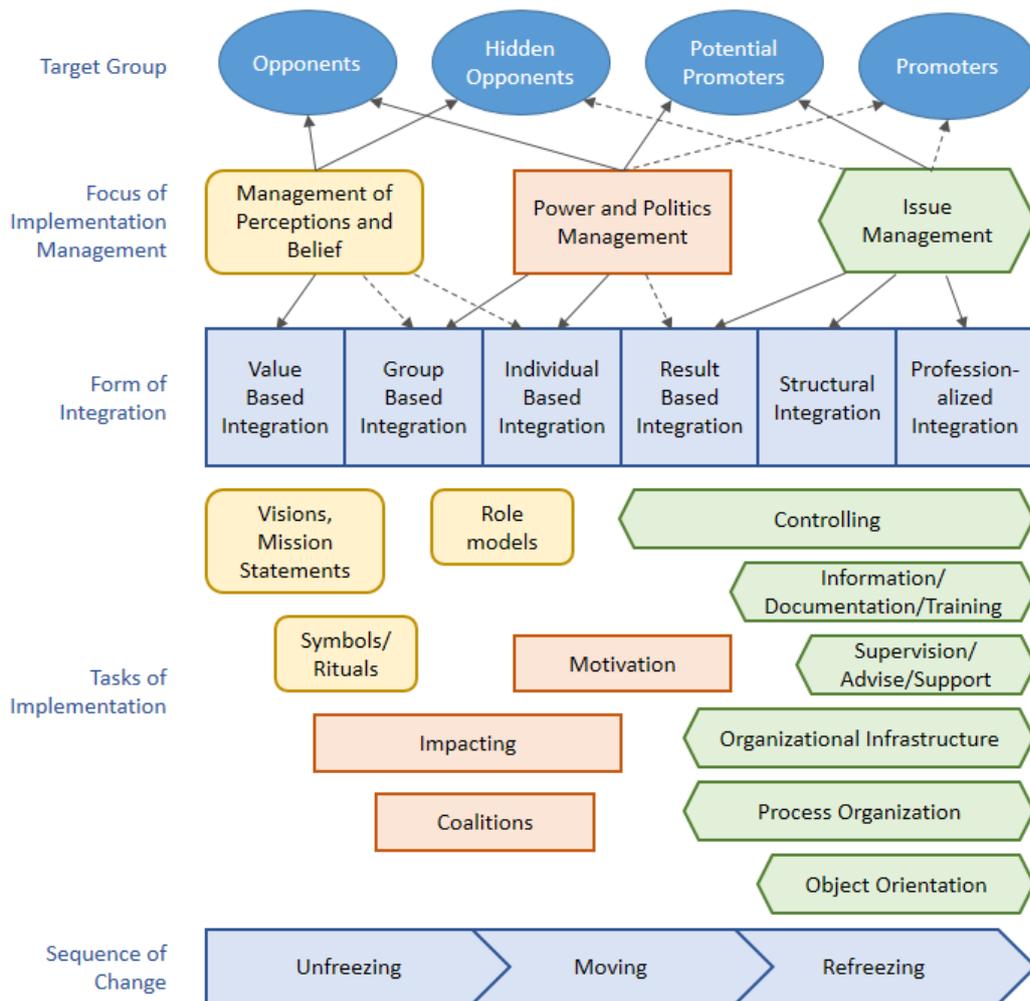
Explicitly stating that their findings are in contrast with the results of Cetindamar and Husoy (2007), Runhaar and Lafferty (2009) do, however, underline that the reason could be their focus on CSR frontrunners. The logic being that UN GC was only one of many initiatives in which the frontrunner companies were engaged. Runhaar and Lafferty (2009) point out that “*it is to be expected that the way(s) in which the GC is actually utilized by companies, depend(s) on company- and context-specific factors*” (p.483). It should be noted that also Runhaar and Lafferty (2009) acknowledges some general features having the potential of providing important benefits. Learning processes through interaction and cooperation with stakeholders and other companies are emphasized.

The empirical analysis conducted by Mageroy and Vildasen (2012) conclude that UN GC membership has largest potential when it comes to innovations of organizational and incremental character. Changes are mainly caused by the introduction of a systemic approach and the need for reporting on progress. The same logic is given by McKinsey (2004), arguing that UN GC seems to have a role in facilitating strategies that already exists, and hereby accelerating implementation and incremental change (McKinsey, 2004).

### 2.2 Barriers in organizational transition processes

According to Krüger (1996) managers tend to underestimate implementation, which should actually be regarded as the core task of change management. A typical point of failure is that the people concerned do not accept new solutions. Problems often arise from issues which are not directly related the change program or are hidden by day-to-day business. The main message is that individuals in the organization should be integrated in the change process through different means spanning from *value-based integration* to *professionalized integration*. The underlying reasoning is that *management of perception and beliefs* aims for attitude acceptance, while *power and politics management* deals with

behavior acceptance. The last stage of the process is *issue management* where activities are based on information, training, supervision and control. This is the phase where new solutions and practices are learned in order to “refreeze” patterns of thinking and behavior.



**Figure 1: Framework for change management introduced by Krüger (1996)**

The change management framework highlights the importance of organizational barriers, which can be analyzed by introducing target groups as shown in the top of Figure 1. By doing so, it is possible to support positive and diminish negative attitude and behavioral patterns. *Promoters* represent both positive attitude and behavior while *opponents* are negative. The former would show joy, motivation and enthusiasm while the latter would show disappointment, resignation, disapproval and resistance. In general, those who expect to benefit from changes are likely to act as promoters and those who expect to suffer disadvantages, become opponents. However, sometimes there exists a gap between (internal) attitude and (external) behavior. *Potential promoters* have a positive attitude to change in general, but show negative behavior because of expected negative consequences of the specific change at hand. *Hidden opponents* have a negative attitude towards change in general, but show positive behavior due to expected advantages.

In the following, the focus of implementation management are elaborated and related to the different forms of integration. When it comes to different tasks of implementation as illustrated by Figure 1, these are also included and explained.

### **2.2.1. Management of perception and beliefs**

Management of perception and beliefs represent the start of the change process. The focus here is on achieving attitude acceptance, which typically will target *opponents* and *hidden opponents*.

The need for change and the way in which change will occur, must be communicated. Hence, *vision* and *mission statements* along with *symbols* and *rituals* are important implementation tasks. The objective should be to ensure every employee's permanent personal commitment to values and norms. In practice, *role models* have proved to be of great importance. Both individuals and groups can serve as models, and it is regarded crucial that top management live the values they are thriving for.

As indicated in the framework, management of perception and beliefs focuses on *value-based integration*. *Group-based* and *individual-based integration* are also targeted when role models are used.

### **2.2.2. Power and politics management**

Power and politics management aims at behavior acceptance, and target groups are therefore *opponents* and *potential promoters*.

Important means of power are rewards such as appreciation, praise, bonuses and compensations. The opposite is also possible, e.g. withdrawal of support and advantages, but this is restricted by strict legal limits. Rewards or punishments influence *motivation* and are linked to satisfaction and performance. A change supporting *coalition* is also crucial in an implementation process. For example, it is advantageous to use promoters who are already identified in order to achieve multiplication effects.

Power and politics can be exerted by individuals as well as by groups and this type of management are thus important for *individual and group-based integration*. Higher ranks and direct superiors do vertical integration, while single or group of colleagues carries out horizontal integration.

### **2.2.3. Issue management**

Issue management can be regarded as the rational and factual dimensions concentrating on cost, time and quality. *Potential promoters* are the main target group.

Important activities would typically be *informing*, *training*, *documenting*, *supervising* and *consulting*. The main purpose is to achieve *professionalized integration*, which means that employees are adapted to new tasks, structures and procedures. Such activities should be initiated partly or entirely through project teams or steering committees, and are examples of *organizational infrastructure* and *process organization*. *Result-based integration* reflects *controlling* progress and results during the implementation process.

Issue management will typically receive most attention from managers. This could prove to be risky because then the importance of *power and politics management* and the *management of perception and beliefs* is underestimated. The main point is that implementation must begin before the change project is defined because employees must be included in the process of identifying needs and intentions, as well as the establishment of goals. Thus, people concerned must be convinced of the need for change before the project starts.

### **2.2.4. Summary**

The general implication from applying the change management framework is that employee acceptance should be a separate implementation goal in order to overcome organizational barriers. Krüger (1996) argues that implementation must be designed as an individual and organizational learning process in order to be successful. Furthermore, groups in the organization must be approached differently based on their likely attitude and behavior to the proposed change.

## **3 RESEARCH METHODS**

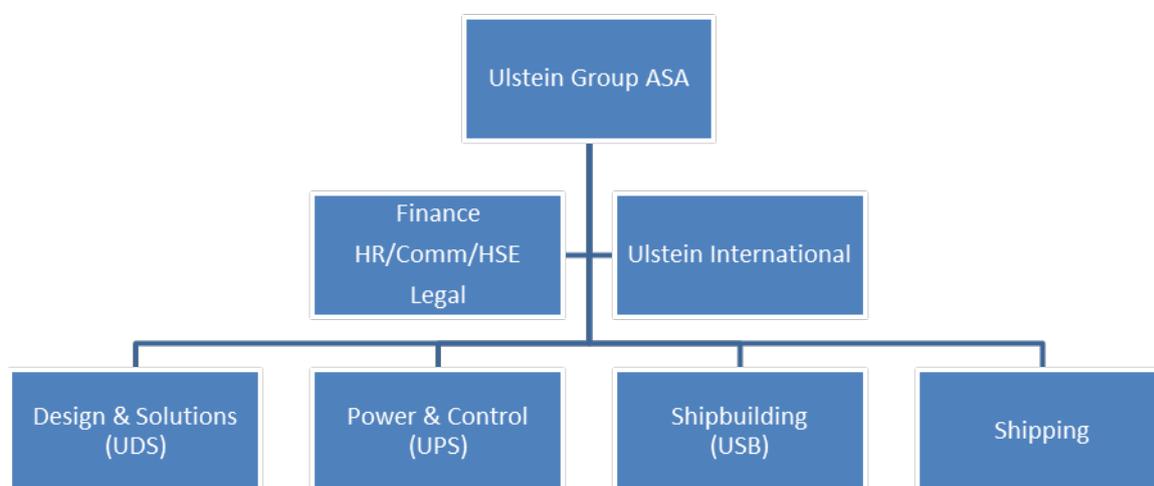
Following an exploratory approach, qualitative investigations as means for collecting data from the case company was chosen. In essence, a qualitative study deals with words rather numbers, the approach is open-ended and contextual understanding is emphasized (Bryman and Bell, 2011). Interviews were selected as the main source of evidence, and typical features of the research process are presented in the following. Some methodological dilemmas are discussed in section 3.2 in order to evaluate the research quality.

### 3.1. The case company

The empirical investigations of this study are mainly based on a visit with the Ulstein Group in the period of 15<sup>th</sup> to 19<sup>th</sup> of April 2013. Furthermore, follow-up meetings and discussions throughout the fall of 2013 have been indirect sources of information.

The case company is an important actor in the Norwegian maritime industry, and is internationally renowned as a provider of ship design, shipbuilding and power and control systems for ships. The family-owned company with history back to 1917, is today also established within shipping through Blue Ship Invest. The Ulstein Group wants to secure long-term competitiveness by a strong focus on results and active use of the firm's three core values: innovative, engaging and advancing.

The group is divided into four main business areas: Design and Solutions (UDS), Power and Control (UPC), Shipbuilding (USB) and Shipping (Figure 2). UDS and UPC have subsidiaries abroad in countries as Brazil, China, Poland and The Netherlands. In addition, the support organization Ulstein International have sales offices in Shanghai, Singapore and Rio de Janeiro.



**Figure 2: Company structure**

### 3.2. Semi-structured interviews

Seventeen semi-structured interviews were conducted in total. Sixteen of them were recorded and notes were taken simultaneously. Both investigators were present at the same time and the interviews lasted in average an hour. One interview was more informal and documentation was done by taking notes only.

According to Bryman and Bell (2011), a typical feature of semi-structured interviews is to develop an interview guide. This was conducted based on a theoretical analysis. However, some adaptations and spontaneous changes to the guide were carried out during the process. For instance, questions asked during the interviews were adapted to the specific interviewee. This was mainly due to differences in background, meaning that some people were better qualified to answer some of the aspects. In other cases, certain topics were regarded relevant and interesting, and therefore people were allowed to speak more freely. The notes taken during the interviews were used as data source when interpreting the findings. If topics and statements were perceived unclear, they were double-checked with the recordings.

The table gives an overview of the interviewees and is the frame of reference when presenting the empirical findings.

Table 1. Interviewees

Work title	Business Area	Reference number
Sales Manager	Shipbuilding	1
Process Development Manager	Power and Control	2
Business Consultant	Ulstein International	3
Chairman of the Board / Deputy CEO	Group Management	4
HR Director	Group Management	5
Public Relations Manager	Group Management	6
HR and HSE Manager	Shipbuilding	7
Business Controller	Power and Control	8
HR Manager	Design and Solutions	9
Chief Designer	Ulstein International	10
Manager Supply Chain Department	Design and Solutions	11
Legal Council	Group Management	12
Superintendent and Manager Service Department (joint interview)	Shipbuilding	13
Deputy Managing Director	Shipbuilding	14
Manager Strategic Sourcing	Shipbuilding	15
Project Director	Design and Solutions	16
Manager Planning Department	Shipbuilding	17

### 3.3. Evaluation of validity and reliability

The quality of the research design is a core subject that should be discussed because qualitative research in general could be criticized for being too subjective (Bryman and Bell, 2011). Issues related to validity and reliability are therefore reflected upon in the following.

#### 3.3.1. Validity

Validity is concerned with the integrity of the conclusions generated (Bryman and Bell, 2011). Internal, external and construct validity are the typical forms of integrity measures (Yin, 2009). Internal validity is left out in the following because according to Yin (2009) this integrity measure is mostly relevant when conducting explanatory rather than exploratory investigations.

Construct validity concerns the issue of identifying operational measures for the concepts being studied. A recommended strategy is to use multiple sources of evidence. Even though some statements were supported by documentation, the main data source was interviews so this criterion is not regarded fulfilled. That being said, quite a large number of interviews were conducted which could enhance trustworthiness of results. Another strategy recommended by Yin (2009) is to maintain a chain of evidence that enables a logical link between initial research questions and case study conclusions. Efforts have been made to follow this strategy through usage of theory as basis for interview guide along with explicit citations to sources when presenting empirical results.

External validity deals with generalizability of the study's findings (Yin, 2009). Usage of theory would enhance external validity, but given the open and exploratory nature of this study, generalizability is regarded low. The results are probably better suited as a foundation for further research and investigations.

#### 3.3.2. Reliability

According to Yin (2009), reliability is the criterion for securing the same results when an empirical study is repeated. The key principle is to document all the steps in the research process so that the research is replicable.

A recommended strategy in order to enhance reliability is to develop a case study protocol (Yin, 2009). This was to some extent taken into account through an interview guide based on theoretical

considerations and data collection procedures during the stay in Ulsteinvik. Furthermore, sixteen out of eighteen interviews were recorded which would make it possible for other researchers to analyze the data collected. A complete transcription of all the interviews could have strengthened the reliability, but because of time constraints this was not conducted. Most of the questions asked during the semi-structured interviews were quite open-ended. A weakness is therefore that respondents do most likely not answer an open question the same way twice.

Because of the open-ended and flexible approach of the investigations, reliability is regarded limited. In other words, it is likely that investigators could obtain different results if conducting the same data collection procedures.

## 4 RESULTS AND EMPIRICAL ANALYSIS

The case study findings are presented and analyzed in the following. Section 4.1 aims to describe the organizational context in which UN GC membership has been evaluated. Section 4.2 aims to answer the research question by analyzing organizational barriers for implementation.

### 4.1 Decision making processes regarding membership in UN GC

At the board meeting in April 2012, it was decided that the administration should to a higher degree formalize their work within compliance and increase their focus at ethical guidelines and anti-corruption. In this setting, both the HR director and the legal counsel see UN Global Compact as a desirable way of structuring the work. Therefore, they oriented the board the 24<sup>th</sup> of April 2013 of their recommendation to join UN GC.

Ahead of this, membership in UN GC was discussed in the group management in March 2013. The discussion unveiled that the chief operating officers of two of the business areas did not consider membership valuable, as the extra work required was perceived more costly than the benefits. This opinion should be seen in relation to an ongoing process of reducing the indirect costs in the business areas. In other words, a new task instructed by the group management was considered inconsistent with current focus.

Membership was discussed in the management group on several occasions throughout the spring and early fall of 2013. After several rounds, the business area managers were convinced and CEO Gunvor Ulstein send a letter of commitment on 19<sup>th</sup> of August 2013 to the UN. Ulstein delivered their first communication on progress (COP) on 22<sup>th</sup> of January 2014.

### 4.2 Organizational barriers to change

Issues related to change management and the process of implementation, are given in the following. The brackets indicate reference to an interviewee as shown in table 1. The titles of the sub-clauses are indicating the topics addressed in the interviews.

#### 4.2.1. Support and resistance

*"Most people will think that GC is a good idea, but most probably they don't want to have anything to do with it. Some will probably not understand why this is important." (2)*

Opinions are quite divergent when it comes UN GC membership. One statement is that employees most probably are divided in two because some will say that this initiative is something we must have, while others will argue that Ulstein should focus on ship building and not everything else (6). Another statement is that attitude towards UNGC will differ on an individual level and not necessarily on department level (5).

It was mentioned in most of the interviews that sales, marketing and external-oriented departments most probably will see possibilities within UN GC membership or that they are important target groups on the process (1, 2, 5, 6, 9, 12, 15 and 16). However, it is noted that sales representatives and brokers located internationally could be more sceptic towards UN GC (1). People working with supply chain management are also believed to support the initiative (12, 15 and 16). Furthermore, academic

oriented people will most probably be most enthusiastic. Such groups are typically found in Design and Solution and Power and Control (7).

A common point made was that people more production and operational oriented could have difficulties seeing benefits of UNGC (6, 7 and 16). It was also stated that those who have worked for a long time in the company and have seen many initiatives come and go during the years, will probably not invest that much time in this. This group is typically focused on delivering operational results (6). Furthermore, people that have ship building as their main task are mostly concerned about how they can limit time spent on projects (7). As an example, UN GC could be advantageous when Ulstein is utilizing third-party companies in production activities because it is important to ensure that they are up to standards (16).

A general remark is that UN GC will be a burden if actions are not related to daily operations. For instance, in the shipyard there must be measures and activities oriented towards daily operations, and in sales departments they clearly will be motivated if this helps them in their relation to shipping companies (16).

#### **4.2.2. Concrete activities**

*“Implementation must result in concrete changes in documents and processes. Only nice writings on the webpage are of no use.” (15)*

During most of the interviews it was mentioned that the core issue is how different roles and function can use UN GC membership in practice. One argument is that when people can see that UN GC can be helpful in their work, then it is easier to make things happen (16). Here it is crucial to focus on concrete activities and content (6). One way of doing this could be to link the initiative to action plans (5). Another example could be to use workshops in order to identify what this could mean for different groups (15). A central actor in the implementation process mentioned that the company today does not exactly know implications of membership and this will be important to identify (12).

It was a common finding that UN GC membership should be coupled to existing activities. One example was recruitment processes because younger, well educated people are more concerned about aspects that the UN GC principles represent (7). Furthermore, some found it useful to see the principles in relation to existing ethical guidelines (1 and 8). Issues related to legal compliance and corruption was also emphasized (5 and 12). It was stated necessary to refresh knowledge about ethical guidelines through training programs, and that dilemma training and anti-corruption needs to be developed. UN GC membership could act as useful tool in this context (12). Another example was to see implementation of UN GC as a project where Ulstein’s project management model should be utilized by identifying which employees to involved and related costs. A pre-project should be conducted along with a cost-benefit analysis (2).

The need for concretization was by many related to the need for understanding why the company should become a member. It is crucial that people see clear what benefits that are involved for their tasks and on department level. If this is neglected it could be a risk that people see this as something extra and on the side of core operations (3). In this context it could be useful to argue linkages to strategic choices, such as being proactive, preparing for future regulations or because of international activities (8). It was stated that people in general are not that interested in things that are “nice to have”. Therefore, it is important to spend time to inform and explain reasoning behind the decision (9).

#### **4.2.3. Reporting and measuring**

*“The most important aspect is to get things done and to limit paperwork.” (16)*

A recurrent point made was that UN GC membership should not involve too much administration and bureaucracy (2, 13 and 16). However, it is also regarded beneficial to link UN GC activities to regular reporting and measurement systems (8). In this context it is argued that membership could be easier to execute if there will be a continuous focus and not just annual reporting (16).

Furthermore, it is important to establish a “living” system that measures progress. This would mean that concrete targets on Group level are established first. In the next round, it is natural that business areas and department on lower levels also develop similar ones. Concrete performance indicators, which are checked regularly, are necessary, but this is typically difficult to establish for human capital (5). Nevertheless, it is regarded crucial to measure other factors than just cost and earnings in order to get a successful outcome because people are in general motivated to do things on which they are measured (2).

In order to develop realistic objectives, it was suggested that relevant departments within the organization should be involved in an open process where ideas are discussed. Workshops could be good arenas for such activities (11). A similar suggestion was to use multidisciplinary groups with members on different levels along with union representatives in the implementation process. This is could be a good way to identify and evaluate measures in different areas (17).

#### **4.2.4. Anchoring**

*“Anchoring in top management is crucial and initiatives have to be announced by them.”* (13)

The role of top management is emphasized in several of the interviews. One person states that change processes can be “born” down in the organization, but it must be anchored in the top management (2). Another thinks that top management should work out a plan for implementation and it should be identified what membership means for the company (3). Top management should focus on ownership, responsibility and guidelines for how to implement in the departments (2). It was noted that a too top-down governed process is risky. The worst thing you can do is to force such an initiative down on people because it will create resistance and they will think that the decision is poor (10).

Anchoring and ownership were mentioned in many of the recommendations given. First, it was emphasized that every member of Group management should support membership (16). In the next phase, management groups on lower levels are mentioned as important actors in the process along with union representatives (7, 9, 13 and 16). Some argue that involvement of these groups also should happen before the decision of membership is taken (7 and 9). In this context, the Group committee meeting and extended management groups could be relevant discussion arenas (7). HR functions are assumed to play an important role during the whole process (16). In general, group management, HR, sales, marketing, sourcing departments and communications are important target groups in an implementation process (1 and 6).

#### **4.2.5. Involvement**

*“Involvement does not take much time and it is important that people feel listened to. It often takes much longer time to achieve same support if processes are governed too much top-down, and it could actually become impossible.”* (9)

Information should be sent to every employee (7), and giving information is in general something which should be prioritized in an implementation process (8). A concrete way of doing this could be through “question and answers” on internal webpages (6). In general, marketing both externally and internally is essential (15). When it comes to involvement that is more active it was argued that it is useful to involve a broad set of employees because if people are allowed to contribute, they will feel ownership and pride (10). That being said, it is important to evaluate the number of employees involved in order to spend a reasonable amount of resources (6 and 7).

Regarding target groups, HR could have main responsibility for worker rights while for instance anti-corruption is especially relevant for sales and supply (5). It is natural to include some groups even more, for instance sales and supply along with management groups (15). Furthermore, it is wise to involve department managers first and give them mandate to give feedback and input. Next, they will then be responsible for involving their own department (10). In general, it is very important to involve department managers in order to reach out to production workers (13).

## 5 DISCUSSION, RECOMMENDATIONS AND IMPLICATIONS

As stated in 2.2.4, the recommendation from Krüger (1996) is that acceptance should be a separate implementation goal for reducing organizational barriers. Given such a premise, practical implications based on the empirical analysis are discussed in the following.

### 5.1 How could organizational barriers to sustainable value creation be reduced?

Support and resistance are simultaneous factors in organizational dynamics when implementing sustainability initiatives. Employees are likely to relate overall concepts to their personal values and what they believe is right to do. In other words, this could be an important source for internal support. However, the risk concerning internal resistance is also substantial because such initiatives can be perceived as irrelevant for core activities.

A central factor for reducing organizational barriers is power and politics management (2.2.2). In this context one could argue that people will experience motivation, feel ownership and pride if they are allowed to contribute in developing activities and objectives. Another critical aspect is involvement in decision-making. It is probably much harder to achieve support after a decision is made, than if one involves people on forehand. It is typically argued by HR managers that union representatives and management groups below Group level also should take part in the decision-making process. As pointed out by one of the HR representatives, such involvement does not need to take much time.

Furthermore, the theory implies that involvement is especially important towards groups of employees that are likely to be opponents (2.2). The findings reflect that this could be employees working in operational roles where short-term delivers are main focus. These groups probably perceive the generic nature of the UN GC principles as distant. In addition, the empirical analysis suggests that employees working towards external stakeholders will most probably see potential benefits more easily. One concrete recommendation could be to use people in procurement or sales roles as part of a support coalition (2.1.2) in order to convince key personnel in roles that intuitively not regard the initiative as important.

### 5.2 Recommendations and implications for managers

The core message from the analysis is that risk of resistance is probably high when it comes to a sustainability initiative such as UN GC because people will have difficulties grasping relevance and benefits. Therefore, establishing concrete objectives seems to be crucial. In addition, the process of developing such goals is regarded as an important way of involving employees. This could also be an efficient way of reducing the sense of bureaucracy and mitigating organizational barriers.

Furthermore, the following suggestions would aid managers when implementing a sustainability initiative:

- Identify and formulate linkages to existing policies before introducing it to the rest of the organization.
- Involve employees early in the process and ensure that real influence on performance targets and overall objectives is possible.
- Include implementation tasks in performance assessment and appraisal of managers and key employees.
- Relate new activities to existing tasks and work processes at different levels in the organization for instance within HR, HSE and QA.

### 5.3 Evaluation of the change management framework

The framework of Krüger (1996) was chosen because of its prescriptive nature, which makes it useful for managerial recommendations. However, some inherent weaknesses should be reflected upon.

A strength, but also a weakness of the applied framework, is its generic nature. Krüger (1996) points out that type and depth of change will influence how the framework can be used. However, there exists little guidance regarding which factors being important and how the framework can be adjusted to the case at hand. An issue which could be criticized is thus practical applicability. A central point is that the framework in many ways requires that every type of change projects should follow a linear process of integration starting with value-based integration. Therefore, a challenge emerges when the

change at hand is intertwined with other ongoing processes or policies. It is then difficult to determine if change processes have already started or if it is necessary to start with activities related to “unfreezing” the organization.

Another aspect giving practical challenges is that the different forms of integrations should be conducted in stages. For example, value-based integration should be completed before group-based integration is targeted. Even though the framework proposes relevant tasks for the different stages, there exist few guidelines when it comes to assessing when a certain stage is completed and when it is natural to continue to the next phase.

Despite of its limitations, the key concepts of the framework seem applicable in the case at hand. Most importantly, utilizing such a framework gives structure to the discussions, which again makes it less challenging to deduce managerial recommendations.

## 6 CONCLUSION AND FURTHER RESEARCH

The purpose of this paper was to analyze how managers can achieve sustainable value creation. In the case of the sustainability initiative UN GC, the first necessary step is to evaluate ambitions and motivation for spending resources on such activities. Given such an analysis, the important task for managers is to communicate practical relevance, and to develop incentive systems so that people are rewarded for spending time on new activities. This is probably the most important aspect in order to create value from a sustainability initiative such as UN GC.

It is important to note that UN GC is one of many policy frameworks to which a company can commit in order to increase their sustainability performance. UN GC facilitates incremental change processes and contributes to organizational innovations. However, despite good intentions many companies fail to integrate the UN GC principles in their management systems and daily operations. An overall research topic could thus be on how sustainability challenges imply change management in order to reach strategic objectives. More specifically, further research could be conducted on implementation and certification of environmental management systems according to international standards, and related effects on core activities and organizational dynamics in a company.

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# ENGAGING SUSTAINABILITY – A MULTILEVEL APPROACH TO STRATEGIC SUSTAINABILITY CHALLENGES

Carl Brønn<sup>1</sup>, Michael von Kutzschenbach<sup>2</sup>

<sup>1</sup>Department of Economics and Business, Norwegian University of Life Sciences

<sup>2</sup>Institute for Information Systems, University of Applied Sciences Northwestern Switzerland

## ABSTRACT

“Sustainability” challenges the limits of human decision making capability but managerial prescriptions and recommendations for sustainability are mostly based on simplifying disciplinary assumptions that reduce the complexity of the challenge that organizations face. This limits the effectiveness of organizational initiatives for change. A deeper appreciation of the problem context is required. When is coupled with a process-oriented problem structuring methodology and a learning-based approach to innovation, this can result in organizational strategies that are both more effective and that ensure organizational flourishing. This paper describes an engagement process that is based on three elements: an inquiry and structuring process based on Aristotelian causality, the use of systems thinking for analysis and communication, and an innovation process based on the logic of effectuation. Aristotelian causality is the foundation of the engagement process and links systems thinking and effectuation in a natural way. The organization’s learning culture is shown to be a key element in the engagement process.

*Key words: Learning, effectuation theory, sustainability, innovation, wicked problems, problem structuring*

## 1 INTRODUCTION

The years following the publication of Rachel Carson’s *Silent Spring* [1] saw a dramatic increase in regulatory and institutional structures designed to address the environment. Establishing emission standards and having enforcement power dramatically improved the environment in almost all parts of the world. Reliance on rules and regulations are examples of a command and control policy that has resulted in improvements but which also had unintended outcomes. One is that the focus on emission standards contributes to a technology-based approach to environmental management which has the effect of creating a belief that technology can solve all problems. The second consequence is that it has encouraged a reactive mindset in organizations. Firms’ environmental strategies are designed to meet the letter of the law, but not necessarily the spirit in which the laws were intended.

The book “*Our Common Future*” [2] introduced the concept of sustainable development to a broader public. The definition offered by book, “... development that meets the needs of the present without compromising the ability of future generations to meet their own needs,” was inspirational, but did not provide a solid basis for action. Unlike easily collected physical measurements of emissions and energy consumption, terms such as poverty and intergenerational equity are characterized in many different ways, some of which conflict with each other. The playing field may have changed but the rules remained the same. The essence of the sustainability challenge was well captured by Schön[3], “*In the swampy lowland, messy, confusing problems defy technical solution. The irony of this situation is that the problems of the high ground tend to be relatively unimportant to individuals or society at large, however great their technical interest may be, while in the swamp lie the problems of greatest human concern.*”

This quotation highlights that the challenge for incorporating “sustainability” into society’s efforts to improve the human condition will require a shift in focus away from the established ways of thinking. Sustainable development has influenced the development of alternative performance measurement systems. For example, the triple bottom line [4] and similar frameworks were developed to capture

sustainability's three traditional dimensions – economic success, environmental protection, and social responsibility. Although a “sustainable” organization was seen to be one that managed to balance all three concerns, [5] points out that reducing unsustainability is not the same as sustainability.

Internally, organizations also face challenges. These come from several sources: employees have a desire for a “better world” and want to orient their organizations in this direction and “green imperatives” from upper management. These are confronted with powerful obstacles such as established organizational values that reject change, accounting systems that disregard externalities, reward systems that are tied to quarterly profits, and the ongoing reality of meeting the bottom line (see [6]).

In the control perspective, managerial prescriptions and recommendations for achieving sustainability are based on simplifying assumptions regarding the business context. In this view, the outcome is a known and generally agreed upon set of performance measures. The management question is how to best achieve the desired effects given the selection of possible means. “Sustainability” stretches the limits of human decision making capability and policy makers often retreat to their disciplinary roots for guidance, overlooking potential synergisms with other disciplines [7]. An alternative approach for the sustainability awareness-driven business environment is based on the idea that the future can be created. Thus, traditional control is not applicable [8]. The approach uses the logic of effectuation and concentrates on using available means to create possible outcomes. It is the logic of innovation and offers a more effective way to engage with sustainability issues.

While implementing traditional initiatives for improved environmental performance is better than doing nothing, we argue that a deeper appreciation of the problem context is required. In the following we present an approach to engagement that draws from multiple disciplines and effectively uses the organization's learning capabilities to develop more innovative, high leverage initiatives to improve organizational sustainability performance.

## 2 THE CONTEXT OF SUSTAINABILITY

Sustainability has no single disciplinary foundation. Although most of the work in sustainability comes from either economics or ecology, which derives from the same linguistic root, much of the thinking about how to “do” sustainability is locked into an “either-or” mindset. Initiatives such as certification, information systems, and technical improvements to existing processes dominate the set of options that are considered. Some of these are required by law, others are driven by shareholder demands, but they all represent a reactive attitude on the part of the organization. These activities are important and have resulted in significant improvements, but they have relatively low leverage [9] and are insufficient to meet future expectations.

### 2.1 What is a “problem”?

“Problems” do not have a life of their own. They are artificial constructs; there are only situations or conditions. In order for a “problem” to exist there must be some sort of reference point against which to compare the current situation with some desired or expected condition. The desired conditions reflect the aspirations and expectations of the stakeholders who are involved in the situation. As a consequence of multiple perceptions, there may also be differences regarding the significance of the size of the gap, or even if the condition is important. A current example can be found in the debates surrounding the existence (or non-existence) of human-caused climate change.

There are many possible explanations for such disagreements, including ideological ones [10]. Fundamentally, they are all based in the concept of the mental models of the actors who are involved with the situation. People are sense-makers [11] who attempt to create understanding through using mental models, or small-scale cognitive constructs of reality [12] that are employed to make sense of real-world situations and to anticipate events in the world.

### 2.2 “Wicked problem” characteristics and sustainability

The concept of sustainability and its implications are arguably the most difficult and problematic issues facing society today. “Sustainability” is an ill-defined problem. Rittel and Webber [13] formally described a class of ill-structured problems as “wicked” and identified ten characteristics of wicked problems. The criteria that are most relevant for sustainability include 1) there is no definitive problem definition, 2) there is no stopping rule, the process is on-going, 3) there are no right or wrong solutions, only good or bad ones, 4) the problems are essentially unique, 5) the “problem” can be

explained in many different ways, which influences the choice of methodology, and 6) due to complexity and interrelationships, every problem is a symptom of another problem.

### 3 A FRAMEWORK FOR ENGAGEMENT

Despite the “wickedness” of the context, it is possible to navigate through this environment as well as to improve the situation. The common element in this process is Aristotelian causality. It is central in structuring the context and is related to both systems thinking and innovation. In the following section we argue why a hierarchical approach for structuring, systems thinking for analyzing and communication, and effectuation theory for innovation are necessary elements of a framework for engaging sustainability.

#### 3.1 Structuring with Aristotle’s four causalities

The American engineer C.F. Kittering stated that “a problem well stated is a problem half answered.” Formulation imposes a structure on the decision context that translates the initial conditions into a set of problems, causes, and questions [14] that are required to implement an appropriate methodology. The literature on problem structuring is extensive (for example, see [15], [16]). We apply the hierarchical approach suggested by Braman’s [17] and the notion of Aristotelian causality to structure our understanding of sustainability.

While the questions of inquiry and methodology are rife with philosophical and epistemological questions [18], these are of little direct concern to organizations concerned with the practical challenge of meeting demands for more sustainable behavior. Braman [17] proposed a hierarchical approach to structuring the concepts of “information” as a guide for policymakers. Information also suffers from a definitional dilemma that complicates the task of developing an information regulatory regime [17, p. 234]. Sustainability has an analogous challenge. Using a very narrow definition necessarily excludes many issues that are irrevocably connected. This leads to overly simplistic, low leverage initiatives. This approach can favor one disciplinary perspective over others, some of which may be more effective than the chosen perspective’s recommendations. Essentially, the process can become politicized, for example see [19].

The issue of sustainability and the organization’s responsibilities with respect to it may be understood at many different levels. A key question that decision makers should reflect upon is “Why?” What is the purpose of what is being done? The question is important because how it is answered guides the selection of methodologies employed to address the situation. An organizational sustainability inquiry process must support multiple levels of insight. Each level of perception, ranging from the real world of hard measurement to the level of human aspirations and goals, yields different insights and suggests different courses of action. The Aristotelian philosophical approach to the question of “Why is something the way it is?” provides a framework for integrating the components of organizational engagement with sustainability.

According to the Aristotelian tradition, there is only a single answer to the “why” question but there are several different approaches to getting at it. These have been identified as:

- Material cause – natural capital: an objects focus in the material domain.
- Efficient cause – processes: a subject-objects focus in the material domain.
- Formal cause – design: a subject-subject focus in the relational domain.
- Final cause – intent: a transpersonal focus in the relational domain.

#### 3.2 Systems thinking for analyzing and communicating

Systems thinking is the art and science of linking *structure* to *performance*, and *performance* to *structure* – often for purposes of changing *structure* (relationships) so as to improve *performance*. Systems thinking consists of a *paradigm* and an associated *learning methodology*. Systems thinking seeks to change the way in which decision makers structure and explore their understandings of the problem situation. It is based on the concept of feedback and is a framework and methodology for becoming more aware of the full range of consequences of the actions under consideration, and for finding high leverage action points [9].

There are two main reasons for considering systems thinking. First, interdependencies are becoming increasingly difficult to ignore. These exist at all levels. Second, as webs of interdependencies among

systems expand, the likelihood of any action having *unintended consequences* increases, as does the ramifications of those consequences in both space and time. The more unintended consequences that are generated by an action, the less likely it is that the *intended consequences* of the action will be achieved. Another common effect of attempting to change a complex system is *counter-intuitive behavior* [20] where the system does not perform as expected by the policy maker.

The systems thinking perspective requires that we shift our focus from the detailed “things” that make up the system to considering the relationships among the system’s components [21]. The “pushed back” portion of the multiple level vantage point causes three shifts in viewing orientation: 1) from seeing either/or to seeing continuity, 2) from seeing differences to seeing commonalities, and 3) from seeing events to seeing patterns. This shift is significant; rather than focusing on the specific differences inherent in the pieces, the “natural” way, we see the generic nature of relationships. And although the attention is taken away from specific events, they now become interesting within a longer-term pattern of behavior.

### 3.3 Acting through effectuation

Increasing pressures for organizations to become more “sustainable” presents a fundamental challenge to the institutionalized idea of management as control. A decision problem consists of effects and means, where the effect is the operationalization of an abstract human aspiration [22, p. 245]. The means are the ways in which the effect can be realized. Traditional decision-making represents a process of causation where the effect is given and the focus is on selecting the best means to achieve it. This decision function is a mapping of many means to a single effect.

An alternative decision logic, effectuation, is based on the notion that the effects are not given a priori but are a set of operationalized general aspirations. The means are identified by the characteristics or circumstances of the decision-maker [22, p. 249]. The essential difference between the logic of causation and the logic of effectuation lies in the view of the future. From the causal perspective the future is seen to be a continuation of the past and can be predicted. The effectuation view sees the future as a function of the actions of willful agents. In effect, this is the notion of creating the future and taking the actions required to realize it. In this framework, structuring is the critical step because it sets the stage for all subsequent activities. The causality approach to problem-solving is to assess a number of means with respect to their ability to achieve a desired effect. Effectuation logic [23] starts with an assessment of the means and considers the question of what set of possible effects (outcomes) can be created with them.

Aristotelian causality has a natural connection with the decision-making approaches described by causation and effectuation. While significant improvements in the environment have been achieved through technical achievements, these advances are the consequence applying a causation-based decision approach. Initiatives linked to the material domain also include institutional and regulatory programs of taxation, standard settings, and oversight agencies. The implicit objective is to continue economic growth. The question is how best to accomplish this; questions of this type are linked to Aristotle’s material cause and efficient cause. Both of these are based in the material world of objects (material cause) and processes (efficient cause). With respect to sustainability, these are necessary but not sufficient conditions.

Engaging with sustainability in an effective manner will require that more emphasis be placed on the redefinition of goals (formal cause) and paradigms (final cause). This will automatically result in changes in the material domain. The reverse is not always the case – more fuel-efficient cars have not changed the underlying attitude towards personal transportation. Ehrenfeld [5, p. 13] claims that we need “a shift in our consciousness and in the language we use to give meaning to the incoherent signals the world sends our senses.” Using the hierarchy of Aristotelian causality helps us to conceptualize sustainability in a manner that includes the beliefs, values, and aspirations of human beings. Aside from the current focus on nature (the mechanistic view), it is important to address the loss of caring and ethical behavior (the relational view) that makes the human species distinct. Aside from the current focus on nature (the mechanistic view), it is critical to address the loss of caring and ethical behavior (the relational view) that makes the human species distinct. Greater focus on the formal and final causes will contribute to making responsible and ethical decisions that develop more sustainable habits and mindsets.

## 4 DISCUSSION

#### 4.1 Engaging sustainability - Integrating multi-levels of sustainability

Vanasupa et al.[25] made the linkage between systems thinking and Aristotelian causality explicit. Figure 1 shows how the four causalities are related to the systems thinking skills of discerning events, patterns, structuring, mental models, and vision.

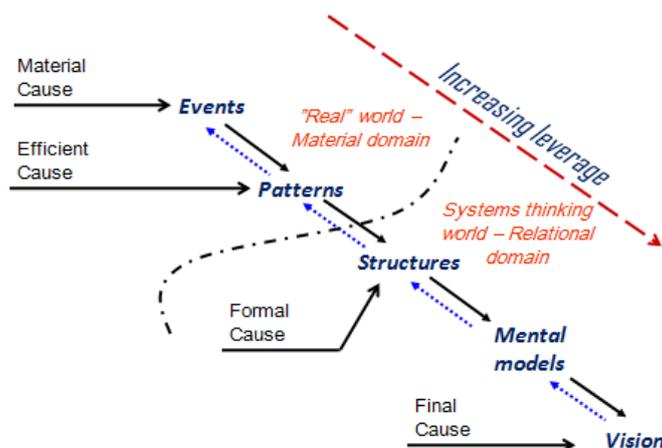


Figure 1. Engaging sustainability framework

Sustainability can be approached by two modes of thinking -causation and effectuation. Sustainability as causation is shown by the solid arrows between the levels and begins with the current situation at the level of events and seeks to develop the underlying systemic structure that generates this behavior. In this way, the underlying mental models associated with the unstated paradigm can be revealed and the assumptions upon which it is based may be tested. This approach is applicable to the material domain because it is based in the consequences of the current situation. Sustainability as effectuation, shown by the dotted arrows, begins with a vision of desired end states and works through the new paradigm to the design of new structures that will result in observable conditions that are desired.

While much of the effectuation literature is focused on the individual entrepreneur, our interest is in leveraging individual entrepreneurial energy in an organizational context. The process is completed by emphasizing the learning aspects of the engagement activities. Individual and organizational learning are the most essential skills and capabilities that an organization can develop and is a prerequisite for effective organizational performance.

Senge [24] identified three skills for working with mental models. *Reflection* is a personal skill where the decision maker works consciously to maintain a critical attitude towards his or her own mental models. *Inquiry* involves interacting with others and is the act of attempting to understand other actors' mental models. *Advocacy* involves making explicit the stakeholder's reasoning and evidence in support of a desired course of action. Consequently, the emphasis in structuring should be dialogue based and focused on the "Why?" question when exploring the stakeholders' mental models.

#### 4.2 An organizational learning culture perspective

Effectuation theory is concerned with understanding the nature of entrepreneurial expertise and the object of focus is the individual and associated attributes [23]. Making effectuation happen in an organizational context requires a willingness to make changes in how the organization is managed. A firm's learning orientation is the most important aspect that influences organizational effectuation [26]. Associated with the learning orientation, an expression of the organization's learning culture, are a set of facilitating factors. These describe the structures and processes that influence the difficulty and quality of the learning that does occur.

An effectuation-based approach to innovation is supported if the firm's learning style is compatible with the characteristics of the effectuation process. In Table 1, the effectuation process elements [15, p.15] are linked with the factors that characterize an organization's learning environment.

In addition to the learning culture, the success of the effectuation process depends on the ability of the innovator to build a network of committed stakeholders. Organizations are designed and function according to formal structures and processes but are also comprised of individuals who develop

informal social networks. This creates a shadow organization that functions in the background of the formal structure. The interaction of formal and informal networks influences the learning ability of individuals as well as the organization as a whole.

The dynamics inherent in formal and informal organizational structure provide a context that both facilitates and constrains the exchange of information and organizational learning processes in the organization [27]. However, successful organizational effectuation requires a clear picture of the organization's capability to enable cross-border collaboration and to foster the possibility to develop and test ideas that are not directly linked to daily business activities.

*Table 1. Combining learning culture and elements of the effectuation process*

<i>Effectuation process elements</i>	<i>Organizational learning culture elements</i>
Entrepreneur's self-assessment	Skill development focus Involved leadership
Focus on possibilities rather than what ought to be done	Climate of openness Concern for measurement Experimental mindset Multiple advocates Systems perspective
Stakeholder selection – self-selection based on making commitments	Documentation mode Dissemination mode
Increasing commitments implies new means and goals for the venture	Systems perspective Climate of openness
Network growth increases access to resources but also increase constraints on changes and recruitment	Climate of openness Continuous education
Assuming stakeholder accumulation process does not abort the venture, goals and network converge to form new market and a new firm	Experimental mindset Operational variety Learning focus Multiple advocates Value chain focus

## 5 CONCLUSIONS

The business environment has expanded from the relatively simple forces of the marketplace to one that is significantly influenced by many non-traditional stakeholders and processes. The underlying driving forces of these challenges require that business managers adopt both a broader and more sensitive attitude to the world outside the immediate competitive environment. In order for organizations to interact effectively with the wicked problem of sustainability, the initial step of developing an understanding of the context becomes important.

The four Aristotelian causalities provide guidance in this aspect of engagement. Previous work in environmental management has focused attention on the causalities in the material world. The important limitation of the answers to the “Why?” question at this level is that they do not address the underlying paradigm that guides behavior. In this sense, the material causalities correspond to incremental learning. The relational level causalities provide deeper answers to the “Why” question. Effectuation-based innovation enables decision makers to assess their capabilities and to design a future that can be achieved with them. This may entail challenges to established ways of perceiving and acting but can result in developing significantly higher leverage initiatives for change. These initiatives are also more difficult to develop and to implement as they require behavioral change at the personal level.

Systems thinking is both a methodology for analysis (performance) and a communication tool (meaning). The methodology is especially useful in situations where there may be different understandings of the causes of problematic behaviors that are being experienced. The tools of systems thinking enable policy and decision makers to operationalize and experiment with the many

possible answers to the questions generated by applying Aristotelian inquiry to the organization's engagement with sustainability.

In the effectuation perspective, an important innovator attribute is access to others. The scope of the innovator's personal network influences the process of innovation by providing access to others with relevant means to support the innovator. Organizations concerned with innovative engagement with sustainability issues have to establish the internal conditions that enable the entrepreneurial employees to develop themselves. A requirement for this type of performance is enabling employees to leverage their aspirations and skills in support of a vision of sustainability. These are the conditions that influence the organization's learning culture. The attributes of the learning culture, operationalized through learning orientations and facilitating factors, significantly influence the ability for individuals to engage in effectual thinking.

Finding the balance between the need for a requisite degree of coordination and control (performance) and simultaneously supporting an organizational environment of inquiry and experimentation (meaning) will be difficult. It is important to recognize that there are no solutions to sustainability in the commonly understood sense. As a wicked problem, there are no stopping rules. The organization interested in a meaningful commitment to working with sustainability must recognize that this will be an on-going process that is dependent on the internal organizational environment being alert to supporting a culture of inquiry, experimentation, and learning. Traditional economics-based approaches will still play a role, but other approaches based on discourse and mutual learning offer better prospects for engaging a broader set of stakeholders in this common challenge.

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# STRATEGIC COLLECTIVE SYSTEM BUILDING TO COMMERCIALIZE SUSTAINABILITY INNOVATIONS

**Julia PLANKO<sup>1</sup>, Jacqueline CRAMER<sup>2</sup>, Marko HEKKERT<sup>2</sup> and Maryse CHAPPIN<sup>2</sup>**

<sup>1</sup>HU Business School Utrecht and Utrecht University; e-mail address: julia.planko@hu.nl

<sup>2</sup>Utrecht University, Copernicus Institute of Sustainable Development

## ABSTRACT

The implementation of innovative sustainability technologies often requires far reaching changes of the macro environment in which the innovating firms operate. Strategic management literature describes that firms who want to commercialize an innovative technology can collaborate in networks or industry clusters to build up a favourable environment for their technology. This increases the chances of successful diffusion and adoption of the technology in society. However, the strategic management literature does not offer advice on how to strategically build up this supportive external environment. We fill this gap with complementary insights from the transition studies literature. We introduce the concept of strategic collective system building. Collective system building describes processes and activities networks of actors can strategically engage in to collectively build up a favourable environment for their innovative sustainability technology. Furthermore, we develop a strategy framework for collective system building. To underpin the theoretical analysis empirically, we conducted a case study in the Dutch smart grids field. The resulting strategy framework consists of four key areas for strategy making: technology development and optimization, market creation, socio-cultural changes and coordination. Each of these key strategic areas is composed of a set of system building activities.

*Keywords: System building, technological innovation systems, strategic collaboration, collective strategy, sustainability innovation*

## 1 INTRODUCTION

Society-wide replacement of polluting technologies with alternative sustainability technologies enables consumers to maintain decent life-styles without destroying the planet's ecological capacity for future generations. Therefore, sustainability technologies play an important role for sustainable development [1]–[3]. Sustainability technologies are technologies which enable more efficient use of resources, less stress on the environment or even cleaning of the environment [4], [5]. Many new technologies to solve or mitigate sustainability challenges have already been invented. However, their market implementation often fails – even if their performance may be superior to incumbent technologies [6]. Actors who come up with radically new sustainability technologies have a hard time to further develop their solution and to launch it on the market, because competing established technologies are widely supported by the socio-technological regime within which they have evolved [7], [8]. Moreover, the adoption of the new sustainability technology sometimes requires inconvenient changes in consumption patterns, without offering additional functionalities to the consumer [1], [2]. To overcome these obstacles and to enable wide diffusion of sustainability technologies, significant socio-cultural, economic and legislative changes are required [9]. The active engagement of a wide-range of public and private actors is necessary to achieve these changes [10], [11]. Among these actors, the driving forces of the transition process are often entrepreneurs and entrepreneurial managers who develop and diffuse sustainability innovations [12]. To increase the chances of success of their technological innovation, they can - in collective efforts - try to achieve changes in the macro-environment which are supportive of the implementation and user acceptance of their technology [13]. Strategic management literature describes the need of innovative actors to strategically collaborate to shape their environment. Several authors suggest that firms collaborate in networks or industry clusters in order to compete with alternative technologies. Next to investing in their own development, they need to invest in the development of the business ecosystem in which they operate [13]–[17]. In

collective efforts they can create a favorable environment in which their firm can thrive. However, the strategic management literature does not offer advice on how to strategically build up this supportive external environment. We attempt to fill this gap with complementary insights from the transition literature.

Whereas the strategic management literature takes on the perspective of the firm, the transition literature analyses socio-technological change from the systems perspective. The transition literature field has generated various conceptual frameworks to analyse and stimulate the dynamics of socio-technological transition processes<sup>1</sup>, one of them the technological innovation systems framework [18]–[23]. This framework has generated valuable insights into the processes and activities innovative actors need to engage in to build up a favourable environment for their technology to flourish in. This activity has been coined ‘system building’ [24]. We introduce the term ‘collective system building’ to describe processes and activities networks of actors can strategically engage in to collectively build up a favourable environment for their innovative sustainability technology.

The objective of this paper is to combine insights from the strategic management literature and the transition literature in order to provide a strategy framework for entrepreneurs and entrepreneurial managers to collectively build up a favourable environment for their sustainability technology. Networks of entrepreneurs and entrepreneurial managers who engage in strategic collective system building can use this practical framework to generate system building strategies. The combination of these two literature strands will result in a strategy framework which considers the system level as well as the firm level. Our framework for strategic collective system building therefore contributes to both literature fields. To design a practical strategy framework for system building entrepreneurs and entrepreneurial managers, we focused on two research questions. First, which system building activities can entrepreneurs and entrepreneurial managers engage in to build up a favorable environment for their technological innovation? Second, how can these activities be compiled into a practical framework which can be used for strategic collective system building? To answer these research questions, we reviewed the literature on technological innovation systems with regards to system building and complemented it with insights from strategic management and transition studies. We further conducted a case study in the Dutch smart grids field to underpin the theoretical analysis empirically.

## 2 THEORETICAL BACKGROUND ON STRATEGIC COLLECTIVE SYSTEM BUILDING

System building is defined as “the deliberate creation or modification of broader institutional or organizational structures in a technological innovation system carried out by innovative actors. It includes the creation or reconfiguration of value chains as well as the creation of a supportive environment for an emerging technology in a more general way.” [24] System building can be driven by a single, powerful actor [25], but more often it is carried out as collective effort of a network of actors [13], [26].

We introduce the term ‘collective system building’ here to emphasize the collective nature of strategic system building carried out by networks of entrepreneurs and entrepreneurial managers, with the aim to commercialize their innovative sustainability technology.

The technological innovation systems (TIS) literature has generated valuable insights into the processes of system building [23], [24]. A technological innovation system contains all components that influence the innovation process for a newly emerging technology. The TIS field is concerned with the key processes in an emerging technological innovation system [27]. ‘Functions’ are these dynamic key processes which take place in the emerging innovation system, triggered by activities of system actors or actors outside the system [21], [27]. An overview of all functions is given in Table 1. Each key process contributes to building a favourable ‘business ecosystem’ around the new sustainability technology. Moreover, the interactions between system processes accelerate the emergence and growth of an innovation system in virtuous circles and thereby increase chances of market success [19], [22], [26], [28].

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<sup>1</sup> Socio-technological transitions are major changes in technological, organizational and institutional terms on both the production and consumption side, triggered by the innovation of a radically new technology. The implementation of the new technology in society entails the introduction of new services, business models and organizations [10].

*Table 1: Key processes for building up a technological innovation system*

<b>TIS framework key process:</b>	<b>Description of activities:</b>
F1: Entrepreneurial experimentation	Testing of new technologies, applications and markets, social learning processes
F2: Knowledge development	Learning activities such as research and development and learning in a practical context
F3: Knowledge diffusion	Stimulating knowledge exchange through conferences, workshops and alliances inter-companies but also between government, companies and the market
F4: Guidance of the search	All activities and events which make actors decide to enter the respective TIS or to further invest into it
F5: Market formation	Creation of temporarily protected niche markets through favourable tax regimes, minimal consumption quotas, environmental standards or creation of demand, e.g. through government procurement policies
F6: Resource mobilization	Financial and human resources need to be mobilized to enable the build-up of the innovation system (monetary or in-kind)
F7: Creation of legitimacy	Counteract resistance to change; Lobbying to create legitimacy of the new technology, to put the technology on the political agenda, and for favourable tax regimes

Based on: [18], [19], [21], [22], [28]

Several versions of the TIS framework can be found in the TIS literature. Depending on the respective author, the TIS framework has 7-9 functions. The core processes described are displayed in above table. Recently, Musiolik and Markard stated that the coordination of actors and activities along the value chain is a key process which enhances the overall functioning of the innovation system, which 'has not been mapped yet' [26]. For strategic collective system building the coordination of activities is of major importance. Therefore, we incorporate it into the development of a strategic framework for system building.

The TIS framework gives a comprehensive overview of system level processes. It has been developed and tested for its use by policymakers, who intend to support the development and diffusion of an emerging sustainability technology by stimulating key processes at the system level through policymaking. However, the TIS framework can also be used by networks of entrepreneurs who want to collectively build up a supportive environment around their new technological sustainability innovation. Since the TIS key processes take place at the system level, but firms operate on the micro level, the TIS processes have to be broken down into strategic activities which can be carried out by firms. To bring in the firm perspective, we complement the TIS framework with insights from strategic management literature. We start describing what is mentioned in the strategic management literature with regards to (i) the role entrepreneurs play in the process of sustainability transitions, (ii) how entrepreneurs can build up a supportive infrastructure around their technological innovation and (iii) entrepreneur's collaborative efforts to improve the business ecosystem or industry cluster they operate in.

Entrepreneurs and entrepreneurial managers<sup>2</sup> can be significant drivers of a transformation to more sustainable development. Through the actions of entrepreneurs sustainable products and processes can be developed and implemented in society [12]. Entrepreneurs can become change agents pushing for sustainable economies and societies. Taking on a systemic perspective, understanding that their companies co-evolve in an emerging system while creating value, entrepreneurs can become leaders and innovators in the sustainability transformation [29].

Van de Ven's theory of an 'entrepreneurial infrastructure' defines how entrepreneurs who want to implement an innovative technology need to build up an entrepreneurial infrastructure together with other businesses of their industry sector. Entrepreneurs have to develop their own innovation and make their individual business strategy, but at the same time they need to collaborate strategically with actors along the supply chain, including direct competitors, to build up a supportive infrastructure which will foster a fast diffusion of their technology. Elements of this entrepreneurial infrastructure

<sup>2</sup> Entrepreneurial managers are managers who work for an incumbent company but try to diversify its business to reap new business opportunities in new markets. Both entrepreneurial managers and entrepreneurs of small start-ups are interested in commercializing the new technology and creating a favourable environment. Therefore, in the course of the paper, when we use the term entrepreneurs we also refer to entrepreneurial managers.

are: Market consumption, institutional arrangements, resource endowments and proprietary activities.<sup>3</sup> [13]. Collaborating ('running in packs') with competitors will increase the likelihood of their technology to be successful [13], [30]. Individual entrepreneurs need to understand that they do not have the resources, power or legitimacy to produce change alone. They need to become 'nodes in value chain networks' and compete as network against other networks [30]. Building up a supportive system around their new technology and collectively striving for change towards a new technological regime are essential elements of 'collective system-building'.

In the strategic management literature, the term 'business ecosystem' is used to describe the economic and social landscape which an individual business is part of and in which it co-evolves together with other businesses. A business ecosystem is a business network that goes beyond the supply chain of the focal company. It consists of all individuals with whom a business interacts. It comprises suppliers, technology producers, customers, competitors, producers of complementary assets, sellers, financial actors, governmental actors, media and regulatory agencies. It is impossible to draw precise boundaries of a business ecosystem [14], [15]. The analogy with a biological ecosystem is used to highlight the interrelatedness and interdependency of businesses in a changing environment. The healthiness of the ecosystem determines the success and survival of the individual firm [15]. The key to a successful ecosystem is a network of mutually beneficial relationships with other ecosystem actors. Organizations need to intelligently co-evolve with their overarching business and social environment. Especially with regards to innovation, a strong collaboration with customers and supplier partners is essential; as well as the good management of a wide network of organizations that co-evolves together [14]. Iansati and Levien predict that for technology innovating firms, competition will take place between business ecosystems or business ecosystem domains, rather than in individual rivalries. Business strategies need to go beyond the firm's individual strategy. They need to consider the networked environment in which the company operates [15].

Pitelis describes that some entrepreneurial managers collaborate in networks or clusters and engage in 'inter-firm collaboration' to co-create markets of ecosystems, with the goal to capture value from resulting business opportunities. They collaborate when they perceive the potential for value capture higher than from stand-alone activities [16]. The description of their co-creation of a supportive ecosystem matches the concept of 'collective system building'.

Astley also takes on a systemic viewpoint. He uses a 'social ecology approach' and argues that businesses should not regard the environment they operate in as 'intractable externality' to which they are exposed and merely react on. In contrast, they should realize that they are component parts of their environment, and through interaction with each other create resources and institutions which generate opportunities and threats for organizations. In order to pro-actively manage organization-environment relationships, he advises businesses to generate strategy at the collective level (in addition to their individual business strategy). He defines collective strategy as "the joint formulation of policy and implementation of action by the members of inter-organizational collectivities" [17]. Collective strategy guides inter-firm networks to the collective mobilization of resources and actions oriented towards the achievement of a common goal [17]. Astley describes two important elements of collective system building. First of all, the fact that companies do not merely react on changes in their environment, but that they can actively shape it. Second, companies need to formulate strategies at the network level in order to shape their environment.

In the same line of thought, Davenport et al. argue that today's fast-paced innovation economy requires a new strategic management mind-set, approach and toolbox. Companies need to abandon the idea of individual competition, and instead understand that they need to compete in clusters against other clusters. They need to take on a holistic view of the business ecosystem in which they operate and co-evolve their knowledge and capabilities with peer businesses. Instead of individual growth, they need to focus on holistic value creation through collaboration in business networks [31]. Such holistic collaborative value creation requires 'network orchestration', management at the network level. However, a high degree of competition amongst collaborating network members remains. This competition-collaboration in networks requires tailored management strategies [32]. The concept of cluster competition, the holistic view of the business ecosystem and the collaboration in networks with a remaining degree of competition are important elements of 'collective system building'.

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<sup>3</sup> Market consumption include norms, market creation; Institutional arrangements refer to laws, regulation, legitimation; Resource endowments are science, technology, financing, competence training; Proprietary activities include product development, business functions, resource channels [13].

To summarize, the strategic management literature describes that entrepreneurs are important drivers of sustainable development by introducing sustainable products and processes in society. To develop and implement innovative sustainability technologies, entrepreneurs need to strategically cooperate in business ecosystems, in which they co-evolve and co-create value. Moreover, they need to change the environment in which they want to implement their innovation. This requires the build-up of a supportive technological system, which includes changing institutions and creating markets.

Both the technological innovation systems framework and the strategic management literature mention the importance for firms to collaborate and the need to build up a favourable environment around the new technology. However, concrete system building activities are hardly mentioned in the strategic management literature. The TIS literature mentions system building activities, but it is focused on the system perspective and system level changes, and the firm perspective is underrepresented here. Combining both literature fields therefore generates valuable insights into strategic collective system building for entrepreneurs and entrepreneurial managers who want to achieve system level changes, by carrying out strategic activities at the firm level.

### 3 METHOD

To find empirical evidence on system building activities, we conducted a single-embedded case study in the Dutch smart grids sector. This case has been chosen because it is an emerging technological field in which actors closely collaborate to build up a technological system. In-depths interviews have been carried out with 14 key actors of the field. All interviews have been transcribed and analyzed using Atlas.ti software. We used Grounded Theory's constant comparative analysis [33] to analyze the interviewees' responses. We coded the data according to categories as developed from the literature review. A number of system building activities were derived from the system building literature and tested during the interviews. We used the system building activities and processes described in the TIS framework as basis, and complemented them with insights from the strategic management literature. During the coding process, we added new codes when no pre-defined category was suitable. Then, we integrated categories and their properties. We juxtaposed the data from the new categories and compared them against the literature. The outcome was a set of system building activities, which entrepreneurs of the Dutch smart grid field perceive as important for strategic collective system building. The next step was to analyze the relationships between these activities and entrepreneurs' motivations to engage in these activities. We then clustered them into over-arching categories, based on the system building goal they contribute to. In an iterative process, we compared the findings from the interviews against existing literature on system building. The analysis revealed four main categories, to which system building activities can be assigned.

### 4 FINDINGS

Our research revealed 22 system building activities. Table 2 gives an overview of these activities. The seven 'functions' of the technological innovation systems framework needed to be broken down into system building activities, which entrepreneurs can strategically engage in. Entrepreneurs agreed that these activities are important for system building (column 3). Other system building activities have been identified in the research, which could be underpinned by strategic management literature (column 4); or by transition studies literature (column 5). A few system building activities were mentioned by interviewees to be important, but could neither be underpinned by strategic management literature nor transition literature (column 6).

The purpose of a strategy framework is to help managers and other decision makers to structure and organize information, based on which strategic decisions can be taken [34]. In order to draw up a practical strategy framework, which can be used by entrepreneurs and entrepreneurial managers for strategy making, we needed to cluster the system building activities. Clustering the activities into categories introduces to the framework a structure for organizing information. We clustered the system building activities according to the main system building objectives they contribute to. We analyzed our data with regards to which system building objective entrepreneurs had in mind when they carried out the respective activity. We then compared the resulting system building objectives with the literature on system building, to refine our clusters. Subsequently, we went back to the data and assigned the system building activities to these clusters. For example, entrepreneurs mentioned that they engage in knowledge development, diffusion and testing activities in order to optimize their technology. Comparing these findings with the literature, we concluded that one important objective

for system building is to develop and optimize technology. This is how the first cluster ‘technology development and optimization’ emerged. Applying this approach, we identified three clusters which represent system building goals: ‘Technology development & optimization’; ‘market creation’ and ‘socio-cultural changes’. Moreover, a range of activities were mentioned which entrepreneurs carried out with the objective to coordinate system building activities and thereby accelerate the process of system building. We clustered these activities into the category ‘coordination’. This category is not a system building goal in itself, but it facilitates and accelerates system building and therefore is another key area for strategic system building.

*Table 2: Overview of the findings – system building activities and respective literature fields they can be related to*

Cluster	System building activity	TIS framework based and considered important by interviewees	Stated by entrepreneurs and in line with strategic management literature	Stated by entrepreneurs and in line with transition literature	Stated by entrepreneurs; new to strategic management and transition literature
Technology development & optimization	Testing new technologies, applications and markets	x			
	Knowledge development	x			
	Knowledge exchange	x			
	Development of commercially viable products				x
	Co-creation of products and services	x			
Market creation	Feedback loops with user-groups				x
	Generate new business models				x
	Creation of temporarily protected niche market	x			
	Collaboration with government for enabling legislation			x	
	Collaborative marketing to raise user awareness		x		
Socio-cultural changes	Collaborative competition against other technology clusters		x		
	Creating new facilitating organizations				x
	Establishing collaboration-prone organizational cultures		x		
	Change user behaviour			x	
	Changing the education system			x	
Coordination	Generation of a skilled pool of labour			x	
	System orchestration				x
	Creating a shared vision	x			
	Defining a common goal		x		
	Standardization	x			
	Providing a platform for open innovation		x		
	Thinking in system building roles instead of company objectives				x
Creating transparency of all activities going on in the field				x	

## 5 ANALYSIS AND DISCUSSION

In this section we will discuss the above mentioned findings and relate them to the transition literature and the strategic management literature. We start with describing and discussing each cluster, and then deal with the respective system building activities.

Figure 1 visualizes the four key areas of strategic collective system building. The first pillar of strategic activity is “Technology development and optimization”. This field of strategic activity summarizes all activities that lead to the development and optimization of the new technology, including supplementary products and services. These activities are usually seen as core activity by actors who want to launch an innovative technology. The second category is “Market creation”. Many authors, especially management scholars, highlight the importance of market creation by push and pull

factors. If users are not aware of or interested in the existence of an innovative technology it will not succeed in the market, how optimized it may be. The third pillar is “Stimulation of socio-cultural changes”. Socio-cultural changes regarding changes in the mindsets of customers, producers and policymakers are often a necessary requirement for a new sustainability technology to be embraced by society. Furthermore, changes in the education system need to take place. These three pillars also represent goals of system building. The fourth pillar “Coordination” comprises all activities and processes that contribute to a better coordination of system building activities. It is visualized on a different level in Figure 1 (at the top of the pyramid), as it is not a goal of system building, but a facilitator and accelerator of the system building goals represented by the other three categories. Below each system building category and its system building activities will be described.

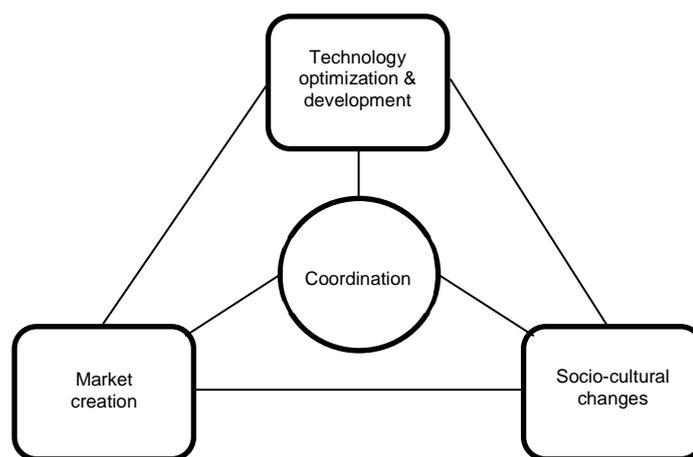


Figure 1: Strategy framework for collective system building by entrepreneurs

### 5.1 Technology development and optimization

A well-functioning and viable technology is the key component of a new innovation system. If the technology is faulty, all other system building activities may be in vain. Especially in the view of system building entrepreneurs, which often happen to be engineers, the development and optimization of the new technology can be expected to be the primary goal. Below we will briefly describe activities, which contribute to the development and optimization of the innovative technology.

The system building activities *testing new technologies, applications and markets, knowledge development and knowledge exchange* are derived from the TIS framework [21], [22], [35]. Entrepreneurs found these activities or processes very important. However, they remarked that from their perspective, the three activities were often overlapping and rather perceived as one activity. E.g. a shared pilot project simultaneously contributes to testing, knowledge development and exchange. With regards to strategy making, this finding highlights the importance of clustering the system building activities according to system building goals. The *co-creation of products and services* is mentioned in the TIS framework as well as in the strategic management literature, specifically the business ecosystem literature. Collective development efforts stimulate complementarity of products and services and cost-effectiveness; thereby the system as a whole is strengthened [14]–[16], [21], [36]. *Development of commercially viable products* emphasizes that while optimizing the functionality of the new technology, developers need to keep in mind the added value for the customer as well as the user-friendliness of their products and services. *Feedback loops with user groups* can be established as part of pilot projects or through communication platforms. In order to optimize technology, especially with regards to user-friendliness and user-acceptance, the cooperation with user-groups can deliver valuable information. This information needs to be captured and processed and used for further technology development. The last two activities are derived from the case study data.

### 5.2 Market creation

One of the main conditions for a new technology to be widely adopted is that there is a market for it [13], [30], [37]. Push and pull factors have to be considered for market creation [5]; producers have to

be supported and interest among potential customers needs to be raised. Especially for radically new technologies efforts have to be made to raise user awareness and demand [1]. Moreover, regulation needs to be adapted to enable and support the new technological system, and to allow market forces to come into play [5], [37].

The *generation of new business models* is necessary to allow the market forces to come into play and support the implementation of the new technology. Entrepreneurs stated that to make the technology commercially viable the market should be designed in a way that economic incentives are provided to those who have to make investments, change their user behaviour or switch over to the new technology. In order to design such stimulating business models which incentivize investments into the new technology and the change of user behaviour, the government would have to conduct regulative changes. The cooperation of private actors - who have the necessary knowledge - and public actors - who have regulative power - is necessary to draw up and enable feasible business models. To illustrate an example: In the case of smart grids, government regulations regarding the energy system have been designed many years ago for the incumbent central fossil fuel based energy system. They do not permit specific pricing mechanisms (e.g. real time pricing) which would allow companies to reap financial benefits from applying smart grid technology or stimulate users to change their behaviour.

Several authors from the transition studies field [8], [23], argue that the *creation of temporary niche markets* is an important measure for a new technological innovation to further develop into a technological regime. However, for the case of smart grids, several interviewees stated that more than the creation of nice markets, changes in the regulatory framework support the commercialization of the new technology. They indicated that temporary niche markets can keep in place the existing structures of the macro-environment which favour and strengthen the incumbent technological regime. However, they conceded that temporarily protected niche markets have proven successful for other innovative technologies. This finding shows that not all system building activities may be applicable for all technologies.

Most interview partners pointed out that the current legislation is one of the biggest obstacles to the introduction of the new technology. The national government plays a big role in creating a market for the new technology. It can adapt *legislation in order to support the implementation* of the new technology [9], [38]–[41]. Entrepreneurs who want to commercialize a sustainability technology should inform the government of the new technology so the government can design a supportive regulative framework [18]. Networks of entrepreneurs can lobby to convince governmental actors to put the support of the new technology on the political agenda [21].

All interviewed entrepreneurs acknowledged the importance of *collaboration with other system actors to raise user awareness and demand* for the new technology. Potential customers have to be aware that the new technology exists and that it delivers benefits. Consumers have a 'selective perception' and only pick up specific messages about products if they have basic knowledge about the product and its general functionalities [42]. Therefore, when marketing radical innovations, first a general awareness and understanding of the technology has to be generated. This first marketing phase can be conducted collaboratively by innovation system actors. This enables them to bundle their resources and achieve higher leverage effects [13], [30]. Once potential customers are aware of the new technology, companies can start individually communicating specific facts about and benefits of their own product or service.

Entrepreneurs were aware that if they want to achieve big-scale transitions, they have to collaborate in order to overcome the existing technological regime. Strategic management literature suggests that the actors of the new technological regime have to understand that they have to compete as a cluster (network of actors) against other clusters of alternative technologies [31], [43]. Firms who understand that they do not have to compete against their peers who develop a similar technology, but that they should *compete collectively against alternative technologies*, are able to create a bigger market for their product or service than they could create when competing individually. This bigger market can then be divided by the collaborating companies [36], [44], [45].

### 5.3 Socio-cultural changes

For the technological sustainability innovation to be widely adopted, it has to be embedded in society. System building entrepreneurs have to strive for changes in mind-sets of consumers and producers; they have to attempt to change values and norms in favour of the new technology. Entrepreneurs do

not have the means and the power to achieve socio-cultural changes individually. However, in collective efforts and in collaboration with the government they can trigger these changes. Considering the lengthy time horizons of socio-cultural changes, it is advisable to already start working on these changes very early in the system building process. The interviewed entrepreneurs acknowledged that socio-cultural changes are very important for the technology to be adopted, but that this area is yet often neglected. Some interview partners mentioned the inattention to required socio-cultural changes in the product development phase as one of the main obstacles to the success of technology implementation. These findings can be related to the strategic management literature as well as the transition literature. Hall and Khan state that even the most optimal new technology may commercially fail if it cannot be embedded in society [37]. The successful implementation of a radically new sustainability technology requires deep societal changes in different areas [9], [11].

The following activities can be carried out by entrepreneurs to trigger necessary socio-cultural changes. We start describing the activities which are underpinned by transition literature. Norms and values of users have to be changed for them to accept uncomfortable *changes in user behaviour* [46]–[48]. Furthermore, the *educational system* needs to be adapted to achieve changes in citizen's attitudes and to *generate a skilled workforce* [2], [29], [38]. In addition, intra-firm changes have to take place. This finding is underpinned by strategic management literature. Companies may need to *change the way they organize their business activities* and introduce a company culture which is prone to collaboration [49], [50]. Moreover, entrepreneurs mentioned the need for *new types of organizations* to be created. These new organizations can play a facilitating role in the emerging industry and support the long-term collaboration between firms in the industry.

#### 5.4 Coordination

The coordination of all system building efforts accelerates system building processes. Many actors are involved in system building, all with their own agendas and their own strategic plans. These actors make resources available for system building. The system as a whole benefits the most if the resources are bundled and efforts are aligned. Without coordination, individual efforts may evaporate. Whereas the system building categories described above represent system building goals, the activities clustered in this category work as accelerators and help to speed up system building processes and to achieve system building goals more quickly - or at all.

Musiolik and Markard have already argued that coordination along the value chain is an important key process for the development of an innovation system [26]. Our data showed that this was the case for the smart grid system as well, and that the interviewed entrepreneurs perceived it as very important. However, the analysis of the data indicated that activities aimed at system building coordination go beyond value chain coordination, but comprise more innovation system actors. Some of the system building activities are already mentioned in the TIS literature or can be connected to the strategic management literature. We will start explaining these activities, and then move to the new activities which emerged from our case study data and could neither be related back to the strategic management literature nor to the transition literature.

The *creation of a shared vision*, towards which the development of the system should move, and the *definition of a common goal* are important for the coordination of system building activities [18], [51]. The creation of a common goal goes beyond trying to find a compromise of individual company goals. Ideally, system-building entrepreneurs should align their company goals towards the achievement of this common goal.

Entrepreneurs stated that *standardization* is an important enabler for co-development of products and services. Standardization is necessary to build up a compatible, reliable new system, in which customers and end-users can easily switch between suppliers or brands. Standardization allows different companies along the value chain to simultaneously develop their products and services. While the system evolves companies can develop their products and services; which then will fit into the new system. Without standardization, too many one point solutions emerge and the new technology cannot be cost-effective (and hence cannot survive in competition with alternative technologies). An integrated approach, in which actors of the innovation system agree on shared standards, is necessary. The importance of standardization is stated in the TIS literature [24], [28] as well as in strategic management literature [16], [36].

To coordinate and accelerate knowledge development and product optimization, the interviewees advised *setting up open innovation platforms*. These platforms also speed up the co-development of complementary products [29], [32].

The activity *system orchestration* refers to the managing and aligning of individual system building efforts. Only if many actors collaborate and bundle their resources a regime change is possible. If they do not align their activities, their individual efforts might evaporate and they are not able to build enough leverage to compete with the incumbent technological regime. To manage and connect all individual efforts, a high degree of coordination is necessary. However, this coordination should not be too rigid; if too many rules are set in the formation phase of the new system, the creativity and innovation potential of the system may be hampered.

If a high degree of coordination and system orchestration has been achieved, as well as trust between networking actors, it was suggested that entrepreneurial managers should '*think in system building roles*' instead of in company objectives. To increase the effects of collective system building, entrepreneurs would detach themselves from the primary idea to sell their company's product or service, and instead consider which role they can play in building the new system. I.e. the system is seen as the entity in which a role is to be performed - not the individual organization. A balance needs to be found between achieving the company objectives and common system objectives.

A much stated problem for system building regarding smart grids was the huge overlap in research and knowledge diffusion activities such as pilot projects and conferences. This overlap results in redundant activities and therefore inefficient resource use. The *creation of transparency of all activities going on in the field* helps to reduce such overlap and to avoid a dilution of resources.

## 6 CONCLUSION

We have developed a strategy framework for entrepreneurs and entrepreneurial managers to collectively build up a favourable environment for their sustainability technology. By creating a supportive innovation system or business ecosystem for their new technology they increase the chances of successful commercialization. A wide diffusion of sustainability technologies, which replace unsustainable technologies, accelerates the transition towards sustainable development.

The strategy framework consists of four key areas for strategy making: technology development and optimization, market creation, socio-cultural changes and coordination. It is visualized in Figure 1. Each of these key strategic areas is composed of a set of system building activities. The first three categories are system building goals which entrepreneurs collectively strive for. The category 'coordination' comprises all activities which manage and align system building efforts, bundle forces and resources and thereby accelerate the system building processes. An overview these categories and the system building activities they include is displayed below in Figure 2.

The system building activities were derived from or could be related back to different bodies of literature. This underlines the importance of combining strategic management literature with transition literature. The combination of these literature fields results in a comprehensive overview of system building activities. Regarding the clustering of system building activities into strategic key areas, it is interesting to see that some categories have activities originating to almost equal amounts from both literature bodies, whereas some categories contain activities that are mainly rooted in one of the literature fields. This shows how the combination of the different bodies of literature is relevant and useful.

A limitation of our research is that it is based on a single case study. As mentioned in the discussion part, not all of the system building activities mentioned in the framework might be applicable for all innovative sustainability technologies. We have based the framework on extensive literature research and related our findings back to the literature where possible to increase its generalizability. However, further research is necessary to test the new strategy framework for different emerging technologies.

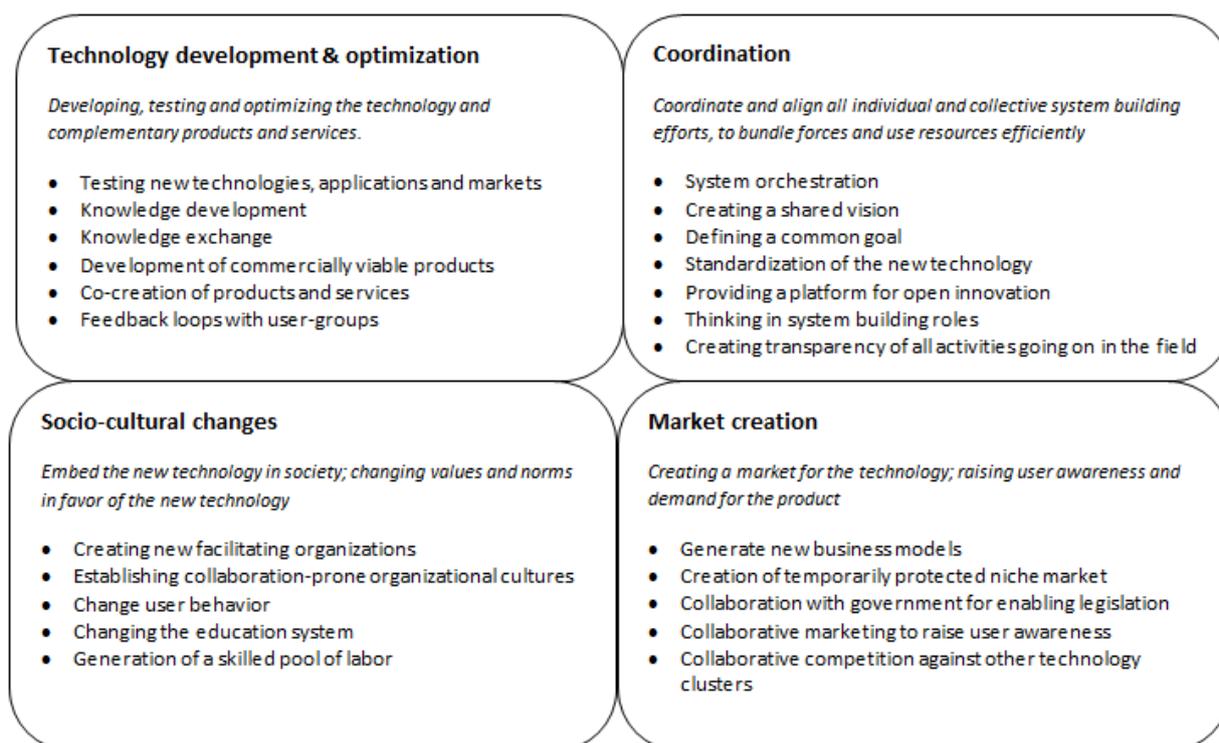


Figure 2: Overview of the strategy framework for system building and its system building activities

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# SUSTAINABILITY AS A BUSINESS MODEL: POLICY AND REAL ESTATE PERSPECTIVES FROM BELARUS

Siarhei Manzhynski – Belarusian State Technological University, Lars G. Hassel –Umeå School of Business and Economics,  
Serg Manzhynski : [manzh81@yahoo.com](mailto:manzh81@yahoo.com)

## ABSTRACT

Environmental sustainability is becoming a key driver for business innovation and new business models. First movers can exploit business opportunities and gain a competitive advantage. Policy makers can foster sustainable development. But what are the roles of policy makers in a transition economy like Belarus? And how aware are Belarusian companies of this new opportunity? In developed markets the business case for sustainability is relevant from a theoretical and practical perspective. Transition economies have many additional economic challenges and many executives perceive sustainability requirements to be a burden and too expensive. What kind of regulation and incentives are available for CEOs, policy makers and other stakeholders in Belarus to improve innovative processes for sustainable development? Based on survey results and empirical analysis we identify the main obstacles that hinder sustainability orientation in Belarus: weak awareness among key stakeholders regarding the potential benefits of and incentives for a sustainable business model; the absence or failure of environmental social and governance factors in strategic and operative plans; and uncertainty over how future economic policy can contribute to sustainable development. Experience from developed countries shows that a possible way to achieve high innovative activities for Belarus and other transition countries is to promote sustainable business models combined with regulatory measures. The essential benefits and measures of this transformation are also considered in the paper.

*Keywords: Sustainability, innovation, transition economy, regulation*

## INTRODUCTION

Amid growing competition in the global economy, a competitive business strives to recognize potential benefits as early as possible, in other words to be a ‘first mover’. Opportunities to improve competitiveness lie not only in short-term financial profit maximization, but also in long-term non-financial drivers of value creation. The concept of sustainable development that emerged as a politic and economic concept during the 1980s [1, 2] to preserve the natural environment for future generations is based on a long-term focus. The concept of sustainability is well-known worldwide, including in developing and transition countries, as confirmed by scientific publications and special training courses as well as by the introduction of environmental and social management standards among industrial enterprises. The use of sustainability mechanisms at strategic and operative levels can potentially give companies significant benefits [e.g. 3, 4]. However, the practical implementation of sustainability principles in transition economies is *a priori* rare and considered not to be successful because of the regulatory and controlling nature. In many ways, this is due to misunderstandings on the part of executives regarding the potential opportunities of environmental and social performance for value creation, and a lack of awareness about internal and external incentives to move towards sustainability by stakeholder initiatives. Transition countries are more exposed to high economic uncertainty, which increases risks of any long-term activity and sustainability-oriented practice. At the same time higher risks also provide more potential for sustainability-driven private initiatives by companies. In spite of the challenges and potential barriers, however, sustainability business models are one of key drivers for innovation in a world facing a growing scarcity of natural resources and environmental problems resulting from emissions. The emergence and growth of the green sector in recent years also supports this statement.

The purpose of this paper is to identify the main incentives for and obstacles against innovation and business models based on sustainability for a transition economy like Belarus and to provide policy recommendations not only for regulation but also for opportunity-driven sustainability. The remainder

of this paper proceeds as follows. Section 1 provides the conceptual framework for a business model based on sustainability that promotes a first mover advantage. Section 2 presents the empirical findings indicating a weak prevalence of sustainability orientation in Belarus and the main reasons behind the conclusions. Section 3 outlines the potential benefits of an opportunity-driven sustainability business model for Belarus and policy recommendations. The paper concludes with a summary of the main conclusions and a call for further research.

## 1 SUSTAINABILITY AS A BUSINESS MODEL: CONCEPTUAL FRAMEWORK

### 1.1 Business model concept

The concept of a business model was introduced in the economic and management literature in the 1990s owing to its implementation in e-commerce [5]. Initially the business model approach was a method to describe different components that together created value for customers and for a company [5]. Now there is a wide range of views regarding the definition, composition and structure of business models.

Demil and Lecocq [6] introduce both a static and a dynamic business model. The first (a static approach) determines the business model as a preliminary plan or even a recipe that aims to provide coherence between core business model components such as resources and competences, its organizational structure and its propositions for value delivery. It helps to realize how added value is created. The second (a transformational approach) reveals the business model as a tool to address change and to focus on innovation. It is devoted to a clearer understanding of how to change the business model [7].

Tecce [8] finds that the essence of a business model is in defining the manner by which the enterprise delivers value to customers, entices customers to pay for value and converts those payments to profit. Thus a business model assists in building implicit assumptions about customers, the behaviour of revenues and costs, the changing nature of user needs and likely competitor responses.

Johnson et al. [9] describe the business model as combining four elements: *Customer Value Proposition*, which can help identify customer needs and propose a service that fulfills those needs better than any alternatives; *Profit Formula*, which is the economic blueprint for value creation; and *Key Resources* and *Key Processes*, which enable managers to identify the strengths and weaknesses of a company.

Osterwalder and Pigneur [10] define a business model as ‘the rationale of how an organization creates, delivers, and captures value’ [10, p.14]. They identify the basic pillars of a business model as follows: *Value Proposition* as the bundle of products and services that creates value; *Customer Interface* as the overall interaction with the customer; *Infrastructure* as the architecture of the company's value creation; and *Revenue Model*, which describes the relationship between costs and revenues. Business model generation can be fulfilled by applying The Business Model Canvas, which is a visual template with nine building blocks. By combining and giving specific understanding to each of the blocks, a user can outline and develop new or existing business models.

Different approaches to business models are described in the extant literature. Wirtz [11] distinguishes three streams of business model studies depending on the focus of research. The first group draws attention to technology, thus the business model uses the latter for creating and capturing value. The second group examines mainly organizational factors. In this case a business model is perceived as a special tool of improvement for representing, planning and structuring business with an emphasis on organizational efficiency [12]. Finally, the third group considers the business model itself as innovation. Innovative business models are an additional advantage in a market.

However, despite the wide variety of existing definitions there is no universal business model. The business model needs to be studied from a set of building blocks to understand the created added value. By changing the content and interaction between building blocks, managers can improve the existing business model or direct the company to use a new one. One way to understand the place of business models in management practice is to use the description presented by Sommer [13] who defines a business model as a ‘blueprint or logic which shows how to put the strategy into practice’ and thus play the role of a ‘glue’ between strategy and operational activities.

### 1.2 Sustainability business model: emergence and distinguishing features

Economic development is cyclical in nature and jumps when innovations are introduced. The innovations can be described in terms of certain performance indicators associated with innovation

breakthroughs. Since the Industrial Revolution we have observed five long waves of innovation: waterpower, steam, electricity, mass production, and information and communication technologies [14]. Moody and Nogrady [15] and Hargroves and Smith [16] argue that the next wave of innovation must be resource efficiency because of increasing competition for scarce resources and potential future environmental problems. Leading businesses will need to change not only their production technologies (renewable energy, nanotechnologies, industrial ecology) but also their underlying business strategies. This implies an emergence of new business model types that conform with actual and future challenges. Since green and sustainable practices occupy a central place in the next wave we can label this type of model the ‘green’ or ‘sustainability’ business model.

The sustainability business model allows a company to innovate through emerging opportunities (technologies, practices) from future resource scarcity. In order to understand what changes non-sustainable companies need to make to be sustainable we have to identify the distinguishing features of the sustainability business model in comparison with the traditional non-sustainable one.

Research into sustainability business model taxonomy and differences between it and traditional business models is still quite rare. Stubbs and Cocklin [17] define a sustainability business model as a model where sustainability concepts shape the driving force of the firm and its decision-making. They examine two organizations that have moved beyond the dominant neoclassical economic model to introduce sustainable business models. Stubbs and Cocklin describe the characteristics of a sustainable business model by means of structural and cultural attributes on the one hand, and internal organizational capabilities and the socioeconomic environment on the other. Structural characteristics are related to processes, organizational forms and structures, and business practices. Cultural characteristics refer to norms, values, behaviours and attitudes. This division helps to identify the main internal and external opportunities for sustainability. The main conclusion that follows from their model is that a company has to be supported by the social-economic system on the sustainability path in order to encourage sustainable attitudes and behaviours on a company level.

Sommer [13] identifies four types of business models as being related to their relative environmental impact: type 0 (*Reference Case*), when a company does not particularly concentrate on reducing its environmental impact; type 1 (*Incremental Improvement*), when a company has initiated some sort of environmental program but without real breakthroughs; type 2 (*Discontinuous Improvement*), when a company implements discontinuous change regarding sustainability achievement; and type 3 (*Strong Sustainability*), when a firm operates without depleting the capacity of the environment. According to Sommer only types 2 and 3 can be classified as sustainability business models.

To identify the main differences between sustainable and non-sustainable business models it is important to consider distinctions in the building elements of models. Boons and Lüdeke-Freund [12, 18] define the main requirements of sustainability according to the basic elements of a business model (in accordance with the Osterwalder business model approach): *Value proposition*, which provides significant measurable ecological and/or social value in concert with economic value; *Supply chain*, which involves suppliers who take responsibility for their own as well as the focal company’s stakeholders; *Customer interface*, which motivates customers to take responsibility for their consumption; and *Financial model*, which should account for the company’s ecological and social impacts.

Bisgaard, Henriksen and Bjerre [19] examine the conceptualization, practice and policies of green business model innovation and classify it as such when a business changes part(s) of its business model, thereby both capturing economic value and reducing the ecological footprint from a lifecycle perspective.

Based on the approaches outlined above and our perception of sustainability attributes, in this paper we attempt to identify the distinguishing features of the sustainability business model and how they differ from that of the traditional business model (Table 1). By ‘traditional business model’ we mean a model in which, in accordance with neoclassical theory, a company’s only obligation is to maximize profits for shareholders, and ecological and social development are subordinate and not taken into account (except as a result of legislative pressure). So in a traditional business model, a company is only an economic entity [20]. This fact restricts development in those economies where the traditional business model is dominant and therefore hinders further development and improvement.

*Table 1. Comparative characteristics of traditional and sustainable business models in transition countries*

Comparing direction	Business model characteristics (features)	
	Traditional	Sustainable
1. Central strategic principal	Defence of shareholders' (owners) interests	Defence of stakeholders' interests
2. Priority aims (time span)	Short- or middle-term aims	Long-term aims
3. Organizational performance targets, dimensions and priorities	Mainly financial dimension	Financial and environment, governance and social (ESG) dimensions. Multi-criteria indicators. Triple bottom line
4. Decision-making processes (decision makers and engagement)	Mostly only by a company's management (involvement of other stakeholders only under legislation pressure)	High level of engagement from all responsible stakeholders (in particular employees)
5. Activity transparency (reporting system and its verification)	'Closed' reporting with low-level information disclosure. Internal verification or compulsory external verification due to government pressure (e.g. tax revisions)	Widespread practice of voluntary reports in particular regarding corporate responsibility and ESG performance. High level of transparency. External verification via standardized reporting
6. Remuneration system	Mostly for financial results (no or weak compliance with ESG performance)	Existence of a portion of executive remuneration for the achievement of sustainability goals [21]
7. Attitude to nature	Mainly as user or 'parasitical' attitude. Perception of ecological challenges only with additional restrictions	Nature as major stakeholder. Threefold strategy: offsets, sustainable, restorative [17]. Ecological challenges are follow-up opportunities for innovation
8. Technology clearness (degree and coverage)	Availability of waste production or in the best case sustainability support only on internal level	Closed-loop systems. Sustainability supporting every element of a supply chain
9. Role of personnel, trade unions in company policy	Mainly formal, low level of engagement in drawing up, correcting and changing policy	High employee representation among decision makers, active role of trade unions

The characteristics presented in Table 1 refer to 'idealistic' variants of the model types. In practice it would be unlikely to find perfect examples of sustainability. Nevertheless the patterns described above can help executives of traditional model companies identify existing weaknesses and develop specific measures for the movement towards sustainability.

## 2 SUSTAINABILITY BUSINESS MODELS IN BELARUS

The present study explores the use of sustainability-based business models in a transition economy, Belarus, and the new ways in which policy makers and economic agents seek transition to a more resource-efficient and sustainable economy. A key proposition for the paper is that a sustainability business model can become a major driver of economic improvement in transition countries. To explore this we study the extent to which sustainability business models are used in Belarus. In the paper we consider the Republic of Belarus to be typically representative of a transition economy.

In Table 2 some socio-economic characteristics of the Republic of Belarus are provided based on data gathered from the Belarusian National Statistical Committee [22]. From an examination of the information presented in Table 2 we can assert that the Belarusian economy has slowed down in recent years, which might be the result of the depletion of traditional national resources. This slow development is accompanied by high uncertainty on the macro level due to a high inflation rate. Moreover, data in Table 2 indicate high dependence on the international economy because more than 80% of GDP was exported, and roughly the same value was imported in 2012.

Table 2. Economic, innovation and environmental indicators for Belarus

Indicator	2009	2010	2011	2012
Index of GDP, percentage of previous year	100,2	107,7	105,5	101,5
Consumer price indices, percentage of previous year	113	107,8	153,2	159,2
Exports, percentage of GDP	43,6	54,6	76,1	83,4
Imports, percentage of GDP	57,8	68,2	80,4	78,6
Share of the EU in exports of goods, percent	43,7	30,1	37,9	38,2
Share of Russia in exports of goods, percent	31,5	38,9	35	35,4
Domestic R&D expenditure, percentage of GDP	0,64	0,69	0,7	0,67
<i>the same in the EU</i>	<i>2,01</i>	<i>2</i>	<i>2,04</i>	<i>2,06</i>
Share of exports in total volume of innovative products shipped by industrial organizations, percent	51,7	50,7	62,3	64,3
Greenhouse Gas Emissions (CO <sub>2</sub> equivalent), ton per capita	8,82	9,04	8,78	—*
<i>the same in the EU</i>	<i>8,54</i>	<i>8,79</i>	<i>8,46</i>	<i>—*</i>
Number of Belarusian companies with Global Reporting Initiative (GRI) reports:				
in Russian/Belarusian	1	1	8	9
in English	1	1	—	—
UN Global Compact Participants (at the end of 2012)	34	42	46	47

\*— statistical data not available.

Belarus has two main export markets: the EU (mainly raw goods (oil, petroleum), chemical and mineral products) and the Russian Federation (mostly consumer goods). Belarus's exports, especially consumer goods, are poorly diversified. Consequently, policy makers should promote the expansion of industrial product exports to multiple countries by promoting innovation. European countries are constantly tightening requirements (mostly ecological) on raw goods and chemical products in their markets, which should also incentivize Belarusian manufacturers to improve technologies and management systems.

In sum, Belarus can be categorized as an export-oriented economy where sustainability-driven business models have potential due to the need to penetrate new foreign export markets, especially developed countries. The threshold for access to these markets is generally high for foreign companies, among others, due to ecological requirements. When considering developed markets as a major target for a company in a transition economy, consumers' awareness regarding sustainability is a strong driver of demand. Companies from transition countries should justify and draw up their strategies and penetration plans taking sustainability factors into account in their product portfolios. A logical implication is that an expansion into new and developed markets should be based on innovations, especially when more than 60% of products in innovative industries in Belarus are exported (Table 2). However, a decrease in economic growth and relatively low funding of R&D (e.g. 0.67% of GDP in Belarus against 2.06% in the EU in 2012) substantially restrict the growth of Belarusian companies.

One such direction for improvement is sustainability as a business model, which is relevant from a theoretical and practical perspective. Regarding a transition economy like Belarus we have tried to estimate the prevalence of the sustainability business model among economic agents by using policy and reporting as a proxy for sustainability. To do this we first used indirect evidence. One of the characteristics of a sustainable company is its transparency as an economy maker in general and its corporate responsibility and ESG performance in particular (Table 2). This implies the presence of a standardized, publicly available and recognized reporting system. One such system in terms of sustainability is the Global Reporting Initiative (GRI), which has pioneered and developed a comprehensive Sustainability Reporting Framework. Now it is widely used around the world [23]. The aim of the GRI is to develop a reporting framework with a strong emphasis on a company's ESG performance for providing stakeholders with relevant and comparable information. More than 80% of

the world's largest 250 companies now report an ESG performance, with 4% of them reporting on an integrated basis [24]. In the case of Belarus, analysis shows (Table 3) that the number of companies that issued sustainability reports based on the GRI is negligible (only nine in Russian in 2012). Only one company issued the GRI reports in English in 2009–2012, which indicates that Belarusian companies are a 'dark spot' in terms of sustainability for current and potential responsible stakeholders from foreign markets (this is especially unfortunate considering Belarus's export-oriented perspectives).

Potentially, the number of companies issuing sustainability reports can be increased by participation in the UN Global Compact (UNGC). The UNGC is an initiative designed to encourage businesses worldwide to adopt sustainable and socially responsible policies, and to report on their implementation [25]. As Table 3 shows, the number of Belarusian UNGC participants is small.

In addition to indirect evidence we also conducted a survey to assess the sustainability business model embeddedness in practice among Belarusian companies, with a view to understanding the environmental performance of those companies. In order to do this we implemented the Global Real Estate Sustainability Benchmark (GRESB) [26], which aims to estimate (via a survey) the sustainability performance of real estate companies. This is an increasingly popular reporting framework in the real estate sector. In 2013, a total of 543 property companies and funds participated in the GRESB survey, a 23% increase on the response rate in 2012 (443 participants) and a 60% increase on that in 2011 (340 participants) [26]. The GRESB 2013 approach allows us to estimate sustainability performance according to seven unique aspects (*Management; Policy & Disclosure; Risks & Opportunities; Monitoring & EMS; Performance Indicators; Building Certification & Benchmarking; Stakeholder Engagement*), generating a total GRESB score from 1 to 100 and comparing the latter with a benchmark. Using the GRESB 2013 questionnaire, we interviewed the directors, department heads and managers of 23 Belarusian real estate companies and compared the results with average scores from the European GRESB 2013 report (see Table 3).

*Table 3. Comparative analysis of sustainability performance in real estate sectors of Belarus and Europe (based on GRESB 2013)*

Aspect of Sustainability	Score (percent)	
	Average in Belarus	Average in Europe
<b>Overall</b>	<b>17</b>	<b>43</b>
Management	34	68
Policy & disclosure	21	50
Risks & opportunities	18	50
Monitoring & environmental management systems	21	40
Performance indicators	7	20
Building certification & benchmarking	8	22
Stakeholder engagement	12	40

Results indicate that the sustainability performance of Belarusian real estate companies in all respects is low, averaging less than 2.5 times that of the benchmark (the average European level of GRESB participants). The worst results refer to such aspects as *Performance indicators*, *Building certification & benchmarking* and *Stakeholder engagement*. Thus the extent of sustainability business model implementation in practice, at least in terms of Belarusian real estate companies, is low and unlikely to reach that of their European rivals. Taking into account that the real estate sector is usually one of the leaders in sustainability practice, we can therefore assume that the sustainable business model is poorly implemented in other sectors of the Belarusian economy as well.

Based on our analysis of the data, the main obstacles to sustainability orientation in Belarus are:

- additional economic challenges and uncertainty over the future economic state (e.g. high inflation hinders the development of plans and building long-term perspectives for investors, who prefer to invest in projects with a short- or at least mid-term payback);
- a lack of initial investment for R&D with regard to sustainability;
- weak awareness among key stakeholders regarding the benefits and incentives of a sustainability business model (e.g. most executives acknowledged during our interviews that sustainability requirements were a burden and too expensive);

- the absence or failure of ESG factors in strategic and operative plans;
- a lack of applied methodology on the part of Belarusian executives in areas of sustainability assessment, support and improvement;
- passivity on the part of businesses in seeking additional opportunities in the sustainability business model and other areas;
- creation of ‘greenhouse conditions’ by government for local enterprises via bland restrictions in terms of environmental requirements (this does not motivate businesses to move towards sustainability and as result leads to weakening of competition in foreign markets).

### **3 THE ESSENTIAL BENEFITS OF THE SUSTAINABILITY BUSINESS MODEL FOR BELARUS AS A TRANSITION ECONOMY: MAIN MEASURES FOR IMPROVEMENT**

The business case for sustainability has been recognized as an economic opportunity and has been made in a large number of publications [e.g. 24, 27, 28, 29, 30]. Nevertheless in transition countries the success of the sustainability business model is not so obvious for policy and business makers. Based on rich theoretical and practical evidence from developed countries, and taking current economic challenges into account, we have tried to identify the main advantages and opportunities for implementation of the sustainable model for transition countries in general and for Belarus in particular. The arguments are conditionally grouped into two parts: internal (which mainly refer to organizational capabilities inside a corporation and interactions with internal stakeholders) and external (which imply the use of advantages gained from interactions with external stakeholders).

1. *Regarding internal opportunities, the sustainability business model allows a company to:*

- identify internal reserves for growth of efficiency by rethinking business processes at all stages in the supply chain;
- adapt to strict environmental legislation (especially important for export-oriented sectors);
- cut costs through a permanent focus on environment-friendly and resource-efficient decisions and via strong engagement of stakeholders (especially in the long term);
- increase income due to reputation benefits and customer retention;
- have an advantage in the recruiting process because of high attractiveness as an employer;
- build corporate culture and ‘staff dedication’ via high social standards;
- raise innovation activity through personnel and other stakeholder involvement in ‘ideas generation’ and development processes in terms of sustainability improvement (e.g. establishing social networks concerned with innovation research; the use of incentive systems for stakeholders);
- adopt new business directions based on the search for sustainability and, consequently, gain additional income (e.g. creation of new products from waste, service groups of utilization, consulting centres for disseminating experience, etc.).

2. *Regarding external opportunities, the sustainability business model allows a company to:*

- retrench costs on tax and other payments (e.g. fines) in frames of severe environment legislation;
- build rapport with government and, consequently, benefit from it (e.g. leadership in ESG performance provides the opportunity to shape some laws using the company as a sector benchmark; or to postpone adopting some measures from government);
- interact with local communities in the promotion and distribution of goods and services in parallel with corporate social responsibility events (PR and marketing);
- reduce external risks due to the strong involvement of stakeholders (e.g. drop in probability for lawsuits by local communities and labour unions);
- enhance investment attractiveness through sustainable relations with stakeholders.

Thus the sustainability business model can be a strong driver for innovation activity and economic growth. Using the presented benefits implies devising and taking practical measures to change the existing non-sustainable state. For example, Nidumolu, Prahalad and Rangaswami [27] suggest making the move towards sustainability in stages, and considering changes to sustainability through challenges, competencies and opportunities.

We argue that for Belarus and other transition countries a complex set of measures for the transition to sustainability should include two strategies:

1. *Promotion of measures.* Based on the presented framework and the advantages of the sustainability business model, executives should draw up strategy, tactics and operative plans, including supporting elements: assessments of ESG performance and reporting standards,

remuneration systems, engagement programs, innovation networks, etc. This would contribute to internal benefits. Moreover, it should not be up to executives alone to further the sustainability concept. Other stakeholders, including government and communities, can also support this via:

- educational activities to raise public awareness about sustainability development issues;
  - promotion of cleaner production, effective energy use and social responsibility through tax perks and other benefits;
  - promotion of public non-profit organizations and labour unions which, as independent stakeholders, are capable of protecting sustainability interests.
2. *Regulatory measures* for the stabilization of the overall economic situation and creation of a favourable business and investment climate. It is essential to realize that, for transition economies, a failure of regulatory policy can destroy all efforts in the promotion of sustainability. Also, government should create appropriate legislation and regulate economic activities with regard to sustainability.

## CONCLUSION

In a transition economy like Belarus, different companies react to social and environmental challenges in different ways. Some try to postpone decision-making, others declare a strong interest in the issues but do not take material action. Only a small number strive to operate decisively and systematically. At the same time a sizeable number of publications and practical cases from developed countries show that sustainability can be an important driver for innovation activity and competitive advantage. Moreover, decisions surrounding sustainability issues, for example, energy and resource efficiency, and emissions and waste utilization, are key opportunities in the fight for consumers in global markets. This means that the export-oriented Belarusian economy is unlikely to expand its competitive position without making changes towards sustainability. However, analysis based on survey and empirical data concludes that the low level of sustainability business model use in Belarus can be explained by a number of factors, including: the weak awareness of key stakeholders regarding the benefits and incentives of the sustainability business model; the failure of ESG factors in planning, activities and reports; and unstable macroeconomic conditions. To improve this situation we consider and systemize the essential benefits of the sustainability business model for use in Belarus, and on this basis we suggest major measures that should be taken by the CEO (on a micro level) and government (on a macro level). These include such practical recommendations for executives as the implementation of ESG performance assessment and reporting standards, development of a motivation system to involve stakeholders and the creation of innovation networks. The sustainability model concept also needs support from macro policy makers, who should encourage sustainability-oriented companies and simultaneously provide a clear and stable macroeconomic background.

Future research could investigate the feasibility of sustainability business model implementation in specific sectors in Belarus or in other (especially export-oriented) economies and evaluate the association between ESG performance and the operational results of companies in transition countries. It could also draw up concrete strategies and operative plans for the transition towards sustainability in business. An export-oriented economy needs to realize the opportunities available in sustainable business models, and policy makers need to understand the dynamic effects that will emerge when regulations are introduced.

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# LONG-TERM VALUE CREATION, CORPORATE SOCIAL RESPONSIBILITY AND INTEGRATED REPORTING -THE EXAMPLE OF CANADIAN MINING AND ENERGY

PETRA F.A. DILLING<sup>1</sup>

<sup>1</sup>NEW YORK INSTITUTE OF TECHNOLOGY; PDILLING@NYIT.EDU

## ABSTRACT

As companies are increasingly focusing on corporate social responsibility (CSR) they are also disclosing more information on the linkage between their company's vision, strategy, and long-term value creation in the context of their external environment. Many of the company stakeholders are now more than ever paying close attention to the financial and non-financial performance from a short, medium and long term perspective. As a first of its kind, this paper provides an in depth analysis of the current state of sustainability and integrated reporting of Canadian public mining and energy companies. Therefore, the financial reports and the sustainability reports for a sample of Canadian public mining and energy companies are analysed. The empirical results of a thorough quantitative and qualitative content analysis show that there is much room for improvement for reporting on long-term value creation for Canadian mining companies. Information gaps were uncovered for various assessment items in both types of reports, most notably in the area of long-term economic and environmental sustainability as well as the connectivity between sustainability and financial information. Based on this detailed analysis, recommendations for best practices for sustainability and integrated reporting will be made. The nature of this interdisciplinary study is exploratory.

*Keywords: Corporate Social responsibility (CSR), sustainability reporting, integrated reporting (IR), stakeholders, long-term value creation, Global Reporting Initiative (GRI), International Integrated Reporting Council (IIRC), economic sustainability, environmental sustainability, social sustainability, content analysis, mining, energy companies, Canada*

## 1 INTRODUCTION

More and more investors claim that annual financial reports cannot provide sufficient information needed to determine a company's long-term value creation. Regulators, standard setters, executives as well as other stakeholders assert that they have a substantial demand for additional information regarding changes in the business environment and the (long-term) impact on business strategy and strategy implementation plans of a company [1]. Theoretically, any company can report on long-term creation in its annual financial report or its sustainability report or both. However, most annual reports will neither address the long-term challenges and opportunities that a company faces nor will they explain in detail the business model, materiality issues, priorities, risk management, innovation, etc. The reason behind this lies in the fact that companies, in their annual reports, will often only report the minimum required by regulators in their respective countries. This might be sufficient for short-term investors; however, increasingly, stakeholders (including investors) want to understand the company mission, business model, strategic initiatives, long-term objectives; taking the current and future business environment into consideration.

There are many definitions for sustainability and corporate social responsibility. Very commonly, corporate social responsibility is defined as the voluntary activities undertaken by a company to operate in an economic, social and environmentally sustainable manner. Therefore, sustainability reporting is a process of publicly disclosing an organization's economic, environmental, and social performance. The term "sustainability reporting" is synonymous with citizenship reporting, social reporting, triple-bottom line reporting and other terms that encompass the economic, environmental, and social aspects of an organization's performance. In contrast to the annual financial reports, a sustainability report is not mandatory in most parts of the world with a few exceptions (e.g. Denmark).

Recent studies indicate that sustainability reporting in general is not only still on the rise but also the quality of the reports seems to reach a new level. This appears to be especially true for mining companies. In fact, research found that many companies are taking tentative steps by presenting CSR data along with financial data in their annual company reports [2]. With regard to the Canadian corporate world, a recent study found that corporate social responsibility reporting in Canada has stayed at a high level. 84% of companies in the mining industry are publishing a sustainability report, the highest percentage of all industries. The majority of companies (51 %) include information on CSR in their annual financial report. An increasing number but still a minority (42 %) is starting to make the link between CSR and business strategy by including CSR information in the Directors' report [1].

In contrast to sustainability reporting, integrated reporting (IR) presents a holistic and complete picture of the business in a clear, concise, connected and comparable manner. Integrated reporting is a means of presenting the material information about the organization's strategy, governance and performance on commercial, social and environmental issues. Through effectively connecting these often siloed areas, businesses are able to provide not only an update on past performance but also a long-term perspective of future value generation [3].

Therefore, the International Integrated Reporting Council (IIRC) has developed a consultation draft of the International <IR> Framework [3]. The intention of integrated reporting is to report on value creation more efficiently than what is presented in either the annual report or the sustainability report. In contrast to financial and sustainability reporting, integrated reporting is forward-looking. So far, only companies listed in South Africa are required to apply integrated reporting guidelines [4]. According to a Global Reporting Initiative (GRI) study, integrated reporting has been embraced by one third of companies while the others still are trying to find their way to a truly integrated report. More specifically, about a third of all integrated reports clearly embed sustainability and financial information together and this proportion is growing year-on-year. About half of all self-declared integrated reports are two separate publications – an annual report and a sustainability report – published together under one cover, with minimal cross-connection [5].

Typically, previous research has focused on individual aspects of sustainability reporting, for example, environmental reporting, stakeholder engagement, etc. However, the main research questions of this study are how and to what extent companies are disclosing information on all main aspects of long-term value creation, including financial, economic and social sustainability. In 2009, Perez & Sanchez, in their research of 31 sustainability reports found "a clear evolution" in the depth and comprehensiveness of sustainability reports of mining companies [6]. The research study on hand goes further than analysing just the content of sustainability reports. For the first time, sustainability reporting is analysed in the financial as well the non-financial annual reports from a Canadian mining company perspective. Data collection for this study includes assessment items and categories from related research literature and recommended standards such as the Global Reporting Initiative (GRI) and the International Integrated Reporting Council's (IIRC) reporting frame work. In this research study, qualitative and quantitative content analysis has been applied to a sample of twenty publicly listed Canadian mining and energy companies. The mining and energy sectors have been chosen due to the fact that, through their significant impact on the environment and the communities, these particular industries face many potential environmental issues and are therefore a focus of attention when it comes to the discussion on corporate social responsibility [7]. In order to maintain their "social licenses" to operate, companies in these industries have started to embrace corporate social

responsibility early on [8]. Moreover, as mentioned above, they are also reported to disclose extensive information on corporate social responsibility.

In summary, over the last decades, we have seen a drastic development towards sustainability reporting. In 2000, the development of the GRI guidelines was initiated. A large percentage of global companies have since adopted the GRI format and voluntarily provide substantive CSR information to their stakeholders in various ways [9]. Due to the importance of disclosure of responsible policies towards environmental protection, several CSR guidelines have been developed by initiatives of the mining and energy industries, namely the CSR guidelines of the Prospectors & Developers Association of Canada (PDAC) [10] and the International Council on Mining and Metals sustainable development framework [11]. In addition, in 2005, the International Association of Oil and Gas producers (OGP), the American Petroleum Institute (API) and the International Petroleum Industry and Environmental Conservation Association (IPIECA) developed guidelines on sustainable reporting [12].

This research article adds to the literature by analyzing the status quo of sustainability and integrated reporting for mining and energy companies in Canada. It is comprised of four parts. After the introduction, the second part will explain the sample and methodology in detail. In the third part, the empirical results will be presented followed by a short discussion. Finally, the conclusion and recommendations represent the last and fourth part of the paper.

## 2 SAMPLE & METHODOLOGY

For the empirical analysis, annual financial reports for the year 2012 were analyzed. The average page number for those reports was 128 pages, with the shortest at 79 pages and the longest at 190 pages, as well as stand-alone voluntary sustainability/community/ stewardship reports with an average of 90 pages (shortest: 14 pages, longest: 205 pages). Only the public companies that were constituents of the Toronto Stock Exchange (TSX) TSX60 that published a financial report as well as a sustainability report in 2012 were included in the sample. It is important to note that this study does not focus on the reporting requirements according to GRI or IC guidelines. Rather it focuses on four main assessment areas that have been deemed crucial for long-term value creation: long-terminism, connectivity between sustainability and financial items, outside and inside linkages. The four assessment areas are based on a thorough literature analysis and a subsequent categorization of CSR items that have been identified as important factors for long-time value creation. In Table 1 in the appendix, the individual assessment items are listed within their specific categories.

In more detail, an analysis and subsequent scoring took place for the following: For the category “long-terminism”, information on company vision, mission, core values, talent & leadership, safety, innovation, and risk management were reviewed. For the second category “connectivity between financial and sustainability information”, information on key performance indicators (KPIs) that connect financials with sustainability factors, materiality analysis and matrix, climate risk, energy consumption, and economic sustainability were scored. As for the third category “inside linkages”, information regarding assessment items governance, diversity, skills, responsible workplace, incentives, recruitment & retention were assigned. Lastly, for the fourth category “outside relationships”, information disclosure on local hiring, local suppliers, infrastructure, partners, communities was analyzed.

For each assessment item, a score between 0 and 5 was assigned for both the financial and the sustainability report. A score of 0 (zero) was applied when absolutely no information was provided in the report. As soon as some mention of the item was made, even briefly, a score of 1 was assigned. If only little information was provided but more than just a mention of it was shown, a score of 2 was assigned. As soon as average information was provided, a 3 would be scored. In the case that average corporate social responsibility information and a few examples or a few numbers provided a score of 4 was assigned. When a company provided extensive information with many examples or many

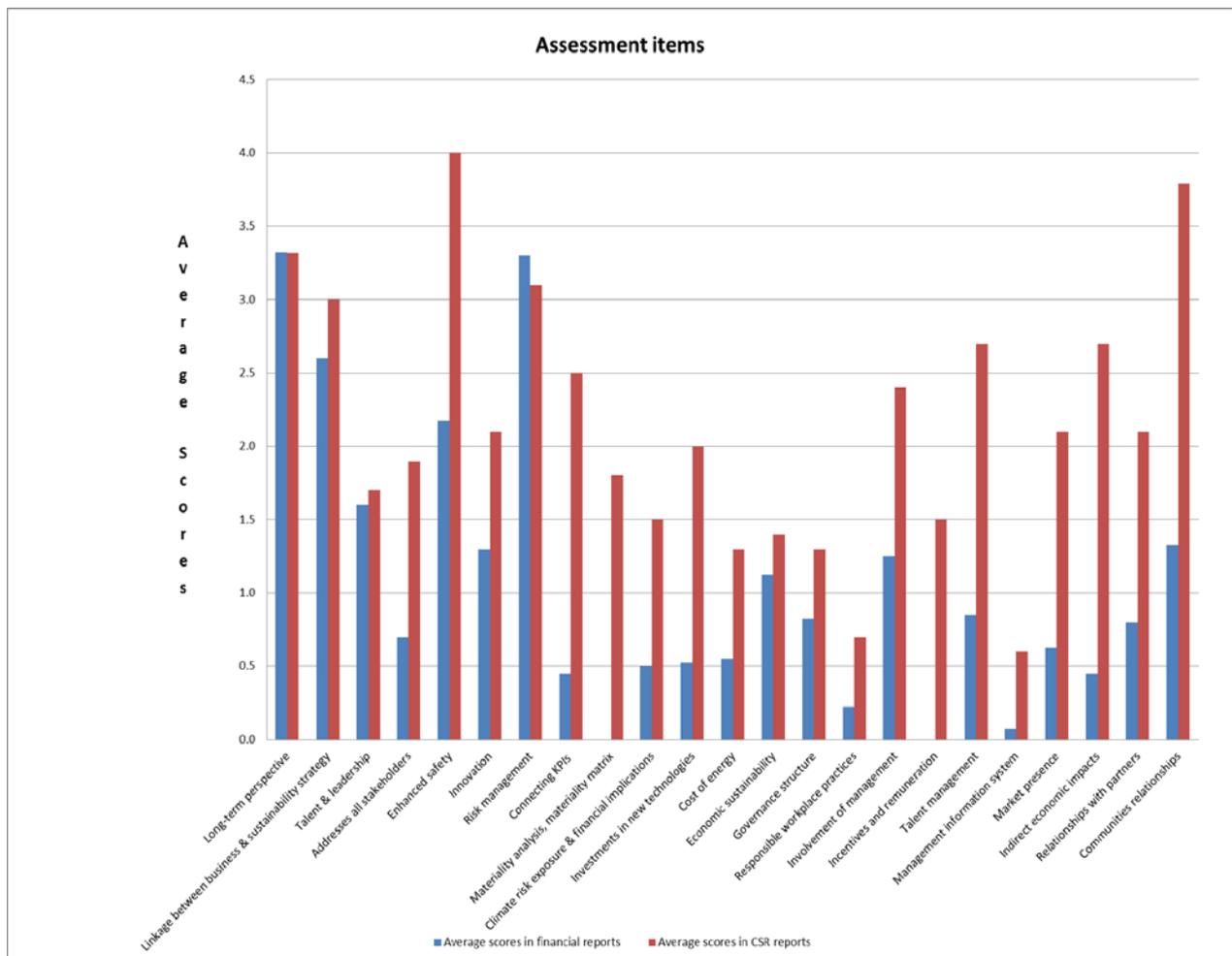
numbers the items received a score of 5. The scoring was performed for financial and for sustainability reports separately.

### 3 EMPIRICAL RESULTS & DISCUSSION

As mentioned previously, as a first of its kind, this study provides an in depth analysis of the current state of reporting on long-term value creation for a sample of public mining and energy companies in Canada. The sample includes all energy/mining companies that were TSX60 constituents and that published an annual financial report and a sustainability report for 2012, in total 20 companies. Consequently, for a total of 40 reports, a total of 920 indicators were scored.

Figure 1 shows the average disclosure scores assessed for the annual financial report and the CSR report.

Figure 1. Average disclosure scores for individual assessment items



When looking at the average disclosure scores for all companies in Figure 1 as well as in Table 2 in the appendix, the analysis shows that the companies place great emphasis on communicating their vision, industry growth and new market development. Information on those items is provided in both the financial report as well as the corporate social responsibility report (score of 3.3 out of 5). Other than that, for the annual financial report, information disclosure is focused on company mission and core values in corporate social responsibility (2.6), risk management (3.3), and enhanced safety (2.2).

The least amount of information was disclosed in materiality analysis (0) and incentives and remuneration connected with corporate social responsibility targets (0). In the sustainability report, the information provided on the first four items was also substantive. In addition, information on key performance indicators, talent development, infrastructure and community investment was provided. On average, very limited information was made available on cost of energy (1.3/5), economic sustainability (1.4/5), diversity & skill set of people in charge (1.3/5), and sustainable people practices (0.7/5). However, there were a few companies that stood out and disclosed very extensive information. What is more, not only did they report on successes and accomplishments but also on failures and things that did not go as planned during the year 2012.

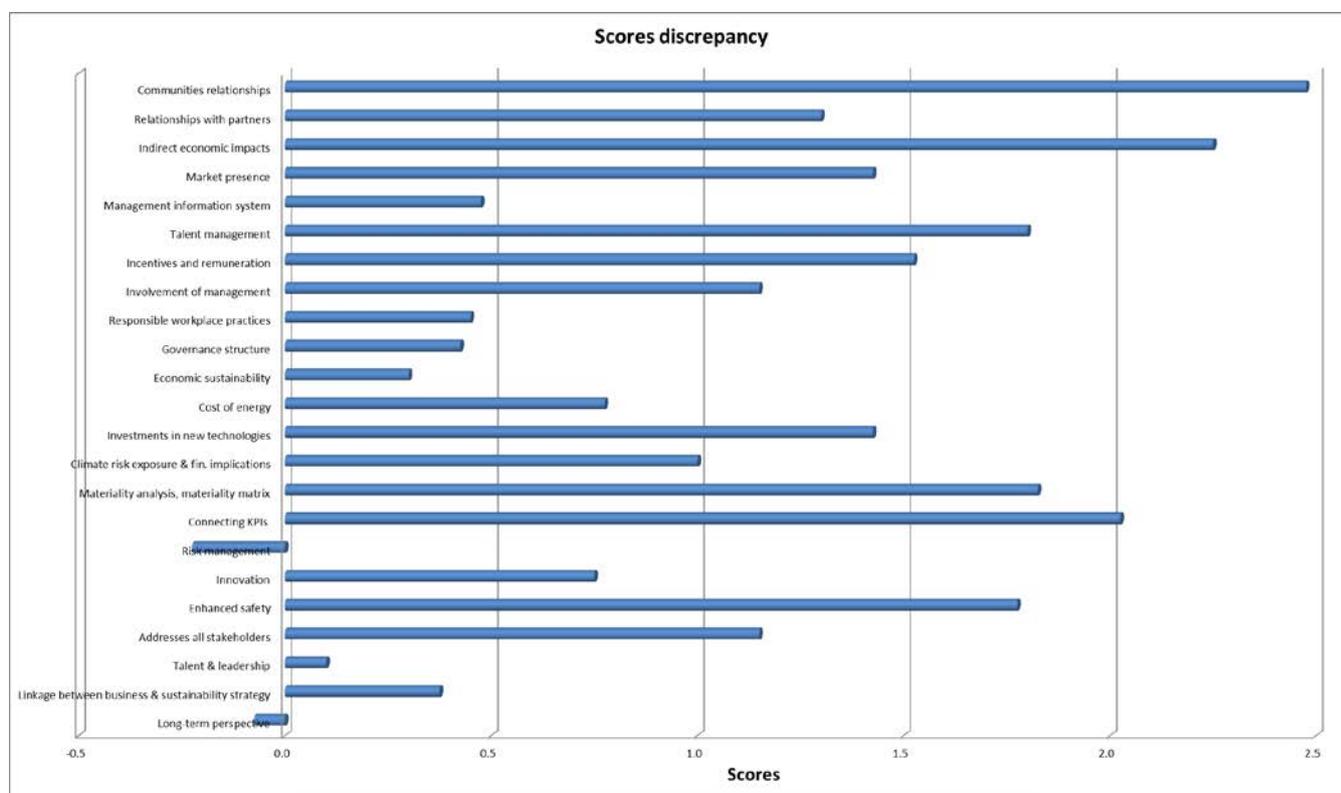
An example would be:

“The company prides itself on setting high performance standards and striving to achieve operational excellence. However, there are times when we fail to live up to our own expectations, and those of our stakeholders.

The following are brief descriptions of the major incidents that occurred between May 1, 2012 and May 1, 2013. Below are updates on issues that occurred in previous years.”

In the analysis, an attempt was made to ascertain in which categories/items more information was disclosed in the financial versus the sustainability report and vice versa. In Figure 2, the discrepancies of disclosure scores are depicted for all 23 assessment items. It can clearly be seen that some items are disclosed in much more detail in the sustainability report compared to the financial report. Only for the assessment items ”long-term perspective” and “risk management” more information is disclosed in the financial report. All other items are published to a greater extent in the sustainability report. This underlines the perception that the sustainability report is still the main vehicle to disclose information on long-term value creation while only very limited information is provided in the financial report.

Figure 2. Discrepancy of scores between financial report and sustainability report assessment items



On one hand, we notice that information indicators in some areas are disclosed in much more detail than others, on the other hand, there are items that are disclosed in more detail in the annual reports versus the CSR reports. When looking at the discrepancies of scores between the annual report and sustainability report, we found that much more details are provided on safety, key performance indicators, materiality analysis, talent development and infrastructure in the corporate social responsibility reports. However, as can also be seen in Figures 1 and 2, when it comes to the category “long-term perspective”, the average scores for both reports are rather similar. In fact, more often than not, similar content is disclosed in both reports. The discrepancies in the category “outside relationships” are quite pronounced and it can be stated that as long as it comes to this particular area, the sustainability report still seems to be the only place where such information is provided and not the financial report.

However, given that a score close to 5 (full disclosure) would be preferred by many stakeholders, a large gap can still be observed for many companies for both reports. Reporting on long-term value creation can only be found in the CSR report with just a few exceptions (long-term vision, etc.). A few commendable examples can be found in our sample, but overall disclosure is not where it could or should be. Given that the average disclosure score in the financial report for all items is 1.1 out of 5 and 2.1 for the sustainability reports, it can be stated that the companies still have ways to go with regard to producing a truly integrated report.

#### 4 CONCLUSION & RECOMMENDATION

As seen above, the empirical results of the content analysis show that there is much room for improvement for corporate social responsibility and integrated reporting for Canadian energy and mining companies. In addition, there are many discrepancies between disclosure in annual financial and sustainability reports. There is still a focus on certain areas. More specifically, most information disclosed in the annual report was in the category of “long-term perspective”. In sustainability reports, those areas are also covered plus information on the “linkage of financials and sustainability” and “outside relationships”.

Information gaps were uncovered for various assessment items, most notably in the area of inside linkages (governance, diversity, skills, responsible workplace practices, incentives, etc.). Certain aspects of sustainability information are reported more extensively in the annual financial reports whereas others are reported more in the sustainability report. On average, supporting data and examples are not sufficiently provided yet.

Moreover, corporations do still not provide sufficient information on financial implications of sustainability initiatives, especially when it comes to long-term effects. Although there is more information provided than previously and quite a few companies are following the Global Reporting Initiative (GRI) or the integrated reporting <IR> standards to some degree, it is still very difficult for external stakeholders to draw conclusions regarding the effects of economic, social and environmental sustainability of the company. In summary it can be concluded that integrated reporting is still in the beginning stage for Canadian mining and energy companies.

This exploratory study is a first step in determining the status quo of reporting on creation of long-term value for large public mining and energy companies. There are many other steps that need to follow suit. One would be to figure out why companies have been so slow in adapting the many guidelines and disclosure frameworks. It is recommended that companies allocate more resources towards greater disclosure. The companies themselves as well all stakeholders would greatly benefit from a mandatory standardized framework for all public companies. By implementing such mandatory reporting, the companies have the opportunity to reflect and elaborate on their intention to create value in the future. Further research in this area is needed. Since this study was using a small sample, it is recommended that the sample size should be increased with an inclusion of companies in other industries as well as other countries.

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## 6 APPENDIX

Table 1. Categories and individual assessment items

Linkages	Variables	Explanation of variables
<b>Overarching themes</b>		
<b>1. Long-term 360 degree linkage</b> Perspective/point of view	Long-term perspective	developing vision, mission, systematic organization and processes; stability; employee development; growth of new industries and new markets; long-term supplier networks
	Linkage between business and sustainability strategy	mission, core values in both areas
	Talent & leadership	
	Addresses all stakeholders	examples: dear Stakeholders, stakeholder commentaries, etc., stakeholder engagement and feedback
<b>Enhancement linkage</b> Improvements/mitigation	Enhanced safety	
	Innovation	eco-friendly; growth of new industries and new markets; new innovation platforms
	Risk management	incl. threats and opportunities
<b>2. Financials and sustainability linkage</b>	Connectivity between financials (natural capital) and sustainability sections	KPIs that connect financial outcomes with other sustainability variables (e.g., emissions to sales ratio, financial impact of consumption or employee turnover, etc.)
		Materiality analysis, materiality matrix
		climate risk exposure & financial implications
		investments in new technologies (low-carbon, energy efficiencies, renewables, social enterprise, etc.)
	Cost of energy	energy consumption practices (not emissions or consumption numbers only)
	Economic performance & economic sustainability	revenues, expenses, employee compensation, community investments, retained earnings, payments to capital providers and governments
<b>3. Inside linkage</b> Within the organization	Governance structure	diversity & skill set of people in charge
	Responsible workplace practices	Sustainable people practices and connection to cost efficiencies
	Involvement of management	Commitment to sustainability; targets and who is accountable for what; board committees
	Incentives and remuneration	
	Talent recruitment, development & retention	training and development expenditures or employee
	Management information system	
<b>4. Outside linkage</b> Outside relationships	Market presence	locally based suppliers policies, local hiring, wages compared to local market
	Indirect economic impacts	infrastructure investments, public benefit, extent of impacts
	Positive relationships and collaborations with outside stakeholders	business and other partners communities

Table 2. Most and least amount of information disclosed

Most amount of information in <u>annual reports</u> :	Least amount of information in <u>annual reports</u> :
• Vision, growth of industry, new markets (3.3/5)	• KPIs that connect financial and CSR (0.5/5)
• Mission & core values in sustainability (2.6/5)	• Materiality analysis/mix (0.0/5)
• Enhanced safety (2.2/5)	• Climate risk exposure (0.5/5)
• Risk management (3.3/5)	• Investments in new technology (0.5/5)
	• Sustainable people practices (0.2/5)
	• Incentives and remuneration (0.0/5)
	• Infrastructure investments, public benefit (0.5/5)
Most amount of information in <u>CSR reports</u> :	Least amount of information in <u>CSR reports</u> :
• Vision, growth of industry, new markets (3.3/5)	• Cost of energy (1.3/5)
• Mission & core values in sustainability (3.0/5)	• Economic sustainability (1.4/5)
• Enhanced safety (4.0/5)	• Diversity & Skill set of people in charge (1.3/5)
• Risk management (3.1/5)	• Sustainable people practices (0.7/5)
• KPIs that connect financial and CSR (2.5/5)	
• Talent recruitment & development & retention (2.7/5)	
• Infrastructure investments, public benefit (2.7/5)	
• Communities (3.8/5)	

# TRANSITIONS TO A MORE SUSTAINABLE RESTAURANT INDUSTRY IN CAPE TOWN: FROM THEORY TO PRACTICE.

Karen Welter

University of Stellenbosch longtableproject@gmail.com

## ABSTRACT

This paper highlights how restaurants in Cape Town are being helped to become more sustainable. It will document the shift from theoretical solutions to implementation and practical business realities. The restaurant sector in Cape Town was highlighted as it can contribute towards environmental and social sustainability as part of the food system, and in its use of resources such as energy, water, and waste. It also employs people in both menial and skilled occupations and communicates its services. By helping the industry become more sustainable benefits accrue to the restaurants, their employees, society and the environment. The central model used was a Business Model Canvas designed by Osterwalder and Pigneur. This canvas allowed for a clear analysis of the systemic logic needed to support the restaurant industry in Cape Town. As an outgrowth of the Business Model Canvas analysis in 2013 a Social Enterprise, Longtable Project was established to support the restaurant industry in Cape Town. Longtable Project was formulated as a theoretical response to ecological and social issues within the city of Cape Town but had to adapt to being a responsive enterprise to support a range of players. The results will highlight the value of the Business Model Canvas as a systemic tool, in envisaging sustainable solutions to environmental and social challenges in an industry that has multiple stakeholders.

Keywords: Sustainable restaurant, business model canvas, social enterprise, food, resources

## 1 INTRODUCTION

A theoretical foundation was laid to help move the restaurant industry in Cape Town to become more sustainable. The restaurant industry is a system within an urbanised world in a state of crisis because of degraded and declining ecosystems and escalating resource use beyond earth's carrying capacity. (MEA, 2005; UNEP, 2007B; UN-Habitat, 2006; Worldwatch Institute, 2010). The globalised food system is also unsustainable because of its dependence on fossil fuels through pesticides and fertilisers. Homogenous large scale agriculture has undermined local food economies and cultures and the biodiversity of ecosystems. (Altieri & Nicholls, 2005; Pfeiffer, 2006; Shiva in Roddick, 2001). A sustainable and resilient system would need to need to address these issues by working within ecological limits and building human and social capital within this system. (Forum for the Future, 2011).

Individually and collectively there are a number of ways in which restaurants can become more sustainable. They are involved with food, resources, people and communication. These four areas interconnect and can be focused on to move to a system that can better withstand ecological and social challenges to become more resilient. Restaurants are involved in the purchase, preparation and sale of food to consumers. By becoming more sustainable in their food choices and communicating these they can contribute to patrons consuming differently. By supporting food production methods that are more ethical or sustainable they can support sustainable production and local economies. They can use less energy and implement energy efficiency measures to reduce carbon emissions in their businesses and in the supply chain. Likewise their efficient and reduced use of water and waste can help support ecosystems and biodiversity. Procurement and labour policies can be used to support livelihoods and local economies. Restaurants engage with suppliers, employees and customers. By educating these stakeholders they can serve to influence their choices beyond the restaurant system (Welter: 2012).

To date in Cape Town there is not strong evidence for sustainable initiatives within the restaurant sector. Restaurants that are going to shift to more sustainable practices are dependent on consumer demand for their offering. If they shift to sustainable food offerings such as organic or free-trade they may need to pass on the premium to their customers. They may be concerned about being uncompetitively priced with the danger of being undercut by other restaurants. At the same time consumers looking for more sustainable food and production methods will reward them with their custom resulting in a competitive advantage in the longer term. So “[i]f you do bother you will set an example for other people. If enough other people bother, each one influencing yet another in a chain reaction of behavioural change, markets for all manner of green products and alternative technologies will prosper and expand...and those who did change the way they live would acquire the moral standing to demand change in behaviour of others - from other people, other corporations, even other countries.” (Pollan in Weber, 2009:176).

## 2 BACKGROUND

A Business Model Canvas was the outcome of a literature review and situation analysis examining the state of the restaurant industry in Cape Town in the light of ecological and social conditions. The research was always intended to have a practical outcome, by investigating the subject matter in order to make practical recommendations about sustainable restaurants in the city of Cape Town. The defining goal of the research was primarily exploratory in nature in order to identify opportunities and possibilities (Terre Blanche, Durrheim & Painter, 2006). Applied research is relevant as being able to contribute to solving issues with a social application (Terre Blanche et al., 2006). The restaurant industry was analysed through a database of 431 restaurants, secondary data and restaurant visits (Eat Out, 2011; Welter, 2012). As result of a SWOT analysis a number of challenges were identified to support the industry.

1. The creation of a support mechanism for the restaurants with a distinctive brand identity that could use restaurants as a pivotal point to help restaurants, consumers and other stakeholders move to more sustainable practices
2. The ability to use innovators within the restaurant system to help drive the move to a more sustainable identity
3. Forging alliances with like-minded parties outside the immediate industry to help the industry become more sustainable
4. Using an online presence supported by social media to communicate and engage with the restaurant industry and provide a space for interested parties to engage
5. Using events as a platform for education, networking and collaboration (Welter, 2012).

In order to support the Cape Town industry a comparative study was made of two restaurant associations, London’s Sustainable Restaurant Association (SRA) and the USA’s Green Restaurant Association (GRA). The Green Restaurant Association (GRA) was founded in 1990 with the mission to create an environmentally sustainable Restaurant Industry. They operate a voluntary certification scheme based on points (Dinegreen, 2011). The Sustainable Restaurant Association (SRA) was established in London in 2010. A potential member voluntarily pledges to operate according to SRA values. The platform supports restaurants with expertise and audits of current practice to help them set future goals with regard to social and environmental actions (SRA, 2010). The voluntary approach of the SRA was favoured as a replicable model adapted to local conditions. (Welter, 2012)

### **Business Model Canvas**

A business model was used as a research methodology as constructing the model employed the research findings of the literature review and situation analysis (Welter, 2012). The value is that “a business model describes the rationale of how an organisation creates, delivers and captures value” (Osterwalder & Pigneur, 2010:14). As part of his PhD work Osterwalder (2004) proposed a characterisation of a business model canvas that is employed as a research tool in this study. These nine themes of the canvas help view the business as a systemic whole with interconnected dimensions that support one another. Not only is the business model a methodology, it is also a real life tool that can be activated to address the issues raised by the research. This approach allows for a simple, straightforward analysis of the business logic of the business problem and creates a blueprint for

strategic application via the structures, processes and systems of the business (Osterwalder & Pigneur, 2010). The diagram below depicts the elements of the business model.

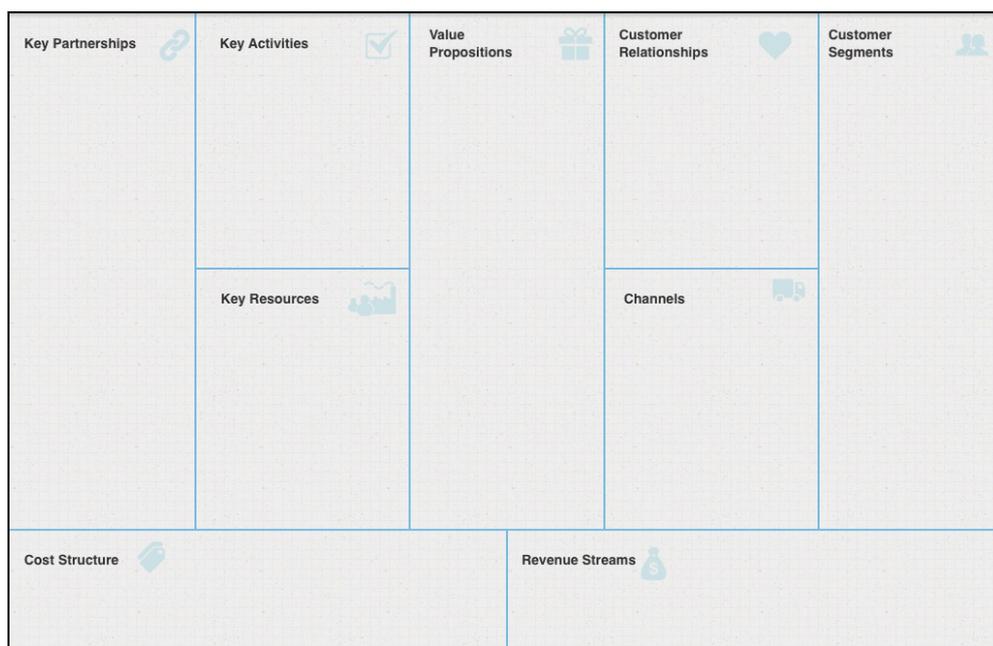


Figure 1: Business Model Canvas

### **Application of the Business Model Canvas**

The Business Model Canvas was theoretically applied to the restaurant industry in Cape Town as a way of making the industry more resilient and sustainable. The elements below are interconnected to create a working systemic logic.

- Value Propositions - how to solve customer problems and satisfy customer needs
- Customer Segments –people you want to serve
- Channels - communication, distribution and sales channels
- Customer Relationships - established with each segment
- Revenue Streams - result from value propositions
- Key Resources - assets requires to deliver the elements
- Key Activities - key activities needed to fulfil value proposition
- Key Partners - outsourced activities
- Cost Structure - based on elements such as channels and activities

### **Value Proposition**

The Value Proposition is the solution to the customer problem (Osterwalder & Pigneur, 2010).

*It is to provide a space, physically or virtually, for Cape Town restaurants and relevant stakeholders where they can be informed, educated and inspired; and can collaborate and be helped to move to sustainability.* Restaurants will be helped towards sustainability within the areas of Food, Resources (energy, water, waste) People and Communication. The initiative will be branded as the Longtable project ([www.longtableproject.com](http://www.longtableproject.com)) alluding to the need for collaboration by multiple stakeholders within the restaurant industry (Welter, 2012).

### **Customer Segments**

Customer segments are the groups served by the value proposition (Osterwalder & Pigneur, 2010).The primary customers are the restaurants themselves. However there are other market segments and stakeholders that need to be addressed. These include consumers, suppliers and other stakeholders

(e.g. NGOs, media, tour operators, concierges). The customer of the business model is any restaurant within the Cape Town region that is looking for information, collaboration, support or ultimately certification. Ideally innovators and early adopters can be targeted and to a large measure can be assessed by existing moves towards sustainability, e.g. local, organic, seasonal food. Additionally sub-segments can be investigated and clustered together as their requirements are unique e.g. Italian restaurants, coffee shops (Welter, 2012).

### **Channels**

The channels are the ways in which customer segments are reached (Osterwalder & Pigneur, 2010). The primary ways of reaching customers are through personal contact, web presence, and social media. A website is a space where multiple needs can be fulfilled and be a reflection of the tools and support the Longtable Project will offer. These will be based on the needs of the various stakeholders. A website can also be easily updated and accessed and is relatively cost effective (Welter, 2012).

### **Customer Relationships**

This refers to the type of relationships created with the customers. Longtable Project operates as a social enterprise as the purpose of the project is to use a business-like approach but offer a service to achieve a social and environmental purpose (Legal Resource Centre, 2011). However there is no legal definition or legal business form in South Africa for the establishment of these enterprises (Legal Resource Centre, 2011). While the enterprise is starting to develop it makes sense to run it as a sole proprietorship in the absence of a legal model.

### **Key Activities**

The key activities are derived from the consumer needs that have been identified. These include education, training, events, consulting, listings and communication on social channels and the website.

### **Key Partnerships**

The model for the business is one that provides information and directs restaurants to key players in the industry who are able to deliver needed services. This model enables the business to benefit from pre existing skill sets in the marketplace as well as optimising the allocation of resources and activities (Osterwalder & Pigneur, 2010). The system needs to connect with other stakeholders –bloggers, the city, consumers, chefs and suppliers (Welter, 2012).

### **Key Resources**

These resources are what make the business model work. The resources pay for the delivery of the value proposition to reach customer segments and earn revenue (Osterwalder & Pigneur, 2010). The key resources needed by Longtable Project are start-up capital, a vehicle and computer, human expertise and intellectual capital of the brand. Initially the impetus will be to get the business started using minimal finance until it is in a position to demonstrate viability to potential sponsors/funders. This interim period will also help assess demand for the service and allow opportunity for flexibility. (Welter, 2012)

### **Cost Structure**

This refers to the costs incurred to set up and run the project. These can be offset by the revenue streams. (Osterwalder & Pigneur, 2010)

Initial costs include:

- Brand design and development
- Website design and development
- Development of audit tool
- Set up of office equipment.
- Initial PR campaign
- Training materials
- Launch event

Initially the venture will be self-funded and financed with a view to creating a working, scalable model. Larger companies and suppliers that tie in with the ethics of the Longtable can be sought to supply funding via sponsorship as well as partners such as Cape Town Tourism, who will have a vested interest in the restaurant industry. The running costs will include the maintenance of website

and social media, transport, materials, marketing and event organisation. Ideally the initiative could start with one fulltime member and drawing on the expertise of other consultants on an ad hoc basis. The initial costs can be absorbed as an opportunity cost to get the enterprise in a position to attract interest (Welter, 2012).

### **Revenue Streams**

Revenue is funds derived from activities. The following revenue streams have been identified:

- Paid for events for the industry
- Consulting work to restaurants
- Social Media/ PR
- Training of restaurants
- A turnkey service to restaurants to meet their sustainability goals
- An online manual that is paid for
- Membership (Welter, 2012)

### 3 FINDINGS

After the completion of the theoretical model the real life implementation began. The test is whether a theoretical construct, albeit thoroughly researched, could hold up in real world conditions. This section will relook at the elements of the business model canvas to understand how the brand has started to live its life.

### **Business Model Canvas in action**

#### **Value proposition**

Firstly a brand identity needed to be created to reflect the value proposition of a space to educate, inform and inspire restaurants to become more sustainable. We were looking at a business that could be collaborative and supportive in providing a service to the restaurant industry in Cape Town to enable the industry to become more sustainable. The brand name stayed Longtable Project for its ability to express what the brand stood for. In December 2012 a designer was briefed to create a brand that would initially live its life online as a blog-based website and on social media (twitter, pinterest and instagram). It needs to be able to stand out as an icon in that space. At the same time the project needs to inspire trust and look simple, clean. A logo and colour palette was eventually agreed on. In the longer term if it takes off it will need to carry on into design work that can be used for an online resource book, fact sheets, invitations and meeting programmes.



*Fig. 2 Longtable Project Logo*

#### **Customer Segments**

Longtable Project started visiting Restaurants in the beginning of July after the completion of the design work. Restaurants identified by the research were visited to explain the project. A bistro, Dear Me (dearme.co.za) was the most responsive and had committed to sustainable objectives from the outset. After the first meeting with Chef Vanessa Marx and owner Ilse Koekemoer in the beginning of

July, they offered to invite people from the industry who had a similar mindset to learn about Longtable, effectively a launch event. At this meeting in August we outlined the purpose of Longtable Project and got everyone talking about collectively moving towards sustainability.

Two key insights emerged out of this meeting as shifts from the original intent:

- i. There are already a strong group of people committed to sustainability and it made sense to recognise them as a core for their commitment. This made membership a priority.
- ii. It was decided to use key suppliers could also join the project as this would strengthen the supply chain

This forum became a snowball recruitment platform to identify 24 founder members both restaurateurs and suppliers. These would be recruited to Longtable through email communications followed by personal visits. An agreement was drawn up whereby a founder member would pay R2000 as an annual subscription. They would also host a Longtable event and commit to three sustainable actions based on the Longtable Project audit. In turn Longtable Project would help them identify the three actions as well as help with organization of the event. Events would be open to founder members and other relevant stakeholders.

To date there are 16 founder members. They range from cafes and bistros to fine dining establishments and hotels. They include farmers and produce suppliers. Some of the restaurants are on farms that supply their produce. They are Dear me, Societi, Starlings Cafe, Delaire Graff, Oak Valley, Vineyard Hotel, Shoreline Cafe, Fresh at Paul Cluver, Foodbarn and Deli, Overture, Table at De Meye, Frankie Fenner, El burro, Farmer Angus, Wild peacock and Waterkloof. Award winning chefs are Vanessa Jaynem, Christiaan Campbell, Bertus Basson, Franck Dangerous and Greg Czarnecki. Discussions are in progress to finalise the last eight founder members. Once the founder members have been settled slowly additional members can be added. However they will need to go through a more rigorous process including training to be accepted. They will pay a higher joining fee to accommodate this.

### **Key Channels**

The channels identified to communicate with customer segments are the website, social media channels and any training materials. In January 2013 with the logo, colour palette and fonts in place the next step was to brief a web developer to design a basic website with the domain longtableproject.com that could start out as a marketing and communication tool as well as a link to social medium platforms. A twitter account (longtablect) facebook page, pinterest, instagram page were all started to create links to the site. A presentation document was created that highlighted the purpose of Longtable Project and was used as a marketing tool to prospective founder members. In addition stickers and badges of the logo were created to complete a presentation pack for the brand. Communication is ongoing via the social channels of facebook, twitter, instagram and pinterest and these channels are also used to promote the activities of the restaurants to the public. Specific emails are sent to members to communicate relevant information.

### **Key Partnerships**

Longtable Project has slowly started to connect with individuals and groups that can support the values of the project and make it work. As there are only 24 founding members, suppliers have the opportunity to work with Longtable as partners not members. These partnerships are not formal alliances but the building of relationships over time. As well as real life interactions email and social media are used to foster these connections. Some of these connections are Ed Franklin of the SRA, The Sustainability Institute, Mpumelelo Ncwadi of Indwe Trust, The Western Cape's 110% Green, Eco Atlas and Oranjezicht City Farm. Other partnerships that still need exploring include Eat Out, SASSI and Cape Town Tourism.

### **Key Activities**

These are the most important thing a business must do to offer the value proposition and earn revenue As described in customer segments the key activity is the recruitment of founder members. This process involves contacting a member, visiting them to ascertain their interest, follow up, agreement and invoice, marketing material, assisting them with setting their three projects

- As part of their agreement members need to do two things
- i. commit to three sustainable activities for the year of joining
  - ii. host an event for the year

The actions and events interconnect insofar as a member will host an event around one of their interests. Events hosted by Longtable and members are one of the key activities as they give the opportunity to look for collaboration. To expand, in October 2013 Trish Kratz of Starlings hosted a event where Mpumelelo Ncwadi, engineer and meat guru, used storytelling to help us understand the blockages in the current food system with regard to meat from grass-fed and pasture-reared animals. He shared some of the ways he intends to deal with these and challenged the chefs to join him. Mpumelelo is working on a series of meat challenges where a farmer supplies a cow and four chefs cook up the meat. He later disseminated information on the website regarding sheep-buying to support the Leliesfontein Community. (Longtableproject, 2013). We connected Johan Reyneke, a biodynamic wine farmer who joined us at the event to Perennial Plate. They are sustainable food film makers, who visited South Africa and made a film, featuring Reyneke as a surfer and natural winemaker.

Member Visits are another activity. During the busy season of November to February 2013 Longtable Project visited restaurants to help establish their activities for the year. These include waste management, recycling, identifying suppliers, moving towards sustainable produce, menu changes, customer communication, cleaning methods, new products and farming initiatives. A rating system is planned based on the Longtable Audit that will reflect multiple dimensions of sustainable actions as opposed to a simple star rating that lacks detail and nuance. An infographic with multiple dimensions can be used to depict degree of progress with regard to dimensions such as fresh produce and fish. An Annual Food Conference that draws on the expertise of founder members is also envisaged as a cornerstone of Longtable project.

### ***Customer relationships***

Although run as a sole proprietorship the business essentially lives its life as a social enterprise. The engagement the members have with the business entity is via the contractual agreement and the payment mechanism.

### ***Resources Needed***

As identified the physical, financial, intellectual and human resources needed to run Longtable Project were employed. A challenging dimension is the fact that the footprint of restaurants is larger than intended and therefore requires more travel.

### ***Revenue Streams***

Longtable Project considered the opportunity of sponsorship funding with a major retailer. However this was seen as a potential compromise until the brand had a presence of its own. Sponsorship would bring revenue but may restrict the freedom of Longtable Project. We wanted to maintain a critical stance toward feedlot meat, unsustainable fishing practices and industrialised farming methods without censure. Revenue has primarily been derived from the membership fees which amount to R48000 /year. This means that the business can cover its most basic costs but not generate income. Future standalone projects will need to be costed and self funded or sponsored if necessary.

### ***Costs***

Costs incurred to date have been the events, logo, website hosting and document design, stickers, promotional materials, travel, banking, and communication costs. These can be covered by revenue from founder members fees.

### ***Measurability***

To date there is no way of measuring the social and environmental impacts of the project. However the infographic rating tool that is in development will allow restaurants to track the percentage of their menu in terms of sustainable food and resource usage. These figures will be audited and benchmarked from year to year. Cumulative impacts can be measured. The tool will give consumers and other stakeholders a nuanced view of the restaurants' sustainability initiatives that can be tracked from year to year.

#### 4 CONCLUSION

The objective of the thesis and Longtable Project was to contribute to a more sustainable restaurant system. After a short period of time this vision is still on track but the route has changed. The recruiting of valuable founder members has been as successful process with a high response rate. The vision is to create a strong network of founder members that will be inspirational to other restaurants that are not as innovative. Events are a good way of getting like-minded people together.

Financially the current low cost-low revenue model needs to be scaled up. Other challenges are dealing with restaurants that aren't committed to sustainability as there may need to be more monitoring and auditing involved.

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# EFFECTIVENESS OF SUSTAINABILITY ASSESSMENT IN DEVELOPMENT COOPERATION

**Jean Hugé<sup>1,2</sup>(presenting), Tom Waas<sup>1,2</sup>**

<sup>1</sup> University of Antwerp, Belgium, Institute for Environment & Sustainable Development;  
[Jean.Huge@uantwerpen.be](mailto:Jean.Huge@uantwerpen.be);

<sup>2</sup> University of Ghent, Belgium; Centre for Sustainable Development [Tom.Waas@uantwerpen.be](mailto:Tom.Waas@uantwerpen.be)

## ABSTRACT

As sustainability assessment (SA) is increasingly presented as a key process in operationalizing sustainable development, especially in the development cooperation sector, there is an urgent need to conceptualize and measure its effectiveness. Inspired by recent research, a multidimensional SA effectiveness framework entailing procedural, substantive, transactive and normative dimensions of effectiveness is presented and used to structure interviews performed with SA practitioners and experts. This exploratory study reveals that SA is indeed used as an element in decision-making, but SA fails to trigger major organizational and individual change unless it is embedded into a broader sustainability momentum including capacity-building and leadership. Integrating resilience into SA practice might strengthen the two-way (impact & risk) approach towards *ex ante* sustainability assessment, and might also facilitate a balanced measurement of SA effectiveness in the future, especially given the multiple linkages between resilience and climate change adaptation – a dominant concept in the highly dynamic 21<sup>st</sup> century development cooperation sector.

*Keywords: sustainability assessment, effectiveness, development cooperation*

## INTRODUCING SUSTAINABILITY ASSESSMENT

The paper addresses the topical issue of the effectiveness of sustainability assessment (SA) approaches in development cooperation. Sustainability assessment is defined as a process aiming at operationalizing sustainable development as a decision-guiding strategy, through the identification of the future consequences of current and planned actions. This generic definition builds on the international literature ([1], [2]), and on existing SA frameworks in various jurisdictions. There is variation in emphasis and actual wording of the definition of SA, but this seldom points to actual disagreement, and both scholars and practitioners as a rule accept – and even welcome- the ‘open’ definition of sustainability assessment. Indeed, SA is generally not a prescribed process as such, it rather is an orientation of practice [3], [4]. SA is not as codified as environmental impact assessment (EIA) or strategic environmental assessment (SEA), and while this allows for freedom and inventiveness in develop context-specific definitions, methods and applications it also means that SA frameworks come in many shapes, and entail a wide range of assessment criteria – reflecting the various interpretations of sustainable development/sustainability itself. Indeed sustainable development is characterized by ‘constructive ambiguity’. It gathers many societal stakeholders behind the same broad objective(s) although many interpretations co-exist.

Even when there is agreement on a context-specific sustainability assessment approach, the involved actors may have divergent expectations with regard to the functions of SA in the decision-making process – especially in a North-South context. The variety of experiences and views w.r.t. sustainability and the consequent variety of SA approaches reflects a genuine search for changing decision-making for the better – but it also highlights the need for a more or less consistent set of

process requirements [5]. This has led to the mushrooming of ‘principles’ and ‘characteristics’ of an ideal-typical SA (e.g. the –updated- Bellagio principles [6], which can be summarized as follows [7]: i. SA should foster sustainable development objectives (e.g. [4] distinguish SA from other types of impact assessment as it is objectives-led, instead of using the conditions that are likely to prevail in the absence of the proposed initiative as benchmarks for determining the significance of impacts, although [8] provide an alternative view); ii. SA should have a holistic perspective; iii. SA should incorporate sustainability in the assessment process and procedure (by fostering transparency and participation) and iv. SA should ‘actually’ support decision-making.

These generic characteristics do contribute to turn SA into a somehow more tangible approach, but in order to delve deeper into what a ‘successful SA’ might mean, and in order to define whether SA ‘works’, i.e. whether SA delivers its promises, one has to analyse the core of the SA approach, preferably by focusing on concrete cases where SA has been realized.

Having performed policy-supporting research for actors of the Belgian Development Cooperation for many years now, we are regularly facing scepticism as well as (over-)enthusiasm from policy-makers and other (state and non-state) actors in the development cooperation, when it comes to appreciating the effectiveness of SA. The development cooperation sector has seen the emergence of a range of impact assessment tools and processes in order to improve its results and its ways of working amid a context of global environmental and geo-political change. Partly thanks to the work of the OECD’s Development Assistance Committee (DAC), strategic multidimensional approaches to impact assessment (such as strategic environmental assessment [9]) have been promoted and implemented. Bilateral donor agencies have started to develop and use their own –sustainability- assessment approaches, often triggered by the need to adapt their programmes and project design, as well as their organizational set-up, to the new multidimensional challenges of climate change and to the rise of the poverty-environment nexus on the international agenda.

However, both the conceptualisation of SA effectiveness and empirical studies evaluating the effectiveness of SA in development cooperation are lacking [10]. The paper will provide insight into the interpretation of ‘SA effectiveness’, and introduce the preliminary findings of research on the ‘use’ and on the ‘results’ of SA performed in support of projects funded by the official Belgian Development Cooperation (DGD (Direction-General Development & BTC (the Belgian Technical Cooperation)) and by the regional Flemish International Cooperation Agency (FICA). This research is conducted as part of the inter-university KLIMOS Research Platform on Climate Change & Development Cooperation. The specific objectives of the study are:

- To conceptualize the effectiveness of SA processes in the context of developing countries by proposing an indicative adapted SA effectiveness framework;
- To identify potential indirect results of SA;
- To provide insight into the –factors influencing- effectiveness of SA in development cooperation by way of case studies;

## **CONCEPTUALISING EFFECTIVENESS**

The paper builds both on the demands from practitioners (both governmental development agencies as multilateral organizations, non-governmental actors and recipient country administrations), as well as on current academic research streams focusing on the effectiveness of sustainability assessment. The methodological framework ensures a multidimensional approach to sustainability assessment effectiveness, including procedural, transactive, substantive and normative effectiveness (based on

[11] and [12]). Acknowledging that effectiveness is difficult to measure in absolute terms because of the diverse and even divergent reference points against which effectiveness might be judged, does not need to paralyze scholars aiming at proposing frameworks for comparing and evaluating sustainability assessment practice. [12] define four components of sustainability assessment effectiveness:

- Procedural effectiveness, which focuses on an analysis of compliance with regulatory stages and with expectations of good practice.
- Substantive effectiveness, focuses on the achievement of sustainability outcomes thanks to sustainability assessment.
- Transactive effectiveness, focuses on the cost-effectiveness in terms of human and financial resources used in the sustainability assessment.
- Normative effectiveness, focuses on the degree to which sustainability assessment has reversed unsustainable trends, fostered mutually reinforcing gains and minimized trade-offs.

[13] provide an interesting complementary perspective, by providing a focus on learning effects fostered by sustainability assessment, while we also used the work of Lozano [14] to gain insight into organizational & attitude change that may be triggered by the use of sustainability assessment.

We subsequently developed a sustainability assessment effectiveness framework, inspired by [11,] [12], [13] and [14], to guide the set-up of interviews through which we subsequently gathered information about SA effectiveness (see below).

*Table 1: Sustainability assessment effectiveness framework*

Components of SA effectiveness		Specific questions
Procedural effectiveness		Administrative status of SA & compliance
Substantive effectiveness	Performance	Use of SA in decision-making process?
		SA used as a reference?
		SA used beyond specific cases?
	Individual learning	Learning among involved actors?
	Conformance	Content of the initiative/decision modified thanks to SA?
Significance of the modifications?		
Transactive effectiveness		Required skills & staff present to perform the SA?
		Clear division of tasks in the SA process?
Normative effectiveness		SA led to reversal of unsustainable trends?
		SA led to better integration of the various dimensions of sustainability?
	Organizational learning	Along the following levels of learning: knowledge, comprehension, application, analysis, synthesis, evaluation?
	Individual attitude change	Informational, emotional & behavioural change?

## MATERIALS & METHODS

Table 1 forms a first attempt at translating the components of effectiveness into a series of questions (right column of Table 1). Asking these questions will allow us to identify SA effectiveness criteria, which can then be used to assess the effectiveness of SA exercises through multi-criteria analysis. In doing so, the report of this explorative research step, is positioned among a broader endeavour.

The indicative SA effectiveness framework was used to:

- Guide the semi-structured interviews of actors involved in the pilot application of SA exercise (in particular the KLIMOS Environmental Sustainability Toolkit (i.e. officials, not (necessarily) IA experts);
- Guide the semi-structured interviews of sustainability assessment experts active in the sector of development cooperation (resource persons with a ‘helicopter view’ of the issue and/or broad experience in IA in development cooperation)

Through these interviews, we aimed at:

- Translating the components of SA effectiveness into a set of criteria in order to improve the conceptualisation of SA effectiveness;
- Gaining insight into the appreciation of the effectiveness of SA in specific cases by probing for the respondents’ experiences
- Gaining insight into the –factors influencing- effectiveness of SA in development cooperation.

The respondents were selected among Belgian officials working at DGD, BTC and FICA, who have been involved in the application of SA exercises between 2009 and 2013; and among SA experts (academics from various backgrounds with SA experience in Africa). The interviews were performed in Brussels, Belgium, and in Montréal, Canada between February 2013 and February 2014. The research project is still ongoing, additional interviews will be conducted in 2014.

## PRELIMINARY RESULTS & DISCUSSION

The interviews of 10 respondents were analyzed for the purpose of this paper. The results are presented i. in Table 2, as a percentage of respondents who answered ‘yes’ to the question of column 3; and ii. In the text below, through a selection of quotes. As stated higher, these are preliminary results; more interviews are planned in 2014.

*Table 2: Results of the interviews, expressed as percentage of positive (yes) answers provided by the respondents*

Components of SA effectiveness		Specific questions asked to the respondents	Percentage of positive answers
Procedural effectiveness		Administrative status of SA & compliance	20%
Substantive effectiveness	Performance	Use of SA in decision-making process?	90%
		SA used as a reference?	80%
		SA used beyond specific case at hand?	30%
	Individual learning	Learning among involved actors?	80%

	Conformance	Content of the initiative/decision modified thanks to SA?	70%
		Significance of the modifications?	50%
Transactive effectiveness		Required skills & staff present to perform the SA?	40%
		Clear division of tasks in the SA process?	70%
Normative effectiveness		SA led to reversal of unsustainable trends?	10%
		SA led to better integration of the various dimensions of sustainability?	60%
	Organizational learning	Along the following levels of learning: knowledge, comprehension, application, analysis, synthesis, evaluation?	80%
	Individual attitude change	Informational, emotional & behavioural change?	40%

90% of the respondents stated that sustainability assessment processes were ‘actually used’ in the decision-making process, and in most cases, SA reports/results were used as a reference during the discussions leading to the final decision. 70% of respondents reported a modification of the initial initiative following the SA, although only 50% state that this modification was significant, pointing to the risk of using SA as a corrective add-on instead as a central factor in decision-making. The use of SA beyond the specific case in which it was applied probes for SA-induced changes in anticipation of the realization of an assessment (see e.g. [15]): only 30% of the respondents witnessed such situation, indicating that SA is often an *ad hoc*, case-specific process. The efficiency of the SA process, measured by the ‘transactive effectiveness’-questions, could be enhanced as a majority of respondents indicates that the capacity required to carry out a successful SA is lacking. People know how the SA should work and who should do what, however, financial and human resources are insufficient. This finding points to the need for continued support and capacity-building. This was corroborated by the many remarks about the need for SA to be embedded into broader sustainability dynamics reflected in training, strategic policy change, capacity building etc. As one respondent put it: *“The existence of an SA framework as such is not enough. However, in the period where training was provided, there was a momentum in the organization.”* Or *“SA did not cause major changes as such, but it would if it were backed by heads of departments and if it were part of a larger set of actions.”*

SA is not sufficient on its own to trigger a change in discourses and subsequent actions in the surveyed organizations. SA as such did not reverse unsustainable trends, which underlines the gradual, reformist character of SA, as well as its modest yet key role. A respondent formulated the strength of SA as follows *“Applying the SA had a signal function – we rapidly knew when there were going to be negative sustainability effects thanks to the SA.”*

SA is a pragmatic instrument (e.g. 60% of respondents indicated that SA contributed to a better integration of the three dimensions of sustainable development (still one of the most widely known interpretations of sustainable development)), and is considered important to ‘translate’ sustainable development into an operational concept, as one respondent put it: *“SA is used as feedback in the*

*policy preparation phase, responds to a strongly expressed need in our organization to translate climate & sustainability pledges into -modest yet tangible- program and project action."*

SA is definitely seen as an element in a process of organizational learning towards sustainability yet apparently fails to foster wide individual learning. The surveyed individuals indicated that favorable individual predispositions towards sustainability were key and that individual learning through SA alone was not apparent. Attitude change was witnessed mainly during the implementation phase of SA-supported projects. The following quotes highlight other aspects of SA (such as enhancing the legitimacy of environmental/sustainability departments): *"The use of the SA has become a kind of quality label. Its existence has also made our (climate & natural resources) department better known among our colleagues"*. One respondent also stressed SA failure as an interesting learning opportunity.

In addition, some respondents stressed the need for a flexible approach to SA implementation: *"SA is now mainly used to structure decision making but it is difficult to know what tool is best suited to perform it in various situations"*. Or *"A distinction has to be made between SA used in the Brussels headquarters by desk officers, and the SA that can be used on the field in projects in the South"*. *"SA is a necessity, I think we all acknowledge this, but is it adapted, is it catered to our needs?"*

The presented qualitative effectiveness assessment is a first step. It will be completed by a semi-quantitative appreciation of SA effectiveness in a next research phase, when a multi-criteria analysis framework will be developed and applied to SA cases.

## **RESILIENCE AS A LEADING CONCEPT IN SA EFFECTIVENESS?**

Although SA is considered helpful in translating the sustainability concerns into tangible action and recommendations for development cooperation practitioners (as reflected in the interview findings above), intellectual, policy and behavioral inertia, as well as competing interests, too often dominate decision-making. Sustainability assessment can't fix everything. But it provides an opportunity to launch 'new' concepts and to immediately proceed to their operationalization.

Thanks to its forum function –SA is a process where multiple actors confront each others' views on sustainability-, new ideas and concepts can ideally be launched *during* an SA process. If the involved actors find common ground on what exactly is to be assessed in a particular case, these new ideas can then be translated directly into criteria and indicators, and they can subsequently be used to assess the relative performance of various policy alternatives.

Resilience defined by [17] as the capacity of a system to absorb disturbance and retain the same structure and function, is inherently linked to adaptability and flexibility. An ideal-typical SA should hence assess to what degree a policy initiative can withstand disturbance *sensu lato*. In order to do so, a SA framework should also operationalize 'adaptability to change', by analyzing the magnitude of disturbance (*e.g.* impacts of global change; degree of uncertainty), by analyzing the impact of the disturbance, by increasing the adaptability and transformability of the initiative and of the system in which it is embedded, and by providing mitigation measures.

While resilience resonates particularly in the development cooperation sector –as it refers both logically as intuitively to the social & ecological dimensions of development- it is not yet central in the SA frameworks applied by the Belgian Development Cooperation. The ecosystem services concept provides an entry through which resilience could be introduced in SA [16]. Incorporating ecosystem

services into SA helps practitioners and decision-makers to reflect on the impact of the environment on their plan, program or project rather than just vice versa [16] (as in classical impact assessments such as Environmental Impact Assessment (EIA)). This specificity of SA is a key opportunity for the operationalization of the resilience concept. Focusing on the impacts of development cooperation interventions on the capacity to resist social & ecological disturbance will involve a new way of conceptualizing impact assessment *sensu lato*: the two-way relationship between development interventions and socio-ecological environment can be conceptualized and measured by using the resilience concept. This would also allow to respond to the pressing questions of development practitioners in North & South regarding the added value of development cooperation in a global change context.

The KLIMOS Environmental Sustainability Toolkit (for now the dominant SA approach in the Belgian Development Cooperation) follows this two-way approach, focusing both on the impacts of an initiative on the socio-ecological environment, as on the risks generated by the environment. These risks may jeopardize the development initiative. Resilience, with its focus on adaptability, is closely linked to often heralded climate change adaptation – a concept that tends to overshadow all other sustainability considerations in development cooperation. Resilience may contribute to rebalance that one-sided view, that is, if ‘operationalizing processes’ such as SA succeed in practice.

## CONCLUSION

Sustainability assessment is increasingly heralded as a key process to operationalize sustainable development and its approach fits well within the evidence-based and multi-actor turn in decision-making. It is essential to confront the high expectations regarding SA with the reality of its implementation, and it is key to develop and apply frameworks allowing to measure the effectiveness of SA, in order to answer the ‘does SA work?’ question. As the characteristics of the decision-making process as such have huge effects on the perception of the legitimacy of a decision, analysing the effectiveness of the SA process, and hence going beyond the analysis of the mere outcomes of SA, is key.

By fine-tuning and adapting a multidimensional effectiveness framework inspired among others by [12], we structured and performed a series of semi-structured interviews with actors of the Belgian development cooperation and international SA experts. The empirical data provide evidence for the substantive effectiveness of SA (SA contributed to more sustainable project implementation), but shows that procedural effectiveness is often low (due to the lack of codification), and that transactive effectiveness (efficiency in resource use) and normative effectiveness results are mixed. Resilience is increasingly used as an integrative concept in development cooperation as it can be ‘translated’ into a social (hence ‘classical’) as well as an environmental justification of development. Integrating the concept of resilience in SA might enhance its effectiveness as it would allow to firmly anchor a two-way assessment approach (focusing both on project-induced impacts, as on socio-ecological context-induced risk).

In the same vein, [18] state that future research should aim at investigate the institutional mechanisms that enable or impede transactions between the different types of social & ecological capital. SA might play a central role there, as its holistic perspective, its focus on decision-support and its pragmatic approach to translating sustainability lend it a potentially central role in organizational sustainability frameworks.

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# DEVELOPING A SET OF MEASURES TO ASSESS WELLBEING IN LOW-CARBON CITIES

Christopher T. Boyko- presenting<sup>1</sup>, Rachel Cooper<sup>2</sup>

<sup>1</sup> Lancaster University; c.boyko@lancaster.ac.uk

<sup>2</sup> Lancaster University; r.cooper@lancaster.ac.uk

## ABSTRACT

Policies aimed at reducing the world's carbon consumption often focus on the need to change existing behavioural and social practices as well as to provide technological advances in energy supply, waste, transport, industry and the built environment. While fundamentally important in the mitigation of climate change, little is written about the impact that achieving carbon reduction targets, particularly for the built environment, will have on citizens' quality of life and wellbeing. As part of the *Liveable Cities* project, the authors have developed a set of measures that may be used to assess subjective and objective wellbeing as it relates to the built environment and low carbon in cities. The purpose of the paper is to outline the strategy for collecting and synthesising these measures. Based on a collection of almost 2,300 measures, 100 measures—50 objective and 50 subjective—were selected that relate specifically to the built environment and the low-carbon agenda. These 100 measures may be used by researchers in the first instance to help determine a baseline for how well cities are performing in terms of the relationship between wellbeing, low-carbon and the built environment. Decision- and policy-makers in cities then can consider—along with the use of other wellbeing, low-carbon and built environment assessments—how to transition to a low-carbon future to encourage wellbeing and minimise illbeing.

*Keywords: Wellbeing, low-carbon cities, built environment, cities*

## 1 INTRODUCTION

With the introduction of the Climate Change Act in 2008 and a plan to transition to a low-carbon country in 2009, the UK Government began developing a route map that focused on emissions reductions, resource security, economic opportunities and the protection of vulnerable groups [1, 2]. To achieve a significant carbon reduction, scientists, policymakers, advocates and academics advocate technological, societal and behavioural changes [2,3,4,5,]. These may include greater investment in low-carbon infrastructure; changing the way energy is used, the type of energy and where energy is derived; shifting the mode of transport from private to more public use; altering the patterns of daily social life; and reconsidering governance systems. While such adaptations to the way we live, work and recreate may result in carbon reductions, we are unsure of the impact on our quality of life and individual and societal wellbeing. To date, this issue only has been discussed at the conceptual level and using anecdotal case studies, and not been explored empirically (see [5,6,7,8,9]). Through the *Liveable Cities* project, the authors aim to provide empirical evidence that suggests a relationship between transitioning to a low-carbon future and wellbeing, and provides ways of measuring the impact.

This article begins by explaining the research strategy for gathering and selecting measures to use when evaluating wellbeing within the built environment of cities. The measures then are introduced and explained in more detail. The final section illustrates the 100 measures that were chosen for the project and next steps in the research.

## 2 THE RELATIONSHIP BETWEEN WELLBEING, THE BUILT ENVIRONMENT AND LOW-CARBON DEVELOPMENT

Since the beginning of the 21<sup>st</sup> century, a number of reviews have been published that highlight the mostly correlational relationship between wellbeing and the built environment (see [10, 11,12,13,14,15]). Much less has been written about the three-way relationship between wellbeing, the

built environment and low-carbon development. This may be because low-carbon development is a relatively recent phenomenon and greater emphasis has been targeted at how places will adapt to uncertain futures, rather than to how adaptation will affect citizens' quality of life and wellbeing. Nonetheless, discussion around the impacts of embodied carbon in building materials and the carbon footprint of our built environment has prompted questions about what can be done to reduce the impact of carbon on the environment, the economy and people's lives [6,16]. While already being discussed in the built environment and healthcare sectors to some extent (see [6,7,8,9]), there is a lack of concrete testing and empirical evidence to demonstrate that transitioning to a low-carbon built environment also positively impacts wellbeing. In the next section, the authors discuss their approach for empirically assessing wellbeing within built environments and whether features of low-carbon development support better wellbeing and quality of life amongst residents.

### 3 RESEARCH STRATEGY

The authors began their search of wellbeing and wellbeing-related measures by using an online search engine and entering terms, such as "wellbeing", "happiness", "quality of life", "life satisfaction", "questionnaire", "survey", "checklist", "inventory", "scale", "index", "indicator" and "measure", including plural forms of relevant words. From this search, 2,288 measures from 98 different sources were found.

The next task was to reduce the number to a feasible amount, as the idea is to use a set of measures to assess wellbeing in cities, both as they are now and in low-carbon scenarios. Reducing the amount involved analysing each measure and deciding if it was related to wellbeing, the built environment and low-carbon development. To do this, the authors developed criteria, taken from four influential sources: [6,7,8,9]. From these publications, 30 issues were highlighted, based on two, relevant, built environment scales (12 at home/building scale and 18 at neighbourhood/city scale).

For each measure to be considered relevant, it had to address an appropriate number of criteria. Because some measures were better represented at one scale versus another scale (e.g., percentage of people who feel they belong to their neighbourhood), the total number of criteria addressed might be low. However, at one scale, the measure might have addressed many criteria; thus, it would be selected. Those measures that overlapped both scales and addressed many criteria at both scales also would have been selected.

In an effort to group the measures together, rather than create a large list based on the above analysis, the authors created categories. Like the measures, the categories were analysed to ensure that they made sense, responding to the following question and sub-questions:

1. Does the category make sense?
  - Can the category fit into another category (e.g., can the category, "work", fit into "work-life balance")?
  - Should the category be split into one or more categories (e.g., should the category, "social support", be split into "social interaction", "family interaction" and "digital interaction")?
  - Does the category fit with the wellbeing, built environment and low-carbon agenda?
  - Does the measure fit the category?

Based on the above questions, 30 categories were created and 22 were used in taking forward the 100 measures.

#### 3.1 The wellbeing measures in more detail

The 2,288 indicators were selected from 98 different sources from around the world that were measuring some aspect of wellbeing, happiness and/or quality of life. The sources ranged from those measuring wellbeing across countries (i.e., at the international scale) to those measuring wellbeing among individuals (i.e., at the sublocal scale).

From examining the different sources, over a third of the measures were found at the sublocal scale. These sources, such as the Life Satisfaction Index, are often used by psychologists, psychiatrists and other healthcare professionals to understand how a client or patient is doing in terms of their mental health, including their wellbeing. The next most frequent scale was national, with many countries creating their own surveys to measure wellbeing within their country. For example, through the Scottish Executive, Scotland developed a survey in 2002 called, "Well? What do you think?", which

measures public attitudes to mental health, mental wellbeing and mental health problems [17]. The third most frequent scale was international. Here, international bodies and organisations measure wellbeing and compare results across different countries or larger administrative boundaries. For example, the European Commission set up Eurobarometer in 1973 to monitor public opinion of EU Member States [18]. The remainder of the sources were found between sublocal and national scales, at local/sublocal, subregional and regional/local scales.

Further analysis of the wellbeing measures revealed that approximately 75% were subjective; that is, the indicators asked about feelings, life experiences, judgements and preferences [19,20,21]. The remaining 25% were objective measures, which refer to external evaluations of the social context using measurable criteria [19,22,23]. Asking about a person's fear of crime in their neighbourhood is an example of a subjective measure; calculating actual crime rates in that same neighbourhood is an example of an objective measure.

In terms of the audience that the sources wished to target, the authors determined that 87% did not specify any demographic. That is, most sources did not direct their wellbeing measures at one or more audience. When the sources with no unspecified audience were removed from the equation, the following was observed:

- 37% targeted children or youth
- 19% targeted youth
- 17% targeted children
- 13% targeted children, youth and adults
- 6% targeted children and families
- 5% targeted older people
- 3% targeted adults

Thus, of the 13% of sources that aimed to understand the wellbeing of a specific audience, 92% targeted children or youth in some way. This is not surprising, given the spotlight on community development programmes and initiatives that have attempted to support children and youth since the 1950s [24,25], and organisations that monitor inequality and disadvantage among children and families (e.g., the UK National Children's Bureau).

Finally, in an effort to understand which areas of wellbeing were most popular among the 98 sources, the authors divided all the measures into 31 categories and counted the frequency of measures in each category. Some of the same measures were used by different sources (e.g., a life expectancy indicator was found 21 times amongst the sources) whereas others were distinct, yet still fit into one of the categories (e.g., the Bhutan Gross National Happiness Index asked, "Do you consider Karma in the course of your daily life?").

The category, Psychological health, contained the most wellbeing measures, with nearly 30% of the total indicators represented here. As stated earlier, this may be due to the prevalence of measures at the sublocal scale that healthcare professionals, including psychologists and psychiatrists, use when assessing the wellbeing of patients and clients. The next most frequent category was Social support (almost 10% of the total indicators), which is regarded as one of the main components of wellbeing [26, 27,28]; as such, there is likely to be great interest in better understanding how social support works in various contexts. The third most popular category was Environment (representing approximately 9% of the total indicators). As a result of the tangible nature of certain environmental features, such as the average concentration of particulate matter in cities, or the focus on qualities of urban environments [29], such as residents' perceptions of noise pollution, data from environmental indicators may be collected more often than other, less concrete or valued indicators.

Compared with the above categories, most of the remaining categories had relatively low quantities of wellbeing indicators (i.e., less than 5% of the total indicators; General health and Community participation were exceptions with about 6% and 5%, respectively). In fact, some categories, such as food, information and knowledge, morals, and private services, only had one or two indicators within their respective categories. This latter finding suggests that there are current gaps in the way wellbeing is defined and measured that could be examined in more detail. A more plausible reason—and one that

was confirmed by analysing the categories—is that some categories did not make sense or were incorporated into already-existing and meaningful categories.

### 3.2 The wellbeing measures used to assess the low-carbon built environment in cities

Upon analysing all the measures against the criteria mentioned in the Research strategy section, 100 measures were selected: 50 subjective wellbeing measures and 50 objective wellbeing measures. In addition, from the 31 categories created, 22 categories were selected. The 100 measures represent those aspects of wellbeing that have a relationship with low carbon and the built environment, and therefore may be used to assess the low-carbon, built environment in cities. Table 1 outlines the subjective measures, divided by category, and Table 2 shows the objective measures:

*Table 1. Subjective wellbeing measures by category*

Category	Measure
Community participation	How would you describe your sense of belonging to your neighbourhood?
	What sorts of things stop you from doing any activities you would like to do?
Crime	How safe do you feel walking alone in this area after dark?
	How safe do you feel walking alone in this area during the day?
	How safe do you feel in [CITY NAME]?
	It is safe to be out and about on the streets
Domain-specific satisfaction	Please tell me how satisfied you are with your home/housing
	Please tell me how satisfied you are with your health
	How satisfied are you with how safe you feel?
	How satisfied are you with the basic services offered by your local authority?
	In general, how satisfied are you with the way your local authority is doing its job?
	On a scale of 0 to 10, how satisfied are you with your/a good present standard of living?
	How satisfied are you with your local area as a place to live and work?
Economy	[CITY NAME] spends its resources in a responsible way
Education	How happy are you about the school that you go to?
Environment	In your city or area where you live, are you satisfied or dissatisfied with the beauty or physical setting?
	It is important to me that I can be proud of my local environment
	Do you live within a ten-minute walk of a natural blue or green space?
	What do you think of the parks and play areas in your area?
	My local area is safe for children to play outside
	[CITY NAME] is committed to the fight against climate change
General life satisfaction	Overall, how satisfied with your life were you 5 years ago/12 months ago
	All things considered, how satisfied or dissatisfied are you with your life as a whole nowadays?
	Overall, how optimistic do you feel about the next 12 months/5 years?
	On which step of the ladder would you say you personally feel you stand at this time (0 at the bottom and 10 at the top)?
Housing	How important is housing quality to quality of life, both now and in the future?
	My (family's) home is nice
	I wish I lived in a different house
Planning	How important is more building in the countryside to quality of life, both now and in the future?
Political participation	Which of the following, if any, have you done during the last twelve months? (list several political activity options)
	How much influence do you have over the quality and variety of local sporting facilities?
Psychological health	I love doing things that stimulate my senses
	I feel a sense of pride in the way my city looks and feels
Public services	In general, how would you rate the quality of state childcare services in the UK?
	In general, how would you rate the quality of public health services in the UK?

	In general, how would you rate the quality of care services for elderly in the UK?
	In general, how would you rate the quality of sports facilities in the UK?
	In general, how would you rate the quality of local education services in the UK?
	In general, how would you rate the quality of council housing in the UK?
Social support	On average, about how many people do you have contact with in a typical week day, including people you live with?
	I feel close to the people in my local area
	My parents and I doing fun things together
	Have you been bullied at school?
Society and tolerance	My local area is a place where people from different racial and ethnic and religious backgrounds mix well together
Transportation	How satisfied are you with the accessibility of public transport?
	How important is road traffic to quality of life, both now and in the future?
	In general, how would you rate the quality of the public transport system?
	In general, how would you rate the quality of the infrastructure?
	Why don't you use public transport? (list several reasons)

*Table 2. Objective wellbeing measures by category*

<b>Category</b>	<b>Measure</b>
Community participation	Percentage of people who feel they belong to their neighbourhood
Crime	Personal crime rate
	Percentage of children who feel safe going to/from X
Demographics	Number of inhabitants
Economy	Household/family income
	Wages for different demographics (e.g., men and women)
	Poverty rate
	Private investment in dwellings
Education	Literacy rate
	Highest degree awarded
Employment	Unemployment rate
	Percentage of the working age population in employment
Energy	Greenhouse gas per household
	Average total energy consumption of buildings
	Energy consumption for transport
Environment	Average ecological footprint
	Populations living in areas with in relative terms, the least favourable environmental conditions
	Percentage of wards in the 10% most deprived areas
	Percentage of households satisfied with the quality of the places in which they live
Housing	Total resident population per km <sup>2</sup> of built-up area
	Share of total population/households living in substandard/unfit housing
	Satisfaction of people over 65 with both home and neighbourhood
Physical health	Percentage of people who report daily physical activity
Planning	Share of sustainably-classified buildings of all new and renovated buildings
	Presence of an integrated plan in the city
Political participation	Participation rates in most recent/local/national election
Public services	Spending for sporting and cultural facilities
	Number of people living near open spaces
	Numbers of visitors to national parks/historic sites
Social support	Percentage of people who believe people from different backgrounds get on well together in their local area

	Perceptions that people in the area treat one other with respect and dignity
Society and tolerance	Proportion of people who feel that racial or religious harassment is a problem in the local area
	Proportion of people from ethnic minority groups who feel that racial or religious harassment is a very or fairly big problem in the local area
Standard of living	Household computer access
	Household Internet access
	Household broadband access
	Proportion of the population living in the most deprived super output areas in the UK
	Percentage of the population that live in households that are income deprived
	Percentage of the population of working age that is claiming key benefits
	Average amount of money that a household earns per year, after taxes
Transportation	Annual transit cost
	Vehicle miles travelled per household
	Length of roads and cycle paths
	Mode of transport used by households
	Number of fatal injuries per million vehicle kilometres
	Average density of vehicles on the road per kilometre
Work	Working hours
Work-life balance	Time/week for sleeping (hours)
	Time/week for working (hours)
	Time/week for leisure (hours)
	Have you been to a local park or playground in your free time in the last 4 weeks?

#### 4 CONCLUSIONS

It is clear from this analytical review of measures that the concept of wellbeing is extremely broad and multi-dimensional, and that it is not feasible to use 2,288 indicators in any survey of wellbeing. Therefore, it is essential to focus the assessment of wellbeing on a specific intervention or location. The 100 wellbeing measures listed in Tables 1 and 2 can be used to begin to explore how people feel about or perceive a range of topics relating to wellbeing (i.e., the subjective measures) as well as ‘factual’ information about the places in which people live (i.e., the objective measures). With the importance given to the relationship between wellbeing and the built environment [11,12], it also makes sense to evaluate those features of the physical environment (includes both the built and the natural environments) that relate to wellbeing and low-carbon development. This is where an audit of the environment would be useful; in principle, by objectively assessing the provision of goods in an area, such as the presence, quality and access of pavements and parks, more information about the context in which people live, work and recreate becomes known (cf. [30] for the value-laden nature of built environment audits). A good scale at which to audit the built environment, therefore, would be the neighbourhood, which primarily includes an evaluation of public spaces. Such an integrated approach allows for both top-down (objective measures; audits) and bottom-up (subjective measures) methods, and creates a more holistic picture of wellbeing within an area [31]. Combining this approach with digital technology and social media (see Mappiness project [32]) would further triangulate data and information, and allow for science and ‘citizen science’ to inform wellbeing research [33,34]. To that end, the wellbeing research team within the Liveable Cities project will be investigating the potential of a ‘day-in-the-life’ app that would collect responses from citizens using a selection of the 100 wellbeing measures as well as geo-located data related to physical environment and mobility-related features. This research sits within the wider Liveable Cities project, which is examining how local authorities and other stakeholders can understand and measure the performance of a city, and how this information can be used by cities to transition to a low-carbon, resource-secure future without compromising wellbeing. Thus, it is of fundamental importance that we first understand wellbeing and its relationship with low carbon, and then understand how to measure wellbeing in a way that is useful and inclusive.

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# WELLBEING AND URBAN SUSTAINABILITY: BEYOND SOCIAL INDICATORS

**Quyên N. DUONG<sup>1</sup>, Lai Choo MALONE-LEE<sup>2</sup>, Devisari TUNAS<sup>3</sup>, Chye Kiang HENG<sup>4</sup>**

<sup>1</sup> Research Associate, Centre for Sustainable Asian Cities, National University Singapore, [sdednq@nus.edu.sg](mailto:sdednq@nus.edu.sg)

<sup>2</sup> Director, Centre for Sustainable Asian Cities, National University Singapore, [sdemalon@nus.edu.sg](mailto:sdemalon@nus.edu.sg)

<sup>3</sup> Research Fellow, Centre for Sustainable Asian Cities, National University Singapore, [sdedt@nus.edu.sg](mailto:sdedt@nus.edu.sg)

<sup>4</sup> Dean, School of Design and Environment, National University of Singapore, [sdehck@nus.edu.sg](mailto:sdehck@nus.edu.sg)

## ABSTRACT

In the discourse on urban sustainability, wellbeing is often assessed by a set of social indicators (e.g. OECD Wellbeing Indicators; UN Human Development Index - HDI) which are evaluated with conventionally defined metrics that attempt to define its attributes in quantitative terms. However, wellbeing is a multi-dimensional concept which also refers to the less tangible ideas of happiness, life satisfaction or freedom (Welsch & Kühling, 2009), as well as intellectual, spiritual and cultural pleasure (May, 2007). It essentially looks beyond basic needs to include aspects of life such as family life and work relationships, and would also embrace people's ability to pursue their goals, to thrive and "feel satisfied" with their life (OECD, 2011). In the city context, urban planners and policy makers need to engender supportive environments for wellbeing, and for this, "liveability" can be viewed as the capacity of the built environment to advance the wellbeing of its residents. This paper thus investigates wellbeing, to consider both the tangible dimensions (such as accessibility to amenities) as well as the perceptual and qualitative aspects relating to life satisfaction and quality of life, all of which are explored through multi-disciplinary research. Primarily it seeks to develop a comprehensive assessment framework that considers wellbeing from a multi-dimensional perspective, with a view to evaluate how well cities are doing in making provision for it. It posits that wellbeing is important for urban sustainability, and cities must consider the subject beyond social indicators to also assess its inherent capacity to augment it through interventions in urban planning, policies, and resource allocation.

*Keywords: Wellbeing, Liveability, Indicators, Assessment Framework.*

## 1 INTRODUCTION

In the discussion of urban sustainability, wellbeing is often assessed by a set of social indicators (e.g. OECD Wellbeing Indicators, UN Human Development Index, United Nations Social Indicators<sup>1</sup>) which are defined with conventional metrics that attempt to characterise its attributes in quantitative terms. The idea is to evaluate the extent to which a city has provided sufficient support for its residents' wellbeing, which in turn contributes to its overall sustainability. However, wellbeing is a multi-dimensional concept which also refers to the less tangible ideas of "happiness, life satisfaction or freedom (Welsch & Kühling, 2009), as well as intellectual, spiritual and cultural pleasure (May, 2007). It essentially looks beyond basic needs to include aspects of life such as family life and work relationships, and would also embrace people's ability to pursue their goals, to thrive and "feel satisfied" with their life (OECD, 2011).

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<sup>1</sup> <http://unstats.un.org/unsd/demographic/products/socind/>

In the city context, urban planners and policy makers need to engender supportive environments for wellbeing, and for this, “liveability” can be viewed as the capacity of the built environment to advance the wellbeing of its residents. Thus, to evaluate the extent to which cities have been able to promote wellbeing in the community, it is necessary to consider both the tangible dimensions (such as accessibility to amenities) as well as the perceptual and qualitative aspects relating to life satisfaction and quality of life.

This paper seeks to develop an assessment framework for wellbeing in the urban environment that captures the essence of its role in urban sustainability in a manner that is both academically robust while being succinct and application-oriented. Primarily, the framework will consider wellbeing from a multi-dimensional perspective, with a view to help cities evaluate how well they are doing in making provision for it. It posits that wellbeing is important for urban sustainability, and cities must consider the subject beyond social indicators to also assess its inherent capacity to augment wellbeing through urban planning and design interventions and resource allocation. The ultimate aim is to derive a synoptic evaluative approach that is useful both to city officials and municipal authorities, as well as planners and professionals, who are directly involved in plan making that seek directly to enhancing wellbeing in the local community

## 2 CONCEPTS OF WELLBEING AND LIVEABILITY

The definition of wellbeing and liveability play a central role in framing the discussion of its assessment approach and methods. For a long time, the concept of wellbeing has generated much theoretical discussions and empirical studies across many disciplinary fields, including the social sciences, life sciences, medical studies, humanities and economics. Given this diverse interest on the subject, it is inevitable that there is as yet no single definition of the term that has gained worldwide consensus.

In its simplest form, well-being would refer to “something that is in a good state” (R. Veenhoven, 2004), but the criteria for what is “a good state” are far from clear. In its most rudimentary manifestation, this would refer to basic concerns such as health, safety, etc., the deprivation of which can lead to “serious harm” (Doyal & Gough, 1991). Practitioners, particularly, in the social field, however would call for a more holistic approach, suggesting that well-being should go beyond such basics to include other aspects of life such as family life, work satisfaction, and so on (Webster, 2008). It must also consider people’s ability to pursue their goals, to thrive and “feel satisfied” with their life (OECD, 2011). This more embracing line of reasoning is pursued and enriched by the various schools of thought about human needs, first initiated by Maslow in his “hierarchy of needs” hypothesis (Maslow, 1943). It is also linked to the “desire account” perspective, which is favoured by economists and philosophers who embrace the utilitarian model, and thus see well-being as related to “the satisfaction of desires (or preferences)” (Qizilbash, 1998).

In the context of urban planning, the concept of wellbeing is often discussed in connection with “liveability”. Newman (1999), for example argued that liveability is the human requirement for social amenity, health and well-being and includes both individual and community wellbeing. However, the two concepts have different emphasis. While wellbeing is essentially people-centric, liveability expands its domain application to relate to “place” and “environment”. This is seen in Veenhoven (1996)’s definition, which emphasized the functionality aspect of liveability, suggesting that it refers to “the degree to which its provisions and requirements fit within the needs and capacities of its citizens”. Other researchers have taken this place-people interaction further. Pacione (1990), for example, has defined liveability as a quality that is not an attribute inherent in the environment but is a behaviour-related function of the interaction between environmental characteristics and personal characteristics. This is expanded in Duyvendak and Veldboer (2000)’s analysis which linked liveability to “the district wellbeing and social networks”.

The analysis points to a convergence of thinking amongst researchers that liveability is characterised by the qualities of the built environment and people’s perception and evaluation of it. Essentially, it refers to a condition that is necessary and conducive to induce a sense of wellbeing both individually and

collectively. This condition involves not only certain physical qualities, i.e. urban provisions and environmental qualities, but also social qualities in term of engendering social network and relationships. Underpinning this is the notion that liveability is related to people's individual perception towards all these qualities which can be very subjective but can be influenced through sensitive planning and urban design.

### 3 ASSESSMENT APPROACHES

Currently, there are number of well-being assessment approaches that are internationally used. Most of these approaches are derived from the social sciences, economics and socio-psychological studies.

The Welfare approach assesses well-being from two perspectives: resource-related and consumption-related (Paim, 1995). In terms of resource-based measurement, income is the most commonly used parameter, given that most of the contributing factors to well-being such as housing, healthcare services, education services, etc. can be "bought" in the market (Squire, 1991). Hence, the availability of income is seen as representing the ability to purchase or acquire such goods and services. Consumption-related measurements, on the other hand, link well-being with the consumption of goods and services. Under this approach, well-being is commonly assessed based on the gap between either a person's desired consumption and actual consumption, or their current consumption and past consumption (Paim, 1995). The argument here is that the more goods and services are attained, the higher is a person's well-being (Magrabi, 1991).

These welfare approaches were associated with the wide acceptance of GDP as a measure of well-being that incorporates a multiplicity of real world trade-offs in a single figure, which in itself, could be useful as single welfare measure from a practical point of view. However, the approach has also been criticized as being insufficient to evaluate "real" progress. Primarily, the argument is that it only considers the intensity and the productivity of economic activity without taking into account the wider, and often negative, repercussions on the society and environment, which may be unevenly distributed.

The utility approach, on the other hand, focuses on measuring one's "happiness" as an indication of quality of life. This approach relies mainly on self-reported information, and is premised on the long held philosophical argument that individuals are the best judges of their own condition (Campbell, 1976). The approach works on the assumption that being "happy" and "satisfied" with one's life is a universal goal of human existence (Stiglitz, Sen, & Fitoussi, 2009). Subjective well-being is said to be useful to evaluate the need for and to measure the impacts of certain policies (Diener, 2006). It also contributes to deepening the perspectives on social welfare and public policy previously influenced by economic approaches that focused mainly on materialism (Easterlin, 1995).

Related to this, in recent years, the term "happiness assessment" has come to the forefront of the public discourse. Purportedly initiated in Bhutan, this concept argued that a wealthier society is not necessarily happier; but equal importance should be given to the non-economic aspects of well-being. The proposed alternative method of measurement, known as the *Gross National Happiness* (GNH) which looks at the "national level of happiness" based on four pillars: economic growth and development, preservation of cultural assets, preservation and sustainable use of the environment and good governance. This concept was later adopted into OECD's Your Better Life Index, Global GNH survey, the GNH Happiness Survey USA, and a number of other city-based "Happiness Indices", such as the Sustainable Seattle Index, Queensland's Happiness Index, Anholt-GfK Roper City Brands Index and Gallup-Healthways' Well-Being Index.

Despite of their popularity, these indices are not free from criticisms. They have been often criticized to be politically inspired as they can be used to downplay the importance of economic progress in general. Moreover, as happiness is culturally bias, it is difficult to employ it as a tool of benchmarking across different cultures (Dorn, Fischer, Kirchgässner, & Sousa-Poza, 2007; Lau, Cummins, & Yeung, 2004).

The capability approach as conceptualized by Amartya Sen, was based on the critique of the welfare and utility approaches which "often conflate well-being with either opulence (income, commodity command) or utility (happiness, desire fulfilment)" (Clark, 2005). Sen defined well-being or quality of life in terms

of the capability of a person to achieve valuable “functioning”. The rationale of this thinking flows from the earlier emphasis of the importance of economic growth, expansion of goods and services in human development. Sen argued that mere wealth is not enough, and in judging the quality of life, it is necessary to consider what people are able to achieve, or how well people are able to function with the goods and services at their disposal. In other words, the process in which commodity is converted into utility or happiness very much depends on what people are able to achieve, given that different people and societies differ in their capacity to convert income and commodities into valuable achievements (Clark, 2005; Sen, 1999).

Sen’s approach is often acknowledged for bringing back the focus of human wellbeing as “ends” (not “means” to economic activity) and recognizing human heterogeneity and diversity (acknowledging that different people, cultures and societies may have different values and aspirations) (Clark, 2005). However, the capability approach is also often challenged for failing to suggest a coherent list of important capabilities and functionings (see for example, Qizilbash, 1998). Nonetheless, Sen’s thinking was subsequently incorporated as the conceptual basis for the formulation of the HDI (Human Development Index) by the UN in the 1990s, which has since become one of the most commonly used assessment of well-being, and used to rank countries on the basis of their level of “human development”. Its assessment is premised on three dimensions: life expectancy, education and income, based on the argument that long life motivates people to pursue more meaningful life goals; good education is necessary for productive life in modern society; while income is considered a proxy for the common person’s command over resources that can be used to acquire goods and services, and to save for the future. However, while these HDI dimensions assess the most basic aspects of human development that are related to the aspirational aspects of well-being, they do not reflect on the indicative aspects of the current state of well-being, such as the physical and social conditions that are vital for human development, for example, the quality of living environment and the state of social support in human’s living environment. This highlights the importance of assessing the urban conditions as the human’s living context as it can influence human’s state of well-being and development.

#### 4 WELLBEING IN THE URBAN CONTEXT

In assessing well-being in the urban context, considerations of the challenges of urban life are indispensable. Urban life, as opposed to rural life, has various benefits and trade-offs. Cities can provide better public services such as healthcare, education and cultural facilities that are crucial for human well-being. Higher concentration of economic activities often means that there can be more job opportunities that provide better financial security. However, urban life also comes with several challenges, particularly those related to living in dense environments that could significantly impact the quality of life. For example, high concentrations of people and activities in cities could bring forth severe environmental or ecological pressures that affect the state of its population’s health (Stanners & Bourdeau, 1995). In large cities, the decline in the quality of air, water, soil, flora and fauna, has been known to directly impact life quality (Ekblah, 1993).

The above conditions, often referred to as “urban stress”<sup>2</sup>, are crucial concerns when discussing urban sustainability. The common conditions in the man-made environment as experienced in high-rise massive buildings, auditory noise, urban transportation systems are integral to the manifestation of urban stress (Cappon, 1977). Its impact extends to mental health when people’s level of stress increase due to daily hassles such as annoyances that are occurring continuously or repeatedly in the city arising from density, noise and commuting (Krupat, 1985). In particular, this can be aggravated by the increase of population size in urban areas with limited resources, leading to the so-called “rat race” (Cappon, 1977) where people have to compete with each other to get the resources they need, such as access to jobs, higher salaries, nature, open spaces, recreation, hospitals, schools and so forth. Furthermore, cities tend to attract

<sup>2</sup>Urban stress is defined as “a state of bodily or mental tension developed through city living or the physical, chemical, or emotional factors that gives rise to that tension (Medical Dictionary from Merriam-Webster, Medscape (1997) (<http://www.eionet.europa.eu/genet/concept?cp=8843>))

migrants from diverse locations outside their borders, creating both positive and negative tensions that may engender conditions that exacerbate the stresses of urban living. Also, in many contemporary cities, the “loosening of social ties”, social exclusion and ethnic-related unrests, are some of the commonly pinpointed repercussions of demographic-social-cultural transformation in cities that trigger and aggravate urban stress.

## 5 DEVISING A WELL-BEING ASSESSMENT FRAMEWORK

There are many existing well-being assessment approaches which have been initiated by global institutions such as the OECD (OECD, 2014) and European Commission (Eurostat, 2014); individual countries such as Austria (Statistic Austria, 2014), Mexico (INEGI, 2014), Italy (CNEL, 2014), UK (ONS, 2014) and Portugal (Statistic Portugal, 2014), to name a few. Many of these assessments are influenced by the “beyond GDP” social progress measurement, a seminal report by Stiglitz, Sen and Fitoussi (2009) and concurrently the OECD Better Life Index. Each of them contains a set of prescribed indicators based on their declared principles and motivations. The common indicators include availability and affordability of housing, work-life balance, transport/mobility, security and environmental quality. Some assessment system also includes cultural heritage and poverty reduction.

All of these assessment frameworks seem to have moved away from the primarily welfare assessment approach, and they tend to be quite comprehensive in covering the three key domains of urban sustainability, namely, economy, social and environment. While many of these frameworks are designated for country level application, the built environment and urban context are featured quite prominently in some of them.

Drawing from these examples, and based on the earlier discussion of the urban context and liveability, we develop an assessment framework on the basis that it has to focus not just on the manifestation of wellbeing in the city, but also on the processes that engender it and the resources that enable it. It comprises two domains of assessment (see figure 1), as follows:

### **Inner Domain**

This domain assesses the core of “functioning and capability” which Sen defined as “*what people are able to achieve, or how well people are able to function with the goods and services at their disposal*” (Sen, 1999). The assessment includes healthy life, educational attainment, housing conditions, urban life quality and individual/community life. Essentially, it captures the more conventional measurement of wellbeing, focussing on the delivered outcomes and impacts. These outcomes and impacts are impinged upon by the substantive economic development conditions and the demographic-social context. The most relevant conditions that have both direct and indirect wellbeing consequences are identified in indicators of economic performance such as GDP growth, GDP per capita, etc. and demographic characteristics such as population growth rate, fertility rate and dependency ratio.

### **External Domains**

The external domains are derived from the earlier discussion of “liveability”. They delineate the extrinsic conditions that are crucial to support and enhance the wellbeing of people in cities. Working from the understanding that wellbeing in the urban context goes beyond the traditional realms of capability or utility, as measured by conventional social indicators, the framework suggests three supporting external domains, namely, the urban planning regime, the resource environment; and lastly, the environmental condition itself. Within the urban planning regime, the key considerations would include the state of infrastructural development (e.g. transport systems), amenities provision (e.g. parks, schools, health care facilities, etc.) and governance in planning (including opportunities for public participation, and public expenditure on services, taxes and subsidies, etc.). With regard to the resource environment, the critical concerns relate to the availability and productivity of cultural and natural resources that are regarded prerequisite for wellbeing as people are primarily dependent on the biosphere and ecosystems to function well. They include, for example, land for housing and amenities, farming areas, nature areas, watersheds, etc.

The third domain is the state of environment itself, which refers to conditions such as air and water quality.

In sum, while the inner domain captures the delivered outcomes and impacts relating to wellbeing, the external domains focus on the capacity of the city to deliver these outcomes. It also considers the processes that are undertaken such as those are linked to efficiency or productive capabilities and how well the city involves its citizens and stakeholders to supporting the activities and decision-making.

### ASSESSMENT FRAMEWORK FOR WELLBEING IN THE URBAN CONTEXT

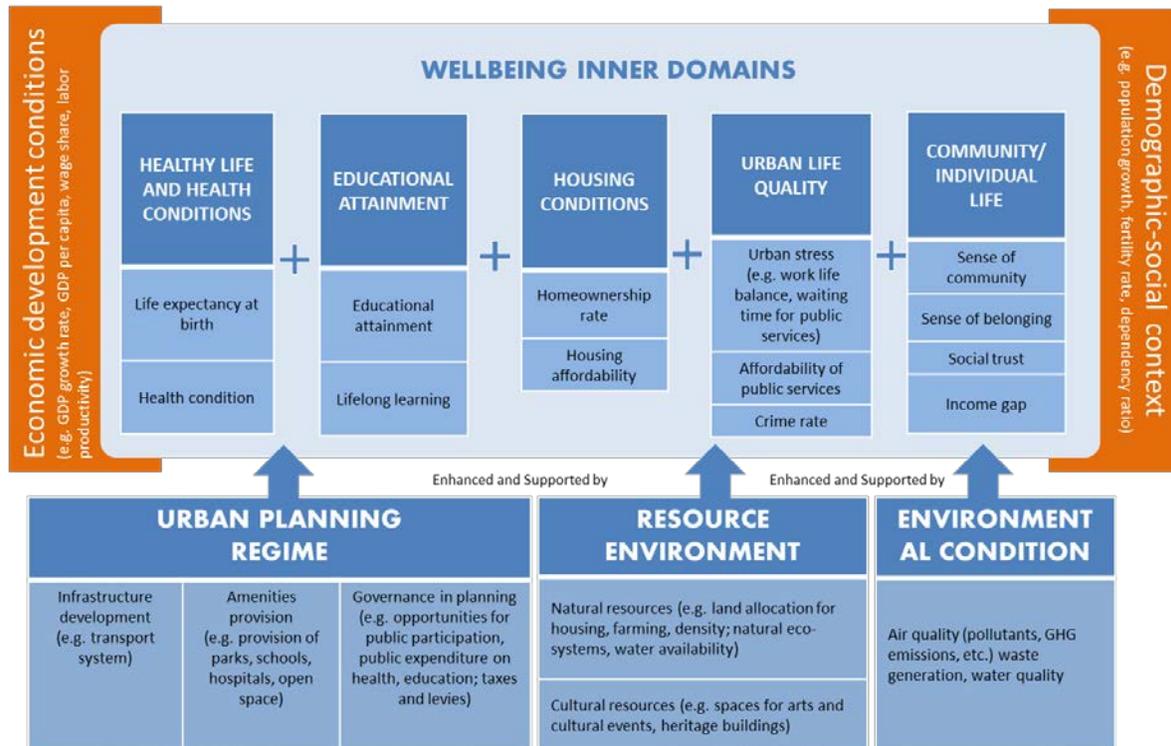


Figure 1 Assessment Framework<sup>3</sup> for Wellbeing in the Urban Context

## 6 CONCLUSION

Wellbeing is an important component of social sustainability and cities must consider the subject beyond social indicators to assess its inherent capacity to augment it through interventions in urban planning, policies and resource allocation. In taking wellbeing measurement beyond the traditional social and psychological realms, the recommended framework linked it to the multiple dimensions of city living. Cities are assessed on the extent to which it promotes liveability, that is, its capacity to support and enhance wellbeing, through a diversity of sectoral interventions, including infrastructure development, amenities provision, to natural and cultural resource use, and improving built environmental conditions. Thus, as an extension of existing assessment systems that focus primarily on the “inner” domains of delivered outcomes and their impacts on life quality in the city, the proposed framework includes the consideration of the processes that deliver these outcomes and the resource capacities that define and support them. They sharply articulate the substantive underlying support systems as well as the constraints within the city framework. In effect, the framework offers both a descriptive and evaluative

<sup>3</sup> The specific indicators for each component in this framework can be drawn from internationally available sources, and selected by cities according to their requirements and priorities. ISDRC2014/6c6

account of the city's condition as well as a critical understanding of the significant contributory factors that determine its current state.

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# LACK OF CULTURAL SIGNIFICANCE IN SOCIAL HOUSING FOR SHIITES IN INDIA

**Ms. IRAM AZIZ**

Consultant to Delhi Development Authority, aziz.iram@gmail.com

## ABSTRACT

Shiite Muslims, world over, is the second largest sect of Muslims which have different traditions than Sunni Muslims and so do their housing needs. This need is usually not fulfilled by the social housing provided in India as these are totally oriented towards economic affordability and not the religious & cultural requirements. To understand the core of these needs, development of their housing is studied at two levels. Firstly, housing development in the light of policy parameters derived from Holy Qur'an and *Hadith*, and secondly, the Shi'as *cultural*<sup>1</sup> practices, as practised in India. From the said study levels, Shiite's requirements have been analysed which act as determinant for shaping their urban habitation, making their housing different from any other social housing. Such specific requirements of Muslims, especially Shi'as, tend them to converge into one single neighbourhood as they lack in any other formal housing. Being the minority religion in India, these homogenous settlements are then largely being viewed as ghettos. Based on the studies & observations, this paper will discuss the requirements of Shiite Muslims into the neighbourhood planning, so that they are no more being marginalised into the city planning/ urban design. This paper will attempt to reduce the gap between the information and the practice of neighbourhood design in Indian context. Thus, it contributes towards the social sustainability by securing concept of 'housing for all' incorporating the community needs, and also secures from undue pressure on ecological resources by channelizing the required housing type.

*Keywords: Islam, Muslims, Shiite, Neighbourhood, Housing, Culture.*

## 1 INTRODUCTION

Around two decades ago, so many unauthorised and informal settlements were noticed in and around most of the metropolitan cities of India. It was then realised as a result of demand & supply gap of formal affordable housing for middle income groups, lower income groups and economically weaker sections. Provision of social housing was then made by the Public sector and/ or through PPP on the peri-urban areas as low cost housing or 'site & services' programme to be affordable to EWS or as 'slum redevelopment' programmes within/outside cities, but then even these are not successful to cater homes to the Indian Muslims, especially Shi'as.

To understand the core base of this community's inaccessibility to social housing, it is required to observe the definition of social housing and understand the situation & practices of Indian Muslims, including Shi'as.

### 1.1 Understanding 'Social Housing'

Housing has always been the bi-product of socio-economic conditions of households and so the targeted section of society. With this fact, any formal housing provision, including social housing, couldn't be considered only on the economic profile of targeted group of society. As per the British definition, social housing can either be termed for provided for people having low incomes or/ and people with 'particular needs' by government agencies or non-profit organizations. These needs could then be identified as religious & cultural (social) too. Also, as per the Architects Council of Europe, 'Social housing is understood as a space for living, planned and promoted by Public Administration. Housing has been created with the support of social policies that help those people who have economic problems to have access to housing. As Human Rights for housing establishes, housing is a

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<sup>1</sup> Term '*cultural*' is in reference to Shiites' beliefs and practices as used by the author on self-observation. The word may not be true to the belief of some or all Shiites' sects. Author has no intention of offence to the referred Muslim sect.

basic need that all humans have and which must be promoted along with social, medical and educational attention.

So it is to be acknowledged that social housing must always be developed based on economics as well as social requirements. In India, it has been observed that the religious minorities either doesn't get access to social housing due to affordability reasons or they willingly do not want to move in these formally developed housing due to lack of social & cultural requirements.

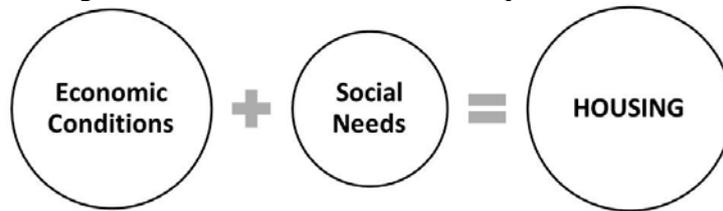


Figure 1. Housing is the bi-product of economic condition and social needs.

## 1.2 Socio-Economic status of Muslims in India

As for the social status, Muslims are considered to be socially backward whereas in the OBC (Other Backward Class) criteria laid by Indian law doesn't account all Muslims as socially backwards but do acknowledge them as OBCs on the basis of household incomes and their castes. Being from the minority community (refer section 2), they live under fear and insecurity as is highlighted in the report of Prime Minister's High Level Committee (Sachar Committee) in 2006. As from the perspective of city planner or city designer, integration of this community with the other communities is difficult as their social requirements (not demand) require extra space as part of social infrastructure for residential area. Taking an example from Sachar Committee report where it is highlighted that Muslims ensure that its future generations acquire knowledge of Islam through *madarsas*, and to have a symbol of Muslim identity in India. So *madarsa* is like an addition to provision of Islamic education institute in addition to the requirement of modern education institute.

As for the economic status, report of Sachar Committee clear states that the Monthly per Capita Expenditure of Muslim groups much lower than the national average, and so it doesn't allow them to own a formal house on their savings. Also, this community remain deprived of loans too due to iniquitous access to public and private banking institutions perpetuating disparities. This reason resorts Muslims (religious minority group) to remain living in their informal settlements without any or little infrastructure. Such concentrated pockets then turn out as easy targets for neglect by municipal and government authorities (refer example of Figure 2)

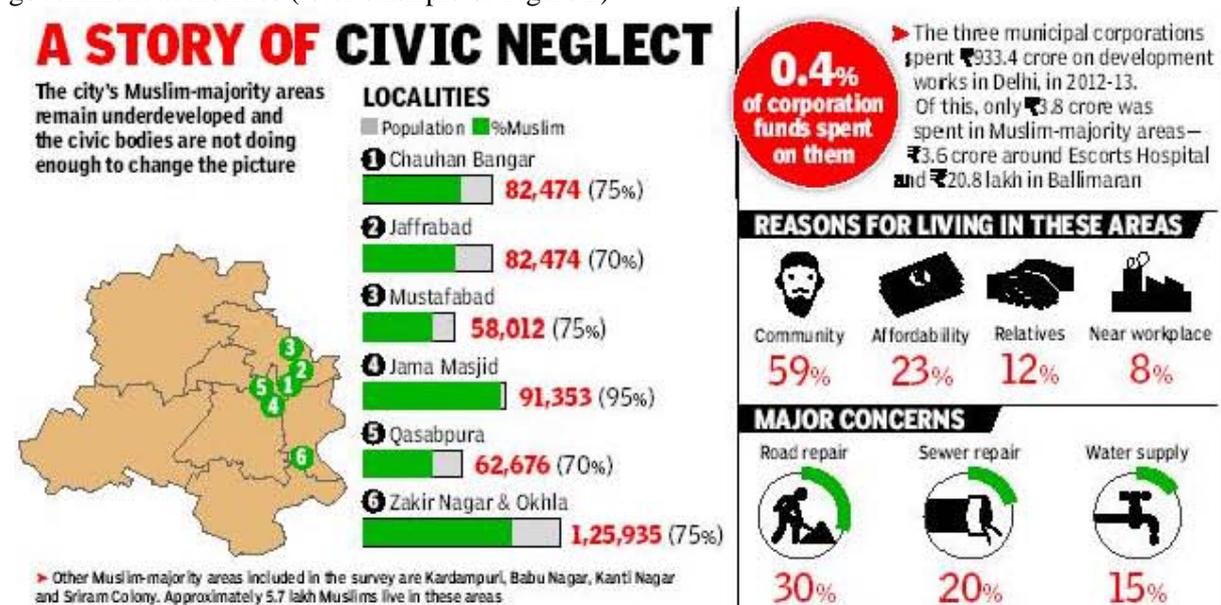


Figure 2. Neglect in infrastructure investments in Muslim dominated neighbourhoods of National Capital Territory of Delhi (NCTD) Source: Sunday Times, April 20, 2014.

### 1.3 Provisions through Policies & Programmes for Social housing

As per aim stated in National Urban Housing and Habitat Policy, 2007 (by MoUHPA) and under section 8.5.1 of Model State Affordable Housing Policy for Urban Areas, 2010 (by MoUHPA), it is observed that thrust has been put to social and cultural requirements of all target groups along with the affordability factor for providing social housing. But then this is limited to the policy vision and framework, and does not get realised on-ground due to lack of cultural knowledge (of targeted groups) by city professionals. In addition to policies, there are several programmes like Rajiv Gandhi Awas Yojna (RAY), Valmiki Ambedkar Awas Yojna (VAMBAY), NATIONAL Slum Development Programme (NSDP), cooperative Housing Programme, etc. which failed to attract Muslims in majority. Though in some social housing, Muslims were housed, but nowhere Shi'as could be noticed as beneficiaries of these programmes. Such examples of Muslim settlements (formal and informal) could be seen in NCTD, Uttar Pradesh, Bihar, Andhra Pradesh, Maharashtra, Gujrat and others. The informal settlements are comprised of various sects of Muslims, whereas formal housing comprises usually Sunnis only.

### 1.3 Concluding the Issue base

At the larger picture, Muslims' requirements for social housing are not limited to its economic conditions but they also possess their religious and cultural requirements. Inaccessibility of Muslims to social housing could be easily assumed to be because of their economic conditions, but then a lot of Muslim section who can afford these formal housing are not willing to move into them due to the insufficiency of the religious needs, especially when it comes to Shi'a Muslims. Even if few settlements get planned and designed specifically for Muslims, which are usually cooperative or private development, they leave out the cultural requirements of Shia Muslims compelling them to keep living in informal housing. Not only this, but planning and designing of such neighbourhoods is usually not done integrated with the adjacent neighbourhoods largely leaving them polarised and marginalised further.

Here the topic of Muslims' inaccessibility to social housing is vast ranging from economic condition to social requirements, this paper will deal with the social (religious and cultural) incapacity of social housing. This paper will identify the religious and significant cultural requirements of Muslims, particular to Shiites, will be done in the light of religious scriptures and ground realities as exists today in India, for delivering feasibly housing and social harmony in the society.

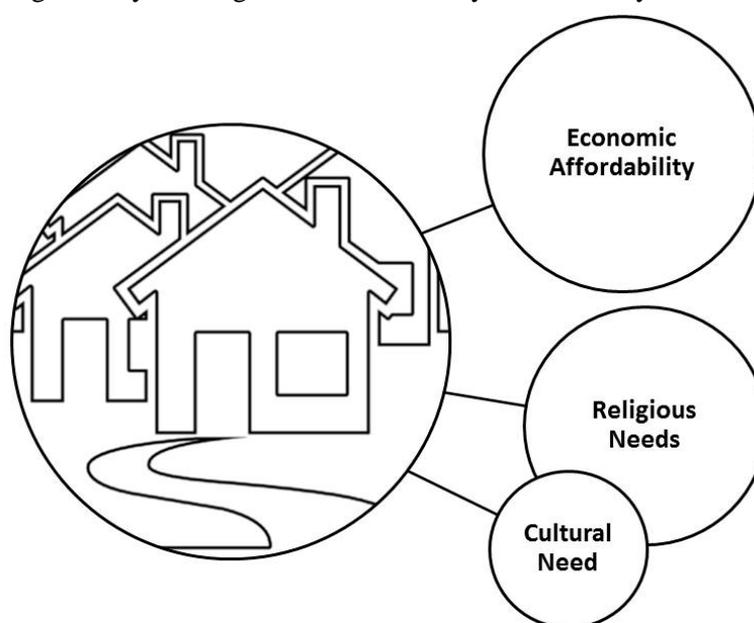


Figure 3. Housing requirement for Muslims (Sunni and Shia sects)

## 2 SHIA POPULATION

As per PEW in 2009, it was estimated that 23% of the world's population followed Islam, called as Muslims. Approximately 60% of the global Muslim population resides in Asia having one-fifth of world's Muslim population residing in countries where Islam is not the major religion. Such ratio at

country level makes Muslims falling in the category of minorities, including India. Of the total Muslim population, 10-13% is Shia Muslims and 87-90% is Sunni Muslims. Here, more than 67% of the world's Shias (among 10-13% of total Shia Muslims) live in four nations: India, Iran, Pakistan and Turkey.

In India, Muslim population figures around 10% of world's total Muslim population making it third largest Muslim populated country after Indonesia and Pakistan. Muslims in India are about 172 million as per Census of India, 2001, which is almost 13.4% of the country's population making them India's largest religious minority.

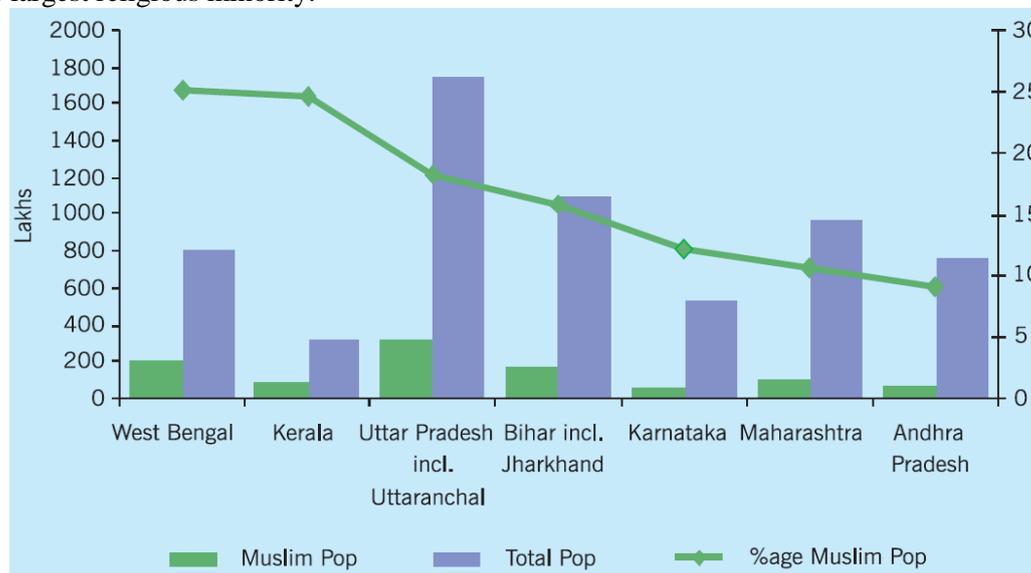


Figure 4. Muslim Population strength in selected States as per Census of India, 2001

It is considered that Shia Muslims are about 4% of the total Muslim population in every state and union territory of India, making them around 6.88 million with the total housing stock of 1.4 million (formal & informal) distributed in the country. Shiite Muslims residing in India and reflecting the special character to the neighbourhood are majorly found in Jammu & Kashmir, Uttar Pradesh, West Bengal and Bihar.

Basic difference between Sunni Muslims and Shi'a Muslims is the belief of *Khilafat* and *Wilayat*. Sunni Muslims recognises *Khilafat* of the four apostles of Prophets – Haz. Abu Bakr (p.b.u.h.) Haz. Umar (p.b.u.h.), Hz. Uthman (p.b.u.h.) and Haz. Ali (p.b.u.h.) as caliphs, where the Shi'a Muslims doesn't recognise Haz. Ali as caliph but *Wali & Imam*. This basic difference among the two Muslim communities, differ few ways of practicing the Islamic religion and life. Such difference is seen on the physical fabric of their settlements as well.

Few case examples across India were studied which have high concentration of Shia population. Here the symbolic and social connotations of the existing traditional environment were examined, in the light of the teachings of Islamic religion. With the gathered information, comprehensive study was made regarding the functioning of urban settlement based upon the religious, social and *cultural* parameters of the neighbourhoods.

The nature of the paper is solely based upon the information analysis of the particular community and place, and may not be completely same for all the urban Shiite settlements of complete India. Based on observations, issues are analysed related to residential neighbourhoods in context to Islamic principles and teachings, but then this paper does not intend to produce concrete recommendations for the provision or rejuvenation of the Shiite neighbourhoods but works towards the thinking process.

### 3 ISLAMIC FAITH AND BUILT MORPHOLOGY

Islam is universal and strictly monotheistic religion. Holy Qur'an encourages believers to "Obey God and His Envoy" (*Surah 8:1*), put forth the prophet as "a fine example for whosoever hopeth on God and the last day and rememberth God much" (*Surah 33:21*). The Holy Qur'an asks Muslims to associate with each other strongly and be tied up with the sense of community as 'Hold on firmly together to the rope of God, and be not divided among yourselves.....'(*Surah 3:103*), whereas simultaneously teaches to have 'no distinction between an Arab and a non-Arab. There is no

preference for black over white, or white over black'. Thus the Al-Qur'an, the *Sunna* and the *Hadith*, together preaches its *ummah* the way of living. These practices contributed greatly to endowing Muslim dominated neighbourhoods with certain characteristics. Such practices realised the importance of social institutions based upon four said sources.

Islam is essentially a religion of law<sup>1</sup> but there are no precise urban planning and urban design norms. For setting up or developing a residential neighbourhood, this law is translated into four policy parameters to be most important for a Muslim housing or neighbourhood based from Al-Qur'an and Prophet Muhammad (p.b.u.h.), are as follows;

1. Dwelling population

*Almighty Allah tells the prophet that a population is to be viewed as a society, and to that population the prophet has to provide his prophetic talents.*

*"We sent him to a hundred thousand or more" (37: 147) Al-Quran*

2. Spatial Extent of housing

*Allah Almighty notes in Al-Quran, "Makkah" as "Harem".*

*"Have we not set up a Harem for them" (2857) Al-Quran*

Also,

*Allah Almighty says that houses must be made homes as they constitute main component of any neighbourhood. If not, some people may end up homeless, even though they possess houses.*

*"So therefore, people's houses, which are main components in neighbourhoods, must be planned and designed in such a way as to function as a safe heaven and places of rest and quiet" (Qur'an, 16:80)*

3. Main focal point

*The Prophet came to Madina and ordered a masjid to be built and said "O Bani Najjar, suggest me the price (of your land). (Bukhari Vol.3, page 53 & 54, Hadith 92).*

4. Environment perseverance/ upgradation

*This environment is to be respected and regarded accordingly. Environment perseverance or development will make you realise of your acts: good deeds reap good habitat, bad deed reap bad habitat.*

*"The environment in its totality is an expression of God's oneness, mercy and omnipotence" (Qur'an, 3:190-191)*

**"Settlement in Islam**, more importantly, stands for the ground for the people's interaction with Allah the Creator & Lord, space, the environment and, of course, with themselves at various levels, given that the settlement is a scene where they live, work, play, learn, worship, rise and fall. The outcome of these and other activities which the people engage themselves in settlements, especially urban ones, is what we call cultures and civilizations but which vary by reason of the principles and values on which they rest, as well as by reason of the objectives intended to be thereby achieved. Hence, it was very much suitable for the name of the prototype Islamic city, i.e. Madinah, to be derived from the word *tamadun*, which denotes civilization.

Muslim neighbourhoods are reflection of above parameters where the built environment is a result of Muslim societal behaviour and social structure. Dwelling population, *masjids*, houses, natural environment and graveyards make important components of the Muslim neighbourhoods. It shows that neighbourhoods' extent of dwelling is not merely confined to people's house walls, but their activities shape their neighbourhoods. Thus, the urban fabric could be considered as an accumulation of many successive activities that reflect the age and degree of maturity of the city to which it belongs. The activities could be subdivided into two categories: the first reflected the private sector and the second are related to the public sector, each of which had its own regulations. Private activity was based on Freedom, and thus led to architectural diversity and urban dynamism, while public activity was based on Public Interest and was mostly related to structuring components of the city.

Planning of any Muslim settlement is in order to have some focal point, which is usually a *masjid* as an integral requirement and so approachable part of the group of clusters. *Masjids* are supposed to be placed in the direction of West face, making entrance on eastern side, and should be within the walking distance of Muslim houses to facilitate offering of *Salah* (prayer) five times a day. From here, planning benchmark is set to plan an area accordingly, with radial or parallel streets running towards the *Masjid* within walking distance (no benchmark for walking distance is defined in Islam).

The religious sensibility of the Muslim inhabitants have further important characteristic, as mentioned before, is the strong sense of community- of common ties, outlook and purpose. Such reasons characterises the homogeneity of Muslim settlements in any heterogeneous city.

#### 4 SHIITES' CULTURAL CHARACTERISTICS

In addition to the practice of 5 pillars of Islam- *Shahadah* (faith), *Salah* (prayer), *Roza* (fasting), *Zakat* (charity) and *Hajj* (pilgrimage), Shiites observe the entire month of *Moharram* as a period of mass mourning. During first 10 days of 1<sup>st</sup> month of Islamic year, Shi'as observe Moharram where there is no celebration or expression of joy of any kind. Moharram has a history of Karbala battle where the sons of Haz'rat Ali got martyred. People do *hadith* telling in gatherings enactment in remembrance of Karbala battle. Public enactments of grief, depicting scenes from the battle of Karbala, are carried out in Shiite *Masjids* on the first ten days of this month. People clad in black assemble and recite plaintive verses. The first nine days are spent in making *tazia*, where on the tenth day, decorated *tazias* are carried through the city streets. A horse is led in procession in memory of Imam Hussain's horse. Destination place for *tazia* is Karbala.

Thus, as per requirement of Shiite practices, spatial character of Shiite settlements is slightly differently from Sunni Muslims and is more intricate being dependent on the social set up and activity pattern. The change in attitude and activity reflects on the built fabric, where in turn, this change in built fabric affects the continuity of the acuity and social set up.



Figure 5. Shias observing Moharram procession

#### 5 BUILT ENVIRONMENT FOR SHIITES

##### 5.1 Shiites' Neighbourhoods

Shiite neighbourhoods are no exceptions than any other Islamic neighbourhood, except in the terms of their *culture* and societal behaviour. Like other settlements, they reflect traits of *fiqh*, close community pattern of *ummah* (community) as physically manifested into cul-de-sac *mohallahs* (street), and few important social buildings and places. This close knitted fabric reflects the concept of *tauhid* (oneness). Their social spaces are usually observed as religious places or institutions which are of major significance determining the settlement pattern as a whole in addition to the *Masjid* and *graveyard*, are *Imambara* and place of Karbala. For example, old Lucknow (refer Figure 6) where *Imambara* and Karbala act as focal points. Existence of such institutions defines the expanse of Shiite habitation and the strength of ritual practice by the community.

In Shiites' settlement, main *masjid* are important to guide and unite neighbourhood same as of any other Muslim neighbourhood, whereas they also have special requirement of Imambaras which are important to practice Shiite rituals caterings to cluster of neighbourhoods. Thus, as per social hierarchy, Imambaras and Jama Masjid are equally important elements of any Shiite settlement. Lucknow has Bara Imambara sharing its precincts with main Shiite *Masjid*, and Chota Imambara, and then *masjids* at *mohallah* level or cluster level (refer Figure 6).

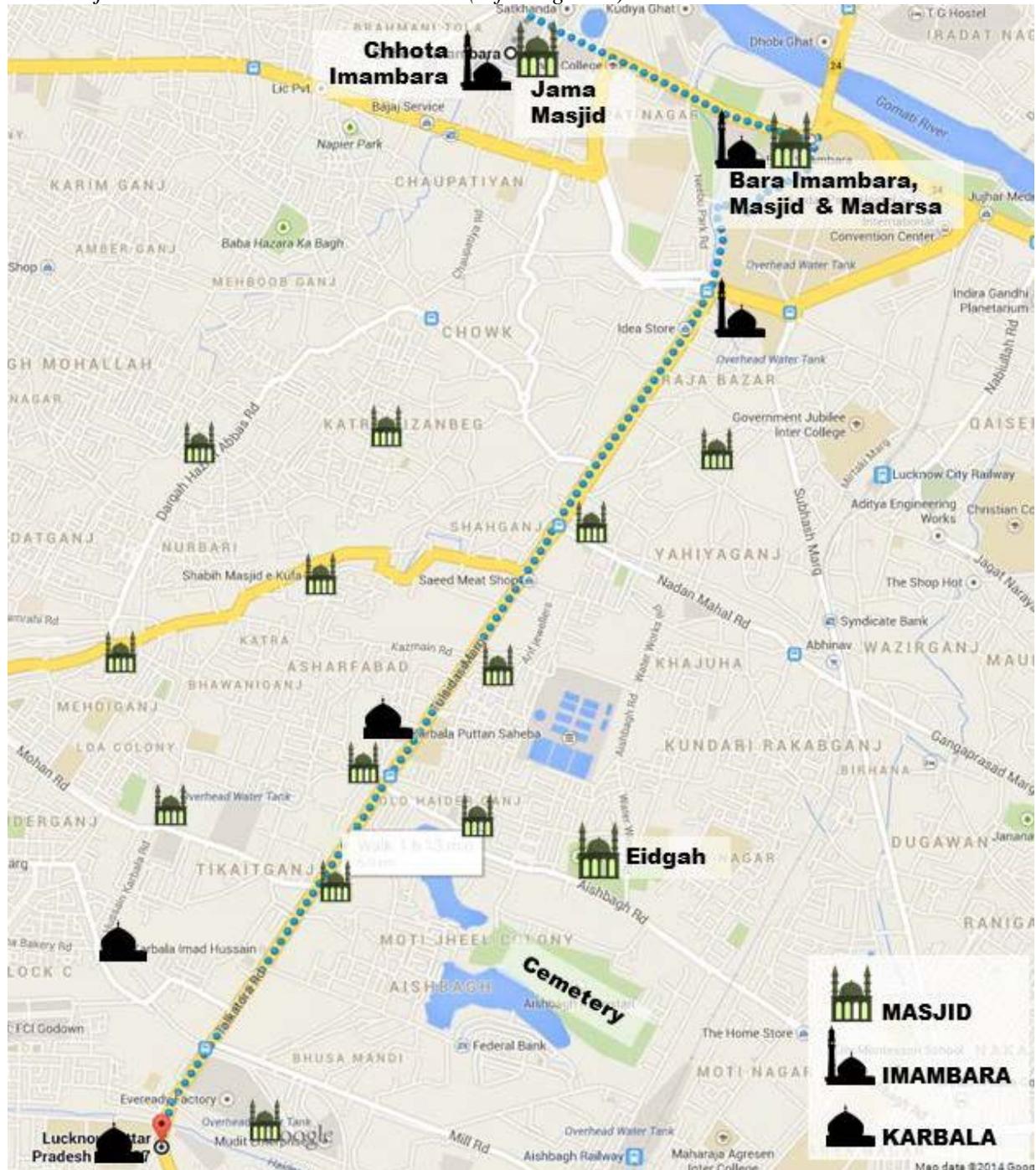


Figure 6. Locational map showing Shia institutes in Old Lucknow

From case examples, it is very clear that there are three foci of Islamic religious life (apart from graveyard) in and around Shiite neighbourhoods- *Masjid cum Madarsa*, *Imambara* and *Karbala*. In *masjids*, prayers are performed and people are imparted education, wherein *Imambaras*, assemblies are held related to Moharram processions for *hadith* telling and expressing grief over *Karbala* battle. *Imambaras* remain open for all irrespective of religion, and tend to bring people together. No one can belittle this function in the present circumstances.

## 5.2 Shiites' Houses

As discussed in 3.2, *cultural* aspect of Indian Shi'as dominantly influences spatial organisation of the neighbourhood and its housing requirement. It is important to study the typology of their dwelling units referred to as *Harem* in Al-Qur'an (*Surah 28:57*). These are actually determined by the religious and social activity pattern. Like many traditional Indian Muslim houses, these too have separate males' area known as *mardana khana* and females' area as *zenana khana*, and a big central courtyard. Notable feature of a traditional Shiite house in India, is that they have a separate room for placing their *tazia* within homes (may not be case for all houses but is usual) (*refer Figure 7*).

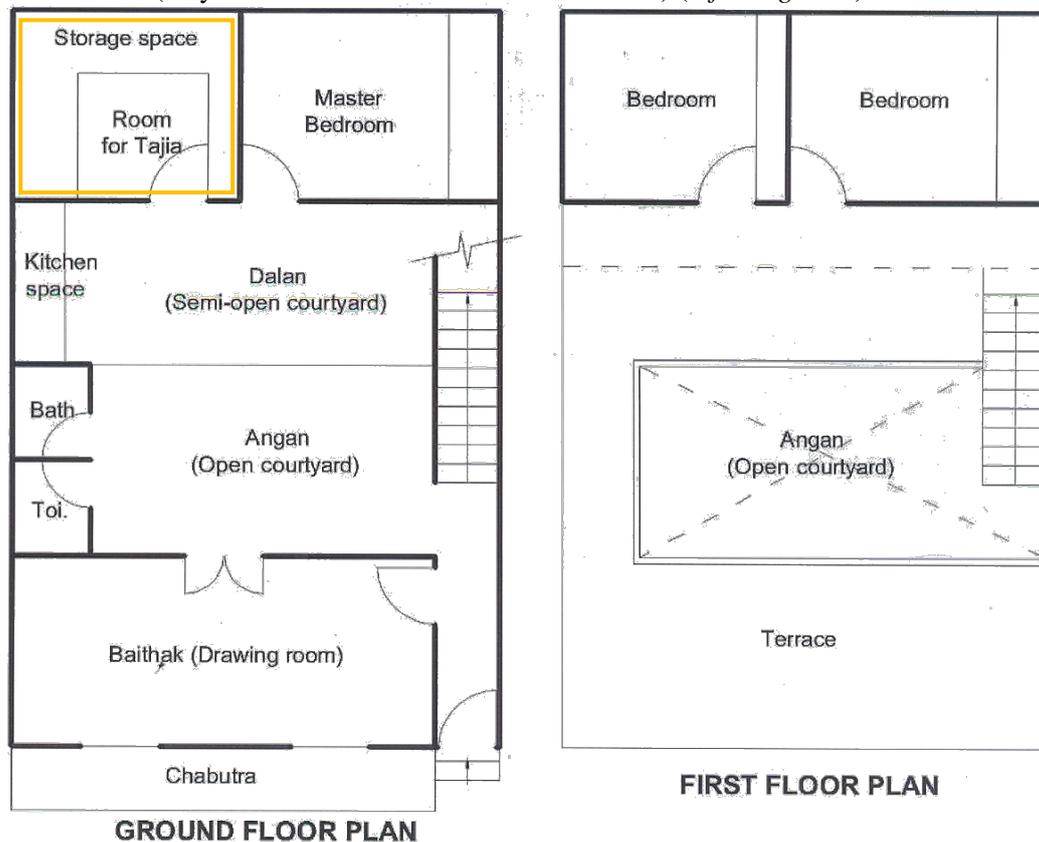


Figure 7. House plan showing the spatial organisation of traditional Shiite Harem

Bigger houses which were used for *majlisi* and mourning sessions do no longer exist in their actual size and use. People have started moving out of their adaptation of urban house form. Even new neighbourhoods of Shiite community now lack the social integration and the required places within the settlement as well as within their own houses. People engaged in *Moharram* ceremonies of *tazia* processions and *majlisi*, have started avoiding participation in such religious and social processions due to overcrowding of streets during the on-going ceremonies.

All these factors for transformation of typical settlement and the loss of ethnic essence are usually called as the process of urbanisation by the planning & city design professionals, ignoring the fact that such transformation is a result of formal housing without incorporation of social needs.

With this so called urbanisation, the housing typology of Shiite neighbourhoods had been compelling the transformation of most of the *harems* and neighbourhoods from their social needs to modern day demands. The new generation is swaying away from their *culture*, though they practice few Shiite rituals but are getting away from their clergy and organisation. Here the housing transformation is notably dynamic in nature and the analysis is complex because of various factors involved.

## 5 CONCLUSION

Identification of such religious and ethnic groups is important for the provision of housing into the metropolitan framework. Neglecting the special needs of the group compel them to set-up their own neighbourhoods largely putting pressure on land as a resource. Gradually, such settlements are viewed as ghettos and become the issue of politics in democratic societies without any solutions or facilitations. With such set-ups, these neighbourhoods start receiving more population of similar

nature pressurising the existing infrastructure further and further, in addition to the depletion of quality environment for living.

Identified formal housing for Muslims is usually seen in traditional or old areas of cities where there had been spaces to fulfil all cultural and religious requirements. Notably, these areas tend to have mixed communities of various religions. Now even these areas are under transformation due to varied reasons leading deviation in land use as well as building floor use. These reasons range from physical planning & designing norms of city & neighbourhoods, non-availability of religious institutes at other places, insufficient cultural spaces in the city, etc. In this process, importance of Shiites' traditional housing is getting lost and at macro level it is causing transformation of urban space of Shiite settlement. Such pressures lead to depletion in natural as well as built environment. Even after the Islamic obligation for environment preservation and upgradation as discussed in 2 (4), these people are helpless to act against their physical and social environment.

As already discussed, such requirements related to religion and faith, Muslims start agglomerating or converge at one place/ vicinity of religious institutes satisfying their religious needs. Muslims, particularly Shi'as, automatically get marginalised due to non-fulfilment of religious requirements from the facilitation of formal houses by the mass housing providers, be it public or private player.

Notably, there is no independent authority to keep track of the developments, neighbourhood transformations and identification/ documentation of cultural & religious activities of the targeted group. Also there is no coordination among the existing urban regulatory and social agencies looking integrately into the urban and social developments.

Interestingly, in the democratic society of India, two schools of thoughts are observed with one being against such homogenous development as it is viewed as a threat to peace and society development, where the other school is in favour of such homogenous development as it satisfies the community needs at local level as well as generate belongingness to the place. With such difference in thoughts lies a question of integrating these homogenous groups with the heterogeneous society.

## 6 SUGGESTIONS

It is important to identify the social needs of the targeted groups to be incorporated into the planning and design of housing for them. So when it comes to housing for Muslims, city planners and designers must also take into account that urban fabric of Shiite Settlements does differ from the usual Muslim settlement because of the *cultural* requirements of the sect. Moreover, with the pace of growing population and urbanisation, the already existing traditional settlements pertain to deterioration, and hence require simultaneous attention to keep the housing stock sustained. These could be done at three major levels;

1. At Policy level, it is necessary to identify the extended Shiite settlements or neighbourhoods distinctively and in contrast to the development zones and the new areas of growth. And thus develop an overall strategy for the future of traditional Shiite settlement as well as providing new formal housing within a metropolitan limit for the sect. Such strategy should encompass religious needs in order to be successful at implementation level and to avoid propping of homogenous settlements. As an observation, heterogeneous settlements are considered to be safer towards city's law & order over having homogenous settlements.
2. At neighbourhood level, integration of physical infrastructure with social requirements needs to be sorted out.
  - a. Additional provision of land requirement for religious purposes be introduced in planning norms, keeping a check on the extent of neighbourhood population they can serve. Such norms will help integrate various religions within one neighbourhood. This will help Indian societies to not to be polarised but to associate with each other reflecting true meaning of "Secular India".
  - b. Integration of various religious groups through urban design is important to pull out this special group (Shi'as) from the tag of ghetto. Example of Chandni Chowk (Old Delhi, also known as Shahjahanabad) could be referred here, where this main road stretch abuts *Masjid* (for Sunni and Shi'a both), Hindu Temple, *Gurudwara* (religious institute for Sikhs) and Church. For such neighbourhood design in today's cities, current planning and city design norms may have to be modified upto the level that can incorporate mixing of religious groups.

- c. Due to the Moharram processions, congestion on roads and streets is unavoidable. The only thing which can be done about it is the provision of separate pedestrian route to be demarcated especially for these ceremonial processions during the month of *Moharram*, as well as alternate routes for vehicular movement must be identified beforehand.
3. At *harem* level, overcrowding of bigger dwelling units tend to split up or partitioned into smaller dwellings including the spaces meant for keeping *tazia* and holding *majlisi*. In order to retain the *ritual* significance of such *harem* typology, need for housing should be taken care by the housing providers- public and private both. Simultaneously, these people must be involved or given the opportunity to set-up their own social housing or neighbourhood rather than being given no choice other than usual formal housing which lead these people to subdivide their own properties.

### GLOSSARY OF TERMS;

<i>MoUHPA</i>	<i>Ministry of Housing and Urban Poverty Alleviation</i>
<i>Muslims</i>	<i>Followers of Islam</i>
<i>Hadith</i>	<i>Prophet Muhammad (p.b.u.h) said and others compiled.</i>
<i>Sunnah</i>	<i>Prophet Muhammad's (p.b.u.h) life activities</i>
<i>Masjid</i>	<i>Mosque/ Building structure for offering prayers by Muslims</i>
<i>Madarsa</i>	<i>Education Institute</i>
<i>Tazia</i>	<i>Replica of Death Bed of Imam Hassan (p.b.u.h) and Imam Hussain (p.b.u.h)</i>
<i>Imambara</i>	<i>Social Institute to house Tazia</i>
<i>Karbala</i>	<i>Cemetary for Tazia, an imitation/duplication of Karbala ground</i>
<i>Fiqh</i>	<i>Study of Islamic Law</i>
<i>Harem</i>	<i>Dwelling Unit</i>

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# SCENARIO WRITING OF FUTURE LIFESTYLES IN JAPAN: CONTINUOUS AND DISCONTINUOUS CHANGES IN LIFESTYLES BY 2030

Tomohiro Tasaki<sup>1</sup>, Midori Aoyagi<sup>1</sup>, Yuko Kanamori<sup>1</sup>, Aya Yoshida<sup>1</sup>,  
Keigo Awata<sup>2</sup>, Naoki Tominaga<sup>2</sup>, Aiko Shimizu<sup>2</sup>, Hiromi Suwabe<sup>2</sup>, and Kaori Nemoto<sup>2</sup>

<sup>1</sup> National Institute for Environmental Studies (NIES), Japan

<sup>2</sup> Hakuhodo Inc., Japan

## ABSTRACT

In order to change current lifestyles to sustainable ones, it is necessary to understand what kinds of changes in our lifestyles could occur and what factors could affect these changes in the future. In this study, we explored continuous and discontinuous lifestyle changes in Japan from the present to 2030. We used techniques of scanning and constrained idea generation in an expert workshop. The participants generated 14 ideas for possible changes that would affect future lifestyles by using a scanning technique, where an idea generator skims (scans) many newspaper and magazine articles from different sources. Subsequently, the participants conducted constrained idea generation (idea generation using a matrix) using these ideas together with mainstream continuous lifestyle changes, which we provided. Five primary ideas for future lifestyles were obtained. Using these primary ideas, we described and elaborated four lifestyle scenarios: “Towards a health-based society,” “Anti-aging town,” “Attaching myself to more than one community,” and “Enhancing communication with Visor-com.”. We investigated selected ordinal people’s reactions to these scenarios. Finally, we discussed the insights obtained from this scenario writing of future lifestyles.

*Keywords: Sustainable Consumption and Production (SCP), scenario approach, future study, household*

## 1 INTRODUCTION

Achieving sustainable consumption patterns was given attention by international society at the 1992 Rio Earth Summit. Since then, many related activities and studies have been conducted—for instance, at the United Nations, the Marrakech Task Force on Sustainable Lifestyles [1] and the UNEP [2]. In recent discussions on sustainable development goals in the context of the Rio+20, sustainable consumption and production has been one of 19 focus areas [3], and it is without doubt an important area for sustainable development. However, changing consumption patterns and lifestyles is not easy. One field of study that aims to overcome this difficulty is behavioral studies, which applies the theory of planned behavior [4] or other theories to various environmental behaviors. In contrast with these micro-level studies, macro-level studies have suggested that consumers are embedded in systems of provision and that it is difficult for them to change their consumption patterns (for instance, Spaargaren [5]). Both micro and macro lifestyle aspects must be examined in order to achieve sustainable lifestyles. In addition, a long-term perspective is needed because the changes will not be easy and will take time. That is, it is important to understand what kinds of changes in our lifestyles could occur and what factors could affect these changes in the future. Scenario approach is one of methodologies that can be applied to such an exploration of the future, and it has recently been increasingly used to write scenarios of future lifestyles (for instance, an EU research project, SPREAD [6], Forum for the Future, Sainsbury’s, and Unilever [7], Levi Strauss & Co. [8], Kimura et al. [9], and Ishida et al. [10]). Our NIES research project on lifestyles, SusLife, is a project to explore possible future lifestyles in Japan from the present to 2030, as well as to attempt to identify ways to transition to sustainable lifestyles and also critical factors that affect lifestyles. Figure 1 shows macro-level social trends in Japan that are the basis of our project. In the face of the macro situations of globalization, the unraveling economy, a decreasing population, and technology development, values and lifestyles are being diversified while disparity in Japanese households is being widened.

This study aims to identify changes in Japanese lifestyles that would and could occur by 2030 and possible Japanese lifestyles that would and could result from the absence of any additional new policies or actions. In this study, we avoided setting any normative environmental/sustainable goals and visions because consideration of this could distort what would/could happen. In another study by the authors [11], we described many lifestyles and identified 16 continuous changes in future lifestyles from the present to 2030. In this study, we explored discontinuous changes in lifestyles by using techniques of scanning and constrained idea generation with a matrix, which were based on Future Dynamics<sup>®</sup> by Hakuhodo. Inc., and we then described four lifestyle scenarios that could happen.

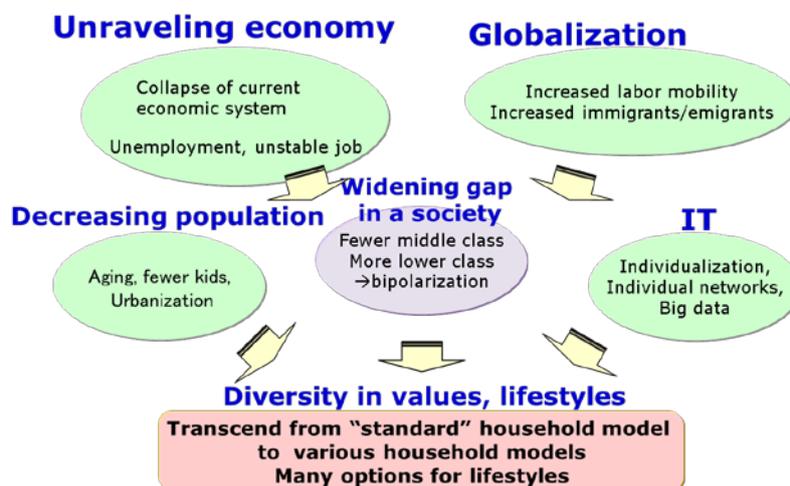
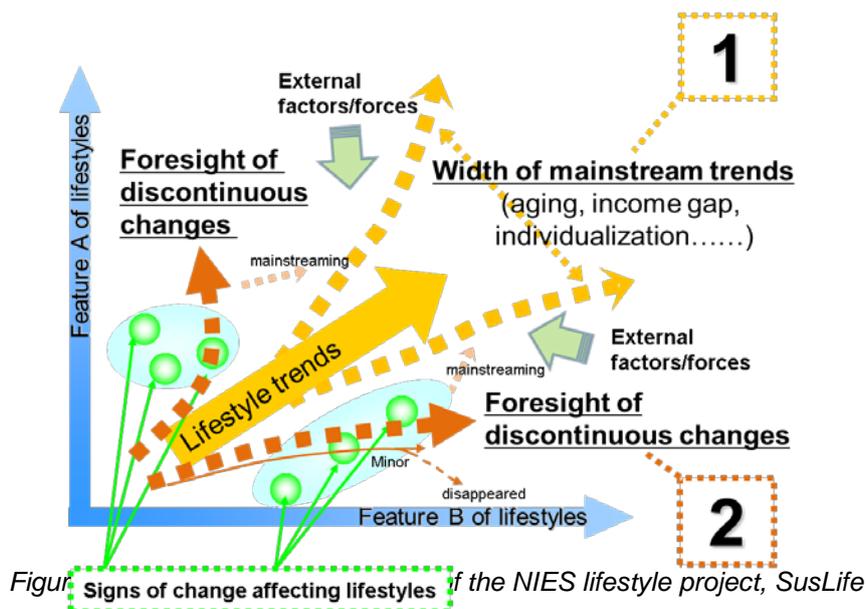


Figure 1. Macro-level social trends in Japan from the present to 2030

## 2 METHODS

### 2.1 Scenario writing of NIES lifestyle project

The conceptual approach of scenario writing of the NIES lifestyle project, SusLife, is shown in Figure 2. There are three main elements. One is the bold arrow in the middle with the label “Lifestyle trends.” This represents trends in lifestyles changes from past to present in a certain coordinate system of parameters relating to lifestyles. The scenario writing task was to explore what would or could happen with lifestyles in the future. The other two main elements, numbered “1” and “2” represent continuous and discontinuous directions, respectively. Even in continuous directions, external factors affect future lifestyles depending on the situation. This results in different future lifestyles and widening trends. As our history has shown, sudden, discontinuous changes can occur. The causes of these changes are represented as the “sign of change” circles. Their emergence bends the continuous trends. To foresee discontinuous changes, consideration of these signs is important (as will be explained later, these signs were taken into account as “scanning clusters” in Figure 3 in this study). Thus, the scenario writing of this study had two tasks. (1) We identified continuous mainstream lifestyle trends and changes in Japan, and (2) we explored discontinuous lifestyle changes, as shown with the numbers in Figure 2. Both major lifestyle trends and changes and also possible changes in future lifestyles were taken into account in the SusLife project. What constitutes “sustainable lifestyles” is truly a very important question, but when people think of “sustainable,” they tend to think of their own ideal and preferred lifestyles, situations, and desired events. Thus, we could have failed to identify and take into account possible futures. Therefore, we intentionally did not consider “sustainable” and explored what could happen with lifestyles in Japan. We will examine the idea of sustainable lifestyles and how to achieve them after identifying (1) and (2). By the time, we refer to sustainable lifestyles as “patterns of action and consumption that are used by people to affiliate themselves with and differentiate themselves from others, and help each individual to meet their basic needs, obtain a better quality of life, minimize their use of natural resources and emissions of waste and pollutants over the lifecycle of the products or services they use or consume, and avoid jeopardizing future generations,” and we consider that “Sustainable lifestyles should reflect the specific cultural, natural, economic, and social heritages of each society,” which was stated by the Marrakech Task Force on Sustainable Lifestyles (2007) [1].



## 2.2 Future Dynamics<sup>®</sup> - Scanning and constrained idea generation

The methods and results for the first part are shown in another presentation [11]. This presentation focuses on the second part. We used a method called Future Dynamics<sup>®</sup> that was created by HakuHodo, Inc. [12, 13]. It mainly combines two techniques: scanning and constrained idea generation. The constrained idea generation method uses the matrix shown in Figure 3. Analysts consider what would or could occur at intersections of the matrix (HakuHodo, Inc. coined this “impact dynamics.” A similar idea generation technique is “morphological analysis,” in which analysts attempt to identify and investigate possible configurations in a problem given in the form of matrix [14]). The matrix column headings are “future issues,” which are future themes from a current viewpoint. For business scenario writing, trends in the market and in industries of interest are used. In this project, we used eight mainstream trends in future lifestyles, which were extracted from another study [11] as follows:

- 1) Escaping group-centered, collective thinking, and establishing a self-centered, self-fulfilling lifestyle;
- 2) Building virtual and real networks through social networking systems, and establishing local businesses and systems to support such small businesses;
- 3) Building self-sufficient communities and people who support those communities;
- 4) Adopting flexible and simple working styles, making a healthy work–life balance available to anyone who wants to work;
- 5) Job-hoppers cannot obtain opportunities for training, and will therefore find it difficult to find better jobs;
- 6) Social isolation for those who no longer care for office and other social relationships;
- 7) Declining health caused by fatigue resulting from caring for one or more elderly parents; and
- 8) People spending more money than they earn, without any plan, and therefore becoming financially insecure.

The stubs of the matrix in Figure 3 are “scanning clusters,” the ideas for discontinuous but possible future changes that were obtained from scanning. In the SusLife project, these were regarded as hypotheses of possible changes that could affect future lifestyles, the green circles in Figure 2. Scanning is an idea-generation technique that was originally invented by Stanford Research Institute and modified and improved by HakuHodo, Inc. Analysts skim a variety of information that could include signs of future changes, and generate ideas for underlying possible changes. That is, this method uses information as a stimulus to generate new ideas. HakuHodo, Inc. created a database of

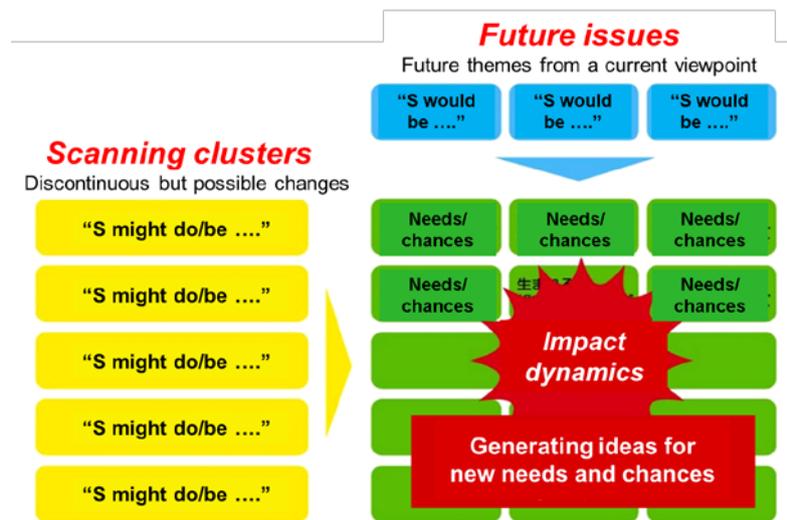


Figure 3. Constrained idea generation with a matrix, used in Future Dynamics<sup>®</sup>

this information and called it “scanning materials”, materials collected from various domestic and overseas information sources such as newspapers and magazines. We used 166 scanning materials selected from approximately 1,600 scanning materials from three recent years (September 2009 to September 2012). Scanning itself is carried out individually, but ideas that are generated by an individual participant can be elaborated by other members, and others’ ideas can serve as other stimuli. In Future Dynamics<sup>®</sup>, group work is introduced. Group members discuss and elaborate on possible discontinuous changes to determine two or three scanning clusters. They also discuss and elaborate on ideas generated in the process of impact dynamics.

### 2.3 Expert workshop

As explained, Future Dynamics<sup>®</sup> relies on idea generation. Participants’ experiences and knowledge affect the results of idea generation. In order to obtain reasonable results, we invited ten experts from the fields of social issues, community design, labor issues, technology and media, and 12 creators (designers and copywriters), and held a two-day workshop in October 2012 (Figure 4). Thirty participants, including eight members of the authors, were grouped in five and discussed and created ideas. In scanning, each group discussed and elaborated on their ideas of scanning clusters, and determined two or three clusters. In a constrained idea generation, each group generated ideas about what could occur at the intersections of the matrix. Two main ideas were generated by each group and then discussed and summarized as primary ideas.



Figure 4. A scene of expert workshop, in Tokyo in October 2012

### 2.4 Scenario writing

In the last part of the workshop, the participants wrote future scenarios based on the primary ideas generated by the constrained idea generation method. After the workshop, the scenarios were checked by the authors in terms of coherency, novelty, and social impacts of the scenarios and then the

scenarios were elaborated on. Subsequently, the scenarios were checked by five experts who had participated in the workshops, and they were then finalized by the authors.

## 2.5 Citizens' reactions to the scenarios described

Not many scenario projects have paid attention to verification of the results based on the scenarios described although it is important. However, verification of scenarios is not easy and may contradict the intent of the scenario approach. The scenario approach is not identical to prediction of the future. Scenario approaches aim to stimulate and broaden views of possible futures (c.f. Schwartz [15] and Godet [16]). Even if a scenario rarely occurs, consideration of that scenario can broaden our views. In this sense, it is meaningless to examine whether a scenario is likely to occur.

We thus investigated citizens' reactions to the scenarios described instead (a similar approach was taken by Thirkell [17]). Our intent was to identify the opinions of both proponents and opponents of the scenarios and to understand the existences of a variety of citizens. We interviewed four groups of a total of 24 citizens (12 male and 12 female) living in different parts of Tokyo in December 2013 about their impressions of the scenarios. The citizens interviewed were aged 20 to 59. (The four groups were comprised of the following: 3 males and 3 females aged 20 to 39 in non-permanent positions at work with household incomes of less than 5 million yen per year; 3 males and 3 females aged 20 to 39 at permanent positions at work with household incomes of less than 5 million yen per year; 6 males aged 40 to 59 with household incomes of less than 9 million yen per year; and 6 females aged 40 to 59 with household incomes of less than 9 million yen per year. Details are explained in Kanamori et al. [11].)

## 3 RESULTS

### 3.1 Scanning clusters—possible changes

Fourteen hypotheses of possible changes that would affect future lifestyles were generated with the scanning technique and are listed below. For instance, possible change 1) describes a situation in which individuals' health is easily managed by individuals because of progress in medical technology and a person's degree of health determines his or her reputation. Possible change 5) depicts the emergence of a new way of dying that people do not fear but face positively; they arrange the way of passing away that suits their preferences. Possible change 8) shows that people place more importance on individual relationships rather than blood relationships and that by disclosing personal information, people's relationship can evolve and they become contents of society. These 14 possible changes included primitive ideas and elaborated on through the subsequent processes of constrained idea generation and scenario writing.

- A) Health identity—health is an individual competency
- B) End of nomadic lifestyles—people create and commit themselves to communities
- C) Japan as a center of world supply chains—shift from flow business to stock business
- D) From stressful to lively—hospitals become anti-aging parks
- E) Design of passing away—beautiful endings
- F) Flexible power generation—road network is gigantic off-grid solar power generation
- G) Monetary economy versus time economy—payments are made with time rather than money
- H) Individuals become the 'contents' in an information society by disclosing personal information
- I) People can live with very "Like" only
- J) Mental (unphysical) desires are satisfied by the Internet
- K) All people are volunteers who share valuable information
- L) Strengthening individuals—importance is placed on ubiquitous, customization, and personal identity
- M) Disappearing borders of sex, work styles, and public services.
- N) Shortsighted products and services—Society pursues shortsighted outcomes

### 3.2 Results of constrained idea generation

These 14 hypotheses of possible changes (from A to N) and the eight mainstream trends in future lifestyles mentioned in Section 2.2 (from 1 to 8) were used for the constrained idea generation as

explained. Five primary ideas were generated. The first was “health as the first priority of society,” derived from the cells of A and 3/7 of the matrix. In the cells, the following elements were raised and summed up the primary idea: families will have no difficulty caring for their elderly because of the sharing of health information and public and private services; meal delivery services will become more convenient; health-related information will be put into one place; health indicators of each community will emerge; special districts for health will be developed; and precautionary medical services will spread.

The second was “rejuvenation in an ‘anti-aging town,’” which was derived from the cells of D/E and 3/5. The elements generated were as follows: services at hospitals will be expanded and jobs other than medical services will be created; entertainment will be one of these services; people will be able to find jobs that fit them at hospitals; changing jobs will be regarded as valuable; people will work in Asia; there will be local branding with health-related services; local food supplies will come from “i-turn” farmers; and power generation by visitors’ footsteps will reduce the cost of hospitals.

The third was “linking people by ‘wants,’” which was derived from the cells of H and 1/2/3/6. It was generated from the following elements: collaborative child-raising; family sharing; matching of hourly employment; workers with multiple titles will increase; universities and lectures will be based on SNS; a self-sufficient community with information exchange will develop; and the isolated elderly’s funerals will be held by web companions.

The fourth was “life curators creating happy communities,” which was derived from the cell of I and 2. The elements generated were as follows: personal know-how will turn into money; there will be public services for migrants; “problem curators” will convey social problems to the public; policy evaluation will be made by ‘Like’; and there will be a matching service for property and persons.

The last was “visualization of personal identity,” which was derived from the cells of L and 1/2. The elements generated together were as follows: a disabled woman making full use of new virtual technologies will run a business; there will be a new metric of trust; and business investment in individuals will start.

### 3.3 Scenarios described

Finally, based on these primary ideas, four lifestyle scenarios were described by the authors in detail (one includes two primary ideas). The scenarios were further examined by the participant experts with regard to their plausibility and impacts on lifestyles and were then finalized. Here, we explain these scenarios very briefly, some with figures, and our understanding of their implications.

The first scenario, “towards a health-based society,” depicts a society in which health is an important barometer of society, as shown in Figure 5. Health IDs (identification) are used in many situations—from medical services and caring for the elderly to communities, business enterprises, and consumption. The health-based society is oriented to both reduced social security costs and efficient work styles, and degree of health is used as an alternative indicator as a complement to or instead of economic indicators. The scenario suggests a preferred model that balances health and the economy.

The second scenario, “anti-aging town,” depicts that urban residents stressed by their urban lifestyles rediscover the joy of life and the value of work in anti-aging towns in rural/suburban areas. This scenario presents a shift from aged people being cared for by family members to being cared for by members of the community; the spread of living in two places (e.g., seasonally or intermittently); and the growth of environmentally sound local industries, indicating a new type of public investment with industrial transition.

The third scenario, “attaching oneself to more than one community,” was derived from the third and fourth primary ideas. It describes a society in which information itself is no longer valuable and information curated “for you” becomes valuable. When people in such a society begin to exchange information about what they would like to do in the near future, people changes their lifestyles and relationships with their cities and communities based on the information exchanged and collaborate towards alternative communities as shown in Figure 6. In this scenario, a multiple resident registry system and collaboration between community residents and external supporters are elements of an alternative autonomous community and a reformed taxation system, which suggests a direction for the rebirth of communities. This scenario also suggests the expanded use of people’s multiple-abilities in the future.

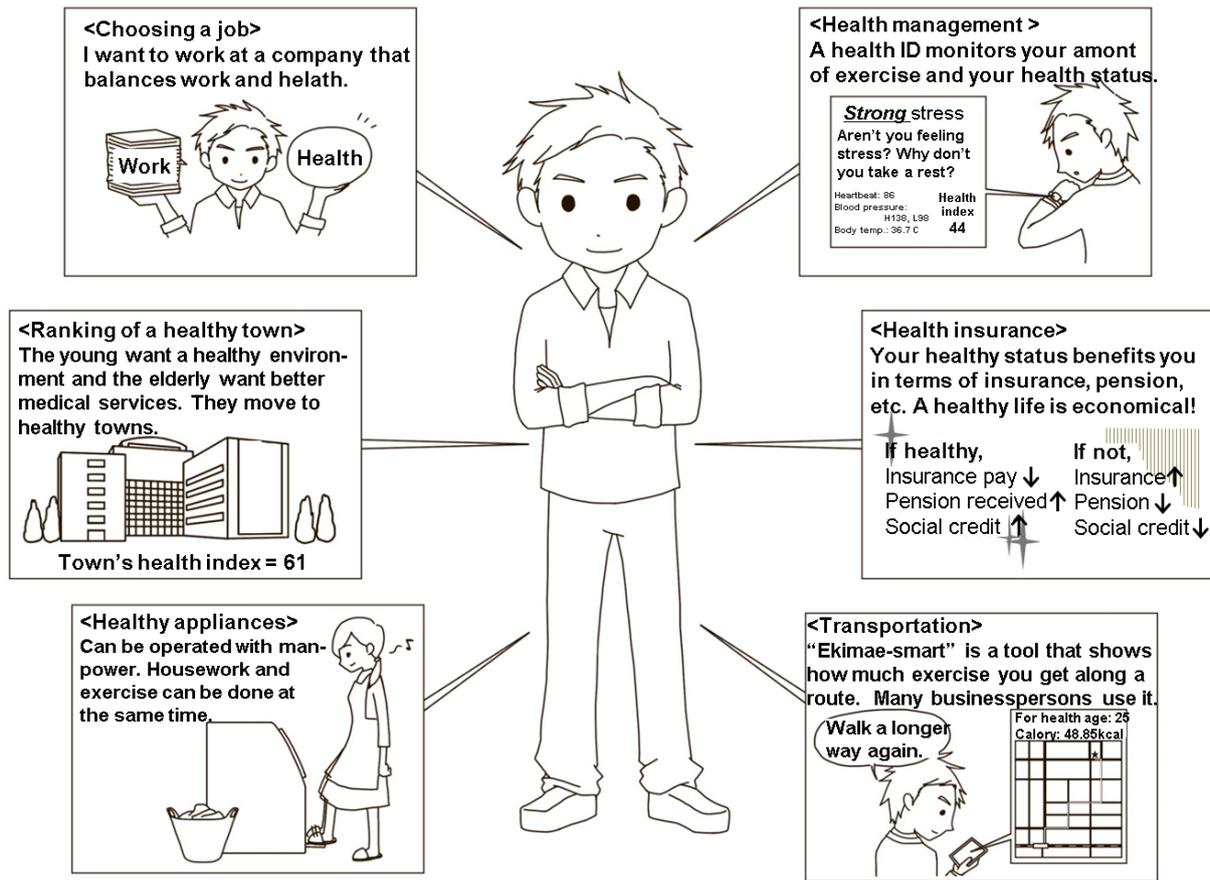


Figure 5. Image of a "toward a health-based society" scenario

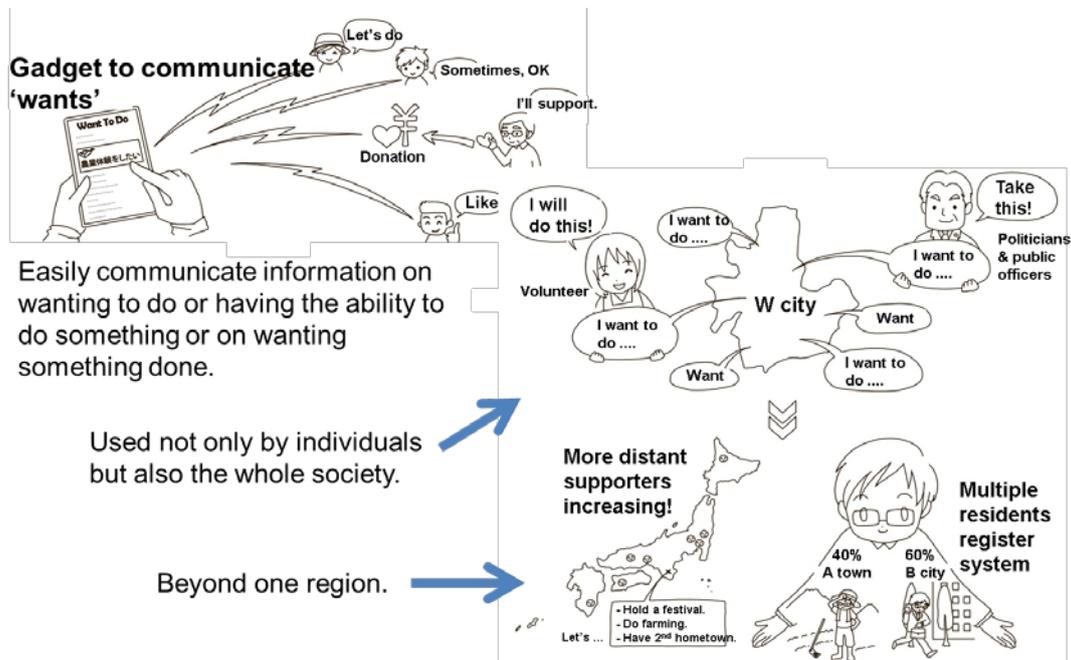


Figure 6. Image of an "attaching myself to more than one community" scenario

The last scenario, "enhancing communication with Visor-com," depicts a society in which people's ways of communication are significantly changed by the development of ICT (Information and

communication technology) as shown in Figure 7. The fifth primary idea relied on new technology to visualize personal identity, and this scenario focused on technology. Within society, the need for many peoples to understand each other increases, and people make full use of a glasses-shaped communication tool, Visor-com, in private and at work to hold dialogues with others beyond distance and culture. Users of Visor-com also utilize pictures and movies as a means of dialogues. Information from good interpreters, office administrators, teachers, and concierges is available at any time, and human knowledge and ability are expanded in a sense. That is, this scenario suggests that technology development expands human abilities.

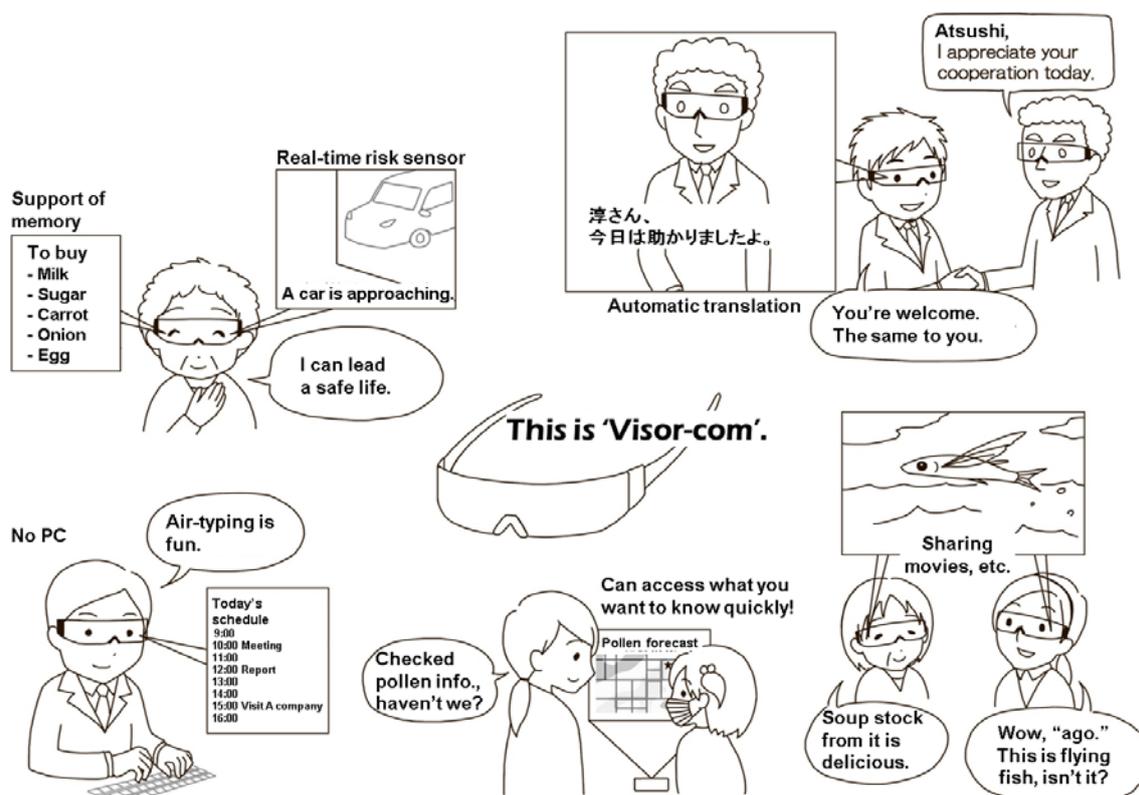


Figure 7. Image of an “enhancing communication with Visor-com” scenario

### 3.4 Citizen’s reactions to the four scenarios

The “toward a health-based society” scenario was basically perceived as preferable. However, several interviewees felt uneasy about the points that health would be controlled with data and that health status would be evaluated by others, noting that, “Health should be managed by each individual person, not by equipment”; “It was extreme that persons in an unhealthy condition have to pay higher health insurance fees and receive lower pensions”; and “Health was for individuals, and it was strange that health was embedded in the philosophy of our society.” A few showed their positive attitudes toward the scenario, noting, “We could diagnose illness at an early stage if the data were provided,” and “It is good that if we are healthy, we can gain social reputation and use medical services and have pensions with lower payments.” One interviewee said, “It looks like machines will keep people alive,” reacting to an image derived from the scenario. These reactions suggest that it is significant who will manage health, even though health is deemed invaluable for citizens.

Regarding the “anti-aging town” scenario, we observed a reaction that the scenario was not preferable in the sense that creating a large, unattractive building/infrastructure seemed very bureaucratic. This scenario showed a new public investment that transformed local industry and the relationship between cities and rural areas. However, the people who criticize the current ways of public investment tend to think that there is no real difference between the current and proposed ways of public investment, and they will not support scenarios with incremental changes from the current state.

As for the “attaching myself to more than one community” scenario, several interviewees seemed to be unable to understand the notion of becoming citizens of multiple communities because they had no attachment to their hometowns. While people in Japan who feel they have few relationships in the cities have begun to pursue relationships in rural areas and move to rural areas from cities, we could not find this as a mainstream trend in the interviews. This implies that the number of people who would like to live in a rural area is small. Regarding the point that people will connect with “wants,” many interviewees perceived that the direction of this scenario was already emerging, saying things such as, “Connecting or being connected with SNSs and apps is happening now”; “We have already been able to pay taxes to their hometowns other than the town/city they live”; and “It is useful for getting together for baseball and futsal.” Contrarily, one opinion was, “It is not comfortable when unfamiliar people gather.” As shown here, there were two different types of people: people who would utilize such a new system and other people who were opposed to it. This suggests that it is important to identify the people who are willing to change in order to leverage transforming lifestyles.

Lastly, one opinion for the “enhancing communication with Visor-com” scenario from the interviewees was, “It is likely to be realized by 2030.” However, in terms of its content, the opinions raised were negative, such as, “People will become stupid”; “Human relationships would get lost”; “People will not use their brains”; “Human abilities will deteriorate”; and “I do not want my kids to use it,” although there were a few positive opinions, such as, “It would be good as an interpretation tool because foreigners in Japan have been increasing” and “It would be useful for the elderly and persons with vision or hearing disabilities.” This scenario was based on an idea that new technologies would be utilized in a way to make individual lives flourish; however, the interviewees did not intend to make use of these new technologies. They may have felt difficulty adjusting themselves to new technologies even now. The interviewees in this survey did not include those who earned high incomes, who would also have high self-efficacy. Therefore, if we had asked these people, we might have obtained another result. Either way, we should conclude that some citizens will not accept the idea that the introduction of a new technology will always make their lives better.

#### 4 DISCUSSION ON THE SCENARIO-WRITING METHODOLOGY IN THIS STUDY

Finally, we reflected upon the scenario-writing methodology used in this study. It would be beneficial to improve relevant methodologies and share our insights with those who are interested in scenario writing regarding future lifestyles. The techniques of scanning and constrained idea generation with a matrix have been used for planning business strategies and making technology roadmaps [12, 13]. By applying them to future lifestyles in Japan, we found that they were also useful for generating new ideas about future lifestyles, especially for discontinuous changes. We also found a potential drawback of our scenario-writing process. It is about group work. Group work is good for generating ideas because participants stimulate each other, but in the process of incorporating the generated ideas into scenarios, we realized that groups could eliminate unusual ideas even though they could be realized in the future. Disregarding certain ideas is one aspect of this, and the other aspect is that the finalized scenarios included not only discontinuous but also continuous changes. That is, the methodology of scenario writing in this study was designed to address discontinuous changes, but the outcomes themselves were mixtures of continuous and discontinuous changes.

Another point that we realized through this study was that scenario writing about lifestyles is more difficult than that for business strategies because many different lifestyles exist. In our methodology, diverse lifestyles were encompassed in the eight mainstream changes in lifestyles, which were used for the column headings of the matrix for constraint idea generation. The more we take the columns into account, the more broadly we can cover lifestyles, but time constraints hindered the consideration of diverse lifestyles. Additionally, participants’ knowledge on lifestyles complemented this limitation. A lifestyle that one person took for granted was, however, not for another person. The limited number of participants may have resulted in the limited consideration of differing lifestyles.

#### 5 CONCLUSIONS

Scenario writing is a tool for exploring events in the future that cannot be addressed with models. It is a useful approach for foreseeing lifestyles in the future. Our SusLife project has examined approaches to foreseeing and exploring continuous and discontinuous changes in lifestyles in Japan from the

present to 2030. As the result of applying the techniques of scanning and constrained idea generation with a matrix, a number of ideas about future lifestyles in Japan were generated. The four scenarios presented here were a way of amalgamating the ideas of continuous and discontinuous changes in future lifestyles. These were: “toward a health-based society,” “anti-aging town,” “attaching myself to more than one community,” and “enhancing communication with Visor-com.” From this scenario writing and the interviews about the scenarios, we understood that health is an important issue, but how to control it is another issue. The financial burden on medical services in Japan will increase, and counter-movements to reduce costs are urgently needed, even though health is highly related to privacy and individuals. We also understood that there were various people who would agree and disagree with certain topics, and that current opponents of a topic tend to reject future scenarios with incremental changes even though those changes would be better than the current states. Some citizens would not accept the idea that introducing a new technology would always make their lives better. This suggests that identifying who would be willing to transform their lifestyles and under what conditions will be an important task for changing lifestyles into sustainable ones.

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# INNOVATION FOR CREATING SUSTAINABLE LIFESTYLE BRANDS: A CASE STUDY

**Kunal Mankodi**

<sup>1</sup>Amrut Mody School of Management, Ahmedabad University

## **ABSTRACT**

The Indian consumer has evolved since 1991, when multinationals entered India, offering products and services which were not available earlier. He now has a large number of options to choose from and globalisation has aided the cultural movement due to which the western lifestyles, products and services are demanded by a typical upper middle class young consumer. He looks beyond product utility, to seek intangibles like style statement associated with the product. But can a service become a lifestyle statement? Can companies think of sustainable innovative business models? This paper attempts to answer these questions with the example of an Indian Company called Kaya Skin Clinic, a leading lifestyle brand in the professional skin care segment. The aim of the paper is to develop a conceptual model and illustrate with example the role and relevance of innovation in creating niche, urbane, and yet sustainable business. Kaya Skin Clinic has been able to create a whole new market segment of scientific approach driven skincare solutions. What was once a supplementary service offered by traditional beauty salons, has now become a thriving business model. Armed with a robust proprietary Information and Technology architecture that facilitates Customer Relationship Management, Loyalty and Referral Marketing, Kaya has created a lifestyle brand from what was once a basic service. (Here - Lifestyle brands create a certain degree of style statement for consumers). The case study shows that developing innovative business model by industry convergence, backed by creation of entry barriers can give sustainable competitive advantage to firms and develop consumer lifestyles.

Keywords: *Industry Convergence, Innovation, Sustainability, Consumer Lifestyle, Skin Care*

## 1 INTRODUCTION

The Indian consumer has evolved since 1991, when multinationals entered India, offering products and services which were not available earlier. He now has a large number of options to choose from and globalisation has aided the cultural movement due to which the western lifestyles, products and services are demanded by a typical upper middle class young consumer. He looks beyond product utility, to seek intangibles like style statement associated with the product. Socio-cultural, psychographic and geo-demographic reasons have led to this altered lifestyle (Joseph and Singh 2013) [1]. An average Indian today is younger, with a higher disposable income and a dispensation to spend on sophisticated products and services which reflect his current lifestyle or the style he aspires for than an Indian consumer a decade and half ago. (ASA & Associates, 2013) [2]. Wellness industry is one the sectors which has witnessed a substantial positive impact of rising consumerism in India. As per FICCI report by PWC, (2011) [3] report, 'Riding the Growth Wave: Wellness', the overall size of the wellness market in India stands at INR 490 bn and wellness services alone comprise 40% of this market leading to the entry of a large number of domestic and international players in the market who are trying novel and innovative methods to target customers offering a value proposition along with a branded lifestyle which leads to dual satisfaction. The report further asserts that the future of the wellness industry in India looks even more promising as the industry will grow at a CAGR of 20% to reach INR 875 billion. Consumers and their needs will continue to evolve, driving the transition from remedial care to a more holistic view on preventive care.

A domestic Indian company, Marico Industries, has been an early entrant into the wellness market in India has been offering beauty and wellness services under the brand name of Kaya Skin Clinic and the current paper attempts to study the innovative practice adopted by Kaya Skin Clinic to tap the potential growth opportunities offered by the market .

## 2 THEORETICAL BACKGROUND

### 2.1 The Contemporary Indian Consumer:

Changes in Indian economic policies have resulted in cataclysmic alterations in the lifestyle of an average Indian, primarily in the consumption choices and patterns. Rising urbanization, increasing number of women joining the workforce, higher disposable income and lucrative credit options available has offered to the market young consumers today who are prepared to pay for an 'extra buck' for an experience which is the most intangible aspect of a 'service'. A few aspects which service providers need to keep in mind are the following: Ambience in which services are offered; Service term and offerings made; Busy Lifestyle of the New Age Generation; Financially independent Self Conscious Woman and the 'Made for You' approach.

**2.1.1 Ambience in which service is offered:** Powe, (2006) [4] indicated that lifestyle service providers of the current times need to be very particular about the non-tangible consumptions. The display or arrangement understood as the physical environment of the service area is a critical factor in deciding how satisfied a consumer would be with the service offered and therefore impacting the sustainability of the service (Bitner, 1992) [5]. The music, lighting, odour, sophistication and courtesy expressed by the service staff impacts the consumers consumption and satisfaction from the service (Baker, et.al, 2002) [6].

**2.1.2 Service Term and Offerings Made:** Most customers look at long term service agreement where the service price and term is bundled in such a way that he can use uninterrupted long service without having to invest too much into maintaining the service. The average Indian customer is price sensitive and looks out for service options in the market before consuming a service. Therefore service providers need to consciously watch out for various factors like service duration offered, maintenance efforts needed for uninterrupted services, customer involvement in and finally the competitive prices (The Marketing Association of Australia and New Zealand) [7]

**2.1.3 Busy Lifestyle of the New Age Generation:** Indian consumers are growingly getting busy and involved in their jobs. There is a mass movement of workers to the cities where they lack any social

support system for care and consultation and therefore there is a dramatic rise in the services offered in the cities. The busy life style brings along additional income but repercussions on health and therefore an average urbane middle class Indian consumer is oriented towards consuming non-essential, lifestyle oriented products and services.

**2.1.4 Financially independent Self Conscious Woman:** The population of working women has increased and today over 26% of the working population are women (PWC) [8] leading to an addition in the number of women who are financially independent and enjoy the confidence and freedom to spend their earnings in consuming products and services which satiate their need to better leading a happy self contended life. Sustainable development of services is only possible when women are financially independent and manage to take decisions on their own (Eyben et al., 2008) [9]. A few services which have witnessed an immediate and direct growth due to additional number of financially independent women in the population are beauty and wellness sector; hospitality and day care services and fashion industry.

**2.1.5 Made for You:** Papathanassiou (2004) [10] clearly stated that there is an increasing demand for customized products and services which exactly fits the customers' needs. Contemporary customer is highly conscious of his needs and expectations and therefore draws higher satisfaction from products and services which are tailor-made to his needs. De Koning, Does, & Bisgaard, (2008) [11] reported that competing services often use customization and individualization as a tool to tap a bigger market share. Therefore services need to be become conscious of the fact that enhanced flexibility in design and offering and a prompt response time are two basic essentials for their long-term sustainability in the market Piller & Müller, (2004) [12].

Apart from the consumer perspective there stand a few macro factors which impact the sustainability quotient of an organization. A strategically designed organization keeps the following aspects in mind while designing its internal and external structures.

## 2.2 Industry Convergence

Usually industries can be distinguished from each other based on variety of product and service offerings which are catering to different markets, through the nature of firm and non-firm organizations, through their knowledge and learning processes, etc. These differences imply a distinct industry specific innovation system Carroll et al. (2000) [13]. At times of convergence, differences between these industries in terms of the above characteristics begin to blur.

Although the concept of industry convergence has been predominantly used for analytical applications in the areas of computing, communications and consumer electronics, it can be a lot more pervasive. Prahlad (1998) [14] cited developments in the personal care products such as body lotions and 'cosmeceuticals', which have incorporated pharmaceutical technologies and processes in New Product Development including clinical trials. Not much of literature is available to throw light on how the concept of industry convergence is used in the services sector. The aim of this paper is to identify one such firm which did it in the area of wellness industry.

### 2.2.1 Industry Convergence by Looking Across Alternative Industries

Kim and Mauborgne (2005) [15] in their path-breaking work on Blue Ocean Strategy, highlighted the traditional way in which firms compete in search of sustained, profitable growth. Invariably, firms fight for competitive advantage, battle for market share dominance which is usually led by price war and hence in the process, struggle for differentiation. The authors argue in favour of "value innovation" – creating powerful leaps in value for both:- the firm and its buyers, rendering concept of rivals obsolete and unleashing new demand. In their seminal work, they have proposed a six path framework which firms can take to ideate and actualise the idea of value innovation product. One such path is: "Looking Across Alternative Industries" through which, firms can create an innovative business model / product by looking across seemingly non-related industries by picking upon the product-market attributes of both these industries and create a new one.

## 2.3 Sustainability of Competitive Advantage

Ghemawat (1986) [16] argued that sustainable advantages can be categorised in terms of *size in the targeted market*, and *superior access to resources or customers*. These advantages are not exclusive. They can interact and the more they do, it creates a stronger base of competitive advantage.

### **2.3.1 Benefits of Size**

Size advantages exist because markets are finite. If a business can commit to being large, competitors may resign themselves to remaining smaller. What holds them back is the fear that if they matched the leader's size, supply might exceed demand by enough to make the market unprofitable for everyone.

First-movers have to be especially wary of environmental changes that can erode the value of their early investments. Such advantages have three possible bases: scale, experience, and scope.

Scope economies are derived from activities in interrelated markets. If they are strong, a sustainable advantage in one market can be used to build sustainability in another. The term 'scope economies' isn't just a newfangled name for synergy; it actually defines the conditions under which synergy works. To achieve economies of scope, a company must be able to share resources across markets, while making sure that the cost of those resources remains largely fixed. Only then can economies be put into effect by spreading assets over a greater number of markets.

### **2.3.2 Access Advantages**

Preferred access to resources or customers can award a business a sustainable advantage that is independent of size. The advantage persists because competitors are held back by an investment asymmetry: they would suffer a penalty if they tried to imitate the leader.

## **3 RESEARCH AIM AND METHODOLOGY**

The research followed development of a case study from the insights gathered from primary and secondary sources with an objective to look at how an Indian company has used innovative business model in the services sector which has led to creating a sustainable lifestyle brand in the nascent Indian Wellness (Skincare) Sector.

The research was exploratory in nature seeking to elicit top management's perspective on the strategic rationale of entering the wellness sector and then to analyse the theoretical conceptions which back the practitioner's perspectives. An in-depth interview was conducted after a discussion guide was developed. The telephonic interview was conducted at a time of ease and convenience which was fixed through a prior appointment with the-then CEO of Kaya, Mr. Ajay Pahwa (November 2009 to April 2013). The interview lasted over 80 minutes with a break after about 50 minutes which the respondent asked for. Respondent was encouraged to talk as much, or as little as he wished, only probing to seek clarification and to explore in detail their comments. The responses were recorded and then transcribed.

Within the context of the aim of the study, the author noted patterns and a theme to the inputs, drawing linkages with literature. To extend the sustainability perspective study further, financial data of 5 years was used to gauge the financial performance of the firm and then compared with financial performance of Marico Ltd. (Financial year 2007-08 to 2012-13).

## **4 CASE STUDY: KAYA SKIN CLINIC**

### **4.1 Introduction:**

Marico Limited is one of India's leading consumer products & services companies operating in the beauty and wellness space. Currently present in 25 countries across emerging markets of Asia and Africa, Marico has nurtured multiple brands in the categories of hair care, skin care, health foods, male grooming, and fabric care. Charting an annual turnover of Rs. 46 billion (Financial year 2012-2013) across their portfolio, Marico's sustainable growth story rests on an ecosystem that promotes innovation and value creation.

## 4.2 Genesis of Kaya – An Innovative Approach of the Owners

Marico has always been an innovation-centric company. In 2002, a New York-based company asked the CMD, Harsh Mariwala if he would be interested in selling laser hair removal machines, he saw a business idea around the concept. After conducting extensive research, Marico identified an unmet need for non-invasive Cosmetic Dermatology services in India. The Marico team travelled to the US and UK scouting for international trends and best practices and came across a host of standalone shops offering advisory services as well as solutions. Until then, consumerism of wellness products wasn't thought of and the little bit of skin care service provided was only to the extent of basic supplementary services such as facials, clean-up etc. provided by existing salons for males and females. In case consumers had any skin related issue, the only source of avenue was getting the services rendered by professional dermatologists. This prompted the company to set up Kaya, a range of skincare clinics. The company decided to bring in a scientific approach by roping in dermatologists who first tested the skin and then recommended a service. This highlights the 'Looking Across Alternative Industries' approach for industry convergence. Hence, this way, the company started a prototype clinic in the Marico Head Office in Mumbai.

## 4.3 The Kaya Experience:

*“To transform in a sustainable manner, the lives of all those we touch, by nurturing and empowering them to maximize their true potential.”* (Annual Report 2009-10) [17]. This philosophy at Kaya is governed by the single value of placing the customer first at all times. Kaya is all about personal confidence through expert skin care which seamlessly blends looking good with feeling good about our inner and outer selves at all times leading to highly customised and personalised services most suited for Indian skin provided in a state of the art clinic ensuring that the first intangible of services, 'Ambience' is offered to the consumers. The customer centric approach is practiced across all service points - services by the staff, the consultation by the dermatologists, service by the skin practitioners or even the Kaya drink. Customers get personalised expert skin care administered with warmth at all the touch points.

The company has identified three core differentiators – an in-house dermatologist, Offerings in the form of personalized skin treatments, research based products and services which suit the Indian skin type and weather which Kaya communicates effectively through various mediums. Its communications strategy targets a typical modern day financially independent Indian woman who looks after herself in a refined way. Kaya targets high end customers in socio-economic class A with age group of 18-60 years across metros and mini metros in the country. The objective is to provide result oriented, personalized, non surgical skin care solutions in a serene zen-like environment. (AR 2009-10). [18]

## 4.4 Growth:

Kaya has been growing and has increased its reach to 81 clinics across the country, in the metro as well tier 2 cities. They also have 14 clinics in the Middle East and 2 clinics in Bangladesh in Dhaka. In May 2010, Kaya acquired the aesthetics business of the Singapore based Derma Rx Asia Pacific Pte. Ltd. (Derma Rx). During the course of this journey, Kaya now has over 600,000 customers which has constantly risen over a period of time indicating sustainability which is backed by innovative practices.

Kaya Skin Clinic was launched in December 2002 when there was no other organized player in the market. The skin care market was dominated by individual dermatologists who provided limited offerings with rudimentary technology. Kaya has revolutionized wellness market in India, it has also provided credibility and trust to the industry with specific reference to cosmetic dermatology leading to an emergence of regional brands with a few clinics and individual doctors offering similar services. However, no one has the scale or the range of technology and services that Kaya offers. The chain has increased its focus on specialized service categories like laser hair removal, pigmentation, anti-ageing and acne treatments, which has led to the average bill size increasing to Rs. 14,000 currently compared with Rs. 12,000 a year ago indicating sustainable growth. The contribution of these specialized

skincare services to overall business has grown to 61% from 50%. The organization still offers regular healthy skin care services with average ticket size of Rs. 5,000 - 6,000 and it likewise has a reach of administrations beginning from Rs. 2,000. (www.livemint.com) [19]

#### 4.5 Competitive Advantage and Sustainability:

Kaya is operating in a large market space which is defined as non-invasive cosmetic dermatology. Business models continue to evolve and even today a significant part of this industry is unorganized. According to Mr. Ajay Pahwa, ex-CEO Kaya, sustaining its competitive advantage is possible through:

##### 1. Economies of Scale:

- A national brand that enjoys over 80% plus brand awareness, built on the back of national mass media, digital and social media
- A robust proprietary IT architecture that facilitates CRM, Loyalty and Referral Marketing
- State-of-the-art technology – often exclusive to Kaya in India
- Products- Manufacturing, distribution and retail of proprietary range of products

##### 2. Services/ Solutions Differentiation:

- Customer Knowledge: Knowledge from the 600,000+ strong existing customer base, technology and CRM
- Service + Products Solutions approach to Skincare
- Continued focus on providing customized and efficacious skin care solutions comprising services and products
- Introducing new technology and services in the country after extensive research and customization to Indian skin type
- Maintaining the highest level of safety standards
- High quality customer experience
- Access to highly efficacious international products through Derma-Rx & technology partners around the world
- Exclusivity agreements with international technology companies
- Dermatologist Expertise: Ability to attract & engage Dermatologists to expand business model across geographies
- Innovation: Ability to partner in technological innovations

##### 3. Business Sustainability through Corporate Parenting

Marico, which generated consolidated revenues of Rs 4,000 crore for the year ended March 31, 2012, had various brands that straddled categories such as hair oil, deodorant, edible oil, fabric care and male grooming besides the Kaya skin care business.

What lingers as an issue of concern and worry for Kaya are the heavy overheads which cannot be covered through penetration into limited markets of metros and tier 2 cities. The reported losses as mentioned below in Table 1 (Financials for Kaya Limited), have been covered up to keep the brand sustainable by corporate parenting of Marico Ltd., the FMCG major which has registered growing profits over the same period, as mentioned below in Table 2 (Financials for Marico Ltd.)

*Table 1: Revenues and Net Profit / Loss for Kaya Limited*

Particulars (in Rs. million)	Year					
	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
<b>Sales</b>	810.4	1183.7	1261.4	1080.2	1417.4	1436.6
<b>Profit / (Loss)</b>	(31.9)	(56.8)	(307.9)	(720.5)	(750)	(1047.5)

(Source: Company Annual Reports)

*Table 2: Revenues and Net Profit / Loss for Marico Ltd.*

Particulars (in Rs. million)	Year					
	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
<b>Sales</b>	19050	23880	26610	31350	39800	45960
<b>Profit / (Loss)</b>	1690	1890	2320	2860	3170	3960

(Source: Company Annual Reports)

#### **4.6 Restructuring and the Way Forward**

Marico Ltd. restructured its businesses into two entities – one housing its fast moving consumer goods (FMCG) unit while spinning out the beauty and wellness business under a separate firm Marico Kaya Enterprises Ltd (MaKE) through a vertical demerger to give a fresh impetus to the potent but ‘yet-to-be-profitable’ retail business.

The changes are a part of a restructuring exercise which began with the demerger of Kaya into a wholly-owned subsidiary of Marico Ltd. The demerger was a strategic essential move by the parent company as it saw a huge potential in the beauty and wellness services market which was estimated at Rs. 11,500 crore in 2013. The industry grew at a compounded annual growth rate of 15-20%. Yet many businesses in the sector find it difficult to turn profitable because of challenges such as high rentals, utility and staff costs, which keep margins under pressure (PricewaterhouseCoopers).

“The skin care solution was a different business for us. We did go through the learning curve and the insight we got was that we ramped up too fast. There is always a challenge in terms of competition from smaller players with no overhead costs,” explained Mr. Mariwala (Chatterjee, P.) [20]. Analysts believe that the decision to demerge will lead to greater focus on the skin care business by a different team with a new entrepreneurial way of running the business. This may yield better results and also provide an option of remerging, once this business becomes profitable.

##### **4.6.1 More Focus on Products**

In spite of Kaya’s top-line growing, the same stores sales growth had slowed down to single digits because the initial monetary commitment which a customer needs to make is high but Kaya is now planning smaller stores with focus more on products than services leading to focussed marketing and customer repeat with a long term commitment to enjoy Kaya services.

With the concept of Kaya Skin Bars being planned in cities of Delhi and Bangalore, these would stock products rather than offer skin care services. The Kaya range is also being offered at counters in Lifestyle stores. The Kaya brand would be adding 18 new skin care products and increasing the number of stock keeping units to 54 with its extended Derma Rx range, which is a premium one, leading to higher margins. The focus on product sales has led to higher footfall through a shift from ‘cure’ to ‘prevention and cure’ positioning reflecting a proactive business strategy aimed at independent women who are driven by logic and reason with limited access to suggestions and opinions by others.

## **5 SCOPE AND CONCLUSION:**

Through industry convergence, Kaya Skin Clinic developed an innovative business model in the Indian Wellness Industry in the skin care market for women in such a way that going to a Kaya Skin Clinic is a fashion as it has created a lifestyle statement. The business model of the company comprises of offering skin care solutions to its customers who are largely financially independent women capable of taking decisions and focussed on the ‘self’. The service revenue includes packaged services for which the consideration is collected upfront towards services to be availed by the customers over a period of time ensuring a long term service agreement and commitment. These advances are non-refundable and hence are designed to constitute revenue at some point of time in the future. With strategic parenting from Marico, the company is in a position to sustain its advantage as the pioneer in this field.

Sustainability of their advantage, despite of negative financial performance till date, can be attributed to the corporate parenting available with the firm in the form of Marico Ltd. Now that the company has been spun off as a separate entity, it remains to be seen whether the restructured company with ideally an entrepreneurial approach can sustain financially become self-sustainable.

There is further scope for research to gauge whether a pure-play new entrant through industry convergence can come up with a sustainable innovation which can create and change lifestyle trends of consumers around in India and around the world.

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# WHY DO WE BUY AND THROW AWAY ELECTRONICS?

Greger Henriksson<sup>1,2,3</sup>, Miriam Börjesson Rivera<sup>1,2,4</sup>

<sup>1</sup>KTH Royal Institute of Technology, Division of Environmental Strategies Research

<sup>2</sup>KTH Royal Institute of Technology, CESC - Centre for Sustainable Communications

<sup>3</sup>gregerh@kth.se, <sup>4</sup>miriamrg@kth.se

## ABSTRACT (250 WORDS MAX)

Electronics such as computers and mobile phones have quite recently become affordable and integrated in the everyday lives of a large proportion of the world population. This has coincided with shorter product life and led to increased, and from several aspects unsustainable, scrapping of electronic products. This development reflects conditions on the markets. It also reflects social and cultural processes behind purchasing and discarding on the everyday life level. We see a need to investigate and analyse such processes. The analysis should be useful for researchers as well as policy-makers. The purpose of this paper is to review, and select knowledge and theory within, social science and humanities that can help understand socio-cultural conditions and processes related to consumption of electronics.

Theoretical frameworks selected through the review are e.g. sociology respectively anthropology of consumption, sociology of technology and practice theory. These frameworks are used, or touched upon, to form hypotheses that could explain choices of buying and discarding in everyday life. A tangible result of our review is the preliminary conceptualization of nine socio-cultural processes that seem to motivate consumption of electronics: mandatory technology (as a citizen you are expected to possess some electronics and functionality); possibility opening (buying access to functionality that you want to explore and *might* utilize); economic opportunity (i.e. decreasing economic constraints for buying electronics); specialization/multiplication (of possessed products within e.g. a household); fashion shifts; social comparison and identity; habits; matching; novelty (newly designed and/or purchased as a stimulus).

*Keywords: Electronics, consumption, motives, motivators, sociology, anthropology, ethnology, socio-cultural*

## 1 INTRODUCTION

### 1.1. Background and aim

Rapidly increasing amounts of produced, as well as discarded, electronic products and the way production and waste handling is taking place presently, implies a development that is unsustainable from several aspects. The development obviously reflects conditions on the markets. It also reflects social and cultural processes behind purchasing and discarding on the everyday life level. We see a need to investigate and analyse such processes. The aim of this paper is therefore to make an explorative review and selection of knowledge and theory within social science and humanities, that can help understand conditions on an everyday life level motivating consumption of electronics. The following two questions of a more general kind motivated our research: What lies behind present trends concerning how consumers in affluent societies buy and throw away electric and electronic products? How could these patterns change towards more sustainable consumption habits? By focussing on widespread patterns of action in everyday life, that seem increasingly significant in terms of environmental consequences, we hope to address relevant and truly interdisciplinary issues on sustainability. The paper is based on an earlier report that we have published together with our colleague, professor of Eco Design, Conrad Luttrupp [1].

## 1.2 Theoretical framework and methodology

Relevant frameworks were selected through an explorative review, and are comprehensively presented in this section. Frameworks were found within sociology of consumption [2], anthropology of consumption [2], sociology (and domestication) of technology [4], practice theory [5] and theory of habits [6]. Below we present some relevant perspectives grounded in these frameworks. We have grouped them together under two sub-headings, for convenience of writing and reading rather than that any frameworks should be seen as particularly related.

### 1.2.2 *Anthropology of consumption, sociology of technology and theory of habits*

From an anthropological perspective, consumption is to a large extent about creating and maintaining social relationships. Consumption of goods is co-evolving with social meanings, values and the purposes and significance that we ascribe to them. One example of this is how things become markers and help us understand our social reality; Eating breakfast in the morning not at dinner and vice versa or treating yourselves more generously in the family during the weekend, buying gifts, decorating for holidays etc. [7]. We need material things to make sense in such recurrent practices and rituals.

Therefore, according to sociology of technology, it is necessary to study what happens when people find ways to use the available technology and consumer goods in their everyday life [8]. Technology is a fundamental part of everyday life, something that is included in all daily activities. The technical development and introduction of new technologies in everyday life contributes to the transformation of everyday routines, but also acts as a stabilizing factor [8]. In order to maintain habits, discretion, self-realization and social relations people plan and carry out the purchase and use of technology. This takes place within the framework of our beliefs about what is desirable and possible [9]. Meanwhile, new forms of (using) technology are often also related to certain shifts in habits and relationships, see e.g. [10, 11]. Objects have always been important for people in this way, which means to bring order and meaning in life. The unique feature of our time is that available objects are mostly and more than ever mass-produced. The majority of things we surround ourselves with today share the common feature that they are made for sale [12].

The start of consumption in a modern sense can be traced to the 1500s and the English court, which became, more than before, a space of exhibition for the nobility [13]. In the 1700s mass consumption broke through in wider social classes than the nobility. Successively more and more goods became available in more and more places and on a larger number of occasions than before [13]. In the 1800s, in conjunction with that department stores began to appear and e.g. fashion shifts could get a wider impact, the modern consumer could be said to be born. In the department store, presumptive consumers learned how to consume [13]. One can also view consumption as an important component of the post-modern existence. Here and in the previous and following, we have drawn inspiration and references from sociologist M. Godskesen [4] and anthropologist Daniel Miller [3]. The (late) modernity is characterized by institutions such as industrial production, market economy, and political institutions, such as the nation-state and democracy. This contributes to a more dynamic social order than in previous eras. This is also related to that individuals can choose how they want to live in another way than in previous societies. An individual in today's society needs to constantly create her own life criteria, while being aware that this is exactly what she does. She is self-reflective. It has been argued that need for self-affirmation has increased in modern society (in relation to was the case for previous generations) [14]. People's habit and emotional anchorage has become more volatile, see [3] with reference to [9], and people search up and consume experiences and artifacts that can provide self-affirmation, which in turn creates new technology needs [13]. Thereby people have been in some sense in a hurry to reach a wide range of activities in their daily life, activities often diverse in time, space and the social dimension. This means that the relationship is strong between our perceived needs of access to places, networks and goods and the technology resources we utilize.

The creation of identity comprises making choices of different kinds, which also provides that there is more or less "informed" choice and because there is so much to choose from, it is hard to know what is "right" and "best." The more important the choice, the more important support and confirmation might be [15]. Here it is also important to observe to what extent consumption becomes self-generating, since it will always pop up a "better" choice.

People consume not only for themselves, but also for others. The social significance and reciprocity of gifts is something that has been studied extensively in anthropology. The gift has symbolic meanings, such that it binds donors and recipients to each other, and calls for mutual trust. Correspondingly, consumption should be understood also in terms of expressing love, care and social relationship. The buyer of a gift might therefore want to accomplish that the person who receives it desires and/or appreciates it. Seen in this way, consumption bears traits of a sacrificial rite in secular society. Through buying there is a hope to influence the recipient (e.g. your child or a friend) to become such a person who would be the appropriate recipient of the goods. One way to understand shopping and consumption is as (a continuation of) ritual sacrifice. We sacrifice consumption goods to our social relationships in order that they should become what we want [3].

In each historical epoch and every social context the pursuit of action and self-actualization has been related to specific forms of technology use and consumption. Acquisition and exploration of new technologies are important ways to create room for action, activity and access, and to reach self-fulfillment [4]. In relation to the tension between individual self-fulfillment and structural constraints, technology is seen as a potentially bridging resource, relieving the tension, e.g. by providing accessibility, see Godskesen [4] with reference to Læssøe [14]. The more connected, equipped, mobile etc. we are – the faster and further we can reach out - the more we can achieve (ibid.).

Within sociology of technology is often emphasized the user's own ability to shape their use of technology in everyday life. Lie and Sørensen [8] (on page 9) state that there is considerable room for action at the users' end, and then continue: 'The users / consumers make active efforts to shape their lives through creative manipulation of artefacts, symbols, and social systems in relation to their practical needs and competencies' [8].

### **1.2.2 Practice theory and sociology of consumption**

As a background as to why we buy and discard electrical items a historical perspective on how new technologies come in to use is illuminating. Practice theory is a framework in which historical as well as contemporary perspectives are put to use. How private homes have become increasingly electrified is relevant for our study. Such electrification occurred in different historical rounds in connection with new technologies successively breaking through. The first round of electrification in the early 1900s comprised mainly lighting. The second round from about 1950 comprised mainly heat and power. According to sociologists and practice theorists T. H. Christensen and I. Røpke we are now in the midst of the third wave of electrification - the broadband revolution [16]. And a very big part of the electronic products consumed can be counted in the category of commercial entertainment [17]. However, also the state has had an important role in the digital revolution and broadband society. An example of how the Swedish state has driven the development is its IT Commission operating around the turn of the millennium 2000. In a large report from this commission it was stated that: 'Sweden should be a society where modern IT helps provide better quality of life for all and a developed welfare. It shall be used everywhere and by all', and that 'IT has crucial importance for the Swedish economy's competitiveness'. Furthermore, an important objective for policies within this area has been that authorities should be able to provide their service at any time of day, all days a week. Such visions have then been dependent on the material conditions in the form of new appliances. Examples include health care contacts and insurance issues, having access to the e-ID, digital TVs that require special boxes, service branches closing down analogue face-to-face services (as with Internet banking), etc., all of which requires internet and/or machine telephone services (touch tone or voice-controlled). This has increasingly made access to computer and internet a prerequisite to cope in everyday life.

This increase and spread of ICT equipment could be seen as part of how a new normality is constructed, and how expectations and standards changes for what is considered a normal home in terms of electronic infrastructure and equipment [16]. This historic perspective provides an understanding of how new product lines are added to the previous product groups owned by householders, and how the total amount of electrical equipment in the home increases. These studies have also identified a number of general factors that have been important for that each round could take off. Increasing consumption of electrical and electronic products can from this perspective be seen as arising from interaction between product development and general consumption drivers which

rests partly on individual motivations and partly on the everyday life conditions [18]. There having been different periods of electrification thus explains holdings of electric equipment has accumulated in the homes. Here we want to discriminate between accumulation in terms of a) *more of various kinds* (increased diversification of product types and new or more specialized uses) and b) *more of the same*, for example by that collectively owned equipment (e.g. freezers, washing machines within a residential area) increasingly becomes individually owned, that equipment duplicated in a second (leisure) home, or is being multiplied in terms of that each individual in the household owns one (a TV set, a laptop) or that it is installed in every room, etc.

Behind the developments of *more of various kinds* and lies, of course, increased economic opportunities for the population, or at least for the broad middle class. Increases in consumption is also associated with new business ideas, business models, marketing strategies and new successful companies etc. Through co-evolution between everyday practice and commerce, supply and marketing there seems to be created short and long term buzz around a certain product categories. A certain kind of product could be experienced as *filling a gap* in for the individual/household. Such *gaps* should be seen as socially constructed through e.g. marketing, consumer journalism and trends among groups of people.

It should be noted that ideas and metaphors like the above one that ‘products fill gaps’ could only be valid for a specific context, viewed from a certain perspective. Within sociology of consumption, linear models of explanation, focusing on e.g. marketing strategies and/or social comparison, have been subject to criticism. For a very brief overview, sociology of consumption is generally seen as emanating from works on fashion etc. published by sociologists, philosophers and economists as early as around year 1900. More than half a century later sociologist P. Bourdieu contributed greatly to the understanding of ‘who consumes what and why’. Since then a variety of frameworks has developed within sociology of consumption. For our review and paper we have found a book chapter by sociologists and practice theorists E. Shove and A. Warde [2] particularly useful. These authors specifically looked for ‘mechanisms driving consumer demand’ within sociology of consumption literature (ibid: 231). In their categorization we found a starting point and structure for categorizing motivators behind consumption of electronics. Therefore we regard the finding of this particular framework as a result and present it in the following.

## 2 RESULTS

We see as the main result, of our review and analysis, the below grouping of motivators behind consumption of electrical and electronic products. This grouping we propose much in line with [2]. Shove and Warde start out from a sociology of consumption perspective and arrive at the six ‘six mechanisms supporting escalating levels of consumption’ (ibid, page 232). We found this perspective very useful for singling out and understanding mechanisms behind buying and discarding electronics. The six mechanisms according to Shove and Warde are: social comparison, identity, novelty, matching, specialization and socio- technical systems. We have chosen to build on these categories with some modification and expansion, see below. When studying how electronics are bought and used we found that factors such as e.g. purchase power and the exploring of new functionalities seemed crucial. Some of the mechanisms we found aspects seemed possible to merge into the mechanisms proposed by Shove and Warde, and others we thought needed a new heading/category. We arrived at the nine motivators, expanded on in the following section. (To make it easier to see where we have built on a category proposed by Shove and Warde we have put their categories in italics, each first time mentioned under a subsection heading.)

### 2.1 Hypothesizing motivators behind buying and discarding in everyday life

#### 2.1.1 *Mandatory (critical) Technology*

Through *sociotechnical systems* [2], inhabitants can provide themselves with food, clothing, medical care, transportation, water, electricity, information, communication and entertainment etc. How the systems are organised, legally, technologically etc., makes up their sociotechnical logic [2]. This logic largely determines what technologies people need for their different roles and situations in everyday

life, as citizens, professionals, parents etc. This includes requirements and expectations of possessing, or in other ways or having access to, necessary equipment (computer, family car, heat pump etc.). For electrical and electronic products electricity and telecommunications networks are crucial systems. The socio-technical logic implies that people have to possess or have access to devices and services (broadband modem, phone etc.) in order to live up to the expectations of employers, government agencies, healthcare providers, business, people in social networks for various common activities, relatives, family members and so forth.

### **2.1.2 Possibility Opening**

The term possibility opening [4] implies that possession of a product could open for possibilities of doing things. By having access to means of transport, information technologies, etc., people can open and expand opportunities for activities and experiencing, even when it is not any strict sense mandatory to provide oneself (or one's household) with the opportunity. The desire to open a possibility could simply arise from an awareness that the possibility exists and is being explored by other people. Keeping options open has been argued to distinguish us as members of late modern society, see e.g. [15]. Having gained access to a possible activity, doesn't necessarily mean the activity will be carried out to any significant extent. The certainty of having an option should be seen as valuable in itself. One way to open up for new opportunities is by acquiring electronics. By owning e.g. the latest version of a game console the option for play playing new (versions of) games might at least temporarily be secured.

Possibility opening should be seen as a motivator directed inwards, toward the operating space and wishes of individuals, as well as outwards, in terms of being able to take part in optional, social activities. In our example of a new game console it could be about playing as well as about talking about the game in different social contexts. Correspondingly, on the mobile side, different platforms and apps etc. could open up for possibilities to process knowledge, and having access to information, social media and experiences made possible through these.

### **2.1.3 Economic Opportunity**

An overall trend is that purchasing power increase relative to the price of mass-produced durable goods [1]. A contributing factor behind this development is, from a Nordic perspective, that products have, for at least half a century to an increasing degree been produced in so-called low-wage countries, while Nordic wages has risen. Other contributing factors are e.g. increasingly streamlined manufacturing processes and globally expanding markets. The electrical products have in addition become cheaper relative to other types of goods and services.

High economic opportunity means that this kind of products can be purchased by large segments of the population without the need plan and budget for, save to or purchases. From the perspective of the consumer the cost of buying, specific business models in the ICT sector also seem to play a role. Mobile phones, in particular, are sold as parts of various forms of subscriptions, where the phone cost is 'baked into' the cost and length of the subscription. This is in turn related to that when the subscription expires, the consumer may feel it is time for a new phone and subscription. For television, broadband Internet etc. it is common that modems, routers etc. are included (without specific visible or negotiable costs). Linked to this development are also certain forms of unpaid do-it-yourself work, of installing modems, routers etc. This means that relative sacrifices and costs (for buying, repairing, etc.) are changing. Consumers, authorities and businesses are interdependent on each other, and the development of supply, demand and business models implies that economic opportunity is a strong motivator behind specific purchases of goods and related services within the ICT and media sectors.

### **2.1.4 Specialization /multiplication**

*Specialization* of products [2] applies e.g. to an increasing variety of shoe types being used for different sport activities. In more general terms the varieties of designs within a product category increase, to fit increasingly specific occasions and activities. In recent decades, the possession of portable computer-like devices with internet access has gone from the possession of only one type of product – laptop – to individual possession of e.g. the three, smartphone, tablet and laptop. One aspect of this development is that the use of each product types becomes specialized for certain situations.

Each one of these products is highly multifunctional, e.g. the mobile phone, that has become 'smarter' by increased integration of functions into it [16]. The increased number of features might lead to a specialized use of each unit and the, related, multiplication of possessed units. This development takes place on the user side, by e.g. the transition from one home telephone, used by the entire household, to each individual possessing her own mobile phone. A somewhat different development is when computers have successively been put to new uses like e.g. keeping in contact with relatives and friends, watching movies and TV, to listen to music, find cooking recipes, play games, go shopping, do homework and assignments. This seems to lead towards households keeping one laptop or tablet specimen in the kitchen, one at the desk, one by the couch, etc. This is what we mean by multiplication, where a truly multifunctional product unit is being reserved for a restricted activity, situation or location. Thus, the integration of functions (multifunctionality) has also led to that the number of purchased and possessed product units has increased [16].

### **2.1.5 Fashion Shifts**

For electronic products fashion shifts are often related to the release of new models, and to trend breaks in popularity for different brands etc. In this modified functionality new systems, platforms and performance levels play important but not always the most crucial roles. Relevant fashion shifts can be predictable, e.g. (nostalgic) fashions that recur at fairly regular intervals, or unpredictable, e.g. when a trend starts outside the commercial sector but eventually becomes embraced by business interests. Fashion shifts can be initiated by small groups of people, trendsetters, who may be professional or belong to a particular social group or so-called subculture.

For electronics rapid product replacement is a dominant trend. This is related to that consumers today find very few reasons why they would buy a used electronic device when they could 1) get a new one for the same or lower cost than the last one they bought, and 2) the last one is certainly a bit slower, uses more power etc. For the great mass of electronic products, there is not very high chance of continued life after its owner decided to go on to a new system, platform and/or level of performance. Therefore many fashion shifts within the ICT and media sectors are evidently related to increased amounts of newly bought, as well as discarded, units.

### **2.1.6 Social comparison and identity**

The concept *social comparison* [2] implies that people use goods and services, as well as activities associated with these, to signal positions on (changing) social and cultural prestige scales. *Identity* formation implies choosing among a variety of available attributes to symbolically and materially portray and create self-images and group belongings. Since symbols, trademarks etc. can be important to mark social position in this way, the acquisition and use of electronic products is affected by social comparison and identity formation. This is evident e.g. in relation to new generations of products on the mobile phone market. In public debate and critique of values associated with consumption, social comparison and identity are often portrayed as a dominant and problematic drivers. Within sociology of consumption at large, however, they are considered important for some products and brands, but not as the single most important, driving forces behind consumption and its environmental impacts.

### **2.1.7 Habits**

Everyday life comprises a wide range of activities, choices etc. that need to be linked together into a manageable number of routines, in order to enable us to function as socially competent and versatile social creatures. This means that we need to start patterns of action without planning, perform them without paying much attention to them and avoid having to evaluate them during or after they have been carried out [19]. A habit is thus a learned response repeating a sequence of action in a suitable situation, using a minimum of conscious effort [20]. Habits economize the mental and bodily capacity available for doing several things at once, directing our attention in a particular direction and reserve it for decision for genuinely unexpected tasks and situations. Use of certain good and artefacts might be crucial for a particular habit. This means that if a habitually used artefact would suddenly be missing the habit would typically be a motivator behind replacing it. Concerning electronics for entertainment and information, changes in both the market and in society are co-evolving with newly created habits of using social media etc. A person's habits are linked to her use of cell phone, computers, video games etc. Also when changes in housing, family or work situation occur reassembly of particular

products, e.g. means of communication and transport, might be needed to maintain the habit. In these ways habits could be seen as drivers behind buying and discarding products.

### **2.1.8 Matching**

The stylistic matching [2] of products with each other might take place as a chain or, domino effect, where having installed one new product in turn makes you want to replace the one 'next to it'. This can apply to the home and other everyday contexts and situations (clothing, things you bring, more or less personal belongings in workplaces etc.). There is a culturally rooted idea of style involving appliances and other possessions to be showcased, and consequently it could be important that they fit together and form meaningful units [15]. Regarding electronic products, such as all those that are portable, there is a clear trend toward increasing stylistic matching, particularly around certain brands. Such portable electronics can thus be matched both as possessions carried, placed in the home and also in the workplace.

### **2.1.9 Novelty**

When applying the concept of *novelty* [2] emphasis is on the mental stimulation and the experience of acquiring something new. One can explain the craving for brand-new and redesigned products from e.g. a social psychology perspective in terms of need for mental stimulation, or a need to avoid boredom and create variety in things we use. What could provide the stimulus is both new looks/design, new bodily activity and the new learning involved in using the product (this stimulus could of course also arise in terms of irritation etc. when 'it doesn't work' as you expect). There is nothing to suggest that stimulus and novelty cannot come from rediscovering and rekindling older fashions, artifacts and uses; to repair, modify, create and renovate; as well as from buying, growing tired of etc. new and mass produced products. Novelty should nevertheless be considered a motivator behind the acquisition of electronic products.

## **3 DISCUSSION**

We believe that it usually takes several interlocking motivators to induce the purchase or discarding of an electrical or electronic device or unit. One way to rank the relative importance of motivators would be according to which motivator that is most or least often in play. The motivator that we tentatively would like to place on top of the list, since we believe it to be in play in almost all contexts of buying and discarding, is economic opportunity. After that we would like to place the motivators mandatory technology and possibility opening, since we also regard them as having a general influence, for many contexts and kind of products. After that we would like to place the remaining six motivators that may be important for certain but not most situations, contexts and product categories. However, scientific validity of such a ranking would naturally require further investigation and evaluation.

We argue that the question of why we buy and throw away as we do we might be answered: it is because we are members of a society that does not prevent us from this, but rather encourages it and demands it of us. Following this a slightly different question could be phrased: How can we imagine a society that encourages citizens to take up more sustainable consumption habits? Below we provide two examples of elements for imagining such a society:

- 1) *Prosumers*: This implies that products are repaired, components replaced etc. Also other ways of caring and upgrading essentially modular electrical and electronic products are feasible. Supportive factors (policy instruments) for this could be deposit (refund) systems, profitable business models for long technical life and well-functioning markets for selling, repairing used products and components. The turnover rate for electrical and electronic products could then be low and the cycles enclosed in a more environmentally friendly way, with much higher degree of reuse and complete recovery than today. Our take on the concept prosumer is that the boundary between producing and buying and consuming is partially erased and that people in everyday life have the potential to be active co-producers of what they use.
- 2) *Collective ownership*: People generally would own a smaller amount of electrical and electronic equipment privately, compared to today. This would be associated with reduced ownership / possession of material goods in general, which in turn could be due to services become relatively cheaper compared to goods. Collective ownership models can of course also be associated with a lower total material consumption space. Collective ownership and

availability to electrical and electronic devices and services is, and could be, organized in a number of ways within a society. Here, inspiration for thinking about new approaches could be found in e.g. business models of how entertainment is provided via broadband, so called media streaming services. Another source of inspiration would of course be historic, e.g. how appliances (such as common laundries and joint freezers) have been used over the last century.

#### 4 CONCLUSIONS

The increased volumes of electrical and electronic products in society and their increasingly shorter life span reflect conditions on the market and pursuit of economic growth etc. The amounts of electronic waste increase because globally expanding markets have made products cheaper. Production and market conditions are also mirrored in the way new goods take place in everyday life. In this paper we have conceptualized motivators for buying and discarding electronics on the everyday life level. To our minds it would be clarifying to differ between at least nine socio-cultural processes that seem to motivate consumption of electronics: mandatory technology; possibility opening; economic opportunity; specialization/multiplication; fashion shifts; social comparison and identity; habits; matching and novelty. We believe these processes to be relatively long term and universal. However, the relative importance of motivators might shift over time and between societies and groups of people. We believe the proposed categorization could be helpful in further, empirical as well as conceptual, studies of how electronics are acquired, used and discarded, and why.

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# RESILIENCE AS AN INCLUSIVE APPROACH FOR SUSTAINABLE, GOOD LIFE – A CONCEPT

**Erika QUENDLER<sup>1</sup>**

<sup>1</sup> Federal Institute of Agricultural Economics; erika.quendler@awi.bmlfuw.gv.at

## ABSTRACT

Considering the current economic, environmental and social challenges one may say that the human development is increasingly losing its resilience. This notwithstanding, over time humanity has shaped nature and nature has shaped the development of human society. A perspective that considers nature and humanity as one system is central to resilience theory. Resilience theory represents a shift in how we view the relationship between environmental issues, economic development, and the health and well-being of human populations. This paper draws upon an idea of resilience within the focus area of sustainable development and of quality of life in order to elaborate an approach to the idea of “a sustainable, good life” by applying an adaptive cycle of a sustainable, good life in a Driving force-Pressure-State-Exposure-Effect-Action framework.

*Keywords: resilience, livelihood resilience, quality of life, sustainable development, systems thinking*

## 1 INTRODUCTION

As an indication of development ecological, economic and social frame conditions change due to global adjustments [26], [71]. More competition, open markets, changes in political frameworks, structural changes etc. form the challenges for society. For the most part, however, the discussion about challenges often forgets the consequences for ‘livelihood’ resilience, i.e. the quality of life and its impact on the environment. One may say that the current development is increasingly losing its resilience [22], [72], [81]. Discussion is necessary to think through human needs, quality of life and sustainable development in order to achieve a more resilient world.

This paper considers how a society or people can work towards a sustainable, good life by adopting a fresh perspective based on systems thinking. The concept of “resilience” [21], [31] borrowed from the field of ecology, enables a sustainable, good life to be viewed as an inherent system property rather than an abstract idea [37], [51], [52], [54], [53]. Already, existing practices have demonstrated many useful techniques for enhancing system resilience [34], [64], [73], [74], [76], [82]. Building on these insights, a generalized approach to a sustainable, good life and its resilience is presented, including an explicit consideration of system boundary conditions and external impacts.

This paper is divided into five parts. The first section introduces the topic of research, followed by a discussion, in the second section, on the concept of resilience as well as an extensive background on the relevant notions in relation to nature and humanity. Expanding on this, the third section investigates in more detail an inclusive approach for sustainable, good life from both a formal and an operational perspective. Subsequently, the fourth section examines the use of an adaptive cycle of a sustainable, good life in a Driving force-Pressure-State-Exposure-Effect-Action framework [13] as a rather vague boundary object and points to some chances and pitfalls. Finally, the fifth section concludes with reflections to better understand the field of research.

## 2 BACKGROUND

Throughout history humanity has shaped nature and nature has shaped the development of human society. Considering the growing human influence on the Earth’s climate and ecosystems, nature, especially also resource use, cannot be understood without considering the influence of humanity. A worldview that considers nature and humanity as one system is central to resilience theory. There are no natural systems without people, nor social systems without nature. Social and ecological systems are truly interdependent and constantly co-evolving. [26], [71]. Resilience theory represents a shift in how we view the relationship between environmental issues, economic development, and the health and well-being of human populations. Hence, a key concept in the resilience framework is the concept

of social-eco-logical systems, which refers to the interplay of disturbance and reorganization within a system as well as to transformability, learning and innovation [21]. It provides a new perspective on managing the coupled systems of people and nature by building resilience and adaptive capacity within the system, rather than attempting to control them for stable optimal production and short-term economic gain [7], [21], [54]. In general, resilience is the capacity of a system – or an individual or society – to withstand adversity, risks, shocks and surprises and then rebuild itself [31].

The concept of resilience is crucial in recasting our approaches to personal and working lives, away from ones that rely on the unsustainable production of goods and services hand in hand with the degradation of ecosystems and the exploitation of people, towards a model that strives to enhance the well-being of all human beings within the limits of our planet. Resilience has been suggested as being one of the guidelines for a conception of strong sustainable development as well as an adequate quality of life [37], [51], [52], [53], [54]. Hereby the term refers to the maintenance of natural capital in the long-term in order to provide ecosystem services that nurture instrumental as well as eudaemonistic values for human society. In search of persistence in the form of a model that strives to enhance the well-being of all human beings, more precisely all species, within the limits of our planet, what are the needs and limitations, how needs were fulfilled and which feelings and emotions or impacts on the environment are caused are crucial questions. The fulfilment of these needs supposes the availability and consumption of resources (clothes, food, clean water and so on), and depends on, effects and shapes life-supporting ecosystems. Human simplification of nature for production of particular target resources to be traded on markets has generated steady resource flows in the short term and yet there are limitations (social, environmental, economic ones as well as regional or prospective ones). It has, however, done so at the expense of diversity and it has eroded resilience. [21]. Hence, social vulnerability is likely to increase and opportunity for development is likely to be constrained if society erodes resilience [22].

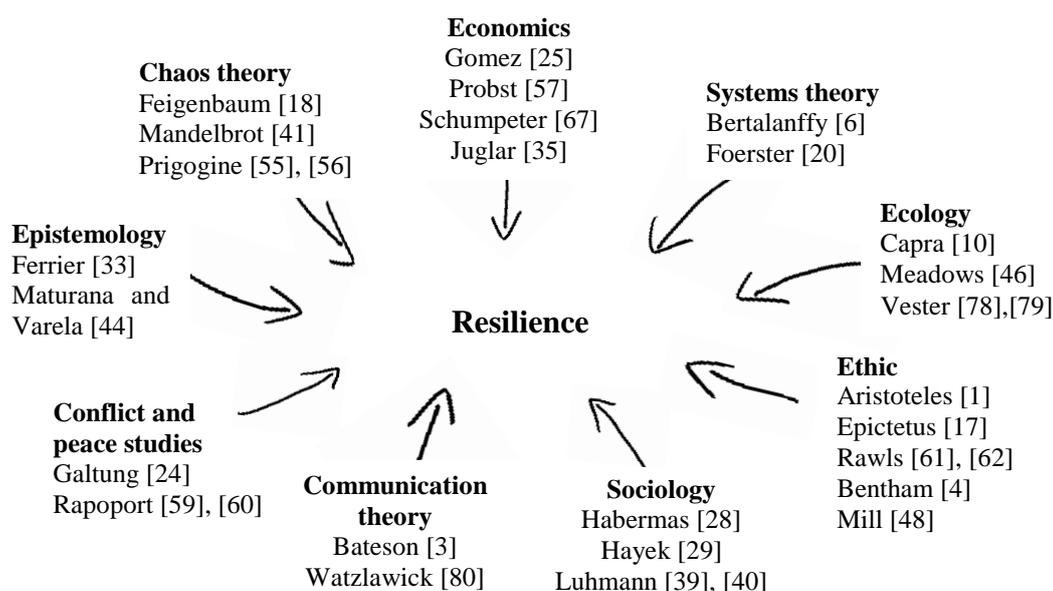


Figure 1: Resilience and selected theoretical models of human development

“Studies of resilience suggest that nature has provided powerful protective mechanisms for human development” [43]. This is precisely because they address our common, shared humanity. The latter’s needs are very complex and cover different dimensions, such as subsistence, work, health, family, love, free time and security [23], [42], [45], [49], [68]. They co-evolve with the norms, preferences and values of people. The development of resilience is none other than the process of ‘healthy’ human development — a dynamic process in which personality and environmental influences interact in a reciprocal, transactional relationship. Resiliency research validates previous theoretical models of human development (c.f. Figure 1). While focused on different components of human development— psycho/social, moral, spiritual, and cognitive — at the core of each of these approaches is an assumption of the biological imperative for growth and development (i.e. the self-righting nature of the human organism) which unfolds naturally in the presence of certain environmental attributes.

Stated simply by Maston, “*When adversity is relieved and basic human needs are restored, then resilience has a chance to emerge*” [43]. Furthermore, the fostering of resilience operates at a deep structural, systemic, human level: at the level of relationships, beliefs, and opportunities for participation and power that are a part of every interaction, every intervention no matter what the focus is.

From the perspective of an individual, the road to resilience lies in working through the emotions and effects of stress and events by meeting needs. Furthermore, resilience develops as people grow up and gain better thinking and self-management skills and more knowledge. [65]. From this perspective an important component of resilience, however, is the hazardous, adverse and threatening life circumstances that result in individual vulnerability [36]. Motivation is expressed in a definition of resilience that comes from ancient common wisdom literature: “*Resilience is rooted in a tenacity of spirit – a determination to embrace all that makes life worth living even in the face of overwhelming odds. When we have a clear sense of identity and purpose, we are more resilient, because we can hold fast to our vision of a better future.*” [47]. While this emphasis might be ignored or underemphasized in academic research, it is critical that it be addressed in daily practical life. Ego resilience has been defined as “*a fairly stable personality trait that reflects an individual’s ability to adapt to changing environments ... and which may include identifying opportunities, adapting to constraints and bouncing back from misfortune*” [12].

While resilience has been increasingly conceived as a perspective, as a way of thinking to analyse linked social-eco-logical systems [21] no clear definition is suggested. Rather, resilience is conceived as a collection of ideas, such as in system theory<sup>1</sup>, on how to interpret complex systems [1] and their sustainable development. Furthermore, the concept of resilience and its applicability to ecological, social, management and individual systems has been investigated extensively by an international group of researchers led by two noted ecologists, Lance Gunderson and C. S. Holling. They have developed a general theory of adaptive cycles, arguing that all systems exhibit similar patterns of slow accumulation of resources, increasing connectedness, and decreasing resilience, punctuated by periods of crisis, transformation, and renewal [32]. Based on an understanding of these patterns, humans may be able to intervene in appropriate ways that take advantage of the system dynamics rather than merely resisting change.

### 3 CLARIFYING THE CONCEPT

We live in a small world of ever-increasing connectivity, with both cooperation and conflict occurring on a global and regional scale in social-eco-logical systems. Individuals, companies, and communities, i.e. systems, are linked through worldwide systems of communication, transportation, and commerce. Similarly, individual needs, products and services are linked to the global value chains in which they are created, delivered, and used. This connectivity presents daunting challenges to the design and commercialisation of an approach of a sustainable, good life when considering resources, needs, risks and limitations. Instead of focusing purely on the function and form of a product or service, today one must consider a broad range of system-level issues, including safety, security, manufacturability, serviceability, material and energy efficiency, end-of-life recovery, environmental emissions, and even long-term impacts upon quality of life for future generations.

In evolutionary terms, a “*population responds to any environmental [and social] change by the initiation of a series of physiological, behavioural, ecological and genetic changes that restore its ability to respond to subsequent unpredictable environmental changes*” [31]. In Holling’s terms, therefore, the viewpoint of resilience emphasizes “the need for persistence”. In this perspective, striving for a conceptual approach based on ‘livelihood’ resilience would emphasize “*the need to keep options open, the need to view events in a regional rather than a local context, and the need to*

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<sup>1</sup> Systems theory study how complex entities interact openly with their environments and evolve continually by acquiring new, “emergent” properties. Rather than reducing an entity (e.g. the human body) to the properties of its parts or elements (e.g. organs or cells), systems theory focuses on the relationships (e.g. feedback loops) between the parts that connect them into a whole. It turns out that many system properties are independent of the concrete substance of their elements (e.g. particles, cells, transistors, people) [30]. Complex systems are generally dynamic, nonlinear, and capable of self-organisation to sustain their existence and be resilient [15]. For example, by supporting social activities (i.e. fostering social capital), corporations strengthen the vitality of the communities to which their employees belong.

emphasize heterogeneity [therefore requiring] a qualitative capacity to devise systems that can absorb and accommodate [current and] future events in whatever unexpected form they may take” [31].

### Sustainable, good life

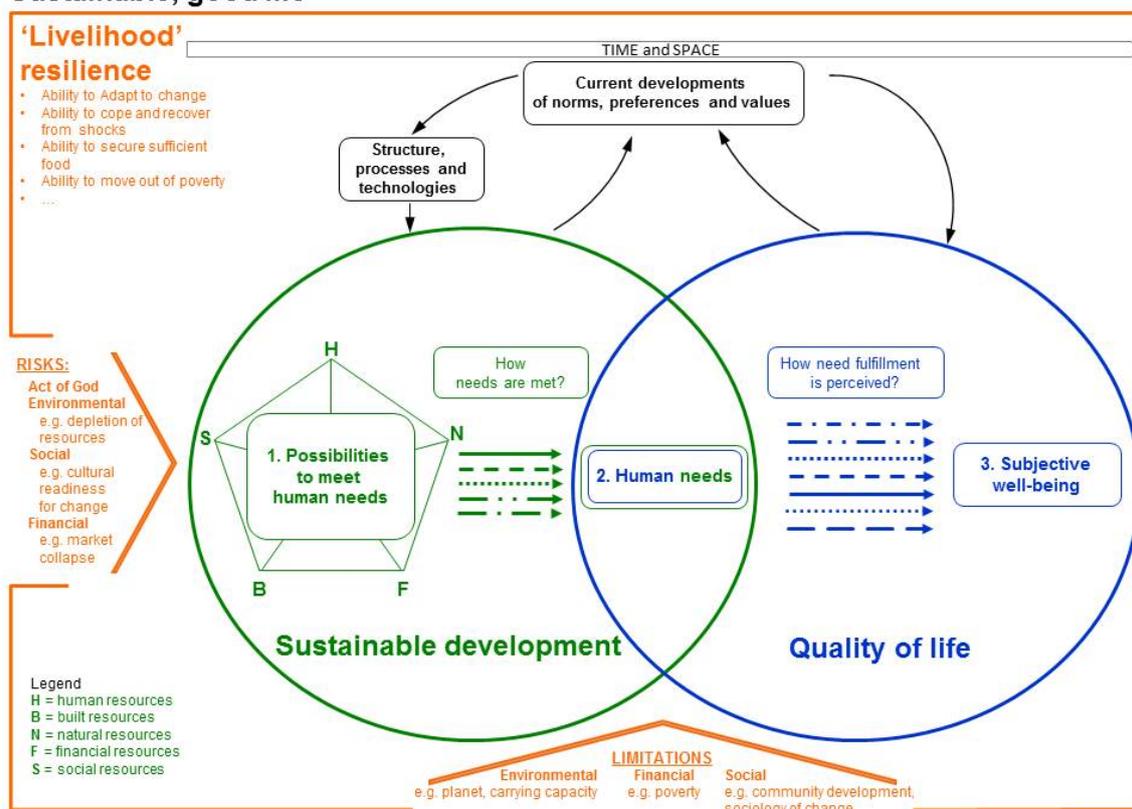


Figure 2: A sustainable, good life [58]

In the face of such complexity, traditional methods for analysing costs, benefits, limitations, risks as well as the social-eco-logical resilience of a system can become overwhelming. This notwithstanding, the purpose of sustainable development is to create and maintain prosperous social, economic and ecological systems throughout the world [22]. Humanity has a need for persistence. And since humanity depends on the services of ecosystems for its wealth and security, humanity and ecosystems are inexorably linked. With sustainable development and this idea of quality of life in mind, humanity, therefore, must strive for resilient socio-eco-logical systems, i.e. ‘livelihood’ resilience. Furthermore, “when considering systems of humans and nature (social-ecological systems) it is important to consider the system as a whole.” [79]. In this concept where resilience is aligned with systems thinking “sustainable, good life” [58] is a multidimensional inclusive development concept which

- takes into consideration the flows of resources (natural resources, human resources, material resources, social resources and financial resources) in social-ecological systems which are complex adaptive systems that do not change in a predictable, linear, incremental fashion;
- results from the different immaterial and material needs at individual, municipal, national and global levels and the resources and services available for their fulfilment (objective living conditions for those needs);
- refers to the experiences of human beings and that which they consider important for their lives and society and
- considers ‘resilience thinking’ as providing a framework for viewing a social-eco-logical system as one system operating over many linked scales of time and space. Its focus is on how the system and people change and cope with disturbance and develop a kind of ‘livelihood’ resilience.

There are several barriers that limit the practical application of the sustainable, good life approach. For one thing, the notion of protecting future generations seems remote in the face of contemporary business pressures, financial crises and excessive resource use. The idea of sustainable, good life is often associated with resource constraints and maintenance of status quo rather than with opportunities

for continued innovation, growth, and prosperity. In addition, the popular metaphor of corporate performance (environmental, social, and economic dimensions) seems to imply that economic profits need to be “balanced” against environmental and social benefits, whereas in truth these three aspects of corporate performance are inseparable and contribute synergetically to shareholder value [19]. Finally, sustainable, good life is often misinterpreted as a goal to which we should collectively aspire. In fact, sustainable, good life is not an end state that we can reach; rather, it is a characteristic of a dynamic, evolving system. Systems thinking offers a potential means to overcome these barriers. Furthermore, building social-eco-logical resilience for a sustainable, good life requires a fundamental shift in thinking and perspective from assuming that the world is in steady-state and can be preserved as it is, by focusing on preventing and controlling change, to a recognition of change being the rule rather than the exception, and thereby concentrating on managing the capacity in complex adaptive social-eco-logical systems to live with change and shape change.

#### 4 THE ADAPTIVE CYCLE OF A SUSTAINABLE, GOOD LIFE IN A DPSEEA FRAMEWORK

As shown, humanity and ecosystems are deeply linked. This is also the fundamental reason why adopting the resilience thinking framework with the Driving force-Pressure-State-Exposure-Effect-Action (DPSEEA) is a necessity for governance. The resilience perspective shifts policy, management and lifestyle decisions that aspire to control change in systems assumed to be stable, to managing the capacity of social-ecological systems to cope with, adapt to, and shape change [5], [69].

This underpins the need for a sustainable, good life approach to embrace resilience thinking. It is not only about being trans-disciplinary and avoiding partial and one-viewpoint solutions. What is needed to solve today’s and future challenges – and especially those linked to a sustainable, good life – is a new approach that considers humans as a part of Earths’ ecosystems, and one in which policies can more effectively cope with, adapt to, and shape change in the sense of ‘livelihood’ resilience.

In order to become more resilient in the sense of a sustainable, good life we need to anticipate the consequences of alternative decisions on life, ecosystems or the value of social services and ecosystem services. Conceptual frameworks provide a tool for capturing, visualizing, and organising the connections between human decisions, the pressures that socio-economic factors exert on the environment, and the potential consequences on the capacities of ecosystem goods and services. By thinking about the whole system within a systems framework, scientists, stakeholders, decision-makers as well as citizens can better anticipate how elements in the system are linked together. [16].

The DPSEEA scheme is a flexible framework that can be used to assist not only decision-makers in many steps of the decision process. DPSEEA was initially developed by Corvalán, Kjellstrom and Smith [13] as an alternative to the Driver-Pressure-State-Impact-Response (DPSIR) by the Organisation for Economic Co-operation and Development [50]. The DPSEEA Framework can help organising decision-making at system-level in a conceptual way. According to Corvalán, Kjellstrom and Smith [13] and Walker and Salt [79] we could identify DPSEEA and the four phases of the adaptive cycle of resilience theory as follows

- Drivers and reorganisation phase: function through human activities in order to fulfil human needs (sometimes thought of as fulfilled by economic sectors) which may intentionally or unintentionally exert pressures on the environment.
- Pressures and conservation phase: exerted by society when human activities fulfil needs so that there is a stress on social-eco-logical system (the environment and other human beings) and may lead to unintentional or intentional changes in the state of the environment.
- States and release phase: changes in the condition of the social-eco-logical system
- Exposure and exploitation phase: factors such as human behavioural and lifestyle choice will influence individual exposure to environmental challenges as well as changes in state in social-eco-logical system services.
- Action: humans take action by making decisions to reduce the Effects on losses of social-eco-logical system services (Figure 3)

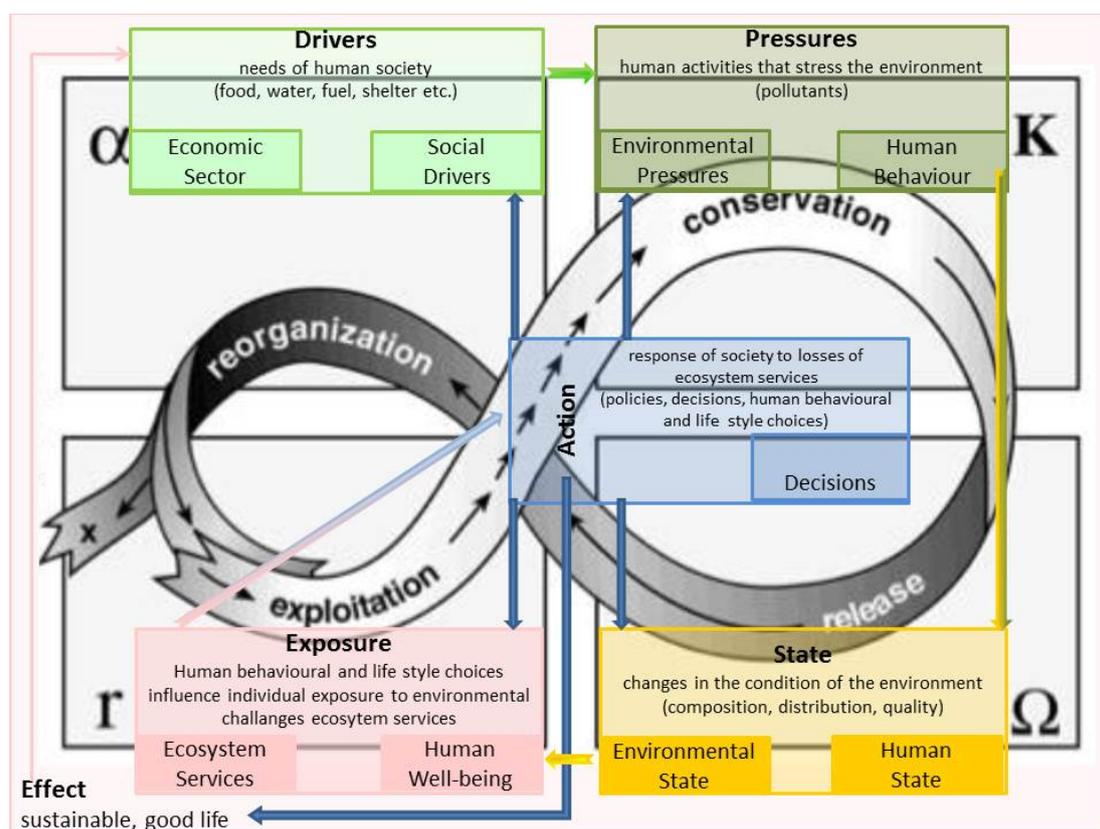


Figure 3: The adaptive cycle of a sustainable, good life – integrated DPSEEA framework [16], [63]

Usually, a system passes through an adaptive cycle by moving through the phases in the order described here (i.e., rapid growth to conservation to release to renewal; drivers to pressures to state to exposure to effect) (see Figure 3). But this is not necessarily so. It is important to re-emphasize that the adaptive cycle is not an absolute; it is not a fixed cycle, and many variations exist in social-eco-logical systems. Systems cannot go directly from a release phase back to a conservation phase, but almost all other moves can occur. As a matter of fact connecting DPSEEA to the phases of the adaptive cycle is not cast in stone; it can be very variable: one may say that the whole DPSEEA can be run in one phase, but also arranged differently to that as depicted in Figure 3.

## 5 REFLECTIONS AND GUIDELINES FOR FURTHER RESEARCH

Most of the time the first reaction when dealing with a sustainable, good life and its 'livelihood' resilience is often, and inevitably, to establish a sustainable, good life and its 'livelihood' resilience in the short term with the most efficient measure, but resilience thinking shifts our attention towards systems thinking with the primary intention of understanding the underlying and long-term rooted factors of a sustainable, good life.

We can say that the first step is definitely trying to consider the whole system, therefore, to analyse and to describe the number of variables that characterise the social-eco-logical systems in which a sustainable, good life and its 'livelihood' resilience is embedded.

Taking into account time horizons comprehensively is, therefore, undeniably crucial. In this case, we propose an interesting hypothesis by Walker and Salt: "if the early settlers had been forewarned of the problems that would be faced some one hundred years later, and had been in possession of the information we now have, would they have made different decisions on how they developed the region?" [79]. Accordingly, Walker and Salt write that a delay of one hundred years, therefore a large time horizon in human terms, between an action and its consequences makes it difficult to take those consequences seriously. In the same way, this is happening for instance with the notion of sustainable, good life and crucial issues nowadays such as climate change, resource shortage, desertification, poverty and social exclusion. Walker and Salt say that humans have both high discount rates and an enormous capacity in believing the future will generate solutions to problems that don't have to be faced in the foreseeable future.

Can therefore resilience and systems thinking help in developing criteria and understanding behavioural aspects for sustainable, good life? Although very complex and multifaceted, many believe that this way of thinking about and approaching change and social-eco-logical systems could pave the way for a more resilient sustainable, good life.

In conclusion, we have a long way to go before reaching a state of sustainable, good life within the limits of our planet. We portrayed the adaptive cycle and the DPSEEA framework as a useful tool to enhance sustainable, good life and its 'livelihood' resilience. This is one way to embark on a new round of consensus-building processes that will re-envision what was institutionalized over the last 70 years.

The need is clear for: (1) new goals with a broader view of interconnectedness among long-term, sustainable economic, social, and ecological well-being and its resilience and (2) better ways to measure progress towards these goals.

Furthermore, the following research topics can be identified based on this paper.

- How can the relationships between resources, needs within the DPSEEA model be analysed by using suitable indicators and data? What are the technical and data requirements for the development of such a model also suitable for further research topics?
- What contribution can the idea of life style make to the identification of economic, social and ecological resilience of a person, a society or a sector? Ideas of life style go beyond classic socio-economic criteria such as profession, age and education and factor into the analysis typical observable behaviour patterns (e.g. consumer behaviour, clothing and housing conditions) and non-observable mental values (e.g. values, doctrines and attitudes).
- How can the future be taken into consideration? In order to measure sustainable, good life and its 'livelihood' resilience properly one cannot just consider the current situation, but one also has to take into account expectations for the future. Any serious assessment of contemporary life should also bear in mind the future quality of life which results from current trends or how it is possible to include risks and fears both currently and for the future.

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# REBOUND EFFECTS FROM A CONSUMER CULTURE PERSPECTIVE – RE-SPENDING AND MARKETING PRACTICE

Cecilia Solér

School of Business, economics and Commercial Law  
Göteborg university, [cecilia.soler@handels.gu.se](mailto:cecilia.soler@handels.gu.se)

## ABSTRACT

This paper addresses a gap in literature on income rebound effects by analysing how re-spending of increased income represent main traits in Western consumer culture. The aim of the paper is to describe estimated re-spending in six studies on energy efficiency, various green consumption activities (abatement) or increased income, as consumer culture characteristics where consumer psychological needs increasingly are compensated for by consumption. The analysis of re-spending as compensatory consumption is based on re-spending themes across a number of studies on indirect rebound effects. This paper contributes to energy policy making by providing knowledge about socio-cultural processes in Western consumer culture valid for re-spending. Policymakers will, based on an understanding for consumer culture specific mechanisms steering re-spending to specific consumption categories, be able to make more well-informed decisions aiming for an absolute reduction in GHG emissions. The results of this study capture consumption meanings strongly associated to consumer culture and direct links between these meanings and categories of re-spending in studies on indirect rebound effects. Hence it is suggested that policy-makers consider market specific cultural meaning communication as a complementary tool in steering re-spending to low GHG categories in order to curb rebound effects.

*Keywords: rebound effects, re-spending, consumer culture*

## INTRODUCTION

This paper deals with income effects following energy efficiency measures. In particular it focuses on how increased household income is re-spent. It provides an answer from a marketing perspective to why increased disposable income primarily is re-spent on recreation, travel, clothing and goods for the home, offsetting substantial parts of estimated carbon savings. In a similar vein it provides an understanding for why this additional disposable income is not spent on less GHG intense products as vegetarian food, solar panels or fine art? Reviews on energy consumption and energy efficiency policy suggest that neither price, the elimination of subsidies, information campaigns nor choice editing (nudge policies) alone, are adequate to promote energy efficient consumption, or as in the case of this study, re-spending (1,2). Marketing research strongly suggests that consumers' perception of value and choice of products is dependent on marketing practices as branding and advertising advertising, both in terms of content and frequency [3, 4]. Therefore it is of uttermost importance to include marketing based theory and understanding in a comprehensive energy policy framework.

In this paper indirect rebound effects, so called re-spending or income effects, are described from a discursive consumer culture perspective. As such consumption is seen as culturally and socially embedded, intimately connected to marketing practice, which differs from individualistic approaches to sustainable consumption where consumers are coined as rational or utilitarian decision-makers [5; 6]. From an individualistic viewpoint the very modest progress in adoption of sustainable consumption patterns (as choosing to spend one's increased income on low GHG intensive consumption categories, or installing energy efficient devices in the home), despite a general awareness of climate change and espoused green values, is labelled the attitude-behaviour gap [2] the knowledge-to-action gap [7] or the value-action gap [6]. Climate change policy, primarily being informed by an ABC framework where A stands for attitude, B for behaviour and C for choice [8, 9], has been heavily criticized as neither individual green attitudes/values, nor sustainability related product knowledge are good predictors for sustainable consumption at the individual level [6]. As an example reviews of product-related environmental information suggest that even though information is provided in the marketplace to help consumers choose resource intensive products, most consumers, even environmentally concerned consumers, do not use it [10, 11, 12].

Recent papers on energy policy issues call for multi-disciplinary approaches including social science, to the design of energy policy aiming for energy efficient consumption behavior [13, 2]. The ‘Energy Cultures’ conceptual framework is developed to assist in understanding factors that influence energy consumption behaviour, and consequently to identify opportunities for energy behavioural change [13]. The energy cultures framework views energy consumption behaviour as an interaction between cognitive norms, material culture and energy practices. Material culture is understood as a technical system energy practices are defined as interactions between individual, social and institutional behaviours and cognitive norms are understood as an attitude/value/belief system. Young and Middelmiss present a wheel of change framework aiming for changing individuals’ actions on GHG emissions [2]. This theoretical framework is based on attitude-based theory how to empower individuals, social norm based empowering communities, changing infrastructure (context) to guide change in actions and quality factors such as cognitive processing time, collaboration, quality of information etc. Both Young and Middlemiss and Stephenson et al. underline the importance of social norms for energy consumption behaviour in line with numerous studies on energy behaviour (see 1 for an overview) [2,13]. However the influence of marketing practice on social norms is not explicitly dealt with. As an example Heiskanen et al emphasis the community and subsequent social norms, acting as drivers or barriers, as an important part of a theoretical framework driving individual GHG emissions, however the power of consumer culture in establishing social norms is underestimated [14]. One exception to the rule is Lutzenhiser who in his “Cultural Model of Household Energy Consumption” state that individual behaviour is interconnected with relationship and cultural meanings [15].

In the field of marketing, the market is commonly described as a predominant arena for setting and adhering to social norms in contemporary consumer culture [16]. Major sociological accounts of the postmodern condition identify the dismantling of moral institutions as the main historical process behind norm differentiation and subsequent market-based norm provision through marketing practices [17,18,19]. Whereas consumption historically has been conspicuous and indicating status interconnections between material goods and psychological/ social processes in consumer culture are considered as unprecedented [20, 21]. Branding and advertising are examples of marketing practices that produce norms by suggesting desired lifestyles compatible with specific brands hence shaping the sustainability of consumption [22, 23, 24]. Marketing practices thus can be regarded as highly influential in shaping carbon lifestyles [25].

In this paper it is suggested that re-spending correlates strongly with meanings of idealized identity provided by marketing practice through the system of fashion and interconnected supply of products [7, 26]. Two main implications follow from this position. First re-spending can fruitfully be analyzed as being shaped by marketing practices (e.g. advertising, product development etc.). Secondly it is improbable that efforts to promote energy reductions through the existing consumer culture of differentiation will automatically lead to aggregate reductions in energy consumption [27]. A socio-cultural understanding of re-spending is therefore essential to fully understand and hence account for indirect rebound effects.

This paper addresses a gap in literature on income rebound effects by analysing how income induced re-spending is shaped by marketing practices in a consumer culture context. The aim of this paper is to describe the correspondence between estimated re-spending and marketing practice in contemporary consumer society and to discuss how knowledge about this relationship can be used to guide energy policymaking. The analysis of re-spending is based on re-spending themes across a number of studies on indirect rebound effects [28, 29, 30, 31]. This paper contributes to energy policy-making by suggesting that a consumer culture based understanding for re-spending is essential to fully account for rebound effects. Insights about consumer culture mechanisms that steer consumption to specific categories through marketing discourse and techniques can help us see why it is difficult to move from high to low GHG intensive consumption categories. Building on these insights policy makers will be able to use marketing practices in the design of policy as they represent vehicles for steering re-spending to low GHG intensive consumption categories in a consumer culture context. Even though this paper specifically deal with income effects and subsequent re-spending, the insights regarding the influence of marketing practice in the context of contemporary consumer culture are useful in the design of policy aiming for sustainable consumption in general and energy consumption in particular.

## BACKGROUND - INCOME EFFECTS FROM A SOCIO-CULTURAL PERSPECTIVE

Rebound literature identifies four main categories of behavioral responses to energy efficiency, so called rebound effects, that encompass micro- and macroeconomic effects; direct rebound effects, indirect rebound effects, economy wide effects and transformational effects [32, 33]. All these categories represent potential drawbacks to energy policy aiming for a reduction of GHG emission. Direct rebound effects has dominated research within this field, the classical example being the home-owner who takes advantage of a lowered cost of heating his/her house by enjoying a higher indoor temperature, resulting in less than forecasted gain in energy consumption. Indirect rebound effects, refer to increases in disposable income due to energy cost savings (in heating, personal transportation or other types of consumption) that are re-spent on other potentially energy intensive consumption categories. This type of indirect rebound effect is sometimes referred to as the income effect. The overall economy rebound effect, i.e. economy wide effects is the sum of all direct and indirect rebound effects [30]. Hence, an estimated rebound effect of 30 % represents a 30% reduction of the gain in potential energy savings due to various behavioural responses to these potential savings. Transformational rebound effects refer to the change induced by cheaper energy on economies and societies [33].

This paper focus on the re-spending of increased income at the individual/household level allowed by either a cut in energy prices, a reduction of consumption of a particular good or service (so called abatements actions [30] or due to anticipated increase in disposable income. Re-spending can cause indirect or direct rebound effects; the indirect effect is the offsetting of carbon savings from increased spending in other areas of the household budget. Literature emphasize that we need to consider qualitative socio-cultural changes induced by energy productivity in order to estimate the full extent of rebound effects [34, 33]. In this paper it is argued that re-spending, allowed by a surplus due to cuts in energy prices or changes in life-style (more vegetarian part of diet, less car driving), is governed by consumer culture values. A consumer culture framework for understanding re-spending builds on postmodern consumer research underlining values as individualization and subsequent moulding of identity that require continuous experiential input [35, 36, 37] which is readily provided by the market. Druckman and Jackson suggest that life style aspirations drive household consumption related GHG emissions [38]. As an example, the most common answer to a survey question about how to spend the surplus generated by lower energy bills was “an overseas holiday including air travel” [39]. Such indication of potential re-spending on recreation and travel is supported in several studies [28,29]. Life style aspiration driven re-spending is in line with a large body of research evidence within the field of consumer culture theory which provides a picture of the market as the most important source of norm production postmodernity [16]. Individuals construct their identities through symbolic meanings provided by the market, meanings which tend to work in the interest of corporate interest.

## MARKETING DISCOURSE AND CONSUMER GOVERNANCE

It is essential to understand the historical process of the market as becoming one predominant norm provider in contemporary consumer society. Major sociological accounts of the postmodern condition identify the dismantling of moral institutions as the main historical process behind *consumption* as the primary provider of norms mediated through symbolic meanings through which identity is negotiated [17, 19]. Individual and aspirational self-defining practices in consumer culture, as opposed to ascribed identities of the past, are viewed as discursive and reflexive from a socio-cultural perspective. In this paper I follow a discursive approach to sustainable consumption [23, 7], in particular Markkula and Moisander’s conceptualization of discourse as “meaningful codes of knowledge that systematically form the object of which they speak through social practice [40, p.49]. From this perspective, the term discursive refers to the signifying practices, *both linguistic and material*, through which social actors make sense of objects of knowledge and achieve social order” [7, p. 108]. Drawing on a discursive approach to social action and identity, marketing practice is assigned a central role in endowing consumers with meaning, both through the provision of products and through the meanings connected to these products by advertising, hence shaping the sustainability of consumption [23, 41, 7]. From a socio-cultural perspective consumer identity is regarded as a product of neoliberal discursive marketing practice and the individual, liberated from tradition and collective norms, is governed through his and her desires in the market domain [42, 43, 44].

### Identity idealization and self-governmentality

Governing the consumer, and thus consumers’ choice of products through desire is regarded as a process of self-governmentality, imposed by messages (conveyed primarily by advertising) encouraging the

individual to improve his/her life, body, home or wardrobe by consuming specific products or experiences. This process of governing the consumer subject as a sovereign self-entrepreneur [42, 40, 26, 45] is commonly criticized on the basis of corporate power constructing freedom as a means of control [44, 24]. Marketing govern the consumers in different ways. Moisander et al suggest four interrelated dimensions of marketing governance that are relevant for our understanding of sustainable consumption in general and re-spending in particular [26]. 1. Visibilities and visual representation which includes images in advertising and in-store visual spatial arrangements as lighting, colours and materials that are designed to construct specific shopping experiences. 2. Knowledge and expertise to define the consumer. Through technologies of consumption as loyalty club programs, or other forms of marketing intelligence, marketers use detailed consumer knowledge to construct and suggest way of being (identity positions) that necessitate specific products and brands [42]. 3. Techniques and practices of government as segmentation and product development build on know-how about consumers acquired through market intelligence. A specific type of product development, product replacement, is used by the fashion industry as well as providers of domestic appliances. Seasonal trends and frequent style modifications through the launches of new collections, types or colours create consumer desire to constantly update their arsenal of products. 4. Identities and forms of identification build on both the visual imaginary in marketing, the knowledge about consumers provided by marketing intelligence and new product launches. Specific ways of being as a person are suggested in advertising and consumers are hoped to conform by adopting the proposed brand [26]. This is not a disciplining technique but a construction of consumers' free will to internalize a problematization of the self and to achieve goals that are in the interest of the marketer which is the essence of the concept self-governmentality [46]. Meanings of idealized identity in a marketplace context have consequences valid for our understanding of consumption of novel objects representing the latest fashion in clothing, in housing or in travelling. Idealized and often unrealistic ideals of the body, the family and of material standing, mediated by advertising, produces experiences of low self-esteem and dissatisfaction which drive consumption of novel products for the sake of finding self-assurance [47]. Re-spending can be understood as reflecting the advertising system where brands and exotic holiday destinations are marketed as the ultimate experience needed as inputs in identity-making. The identity position of the self-entrepreneurial consumer is problematic from a sustainable perspective. Permanent self-improvement through consumption choice as the key identity position provided by marketing holds back collective norms and stable identity [45]. Without collective norms that regulate the absolute volume of products circulating in the economy, marketing discourse even though aiming for the creation of 'green' or 'responsible' consumption identities through green imagery and low GHG intense products, supported by environmental and socially sustainable values, inevitably end up constructing responsible consumption without questioning the level of consumption [23, 48]. As a result, marketing practice that sustains consumer identities of constant self-improvement through commodity choice will risk contributing to environmentally and socially harmful and production and consumption practices (as the volume of goods produced/consumed remain unquestioned).

### **Discursive confusion and social norms as barriers to low GHG intense re-spending**

In contemporary consumer society, where marketing influence on consumer choice works through the governance of desire, low carbon consumption is often marked by discursive confusion. Literature in the field of sustainable consumption reports that consumers, although deeply environmentally engaged, struggle with conflicting norms calling for environmentally responsible consumption on the one hand and adherence to material and aesthetic social norms, involving high GHG intense consumption, on the other hand [35, 7]. Of particular importance for the understanding of mechanisms behind re-spending is that Western sustainable consumption always is situated within consumer culture. Dominant social norms, regarding flying to exotic places for a holiday or updating you arsenal of clothes (and domestic appliances) according to colors and styles in fashion, restrict individual ability (and responsibility) to consume in a manner that reduces carbon emissions [35, 49, 7].

### **METHODS**

Research estimating indirect rebound effects, i.e. income effects, is few compared to intense research efforts concerned with direct rebound effects. In this paper six studies dealing with income effect induced anticipated re-spending form the basis for a consumer culture analysis of predominant consumption categories where increased income is spent. The anticipated increase in household income on which these studies are based is produced by lowered energy prices, abatement activities undertaken by the household or simply by increased wealth. Very few studies discuss the magnitude of the income effect [50]. Four studies analysed here have been selected to represent well-cited studies that explicitly discuss income

effects and re-spending, Alfredsson, Brännlund et al, Druckman et al and Mizobuchi have been selected based on this criteria [28, 29, 30, 31]. To these four studies, two studies on anticipated wealth increases and spending, Carlsson-Kanyama et al. and Girod and de Haan have been added [51,51]. Carlsson-Kanyama et al. and Girod and de Haan are studies discussed in reviews on income induced re-spending [30, 50] as they focus on the same mechanism (allocation of consumption in low/high GHG intense product categories) as studies on income effects. The consumption categories with greatest relative demand change as a result of re-spending are summarized in table 1. In table 1 both direct and indirect rebound effects are presented under the heading re-spending. The direct rebound effect is money re-spend in the very same categories where costs were reduced due to cheaper energy, behavioral change or income increase. In the Brännlund et al study money re-spend on heating and car transport are direct effects of the anticipated efficiency improvement in these categories, whereas money re-spend on recreation, clothes and domestic appliances are indirect effect [29].

A discussion of total rebound effects accounted for in these studies is outside the scope of this paper. The initial description of the findings is concentrated around how anticipated increases in disposable income at the household level are allocated across consumption categories.

## FINDINGS: RE-SPENDING EFFECTS AS COMPENSATORY CONSUMPTION

### **Energy efficiency related re-spending**

The well-cited Swedish study by Brännlund et al. suggests that increased energy efficiency of 20% in personal transportation and heating affect consumer demand patterns [29]. The biggest changes in consumer demand, except for increases in car transportation (5,5%) and in heating (5,6%) (direct rebound effects) were noted in consumption of recreation (5, 2 %), clothes and domestic appliances. Mizobuchi follows Brännlund's approach and estimates the effects of energy efficient capital goods among Japanese households [29, 31]. Mizobuchi assumes an improvement in energy efficiency "Fuel and Light" (electricity, gas and oil) and in "Transportation" (car transportation). Money is primarily re-spend on heating, medical care and car transportation. Mizobuchi's differs from Brännlund et al (in the sense that whereas Brännlund et al assume an exogenous improvement in energy efficiency (a change in consumption without increasing in use of resources) Mizobuchi focuses on the case when Japanese households replace old appliances with energy efficient appliances that are more expensive, hence the capital cost is included [29, 31]. Mizobuchi's inclusion of capital cost is however contested, affecting the comparative value of the study [30].

### **Abatement induced re-spending**

Alfredsson estimates re-spending from three types of 'green' consumption choices (abatements); 'green' travel', 'green' housing, and 'green' diet [28]. 'Green' travel' as well as 'green' housing' consists of both behavioral and technological changes 'Green' travel' includes technological changes as improved fuel efficiencies and behavioral changes as reduction in car ownership, increased use of public transport, increased membership in car-sharing organizations, reductions in car-travel (replaced by walking or biking) and changed driving styles (eco-driving). For 'green' housing the behavioral changes imply a reduction of hot water and household electricity consumption. Technological changes consist of changes in the energy sources used for heating (i.e. new efficient boilers) and replacement of old houses with new energy efficient types of houses requiring less energy for heating. The 'green' diet consisted mainly of food from vegetables and to a lesser extent food from dairy products, fish, and meat. The highest relative increase in re-spending following money saved by adopting a 'green' lifestyle (the total effect of the three green consumption choices) is found in furniture, clothes, recreation, services and travel [28]. Druckman et al estimate the effects from for three abatement actions; reducing internal temperatures with 1 degree Celsius, reducing food expenditure by one third by eliminating food waste and walking or cycling instead of using the car for trips less than 2 miles [30]. Money saved from these abatement actions were re-spend in accordance with current consumption patterns indicating the largest relative increase in housing, transport, goods and services. There is an interesting difference between these two studies focusing on the re-spending effect of abatements, i.e. voluntary changes in consumption. The 'green' consumption choices in Alfredsson's study lead to less re-spending in heating and transportation (so called direct rebound effect) compared to Druckman et al [28,30]. This means that less money saved on energy spent on travel and housing is re-spent in these categories. The combination of behavioral and technological changes of 'green' travel 'and 'green' housing and the scope of behavioral change affect anticipated re-spending. Taking the example of travel abatement, Alfredsson positions behavioral change in 'green' travel as reduction in car ownership, increased use of public transport, increased membership in car-sharing organizations, reductions in car-travel (replaced by walking or biking) and changed driving styles

(eco-driving) whereas for Druckman et al the transport abatement includes walking or cycling instead of using the car for trips less than 2 miles [28,30]. The scope of behavioral changes connected to 'green' travel in Alfredsson's study, including measures like reduction in car ownership that will refrain consumers from re-spending money saved on cheaper driving on driving longer distances, will steer consumers' re-spending to consumption categories other than car use [28].

### Estimated affluence and (re-)spending

Studies on anticipated wealth increases and spending are often cited in support of findings in re-spending. Carlsson-Kanyama et al. used four household ideal types in Stockholm inner city, Urban Rich, Young and Poor, Single with car and Squeezed with children to estimate effects on spending and GHG emissions [51]. The proportions in spending were similar across household types, the largest expenditure were put on housing and food. The greatest relative difference in spending (due to affluence and household composition) is found in the large percentage spent on recreation by the Urban Rich and the on clothing among Single with car. Girod and de Haan estimated changes in consumption following anticipated increased affluence in Swiss households [52]. Based on current Swiss expenditure patterns, the behavior estimate with a business-as-usual model of allocation of Swiss consumption expenditure show that the greatest relative positive demand change is found in the categories of eating out, goods (clothes, furniture, other), services and mobility (travel /transportation).

Study	Focus on re-spending effects	Re-spending, money saved spent on consumption categories with greatest relative demand change
Brännlund et al (2007)	Examination of the effect of 20% energy efficiency improvement in personal transport and heating	Heating Car transport Recreation Clothes Domestic appliances
Mizobuchi (2008)	Estimation of effects of energy efficient capital goods	Heating Medical care Car transportation
Alfredsson (2004)	Estimation of effects from 'green' consumption choices, transport abatement, green housing and green diet	Furniture, Clothes Recreation, Services Travel Health Housing
Druckman et al (2011)	Estimation of effects for three abatements; household energy reduction, more efficient food consumption and reduced vehicle travel	Housing Transport Goods Services
Carlsson-Kanyama et al (2005)	Estimation of changes in consumption following income, household composition and living space.	Housing Food Recreation Clothing and footwear
Girod and de Haan (2010)	Estimation of changes in consumption following increasing affluence of households and allocation of GHG emissions	Eating out Goods (clothes, furniture, other) Services Mobility (travel /transportation)

Table 1. Allocation of re-spending in six studies on estimated effects of energy efficiency, abatements or increased income.

## DISCUSSION

According to this study re-spending allocated to consumption categories other than those where changes in price or behaviour were estimated, corresponds with dominant marketing practice in contemporary consumer society. The estimated re-spending described in recreation, travel, clothes, and goods for the home, represent consumption categories where a supply of consumption objects are positioned as idealized identities. In line with marketing governance of the consumer as a self-entrepreneur, such contemporary marketing practice produce re-spending that reflect a need for self-assurance.

### Re-spending reflects provision of idealized identities

Re-spending on recreation, travel, clothes and goods for the home (furniture and domestic appliances), reflect consumption categories where objects are positioned as idealized identities in branding and

advertising. In Sweden, the context in which this paper is written and a country representing Western consumer culture, exotic holiday destinations, recreation activities as gardening, home decoration and indoor renovation (which is positioned as the ultimate recreation in advertising for DIY-retailers) are communicated as idealized and fashionable life style options frequently described in magazines and TV programmes. Supply and availability of products is a prerequisite for business to market these as part of an ideal identity. The intimate connection between a rich supply of fashionable/trendy products and marketing discourse idealization is illustrated example by the development of the Swedish market for home decoration. Fuentes describes the expansion of the home decoration market in the period 1990-2006. During this time, established retailers expanded and new retailers entered the market [53]. Sales figures skyrocketed 2005-2006, there was a parallel explosive increase in the number of Swedish home decoration magazines and a number of home decoration TV programs were launched. The magazines and TV-programmes provide ample home decoration ideals both in the advertising carrying the cost of magazines/TV-programmes hence constructing home decoration consumption as idealized identity-making [53]. Re-spending in the category of goods for the home without any doubt reflects the material and linguistic construction of consumption produced by marketing practice [23, 41, 7].

In the same vein marketing practice is assigned a central role in steering re-spending to consumption of clothes, recreation and travel as visual imaginary in marketing and new product offerings suggest idealized ways of being as a person [26]. Marketing discourse based identity idealization via visual imagery in advertising is well-documented in the area of clothing where fashion meanings are coupled with frequent launches of new collections and styles [54, 55]. For clothes consumption this phenomena is best understood in studies on fast fashion consumption. Fast fashion provides cheap chic and fast cycles of fashion, often based on limited editions offering idealized personalization of the mass-customized [54]. The same interconnection between identity idealization in advertising and ample supply of new recreational experiences (challenging sports that will shape the body and the mind, exciting adventures) and exotic holiday destinations, or combination of the two (going to Thailand to learn yoga) promote re-spending in the areas of recreation and travelling. Consumption of recreation and travel corresponds to an expanding tourism and leisure industry that has grown by 1-2% per year for the last 30 years and where advertising, connecting (exotic) destinations and leisure activities to ideal life style aspirations, is booming [56].

The type of idealization that re-spending on recreation, travel, clothes and goods for the home reflect can be understood against the background of individualization and instable identities in consumer culture [35, 37]. The lack of stable self-identity is compensated for, by a supply of consumer goods associated with idealized/achieved identity image. Plentiful supply of products heavily advertised and positioned as idealized identity and life-style steer re-spending to the recreation, travel, clothes and home decoration market.

### **Re-spending reflects consumption based self-assurance**

Re-spending on products in the categories of recreation, travel, clothes and goods for the home, associated to idealized lifestyles, can be understood as seeking acceptance, or assurance among one's peers. The lack of stable moral guidelines and consequent consumption based identity, marked by idealization, characteristic of contemporary consumer culture, produce a need for self-assurance [19; 57]. Our contemporary consumer culture where consumers are encouraged to problematize and improve the self, i.e. self-governmentality [46], through consumption, both produce and relieve anxiety [20, 21]. Within such a culture of self-governmentality consumption of various products become as a process of "establishing normativity in kinship", i.e. a process regarding who to be in relation to important others [58, 59]. Hence, following the logic of self-governmentality consumers most probably seek self-assurance in regards to products marketed as idealized identities and life-styles. One important arena for self-assurance is the reliance on expert systems, such as advertising, brands, one's peers or aesthetic experts, who offer guidelines as to what to consume connected to consumption choice and identity [58; 60]. Clarke and Miller's study about British females' choice of clothing provides a good example of the need for self-assurance in consumption. They found that most participants did not know what their taste was and were too anxious to choose what clothing to buy without social (family and friends) or institutional support [58]. Relevant for our understanding of the additional income, produced by cheaper energy provision, that is re-spent on high GHG intense consumption categories, is how marketing practice shape consumption within contemporary consumer culture. Governing consumers' choice of products through individual desire to improve one's life through consumption, i.e. self-governmentality, spur re-spending as self-assurance in consumption categories where products are marketed as idealized identities.

### Re-spending is affected by the scope of behavioral change

As proposed above in the discussion about the difference in scope of suggested behavioral abatements in Alfredsson and Druckman et al, the scope of proposed behavioral changes connected to 'green' travel in Alfredsson's study, (including measures like reduction in car ownership that will refrain consumers from re-spending money saved on cheaper driving on driving longer distances) affect consumers' re-spending by allocating spending to consumption categories other than car use [28, 30]. A broad set of behavioral changes coupled with technological efficiency measures might increase indirect rebound effects at the expense of direct rebound effects as illustrated in Alfredsson and Druckman et al [28, 30]. Hence more ambitious behavioral changes in for example personal transport (reducing ownership of cars, becoming member of car pools, and replacing car driving with walking/cycling for short distances) combined with fuel efficiency result in less re-spending in car use than behavioral changes of limited scope (only focusing on walking/cycling instead of taking the car for short distances). From a socio-cultural perspective broader sets of behavioral changes (accompanied by technological change) are more likely to affect energy consumption and the allocation of re-spending. The discursive position taken in this paper, where social actors are assumed to make sense of the world and achieve social order *both linguistically and materially*, the scope of proposed behavioral changes represent changes in material constitution of consumption. Material objects (as cars and bicycles) and infrastructures (as car pools) are regarded as having signifying properties, hence influencing social action. For the abatements suggested in Alfredsson and Druckman et al this means that the estimated re-spending (which differed considerably between the two studies) corresponds to the signifying influence of material objects and infrastructure [28, 30]. Drawing on theories of (marketing) governance where idealized identities and lifestyle are built on both linguistic meanings and material surroundings [26], more ambitious behavioural changes having an impact on the material aspects of energy consumption are more likely to affect social norms in a direction towards low-carbon spending. This is in line with a practice-based approach to consumption where material, meaning, and competence elements of practice configure each other and change in any of these elements are interconnected [61]. Thus changes in the material aspects of transportation (as reduced availability of cars) or food (in terms of the availability of meat) will entail changes in the meaning of transportation and food. Hence the number and combination of proposed behavioral changes in re-spending studies will affect achievements in energy efficient consumption as a broader spectrum of social processes being constituted both *linguistically and material*, are affected, which will lead to a normalization of energy efficient life-styles.

### CONCLUSION

In this article it is argued that a multi-disciplinary frameworks guiding energy policy must include research on the influence of marketing practice on individual consumption. The results should be viewed as a call for using marketing practice as a vehicle for promoting a reorientation of re-spending towards low GHG intense consumption categories. Such policy making must start by considering material as well as discursive signifying marketing practices. Both the supply and availability of products and the meanings connected to these products by advertising shape the allocation of re-spending and thus the sustainability of consumption [23, 41, 7]. This is well in line with energy consumption research, Southerton et al state three general barriers to low carbon lifestyles; resource limitations, normative requirements (e.g. desired life-style) and material and infrastructural arrangements (e.g. choice and availability of products) [25].

Building on literature on marketing governance of the consumer there are two predominant ways to curb idealized identity connected to high GHG intense spending; less supply of goods and less advertising positioning these goods as being part of an idealized identity. According to this logic limiting the access to high GHG intense products by higher prices would be instrumental in producing low carbon lifestyle, especially if accompanied by lowered prices on low GHG intense goods [62]. However as long as high GHG intense products are positioned as idealized identities, limited supply alone would not provide incentive enough for change in re-spending. Higher priced idealized products would probably spur demand for positional reasons. In this article it proposed that GHG intense re-spending can only be affected by policies that affect supply of high GHG intense products and advertising of these products simultaneously. Policy addressing advertising of products within high GHG intense categories, in parallel with restricted supply, can be effective if designed to influence the content and /or the frequency of advertisements as consumption choice is influenced by both these factors In parallel with restrictions on

high GHG product advertising, advertising and supply, of low carbon products supported by policy-makers would strengthen low carbon re-spending [62]. High carbon product advertising content and frequency can be regulated by policymakers in various ways. It is outside the scope of this article to develop ideas about concrete policy further. Future research is urgently needed to address the question of how effective policy measures regulating supply and advertising for high GHG intense products can be developed.

A consumer culture based understanding for re-spending is essential to fully understand and hence account for indirect rebound effects. Marketing theory can help us see why it is difficult to move from high carbon to low carbon intensive consumption. Building on these insights policy makers will be able to include marketing practice as a driver of re-spending in comprehensive and multi-disciplinary models of energy consumption and, more importantly, consider marketing practice as a vehicle for steering re-spending to low carbon intensive consumption categories. Research within the field of sustainable consumption suggest that high carbon intensive consumption can be addressed by working to disconnect consumption of energy intensive products and services from social norms and life-style [27]. Re-spending in low energy intense categories positioned as socially desired and emotionally rewarding consumption, connected to idealized identity and life-style aspirations could be a model for policy-making that complement information campaigns that encourage households to engage in energy efficiency improvements of different kinds [30]. When designing energy policy aimed at reducing household energy consumption the scope and mix of proposed behavioral and technological changes need to be addressed. Shove et al discuss the implication of a practice based approach, viewing social action a being constituted by interconnected material, meaning, and competence elements, on climate change policy [61]. Shove et al see the design of (material) elements that support low carbon consumption as instrumental in energy policy making. Investments in infrastructure supportive of low energy consumption and a greater degree of planning of institutions that sustain low GHG intense spending reflect a position where the influence of material goods and structures is fully recognized by climate policy.

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# BUILDING SUSTAINABLE LIFESTYLE SCENARIOS IN JAPAN BY 2030

Yuko KANAMORI<sup>1</sup>, Tomohiro TASAKI<sup>1</sup>, Midori AOYAGI<sup>1</sup>, and Aya YOSHIDA<sup>1</sup>

<sup>1</sup>National Institute for Environmental Studies (NIES)

## ABSTRACT

The purpose of this paper is to identify what kind of changes in lifestyles in Japan would and could occur by 2030 and to verify these lifestyle changes with ordinary people using focus group method. In order to identify lifestyle changes in 2030, we used several steps for building scenarios. At the first step, we picked up several points to be considered for describing people's lifestyles, such as living area, family status, and future direction of living status and then identify main underlying factors changing lifestyles behind the described lifestyles in the future. At the next step, using these factors and household projection by household type, we identified main trends of Japanese future lifestyle that most people would live and expressed those trends in 16 stories. At the final step, to verify these 16 lifestyle changes, we used focus group method for four groups. We asked these participants of focus groups to evaluate our stories. Many focus group participants responded that most of these changes were likely to happen in the future in Japan, but two points were not accepted by them. First point was that there would be more people living in rural area to keep the community alive and their way of being themselves. Second point was that some family work, such as taking care of children and older family members, would be shared not only by the family members but also by the community.

*Keywords: Sustainable lifestyles, scenario study, focus group method*

## 1 INTRODUCTION

Consideration of future social changes due to take place in the medium or long term, by 2030 or 2050, has become common recently. According to all these considerations, all bodies, including those determining the policies, businesses and citizens, are required to make an effort to achieve such targets. Citizens have always been considered as playing an extremely important role in transforming the society. Sustainable consumption and production has been recognized as a priority by the UN [1], and the Action Plan arising from the 2002 Johannesburg Summit led to the establishment of "Task Force on Sustainable Lifestyle" as one of the seven Task Forces resulting Marrakesh Process, with its subsequent activities (see UNEP [2]). The great diversity in lifestyles, however, and the fact that it is difficult to forcibly implement direct limitations on activities (see, for example, Salzman [3] on the state of legal regulations in regard to consumption in the USA) means that when creating environmental scenarios, there is a tendency to base measures on controlling demand and providing financial incentives, utilizing taxes and subsidies, or to assume that consumption patterns will change easily in the future. Even if environmental awareness rises in the future, however, it is clear that bringing about changes in people's lifestyles simply for the reason that "it is good for the environment" is difficult. In creating environmental scenarios, too, it is necessary to consider more specific changes to lifestyles, and it is vital to understand the sort of lifestyles that may become popular.

A range of existing research [4] indicated the ease with which lifestyle can be identified based on individual factors (e.g., age and gender) and household factors (e.g., income and type of household). In this paper, we categorized households according to the age of the head of the household, and the type of household, and examined the changes in lifestyles, with the purpose of identifying the major lifestyle changes that would have taken place in 2030. Furthermore, we implemented focus group interviews, in order to study the reaction of ordinary people to the lifestyle changes we proposed.

## 2 METHODS

### 2.1 Consideration of Methods

It is not easy to determine what type of lifestyles will become popular in the future. If present changes continue in the future, future observations are possible based on extrapolation, but if our scope is to be wider, and take in, for example, the potential for unexpected phenomena, then this approach is inappropriate. Given this, several studies have used idea generation methods [5] such as brainstorming, during which specialists create future scenarios in-group work [6]-[8]. These methods, however, have been used in order to describe future macro trends, and do not depict things at a micro level, such as various lifestyles by different types of household. Describing radical lifestyles, on the other hand, has been categorized by Tasaki et al. [9] as the “emergent approach”, and has been implemented, for example, by Ishida et al. [10]. In such cases, brainstorming and its applied methods are used to specifically describe individual lifestyles, but in such cases, it becomes, rather, difficult to know how many people likely to choose that lifestyle. The scenario approach has also been used to explore changes in lifestyles. SPREAD [11], a recent research project, used the backcasting method to describe four scenarios with sustainable lifestyles. The scenarios were defined at workshops involving specialists, at which the technology and systems used in various lifestyle situations were discussed. Whilst this kind of method [11]-[13] allows the definition of ideal lifestyles, it does have a tendency to pass over factors that inhibit their realization [9].

Given the attributes and problems thrown up by the methods used in existing studies, we attempted the following approach. We focused on certain categories of household, considered likely to become popular over time from now on, which were predictable to a certain extent based on future population categorized according to individual attributes and the number of households by household attribute as well as “changes” such as increasing trends; they thereby extracted potential changes to the lifestyle of such household categories during the course of predicted future changes to society.

Firstly, having described future changes to lifestyle using brainstorming, the authors inductively extracted the factors likely to cause major impact in lifestyle changes (hereinafter referred to as “lifestyle change factors”) (STEP 1). Next, based on estimates of future population and number of households, we selected the attributes of major types of household in 2010, and 2030 (STEP 2). Subsequently, using a matrix method combining 1) lifestyle change factors and 2) major households, we proposed the ways in which lifestyles may change among major household types by 2030. Additionally, we considered and interpreted the implications of these changes (STEP 3). Here, STEP 1 was similar to the existing approach described above in that it used conceptual methods to ascertain future micro trends. The inductive extraction of factors was done with two objectives. Firstly, since this research method relies on idea generation, there are limits to both the reproducibility of the details of lifestyle changes recorded, and the comprehensiveness of potential changes; as a result, one objective was to supplement these limits. Secondly, the other objective was to extract the most important change factors by separating the important lifestyle change factors that are common to various scenarios described, and those that are factors only in specific changes. Finally, the authors implemented focus group interviews, and verified response to the lifestyle changes resulting from STEP 3 (STEP 4). The following is a specific explanation of the processes engaged in during each step.

### 2.2 STEP 1: Method Used in Describing Lifestyle Change and Extracting Change Factors

Discussions of future lifestyle involve the problems faced by contemporary Japan, such as the aspirations and problems of the elderly, the aspirations and problems of young people, changes to the lifestyles of women, and the consideration of hopes and happiness as indicators of growth, in place of the economy, etc. Initially, brainstorming of lifestyle changes was carried out to ascertain the breadth of lifestyles anticipated in 2030, and then lifestyles in 2030 were written down in a format. Since the perception of participants has an impact on the results when using idea generation techniques, which is an applied method of brainstorming, the team included five members with between three and 20 years’ experience in researching and engaging with consumer lifestyles.

The details of the lifestyles recorded included the age and gender of the person being described in 2012 (as the base year), the type of area in which they lived, the makeup of the household, employment and income, values (what they felt brought them happiness, satisfaction, anxiety and a

sense of risk), and other attributes (final educational level, transportation used, etc.), as well as specific information about their lives (dwelling, consuming, working, childrearing, comforting, engaging in leisure, learning, interacting, traveling). Scenarios were envisaged for 10 years and 20 years into the future, in which living conditions had improved (improving scenarios) and worsened (worsening scenario), and reasons for the change in status were also recorded. In order to imagine and record details as specifically as possible, the records were written not to represent a particular class of people living a specified lifestyle, but to consistently represent a particular individual, living his or her specific lifestyle. At the end of STEP 1, the major change factors contributing to the changes in the lifestyles described were extracted for both improving and worsening scenarios.

### 2.3 STEP 2: Method of Selecting Major Households Using Household Classification

The authors ascertained the distribution of households, based on household estimates for each household attribute in 2030, by combining the three types of residential area and different categories of household. The distribution of households in 2010 was ascertained from the national census [14], while that for 2030 was ascertained using the methods of Matsuhashi et al. [15]. Subsequently, several major households were selected.

### 2.4 STEP 3: Recording of Lifestyle Changes in 2030 Using the Matrix Method

After combining the results of 2.2 and 2.3, we examined ideas regarding what sort of life status was likely in cases where major households faced lifestyle change factors by using the matrix method. Since the probability of young and middle-aged people facing health risks is low, the combination of these factors was removed from the scope of the matrix method for the purposes of this paper. The ideas obtained were used to describe specific consumption and turning points realized by lifestyle changes (changes in technology, regulations, systems, and corporations and businesses), and compiled into the records of lifestyle change.

### 2.5 STEP 4: Focus Group Interviews to Verify Citizens' Response to Lifestyle Change

The lifestyle changes obtained in 2.4 described entirely those applicable to the major households. In order to examine how citizens would react to these results, we implemented focus group interviews (hereinafter referred to as FGI) for the purpose of verification of our scenarios. We formed four groups for FGI implementation. The contents of the FGI are as shown in Table 1.

Table 1. Details of FGIs implemented

Group name	Young, at-risk (A)	Young, non-risk (B)	Middle-aged males (C)	Middle-aged females (D)
Subjects	<ul style="list-style-type: none"> <li>• Three men and three women aged between 20 and 40</li> <li>• People facing some sort of lifestyle risk</li> <li>• In fact, all were facing economic risk</li> </ul>	<ul style="list-style-type: none"> <li>• Three men and three women aged between 20 and 40</li> <li>• People not facing some sort of lifestyle risk</li> </ul>	<ul style="list-style-type: none"> <li>• Six men aged between 40 and 65</li> <li>• People with some sort of lifestyle risk (corporate restructuring, caring for parents, etc.) in the past</li> </ul>	<ul style="list-style-type: none"> <li>• Six women aged between 40 and 65</li> <li>• People who had experience themselves, or their partner had experience, of facing some sort of lifestyle risk (corporate restructuring, caring for parents, etc.) in the</li> </ul>
Scenarios presented	L1, L2, L3, L5, L6, L7, L8, L10, L11, L12, L13, L14, L15,		L1, L2, L4, L5, L6, L7, L8, L9, L11, L12, L13, L14, L15, L16	

When implementing FGI, in order to focus on the issue of how those who had specifically experienced facing risk, or those who may experience it, felt about the scenarios, we targeted people who are currently facing, or had in the past faced, some sort of risk in the older two groups. In order to clarify the thoughts of those people who will fall into the “elderly” group in 2030 and may face risks specific to older people, and to verify whether some experience of facing risk impacted on avoiding future risk, we made a group of middle-aged people consisting of people aged from 40 to 59. In order to clarify the thoughts of those in the young group, who will be middle aged in 2030, and who may face a range of

risks in regard to themselves and their families, we targeted those aged from 20 to 39. Additionally, in order to verify the thinking of the young, low-risk group, who have not faced risk as yet, we added them to the group. The participants in all groups lived in and around Tokyo.

Specifically, after 14 out of the 16 lifestyle change categories described in 3.3 were selected depending on age range, participants were given printed materials relating to the changes in their lifestyle anticipated in 2030 and asked to draw a line underneath the parts that they thought may happen either to them or someone close to them. Based on these results, a certain amount of discussions were held regarding the details that many people believed might happen, those that many believed would not happen, and those that only specific people believed might happen.

### 3 RESULTS

#### 3.1 Results of Describing Lifestyle Changes and Extracting Change Factors

The following is a description of the results of our inductive search for lifestyle change factors from the images of lifestyles described by brainstorming. We initially looked at the factors in lifestyle worse off, and compiled them into four risks that have an impact on lifestyle (financial risks, health risks, risks relating to social networks, and risks associated with changes between life stages; hereinafter these are referred to as “lifestyle risks”). The following is an explanation of each of these risks.

An example of a situation in which a subject would face a financial risk would be one in which he/she loses his/her job, or in which he/she is working, but not earning enough to live on, or subject to instability in terms of sustained income, or one which is caused by the planning of the subject. Alternative scenarios could include those such as failed investments.

Examples of health risks include unstable health during old age, or becoming depressed or experiencing adult illness due to overwork or stress in the working environment during middle age.

Risks relating to social networks include the risks incurred as a result of breakups or changes in his/her relationships with others, or the relationships that connect the subject to his/her group. Examples of subjects facing this risk include reduced external ties, such as weakening trust or relationship to neighbors, weakening ties within the workplace as a result of increasingly irregular employment, or weakening ties caused by changes in lifestyle among friends or colleagues, etc. (marriage, job transfer, birth of children), or with regard to family, becoming single as a result of divorce or the death of a partner, never getting married, or weakening relationships with the conventional family as a result of the increasing choice not to have children.

Various other types of risk were also identified, but most of them could be categorized as risks that could not be dealt with by changes between life stages. A “change between life stages” would include, for example, marriage, divorce, birth, separation from or the death of a partner, unemployment, leaving employment, retirement or renewal of contract with a company, children growing up and starting/graduation of school, etc. Changes between life stages can happen at any time, but the fact that Japan has become a very different country compared with the past, when people experienced comparatively similar courses of life [16], means that they are now at risk of being unable to cope with certain changes in life stage. Furthermore, scenarios were also described of being unable to cope with life course selections, such as families in which children leave school without graduating, and children remain economically dependent for far longer than they used to.

Next, we looked for factors on better lifestyles, from the improving scenarios. The scenarios were described based on diverse values and aspirations, specifically, materialism and anti-materialism, career aspirations, aspirations to independence, regional aspirations, aspirations to evolve and to settle down, acknowledgement of self and others, and being family-centered. A factor common to the people appearing in such improving scenarios was an attitude of self-fulfilment, based on one’s own values and aspirations.

#### 3.2 Results of Selecting Major Households Using Household (Living Individuals) Classification

In 2010, 30% of households were single-person households, 60% were nuclear households, and the remaining 10% were the other households. Categorized by age of head of household, single-person households were the major household among young households, while among middle-aged households, most comprised households comprising a couple with a child or children or single-person households, and among elderly households most comprised households comprising a couple only and

single-person households. Between 2010 and 2030, the major household composition in 2030 has not changed significantly compared with 2010, but notable changes include a startling increase in the number of elderly households and single-person households, and as a result, the decline in the number of young and middle-aged nuclear households is also significant.

### **3.3 Results of Recording Lifestyle Changes in 2030 Using the Matrix Method**

We examined the sort of lifestyles that would result from the four types of major households selected in 3.2 facing any of the four lifestyle risks, and the state of the lifestyle in those household categories already subject to the four lifestyle risks, using the matrix method. As a result, we found that lifestyles become worse off in some cases when people face some specific risks, but that in many cases, lifestyles become worse off when multiple risks occurred at the same time, or occurred in a chain effect. It is also noted that there are cases both wherein a specific person within a household faces risk and wherein multiple members of that household face risk. In order to clarify changes to individual lifestyles as part of this research, we compiled the changes that take place in a lifestyle as a result of a chain reaction of risks into a single lifestyle change. Furthermore, in cases where multiple members of a household experience lifestyle changes as the result of facing risk, we focused on the person who symbolically expresses that lifestyle change, and compiled seven types (L1-L7) of change that result in worsening lifestyle. Additionally, becoming a full-time homemaker, which is one of the major lifestyles adopted by women, was identified as the eighth lifestyle change (L8), since it can be evaluated in a range of different ways. On the other hand, we examined changes that improve lifestyles based on the values and aspirations outlined in 3.2. We found that values and aspirations are often unrelated to the category of household, and that they are not clearly divided according to age and generational attributes. For this reason, we compiled eight types of lifestyle change (L9-L16) to characteristically express the attributes of those achieving self-realization based on values and aspirations. A list of the 16 types of lifestyle changes is given in Table 2.

Table 2. Summary of Lifestyle changes

	Up until now	15 years from now
L1	NEETs and social withdrawal are a "special" phenomenon occurring in people between their teens and thirties, and are becoming an increasing social problem. People who are absorbed in the virtual world and have lost interest in the real world are also a big problem.	An increase in aging NEETs and people in social withdrawal, so that those in their 40s and 50s make up a significant proportion of the whole. A range of countermeasures are attempted in response to this. Furthermore, measures are implemented to counter dependency on the virtual world, and to prevent further such tendencies.
L2	Would like to "get a job (regular employment) and get married like normal", but the fact that the person cannot become "normal" is a social problem.	Regardless of educational history, the young and middle-aged people who have not been able to get married or find a job "like normal" is increasing, to the extent where this has become the normal situation.
L3	Up until now, was able to marry and gain employment without a particular life plan, and have achieved a certain living standard.	The number of people simply accepting the fact that if they do nothing, their living standard will fall is increasing; even if their current living standard is not satisfactory, they feel no need to make a response such as reviewing income and expenditure, or changing their job for one that is better paid; rather, they attempt to manage their life by "buying cheaper products".
L4	For ordinary households, taking on a loan or credit card did not pose major problems in daily life.	Risks such as corporate restructuring and bankruptcy are increasing, and increasing numbers of ordinary families may find themselves, for unexplained reasons, in so much debt that they struggle to live a "normal" life.
L5	It was considered virtuous for women who divorced to return to their own family homes, as evidenced by the word "demodori" (leave and come back), or to work with her bare hands, sacrificing herself so that her children could be reared properly.	The concepts of "demodori" and a woman working with her own bare hands are obsolete and forgotten. But employment continues to be difficult for women above a certain age, and low incomes mean that "independence" remains a difficult road to travel. Single mothers continue find it impossible to become independent, but have to live with their insecurities.
L6	It is considered social common sense that children should look after their elderly parents.	Independent living is on the increase, regardless of age or gender. The number of people dying alone, since people do not communicate with those around them or with their families, and many people are lost without trace while alive. An increasing number of people live as though they have "no family ties" despite having family and blood relatives.

Table 2. Summary of Lifestyle changes (Cont.)

	Up until now	15 years from now
L7	Was looking after own parents, and local elderly people were looked after by their own children or relatives. Alternatively, they were placed in an old people's home, for which fees were paid.	Despite the fact that they imagined the future and prepared for it, an increasing number of people are bogged down by living without care, either from public sector or private sector carers, after illness or injury in themselves or their partner.
L8	Full-time homemakers increased along with the growth in salaried employees in the period of high growth after the war as such a way of life was considered "normal" for a majority of women. It is common for women to focus on homemaking after marriage, particularly while they raise children.	Only a few wealthy households can support a full-time homemaker, and in cases where the husband's income (or pension) is lower, it becomes normal for the wife to work to support the household economy. While full-time homemakers are envied by some women, an increasing number of homemakers are attempting to polish their skills in preparation for divorce in middle age.
L9	As you get older you are looked after by your family, and leave many of the decisions to be taken by the family. Dying and leaving behind an inheritance is considered by society to be a conventional way to end your old age.	An increasing number of people focus on how they can achieve the things they want to out of the life you have left, make decisions based on themselves without consideration for family or respectability, and die without leaving any inheritance.
L10	It has always been considered a (socially accepted) common sense to marry at the point at which you reach the marrying age.	The number of people recommending an "easy" single life are on the increase, and the age at which people first marry is rising higher and higher.
L11	It was considered a normal way of life to play the various roles expected by others in an impromptu way, depending on the existing living environment such as companies or local community.	A lifestyle in which people use their own knowledge and networks to become independent and select their work location and contents autonomously, in response to the risks occurring as a result of not depending on a specific community or company, becomes normal.
L12	Since single mothers and single fathers do not have social or economic stability, society dictates that divorce and remarriage cannot be done easily.	Men and women not depending on a specific partner, but rather choosing to live independently and autonomously, have become normal, and new partnerships that are not concerned with the format of marriage are widely accepted. As a result, single mothers and fathers no longer occupy their formerly weak positions in society.
L13	It is normal for women to have a life plan that assumes getting married, and normal for them to stop working or put their careers on hold when they get married or have children.	Both men and women will be able to consider their career plans separately to their family, and the support systems for this (systems such as kindergartens, nurseries, children's centers, etc.) are improved. It becomes normal for marriage, childrearing and family to become waypoints in autonomous life planning.
L14	Households where both partners work and children tend to place a burden of housework and childrearing on the mother; this is considered a family problem, which must be solved by the parents themselves	"Ikumen", men who raise their children, will be considered completely normal, and childrearing will be undertaken not only by both partners but also shared with the local society and community in all aspects, facilitating a society in which it is easy for both partners to work.
L15	Families engaged in primary industry in rural agricultural and fishing villages are finding that their children do not wish to carry on the farming and fishing, with the result that areas that have depended on such industries have lost their vitality.	Young people from cities will perform "I-turns" to engage in agriculture, forestry or fishery, and join hands with young people living in rural environments
L16	Social movements up until now have been caused by existing agencies organizing and bringing people together.	Future citizens' movements will spread based mainly on the "sympathy" of individuals via SNSs (networks of people connected by the internet).

### 3.4 Results of FGI

The lifestyle changes shown in Table 2 are a compilation of the breadth of lifestyle changes that may occur, which describes how people considered "normal" up until now respond to risks they are highly likely to face in the future or lead a life based on values and aspirations they have. In order to confirm whether or not these results are acceptable to the general population, the authors implemented FGI, in which participants were asked to draw a line under the parts of Table 2 that they could imagine happening either to themselves or to those around them. Table 3 shows the situations that many people

considered might occur, and those that people considered were extremely unlikely to occur. The numbers before the hyphens indicate the number of the lifestyle change.

The situations considered generally likely to occur were mostly lifestyle changes resulting in a worsening standard of living. Few of the improvement lifestyle changes were considered, overall, likely to happen. This is believed due to the fact that the improvement lifestyle changes were lifestyle changes based on various values and aspirations seen in contemporary society, and differed from the situations considered likely to occur by many individuals.

From among the situations considered most likely to occur overall, those strongly related to family problems detailed in Statements 2-1, 5-2, 8-2 and 16-1 were considered unlikely to occur by Middle-aged males. Statement 5-2 was considered unlikely by the Young non-risk group, but it is considered possible that a lack of personal experience meant that the group simply could not imagine it happening. On the other hand, the situation of concerns relating to old age detailed in Statement 6-2 was considered likely to occur by all Middle-aged males, whilst only a proportion of Middle-aged women felt it was likely to occur. This result indicates the fact that almost all the relationships within families and the community among the current middle-aged to elderly generation in Japan have been built by women. Statement 15-1 was considered a likely scenario by many of the Young, low-risk group. A certain proportion of the Middle-aged group felt the scenario was likely to happen, indicating the extent to which current elderly people are skillful in their use of technology. At the same time, many of the Young, at-risk group considered that it would not happen to them. This indicates the possibility that not only are they facing economic risks, but also that there may be a problem with community relationship building in the future.

On the other hand, if we look at the situations considered unlikely to occur, it appears that there is little or no expectation of the implementation, etc. of systematic and structural social reform of contemporary society such as Statements 2-2, 11-3, 16-2, and 16-3. While people expect that an increasing number of fathers may become actively involved in childrearing, the idea of people outside the family cooperating or systems being reformed was met with outright denial. In particular, while around half of Middle-aged women considered new models of life plan (12-1, 12-3) and proactive, energetic ways of living (14-1, 14-2) potentially possible, other groups considered that these things were almost totally unlikely to happen. This suggests that Middle-aged women who were born post-war have lived through radical changes in social status and values, and have extremely strong aspirations and determination in regard to their way of life.

Furthermore, situations relating to “I-turns” (14-1, 14-2) were considered unlikely to occur by all young participants. Additional discussions were held on the participants. Participants who were originally from rural or suburban areas understood that their hometowns were losing vitality, but there were no specific statements that this was “a shame”; rather, there was a vague awareness of this being the situation. The recent introduction of local tax systems and the fact that “I-turners” have been taken up in the media, etc., led the authors to anticipate a greater level of interest in the participants, but it appears that only a very small number of people may in fact be interested.

#### 4 DISCUSSION

The eight changes that worsened lifestyle were categorized into two types, based on the perspectives of awareness of and response to lifestyle risks. The first category was that of people who were “aware but incapable of risks”. This indicates that, while there may be an awareness of a lifestyle risk, the lack of ability to respond may cause the risk itself to occur. At the same time, it is clear that lifestyle worsening changes come in the form of “lack of risk awareness”, in which there is simply no awareness of lifestyle risks. In such cases, risks occur whilst the subject is taking no measures to avoid them. Changes that improve lifestyle can be broadly divided into two categories, depending on the way used to avoid lifestyle risks. The first is lifestyle changes in which lifestyle risks is by challenging, defined here as “countering risk by challenge”, where the individual involved counteracts the risk by improving his/her own abilities. The second is lifestyle change in which the risk is dealt with by a certain amount of individual ability to counter it, in combination with the cooperation of others, which is defined here as “countering risk collaboratively”.

**Table 3. Statements with which participants agreed, and did not agree, in FGI (The numbers in the left represent the lifestyle change number (left) and part in scenarios (right))**

Situations considered to have potential to occur by half or more of subjects		A	B	C	D
2-1	Aging NEETs and social withdrawn cases will increase, so that those in their 40s and 50s will make up a large proportion	5	4	1	6
5-2	An increasing number of cases where ordinary households will be so heavily in debt, for unexplained reasons, that they can hardly maintain an ordinary life	5	1	1	6
6-2	An increasing number of people are bogged down by living without care, either from public sector or private sector carers	5	4	6	2
8-2	It will be completely normal for wives to work to support the household economy	5	5	3	6
15-1	The "sympathy" of individuals via SNSs becomes a major means	2	6	3	3
Situations considered to have potential to occur by half or more of the Young group (A/B)		A	B	C	D
3-2	Employment will continue to be difficult for women above a certain age, and low incomes will mean that "independence" remains a difficult road to travel	3	3	-	-
3-3	Single mothers will continue find it impossible to become independent, but will have to live with their insecurities	3	3	-	-
7-2	Increasing numbers of young and middle-aged people will not be able to marry or find work, and this situation will become "normal"	3	3	1	4
10-2	The age at which people first marry will become older and older	5	1	-	-
16-1	It will be completely normal for fathers to be involved in childrearing as "Ikumen"	2	4	0	4
Situations considered to have potential to occur by half or more of the Middle-aged group (C/D)		A	B	C	D
4-1	The number of people living alone (regardless of age and gender) will increase	-	-	6	3
9-2	People will make decisions based on themselves, without consideration for family or respectability	-	-	4	4
9-3	People will die without leaving any inheritance	-	-	3	3
13-1	People will use their own knowledge and networks to become independent and select their work location and contents autonomously	2	0	3	3
Descriptions considered almost entirely unlikely to happen by all participants (1/8 or fewer)		A	B	C	D
1-2	An inability to take responsive measures such as reviewing income and expenditure, or changing job to obtain a better income	2	0	1	0
1-3	An increasing number of people will attempt to survive by purchasing cheap items	1	0	2	0
11-3	The inferior social position of single mothers and single fathers will be a thing of the past	1	0	2	0
14-1	Young people from cities will perform "I-turns" to engage in agriculture, forestry or fishery, and join hands with young people living in rural environments	0	0	0	3
16-2	Childrearing will be done not only by the parents, but also in combination with local society and the community, in all aspects	1	0	0	1
Situations considered almost entirely unlikely to happen by the Young group (A/B) (1/6 or fewer)		A	B	C	D
2-2	A range of countermeasures will be attempted in response to the increasing number of aging socially withdrawn cases	1	0	2	1
8-3	Full-time home-making, with no need to work outside the home, will be the desired lifestyle of some women	1	1	0	2
12-1	Both men and women will be able to consider their career plans separately to their family	1	1	0	3
12-3	It becomes normal for marriage, childrearing and family to become waypoints in autonomous life planning	0	1	1	2
14-2	People will engage in attractive community building measures, enlivening local regions	0	0	1	3
Situations considered almost entirely unlikely to happen by the Middle-aged group (C/D) (1/6 or fewer)		A	B	C	D
6-1	After illness or injury in themselves or their partner despite the fact that they imagined the future and prepared for it	3	1	1	0
8-3	Full-time home-making, with no need to work outside the home, will be the desired lifestyle of some women	1	1	0	2
16-3	Society will be more accepting of both partners working outside the home	1	2	1	1

Based on the above-mentioned awareness of lifestyle risks and division of countermeasures, and the results of FGI, the authors would like to attempt to verify lifestyle changes. Firstly, it was not clear whether or not the experience of facing risk, or challenging risk, had an impact on the awareness of risk. For instance, 2-1 and 5-2 are examples, in part, of non-awareness of risk, but Middle-aged males considered them almost entirely unlikely to occur. In regard to situations given coverage by the media, etc. as social problems, participants were strongly impacted by whether or not they themselves, or someone close to them, or an acquaintance, had experienced such situations, and whether or not they considered the situation to be someone else's problem or something that might, in fact, happen to them.

In terms of avoiding lifestyle risks, people are considered to rely on either autonomous or collaborative ways, but when it comes to the collaboration, we saw almost no cases in which participants had expectations of cooperation from people outside of their own family or friends, or from new systems. At the same time, the participants themselves also appeared not to have any strong sense of obligation to cooperate with or help anyone other than their own family or friends. They were aware of the occurrence of various social problems, but appeared to have a strong sense that one should make the effort to solve such things oneself. So, if risks are faced particularly when young, the participant finds it difficult to rely on or receive assistance from society, and it is clear from the awareness among such participant that there is a high risk they may find themselves in difficult lifestyle situations.

Let us verify the awareness of risk based on Statement 6-1. It depicts a situation in which the participant was aware of the risk, and took measures to avoid it, but was unable to do so; only the Young, at-risk group thought this likely to occur. This study focused on the two Middle-aged groups who had also faced risk, and the fact that they considered the risk unlikely to occur indicates the possibility that there is an awareness among people with a certain amount of life experience that the occurrence of risk is an indication that insufficient measures have been taken in advance to avoid it. In contrast to this, younger people are significantly more likely to consider that they face risk due to reasons that are unconnected to their own lack of effort.

The Young low-risk group considered that the situation in Statement 5-2 would not happen to them. While they considered it possible that there may be an increasing number of young and middle-aged people who could not marry and get jobs in a “normal” manner, since a “normal” amount of effort had brought about such “normal” occurrences in their own lives, it is considered that they find it difficult to imagine that a “normal” household would fall into a situation in which they found “normal” life difficult, such as that described in Statement 5-2. The participants in our FGI Young low-risk group included almost none working in relatively stable employment; rather many of them were employed in small or medium-sized enterprises, or ran their own businesses. Despite this, the fact that their awareness was thus indicates the possibility that they may have an extremely low capability in regard to risk awareness.

## 5 CONCLUSIONS

In this study, the authors examined changes to household composition, as well as risks impacting lifestyle and values and aspirations and clarified the 16 major lifestyle changes that may occur by 2030. In addition, FGI was employed in order to verify whether or not people considered that the 16 types of lifestyle changes could happen to them or people close to them. As a result, the following four points were understood.

- Four types of risks that impact lifestyle were identified: financial risk, health risk, risk relating to social networks, and risk associated with changes between life stages.
- Of the 16 types of lifestyle changes, eight types were changes that involved a worse off than the current one, one was a change relating to the lifestyle of full-time homemakers, of whom most are women, and seven involved either maintaining the status quo or lifestyle changes that brought about improvements to the current state.
- In the FGIs, many participants considered that worsening lifestyle changes were likely to happen. Most middle-aged men, however, had low interest in such worsening changes and family problems.
- Many people considered that collaboration in avoiding life style risks may occur in terms of cooperation with family members, but in contrast it would not occur if the context was cooperating with, or requesting cooperation from, society at large.

In another study [17] we explored discontinuous changes in lifestyles by using techniques of scanning and constrained idea generation with a matrix in addition to (continuous) changes described in this study. Based on the breadth of these major lifestyle changes identified, it should be undertaken to explore how to make the shift to sustainable lifestyles.

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# SUSTAINABLE TOURISM IN PRACTICE: PROMOTING OR PERVERTING THE QUEST FOR A SUSTAINABLE DEVELOPMENT?

Professor Carlo Aall, head of research, Western Norway Research Institute, P.O.Box 163, 6851 Sogndal, Norway, [www.vestforsk.no](http://www.vestforsk.no), + 47 991 27 222, [caa@vestforsk.no](mailto:caa@vestforsk.no)

## ABSTRACT

The article presents three perspectives on the relationships between tourism and sustainable development: Tourism as a victim of an unsustainable development, tourism as part of the problem of an unsustainable development, and tourism as part of the solution in transforming society towards a sustainable development. The article concludes by claiming that prevailing EU policies aiming at making tourism more sustainable most likely will result in “sustaining tourism” more than actually making tourism more sustainable.

*Keywords: sustainable development, sustainable tourism, societal transformation*

## Introduction

Sustainable development – thus also sustainable tourism – is basically about the relationship between man and the environment (Lafferty and Langhelle, 1998). The relationship between tourism and the environment has been greatly discussed, with the roots of this discourse reaching back to the very start of the tourism industry itself (Høyer, 2000). To cover this in detail goes beyond the remit of this article. Therefore I will limit myself to focus on the historical development of the use of the specific concept “sustainable tourism”.

## Sustainable tourism on the international agenda

When discussing the history of sustainable tourism, it is worth noting that the environmental challenges relating to the tourism industry were not at all discussed in the United Nations (UN) World Commission's report of 1987. The UN plan of action for sustainable development - Agenda 21 adopted at the Rio Conference in 1992 - covered a total of 40 different topics and 115 programs. But despite the thematic breadth and ambition to include all groups in society, the tourism industry only featured in a few, brief references to eco-tourism as a tool to promote sustainable development (Johnson, 1993). Despite the scant attention paid to it, tourism was the first sector to follow the recommendations of Agenda 21 that all commercial sectors should develop their sector specific version of Agenda 21 at an international level. In 1995, a separate Agenda 21 for tourism was published (WTTC/UNWTO/EC, 1995).. The plan was developed in partnership with the World Travel & Tourism Council (WTTC), the United Nations World Tourism Organization (WTO) and the Earth Council (EC) - which is formed of an international collective of NGOs established to follow up the Rio Conference recommendations. The overall goal of the tourism Agenda 21 plan was threefold: (1) To establish a system and procedures at an international level that rendered sustainable development a core consideration in all decisions within the tourism industry; (2) to identify measures necessary for making tourism sustainable; and (3) to argue that self-regulation is the most effective strategy to implement the sustainable development goal within tourism (Aall og Teigland, 2002).

In 1998, WTTC the experience gained from the execution of this plan in a report to UN's Commission for Sustainable Development (CSD) (WTCC, 1998). After five years of trying to promote the idea of sustainable tourism, the WTTC conclude that the industry's international umbrella-organisations have carried out a systematic attempt to build up a program for sustainable tourism, but that they cannot do so unaided. In the report, it was underlined that the industry is very fragmented and diverse, and consequently experiences difficulty executing coordinated and comprehensive actions. The industry also claims that there is a negative trend in consumers' willingness to pay extra for environmental measures. According to the industry, the authorities should now integrate Agenda 21 principles in all travel and tourism policies, both nationally and internationally, and promote the same principles in

regional and local tourism strategies. Thus, as noted by the industry itself, self-regulation is difficult to pursue in a vacuum of non-regulation.

In 1999 the UN Commission on Sustainable Development (CSD) sought to rectify the World Commission's Report and Agenda 21's near total omission of tourism, by putting the industry on the agenda of the annual follow-up conference for Agenda 21. The conference went on to call for the further liberalization of international tourism regulations since this, according to the final document from the conference, would lead to increased tourist traffic to and between developing countries and by that would strengthen economic development in poorer parts of the world (CSD, 1999). The possibility that this development could lead to increased GHG emissions, and thus could weaken sustainability globally, was not discussed (Aall and Teigland, 2002).

Even though the WTO had presented their perspectives on sustainable tourism already in 1993 (UNWTO, 1993), it was not until 2005 that the presentation of the concept managed to gain the position as authoritative definition – something that took place in the publication of the report “Making Tourism More Sustainable - A Guide for Policy Makers” presented by the UN Environment Programme (UNEP) and WTO. In this publication, sustainable tourism was defined as (UNWTO/UNEP, 2005) (p. 12) “[t]ourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities”. This definition was followed up by a clarification that the principles of sustainable tourism are applicable to all forms of tourism in all types of destinations, including mass tourism and the various niche tourism segments. Furthermore, the report states that (Op. cit) (p. 11): “Sustainability principles refer to the environmental, economic and socio-cultural aspects of tourism development, and a suitable balance must be established between these three dimensions to guarantee its long-term sustainability”.

### **Sustainable or sustained tourism?**

The idea of sustainable development has survived more than two decades of rhetorical excess and academic criticism. From the Brundtland report in 1987 to Agenda 21 adopted in Rio de Janeiro in 1992, and further on through Rio+5 (1997 in New York) and Rio+10 (2002 in Johannesburg), it has remained the central goal and guiding norm of environment-and-development politics. According to Professor William M. Lafferty, this is possible due to the concept's dual ethical foundation (Lafferty, 1996). By giving expression to both “realist” (natural-law) and “consensualist” (democratic) norms, it can claim support with respect to a broad spectrum of moral imperatives. Although many and contesting definitions of what sustainable development “is” have been presented in the discourse to follow the Brundtland report (even the Brundtland report itself present different understandings of sustainable development that is not necessarily complimentary), strong arguments can be presented for the idea that it is possible to develop a generic core understanding of sustainable development. In doing this, Professor Karl G. Høyer uses concepts from thermodynamics – extra prima, prima and sekunda – to develop a “ladder” of all the different elements that together constitute the full meaning of the concept of sustainable development, in which the two on “top” of this ladder – the extra prima characteristics – are the following: (1) Satisfying the essential needs, and (2) securing ecologic sustainability (Høyer, 1997). Lafferty and Langhelle (1998) arrive at the same two-folded definition, stating that sustainable development contains within it the following two key concepts: (1) The concept of “needs”, in particular the essential needs of the world's poor, to which overriding priority should be given; and (2) the idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs'. Thus, we can talk of a Two Dimension understanding of sustainable development (DDS).

This particular discourse on sustainable tourism represents according to Sharpley (2009) and Høyer (2010) a rather problematic turn in the overarching discourse on sustainable development; namely that of expanding the limits of what should be included in the "development part" of the concept of sustainable development.. Most of these policy works on sustainable tourism – including that of the above mentioned report from WTCC/UNWTO/EC 1995-report – refer to the term “Triple Bottom Line” (TBL). The term dates back to the mid 1990's when management think-tank AccountAbility coined and began using the term in its work (Norman and MacDonald, 2004). The term gained public interest through the publication of the book “Cannibals with Forks – The Triple Bottom Line of 21st Century Business” by John Elkington (1997), admittedly to make the sustainable development concept more attractive to actors in the business world by introducing sustainable development as an

additional (third) so-called “bottom line” into the existing logic of the business world. The first bottom line – economic bottom line dealing with economic solidity – has always been around in business, whereas the second bottom – the social bottom line – rested on a discourse that had been introduced during the 1960s and 1970s on the moral obligation for business to become more responsible to problems relating issues like low wages and child labor (Broomhill, 2007). The third bottom line – the ecological bottom line - was meant to introduce (and thus frame) the sustainable development discourse into the business world. However, the naming of the TBL concept gradually changed from three “bottom lines” to three “sustainability dimensions” - namely that of economic, social and ecological sustainability; and this understanding eventually was “exported” from the business back to the policy discourse thus resulting in an expansion from the original two-dimensional (DDS) into a three-dimensional (TDS) conceptualization of sustainable development also within the policy discourse. Out of this process came that TBL – eventually transformed to TDS - became a new argument for business-as-usual in business as well as in politics much more than being an impetus for transforming business and society (Normann and MacDonald, 2004). As Høyer (2000) points out, the two prevailing understandings of the concepts of sustainable development - the TBL/TDS and the original Brundtland Commission DDS-version – are incompatible, and not supplementary: On the one hand the TBL/TDS-concept with three quite separate spheres of sustainability, and where keeping a balance between the three is the major task. On the other hand the original Brundtland DDS-concept where the integrative aspects of the three is highlighted, however under the condition that the task first of all is to secure long term ecological sustainability and support basic needs of the poor today (global justice) and in the future (generational justice). The Brundtland Commission's report underlines the fact that a living standard beyond the necessary minimum to satisfy the basic needs is only sustainable if all consumption standards, both present and future, are established in terms of what is sustainable in the long term (Lafferty and Langhelle, 1998). The majority of people in the rich world lives far beyond the limit of ecological sustainability. Thus, a reduction in consumption levels in the rich part of the world is most likely needed if sustainable development is ever to be achieved (Aall and Hille, 2010).

Internationally there are numerous examples of more or less quantifiable indicator-and-alike systems trying to operationalize what sustainable development “really” is all about in specific contexts and for specific sectors (Aall and Norland, 2005). To develop such systems has also been a longstanding concern for the case of tourism (Butler, 1991; 1999). The most difficult component has according to Buckley (2012: 537) been to establish environmental accounting measures and indicators; and still according to Buckley (2012) this remains a priority for future tourism research. But perhaps even more important is to critically analyze how sustainable tourism is interpreted at a principal level by existing indicator-and-alike systems.

As pointed out above, sustainable development is originally a two-folded concept in which the first refers to the environment-discourse and the need to protect nature from human incursions, whereas the latter refers to the discourse on human needs – in which the UN World Commission Report and the succeeding Agenda 21 both underlines that priority must be given to the needs of the poor (Buckley, 2005). Thus, maintaining economic viability of tourism businesses in the rich part of the world will in most cases be irrelevant to that of promoting a sustainable development - but of course be highly relevant to any business development goals, cf. the notion of the “first” economic bottom line.

Sustainable development is basically about how to balance the protection of nature from human incursions and the use of natural resources to support human needs. Embedded in this is the importance of prioritizing which elements in nature to protect, and to what extent; and which needs to be supported, and at what level of satisfaction. In order to operationalize this quest into practical policymaking, it is necessary to imply some kind of hierarchical structure of concerns and goals. All possible goals, representing all possible needs or all possible ways of protecting nature from human incursions, just cannot be of equal importance. One could rephrase a point formulated by Aaron Wildavsky (1973) relating to planning – “if planning is everything, maybe it’s nothing” – into “if sustainable development (or in the context of this article; sustainable tourism) is everything – maybe it is nothing” (Low et al, 2000: 48). Wildavsky (1973) argued that the concept of planning was beset by too many mutually contradictory requirements – and therefor had ended up including too many aspects – thus making it inoperable. The same could be said about much of what is presented in the sustainable tourism discourse – in which Innovation Norway’s Ten Principles for Sustainable Tourism can serve

as an illustrative example. Thus, the principles of sustainable development and sustainable tourism, while originates within a deep understanding of the environment, can also result in a dilution of the term (O'Brien and Wolf, 2010).

### **Sustainable tourism as a strategy for adjusting or transforming society?**

In a review of the sustainable development debate up to 2005, Hopwood et al (2005) concludes that sustainable development is first of all about transforming society. This insight has recently been put forward also within the climate discourse (O'Brien and Wolf, 2010; O'Brien, 2012). A briefing note issued from the Learning Hub on the concept of transformation at the UK Institute of Development Studies sums up the rationale for moving from what they describe as a traditional approach of incremental change to a new transformation approach (Bahadur and Tanner, 2012: 1): "There is growing debate on the need for transformational approaches to tackle the challenges facing development in the face of climate change. If current incremental approaches to preventing dangerous climate change and adapting to the change we are already locked into are insufficient, then more radical approaches may be required". A similar view can be found in some of the recent works of the Intergovernmental Panel on Climate Change (IPCC). In the introduction to the Special Report "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" the following is stated (IPCC, 2012: 1): "Some strategies for effectively managing risks and adapting to climate change involve adjustments to current activities. Others require transformation or fundamental change". The report goes on defining transformation as "[t]he altering of fundamental attributes of a system (including value systems; regulatory, legislative, or bureaucratic regimes; financial institutions; and technological or biological systems)" (IPCC, 2012: 4).

When discussing transformation as a strategy to achieve a specific goal – be it sustainable tourism – it is important to be aware of an important distinction between "transformation as a directed, desirable process and transformation associated with the effects of inadvertently crossing thresholds" (Nelson et al, 2007: 402). The former may be perceived as "a planned, deliberate process, whereas the latter is an uncontrolled process, which results from insufficient system resilience. One would expect that inadvertent transformation is more likely to lead to undesirable system states with low productivity and less human well-being" (Tainter, 1998: 402-403). The past is ripe with examples of presumably inadvertent societal transformations and civilization demises, many of which have been linked to factors such as the overexploitation of local resources, rapid population growth or failure to adapt to relatively abrupt climatic changes (Tainter, 1998 ; Diamon, 2005). Several authors have warned that unless societies deliberately transform in the face of climate change, climate change will, in combination with other pressures on society, impose transformations that are likely to imply large negative societal consequences (Ehrlich and Ehrlich, 2013).

In developing a planned and deliberate process of transforming tourism into sustainable tourism it can be fruitful to differ between three different modes of relationship between tourism and sustainable development: (1) Tourism as victims of an unsustainable development, (2) tourism as a cause of an unsustainable development, and (3) tourism as part of the solution to that of creating a sustainable development. Below we will outline some aspects of these three modes, using tourism in Norway as illustrative examples.

### **Tourism as victims**

The first mode of relationship between tourism and sustainable development relates to what Nelson et al. (Gössling, 2010) describes as transformation associated with the effects of inadvertently crossing thresholds. As the tourism industry in Norway largely is dependent on the natural environment as its resource base, it is vulnerable to and adversely affected by any environmental degradation relating to an unsustainable development that also manifests itself locally. It is important then to differ between local environmental problems that fall outside the scope of sustainable development and the more severe global problems of an unsustainable development. Two prominent examples of the latter are loss of biodiversity due to changes in land-use and local effects of climate change.

The National Geographic Traveler has designated the fjords of Western Norway as one of the world's most beautiful destinations showcasing an ideal interaction between man and nature in these landscapes (Bryn and Debella-Gilo, 2008). Two ongoing processes are threatening this resource base for tourism in Norway: The loss of pristine areas and overgrowth of the cultural landscapes; both of which could imply a reduced quality of this resource base for tourism.

Loss of pristine areas in Norway is currently driven by an odd combination of processes leading to an increase and decrease of GHG emissions. The first of these processes relates to a recent increase in the building of second-homes. There has been almost a doubling in the annual number of built second-homes the last decade compared with the previous. The latter process relates to a large increase in the development of renewable energy production facilities in the form of small-scale hydropower, wind farms, new power lines and an accompanying road constructing. For instance, the annual number of applications for building small-scale hydropower plant has increased by 400 percent from 2000 to 2010.

Overgrowth of the cultural landscape is a result of many simultaneous socio-economic and environmental changes. Increased mechanization and the decline of small-scale farming in Norway has been the most significant source of loss. From 1999 to 2009 one out of three farms went out of business. The accompanying decline in the number of grazing animals and increase in the number of meadows left fallow has resulted in less open space. In addition reduced logging and also coppicing - used to supplement feed for dairy herds - has been very extensive. A continuous high level of NO<sub>x</sub> pollution (resulting in a fertilizing effect) combined with climate changes are also expected to contribute – the latter due to wetter and warmer conditions and an extended growing season optimizing forest regrowth (Directorate for Nature Management, 2010).

As well as affecting biodiversity and rate of vegetation growth, climate change is the source of a range of impacts that may have direct and indirect consequences for the tourism industry. The most openly discussed one of these are loss in snow reliability and the implications this has for winter tourism. Many of the important winter tourism destinations in Norway are facing an expected reduction of days with snow cover in the range of 50 to 100 days by 2100. In addition, expected changes in precipitation and temperature may increase incidences of extreme weather events. This could affect tourism both directly (e.g. personal injuries from avalanche incidents) and indirectly (for example destinations negative association with extreme weather events; e.g. avalanches in skiing areas).

Strategies to avoid the problems for tourism outlined above could involve a combination of at least three different transformative processes: (1) Changing the overall socio-economic drivers leading up to the identified negative effects for tourism; (2) changing consumption patterns of tourists; and (3) changing the production of tourism products and services.

An important point to bear in mind regarding the two latter processes is the danger of rebound effects. The rebound effect has been presented as a possible explanation why major success is still lacking in trying to curve down the energy use and GHG emissions in rich industrialized countries. Basically the rebound effect refers to behavioural or other systemic responses to the implementation of new technologies or other measures to save energy use or reduce GHG emissions (Saunders, 2000). According to Hertwich (2005) the environmental benefits of any environmental policy measures can under certain conditions be less than anticipated (rebound effect) or even negative (backfire effect). Climate change adaptation in winter tourism has the potential to lead to such effects. At present, nearly all commercial ski resorts in Norway need artificial snow production at some point in the season (Aall and Høyer, 2005). Energy use in the production of artificial snow is considerable, particularly with respect to obtaining water. In Åre, Sweden, the largest skiing destination in Scandinavia, energy used for one season's artificial snow production is equivalent to the annual energy used for heating the towns 1300 inhabitants (Demiroglu et al., 2003). Alternatively to that of installing equipment for artificial snowmaking in "old" skiing arenas, several winter destinations have established completely new satellite facilities in more snow-reliable areas. The latter could lead to increased energy-use and GHG emissions from transportation, particularly if these new satellite facilities are located outside of existing public transportation infrastructure (like old winter destinations located close to the railroad). Thus, to be aware of possible rebound effects and thus develop policy measures to try to avoid such effects is an important part of any transformative process put through to mitigate that tourism becomes a victim of an unsustainable development.

### **Tourism as part of the problem**

In 2005, the tourism industry was responsible for approximately 8 percent of total global GHG emissions, and unless new emission reduction measures are implemented, the industry's emissions of greenhouse gases will increase by 130 percent by 2035 (UNWTO/UNEP/WMO, 2008). No similar calculations for Norway are available, but by looking at the sectors growth and increases in travel to and from Norway, we get an indication of what the likely greenhouse emissions will be. From 1985 to

2005 the number of foreign tourists visiting Norway (including business travel) has increased by 72 percent. For those who traveled by the most polluting means, airplanes and cruise ships, the increase was respectively 192 percent and 449 percent. The most environmentally friendly forms of transport (bus and train) have decreased by 14-41 percent respectively. In 1985 car and coach travel were the dominant forms of tourism transportation, with flights coming third. By 2005 air-transport was clearly the largest. The trend for low-budget flights has since 2005 most likely reinforced this unfortunate environmental development (Hille and Vik, 2011).

There are a number of efforts set up to reduce the environmental impact of tourism. However, by far the greatest effort has been on managing the environmental impact of the non-mobile tourism activities (like housing and eating). The mobile activity – that is the travel to, from and within the destination - is in most cases overlooked (Høyer, 2000; Gössling, 2010). Furthermore, although there have been serious efforts to reduce the relative impacts of some aspects of tourism activities – including that of tourism transportation - the increased total volume of tourism consumption have outweighed these efforts. Behind this situation is the situation that the tourism industry is often exempt from current environmental policy regulations. Environmental efforts involving the tourism industry has largely been in the form of self-regulation and voluntary efforts and rarely specifically aimed public policy measures. Thus, any serious and transformative attempt of reducing the environmental impact of tourism substantially will in many cases have to imply a higher level of public regulation of tourism.

### **Tourism as part of the solution**

The third way to look at the relationship between tourism and sustainable development sees tourism as having a potential role in promoting sustainable development that go beyond reducing environmental impacts of tourism.

In the discourse on the relationship between attitudes to environmental considerations and leisure behavior, at least three, to some extent competing, theories have been proposed (Aall, 2011). The first is perhaps not really a theory, but more like an idea, namely the idea that more leisure time almost by necessity will lead to less environmental problems (Nørgård, 2006), which again can be linked with the idea embedded in the concept of sustainable consumption that we will ‘live better by consuming less’ (Jackson, 2006). This idea is strongly embedded in the Norwegian tradition of outdoor recreation, as well as policy support for it (Klepp, 1998). The theory, or idea, that more leisure time will lead to less environmental problems, is however strongly questioned by empirical evidence (Røpke and Godsken, 2007; Druckman and Jackson 2009; Aall et al., 2011).

In contrast, a second theory holds that during leisure time, people tend to take time “off” from their environmental attitudes, and instead strive for more luxury (Holden, 2001; Dolnicar et al., 2008). However, there are studies that call for some modifications of this latter conclusion. Aall and colleagues (Aall et al., 2011) have characterized the large negative environmental impacts of leisure activities by the proverb ‘the road to Hell is paved with good intentions’. They point out that good intentions like ‘experiencing nature’ and ‘spending time with your family’ have unfortunate side effects in also acting as drivers for producing more negative environmental impacts when applied to leisure activities. Thus, applying these good intentions is not necessarily accompanied by putting aside your environmental attitudes. It seems more to be a question of a negative side-effect of environmental and other good (and not anti-environmental) attitudes governing leisure practice.

A third theory argues that leisure time is an arena in which people are particularly open to new impressions, and may thus easily adopt or learn new ways of living, including more environmentally friendly consumption habits which may later be transferred to everyday life and thus result in a double positive environmental effect (Aall et al., 2011). This perspective is in line with the discourse on transformative tourism. Jamal et al. (2013) defines transformative tourism as the practice of organized tourism that leads to a positive change in attitudes and values among those who participate in the tourism experience. Higgins-Desbiolles (2006) points out that tourism is a powerful social force that has the potential of achieving many important ends, but presents his view of an important prerequisite for this to happen (Higgins-Desbiolles, 2006: 1192), namely that “its capacities are unfettered from the market fundamentalism of neoliberalism and instead are harnessed to meet human development imperatives and the wider public good”.

## Final remarks

Andrew Holden holds that the absence of an effective environmental policy is the main reason for the limited effect so far in making tourism more sustainable (Holden, 2009). Michael Hall offers a more diverse explanation which includes (Hall, 2010: 131): “the relative weakness of sustainability research in tourism as an epistemic community; economic, institutional and political barriers; and the inherent problems of the concept in terms of its capacity to marry social, environmental and economic indicators, and particularly the addiction to economic growth”. Hall’s answer on how to solve this specific last challenge is to pursue what he denotes as a steady state tourism, which he defines as (Hall, 2009: 46) “a tourism system that encourages qualitative development but not aggregate quantitative growth that unsustainably reduces natural capital”.

In its latest communication on tourism policies, the European Union (EU) “Implementation rolling plan of tourism framework” issued in May 2013 (European Commission, 2014a), the word “sustainable” is mentioned 27 times during a 17 pages list of policy goals, measures and deliverables - leaving an impression that sustainable development is important in EU tourism policies. The very important backdrop of this plan is the point made by the EU commission that “the tourist industry has become a key sector of the European economy, generating over 10 percent of EU GDP (directly or indirectly) and employing 9.7m citizens in 1.8m businesses” (European Commission, 2014b)a. The EU commission goes on stressing that “[t]he competitiveness of the European tourism industry is closely linked to its sustainability” and further underlines “[t]he need to reconcile economic growth and sustainable development” (European Commission, 2014c). So – if making tourism sustainable calls for transformation, the key-question in relation to EU policymaking on sustainable tourism is: What does “reconcile” mean in practice? Is it regrowth of tourism – in the wake of the financial crises – or is it degrowth of tourism in line with the alternative outlined by Hall [86]? Going back to the case of Norway, it seems to be both – in the sense that many seem to believe that we can continue the growth in the volume of tourism and at the same time achieve a regrowth in the environmental impacts of tourism. However, the belief that it is possible to combine a traditional growth strategy in tourism with regrowth in environmental impacts has very weak support in research.

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# BRINGING BACK THE '*BROWN*'

Pranita Shrestha<sup>1</sup>

<sup>1</sup> Norwegian University of Science and Technology; [pranita.shrestha@ntnu.no](mailto:pranita.shrestha@ntnu.no)

## ABSTRACT

'Sustainable development' is a term which came into use after the Brundtland Commission's report on global environment and development in 1987. This term is also famously referred to as an 'oxymoron' as it comprises of two words 'sustainable' and 'development' that are in many ways contradictory to each other – very well illustrated by its clear divisions between the 'Green' and the 'Brown' agendas. Allen and You defines the 'green agenda' as ecosystem protection and the immediate effects of human activity at the regional and global scale; whereas the 'brown agenda' focuses on human well –being, social justice and the immediate problems at the local level especially in developing countries [1]. The core question is does this term and its policy implications address both these issues equally. The answer is quite clearly a big NO since the focus is definitely more on the 'Green' agenda inspite of the fact that the real meaning of 'sustainable development' or 'sustainability' for our future generation entails a balance in both these agendas. Hence this paper argues for the need to bring back the 'Brown' agenda into consideration in the whole global discussion of 'sustainable development'. This paper describes a specific case illustrating the conflicting nature of the '*Green*' and '*Brown*' agenda within the capital city of a developing country in South Asia.

*Keywords: 'Sustainable Development', 'Green' agenda, 'Brown' agenda, Justice*

## 1 INTRODUCTION

'Sustainable development' is a concept about reconciling 'development' and 'environment' [2]. This term was first coined after the Brundtland report which connected these two terms basically stating that sustainable development is development which meets the needs of the present without compromising that of the future generations. There is an inherent contradiction in the definition of this term as development or economic growth is one of the primary determinants of depletion of environmental resources. The division in this contradiction becomes even more evident when one compares the stage of development in the North and South. Most of the developed nations in the North are focused more on the long term ecological sustainability which is also known as the '*Green Agenda*' whereas the developing countries in the South have entirely different issues to deal with such as the immediate environmental impacts of rapid urbanization especially in low income urban settlements, also known as the '*Brown Agenda*'.

This paper describes a specific case illustrating the conflicting nature of the '*Green*' and '*Brown*' agenda within the capital city of a developing country in South Asia. The dominance of the former even in this specific case threatens the livelihoods of a number of riverside, squatter settlers. This case question the core issue related to 'sustainable development' as also argued by Redclift '*sustainability of what*' and '*who decides*' [3]. The paper further argues for a balanced approach with respect to this specific case as well as in the whole global discussion of 'sustainable development.' Many dichotomies that are created north – south; developed – developing; First – Third; formal – informal; etc where there are actually no divides in the real sense simply to shift the focus away from the possibility of a continuum approach rather than that of a divided one. This applies even more to the terms 'sustainable development' as it should entail a *holistic* approach, rather than a *skewed* one by simply 'greening' the developed countries which does not assure sustainability (in all its aspects) for future generations.

The main theoretical concepts relevant for this research stems from critical perspectives on the term 'sustainable development' itself [4,5,6,7]. In addition, sustainable development and justice [8,9] core theoretical concepts for this paper. After the first Earth Summit in Rio in 1992, the discussions on

sustainable development shifted from ‘needs’ (as referred to in the Brundtland Commission’s report) to ‘rights’. Redclift (2005: 218, emphasis added) argues that ‘the preoccupation with policy notwithstanding, the links between the environment, social justice and governance had become increasingly vague in sustainable development discourses, and the *structural* relationships between *power, consciousness* and the environment had become blurred.’ The empirical evidence used in this paper is part of the research fieldworks conducted by the author during her masters and PhD research. The paper is further divided into three main parts: *theory; methods; case; analysis and discussion* and; *conclusions*.

## 2 THEORY

### 2.1 Sustainable development: *an oxymoron*

The term “sustainable development” came into use in connecting environmental, social and economic policy goals after the Brundtland Report or Our Common Future [10]. The Brundtland Commission defined this term as ‘...*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*’. Redclift (2005) argues that this definition has been brought into service in absence of agreement about a process that almost everybody thinks is desirable. Consequently, the deceptive, outcome – based simplicity of this approach was able to conceal the underlying complexity and contradictions of the process. There are a number of gaps in the definition of sustainable development. Redclift (2005) argues that the first contradiction within the definition is that development or economic growth itself primary determinant of the change in characteristic of ‘needs’ for future generation. Hence questioning the whole process of economic growth and development in relation to sustainability. Redclift (2005) further also points towards considerable confusion and the failure to address exactly ‘what is to be sustained’ within various discourses of sustainable development. Furthermore, he also argues that the definition does not cover how ‘needs’ are defined in different cultures.

Nevertheless, the Brundtland report paved way for non – governmental organizations to consider a process to consider the serious elements in environment and development, culminating with the first Earth Summit in Rio de Janeiro in 1992 (Adams, 1990; Redclift, 1987; 1996) where the discussions shifted from ‘needs’ to ‘rights’. This Rio declaration in 1992 and the later Johannesburg Declaration in 2002 also detailed out strategies and guidelines for Three Es (Environment, Economy and Equity) in order to operationalise sustainable development [11]. He further elaborates on the Three Es (Tarafdar, 2010: 72, 73, 74)

*‘Environment is what the sustainability advocates have been focusing on historically’*

*‘Economy within the sustainability rhetoric is the argument that economic growth is a prerequisite to tackle externalities and adversities of growth’*

*‘Equity is aimed at including all actors at grassroot level in a process of discourse and dialogue, engage them in conflict mitigation and consensus building and eventually leading to decision - making’*

Although there is clear difference between the issues related to sustainable development in the developed as compared to that of developing countries; a number of sustainability advocates (mostly located in the developed countries) have a skewed view of the world and assume that environmental sustainability in the global North is the answer to universal sustainability. This has given rise to yet another dichotomy between the North and the South – the Green and the Brown agenda.

#### 2.1.1 The ‘Brown’ and ‘Green’ Agendas

The ‘*Brown Agenda*’ is concerned with issues of social justice and satisfying the immediate needs of the ‘poor’ whereas the ‘*Green Agenda*’ is about prioritizing the long term ecological sustainability [12,13,14]. Furthermore, the ‘Brown Agenda’ is mainly about the needs of low income households mostly associated with inadequacy or absence of services giving rise to immediate environmental health impacts. These are mostly prevalent in the global South. Whereas the ‘Green Agenda’ primarily deals with the challenges faced by the North or developed countries in terms of reducing the long term impacts of ‘urban and industrialization based production, consumption and waste generation’ on the ecosystem, biodiversity disruption, resources depletion and climate change.

### 3 METHOD

The empirical evidence used for this paper is based on research fieldworks conducted by the author during her master and PhD research. The primary sources of data generation were semi – structured interviews with key informants, focus group discussions and direct observations; whereas secondary data sources are supported by updated newspaper articles as events are still on - going.

### 4 CASE

#### 4.1 Context

Nepal is a small landlocked country sandwiched between two global giants of South Asia – India and China. Most of the overall urbanization status of the country is contributed by its capital, Kathmandu. Although Nepal is one of the least urbanized countries in the world; Kathmandu is among the fastest growing cities in South Asia. It is therefore also the epicentre of numerous squatter settlements [15] mostly located along its river banks. Kathmandu Valley is located in an area contiguous with the Upper Bagmati Basin, a 600 square kilometer area that includes the drainage of the Bagmati and Bishnumati rivers [16]. Rademacher further argues that rapid urban growth of the capital stimulated a level of housing demand pushing many to seek informal shelter in the riparian zone, an area of large sand flats caused in part by river morphological change. According to a recent report DUDBC (2010) there are 53 squatter settlements in Kathmandu Valley – 35 riverside and the remaining non – riverside squatter settlements mostly on unsettled slopes and below high tension wires.

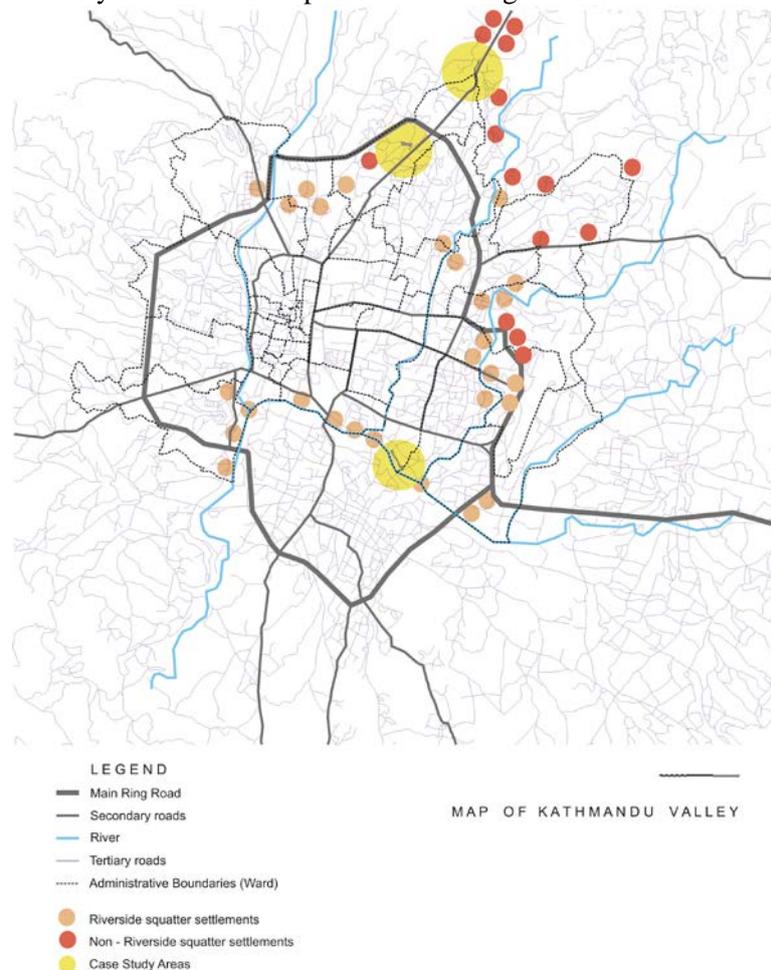


Figure 1: Location of riverside and non – riverside squatter settlements in Kathmandu Valley  
Source: author

In the context of Nepal, squatters are known as “*sukumbasis*” (literally meaning landless people). Ghimire defragments the word into two where “*sukum*” means possessing nothing and “*basi*” means settlers. *Sukumbasi* is a name given to an individual or a group of people who occupy public land such as forest or land actively unclaimed by other owners. Squatter settlements or “*sukumbasi bastis*” can

be defined as parcels of land (“*parti jagga*” in Nepali) for which the inhabitants do not pay taxes, hence considered illegal or informal. Although these types of informal settlements are estimated to be growing at 12 – 13 percent annually [17]; there is absence of a strong policy on squatters and eviction. It was only in the most recent National Shelter Policy documents that the Government of Nepal for the first time explicitly defined the term squatters as “the number of families, who have settled as landless squatters by encroaching unregistered or barren (*parti/ailani jagga*) land of the urban areas, land located at the banks of river, unsettled slope, etc, is increasing in rapid pace” (National Shelter Policy, 2012).

The State and development officials often question the authenticity of sukumbasi landlessness claims especially in urban areas where land is a very scarce and valuable resource. The capital has witnessed a number of cases of eviction of squatter settlements along the river banks; some due to the implementation of large development/infrastructure projects and more recently for environmental reasons/cleaning - up of the holy river. The major evictions of squatter settlements within Kathmandu Valley are illustrated in the Table below:

*Table 1: Major squatter settlement eviction cases within the capital Kathmandu Source: author*

S.no	Name of squatter eviction	Year	Reason for eviction
1	<i>Paroprakar eviction</i>	1995	Government’s plan for the construction of a park which was to serve the purpose of a green belt along the riverside
2	<i>Bagmati Riverside eviction</i>	2002	Government’s plan to heighten security for the South Asian Association for Regional Cooperation (SAARC) summit to be held in the capital
3	<i>Bishnumati Link road eviction</i>	2003	Construction of Bishnumati Link road
4	<i>Thapathali eviction</i>	2012	As part of the government’s plan to clean – up Bagmati River

Only the some of the evicted squatter inhabitants of the Bishnumati Link Road case were resettled as part of Kirtipur Housing Project; the remaining were evictions without any planned resettlement. The main discussion of this paper focuses on the most recent eviction on May 8, 2012 – the Thapathali Eviction case. On 8 May 2012 the Government of Nepal demolished 250 squatter houses and a school from the banks of Bagmati River as part of the first phase of the eviction notice published on 29 November 2011 in the local newspaper.

#### **4.2 The ‘Green’ Agenda: ecological sustainability of the Bagmati River**

This eviction notice was part of the Bagmati Action Plan (2009 – 2014) with the aim to clean - up the river and revive its lost glory. Bagmati Action Plan (BAP) was launched in 2010 with an estimated budget of approximately NRs. 15 billion and was hailed as a national priority. A number of government and non-government organizations are part of the BAP; however to establish coordination among these various institutions, Bagmati Civilization Integrated Development Committee (BCIDC) was assigned the coordinator. Bagmati Civilization Integrated Development Committee (BCIDC) is an autonomous body established in 1995 for the sole purpose of improving the quality of water in Bagmati River through priority sewerage and treatment plants. After months of preparation, the BCIDC called other government bodies to assist them to form a High Power Committee for Integrated Development of Bagmati Civilization (HPCIDBC).

The main long term objective of this High powered is ‘to keep Bagmati River and its tributaries clean by preventing the direct discharge of solid and liquid waste to the river and to conserve the river system’ within Kathmandu Valley. In order to achieve this long term goal, a number of mandatory activities were listed out:

- Construction of Trunk Sewer pipeline along both sides of the river
- Construction of secondary Sewer pipelines
- Construction of wastewater Treatment Plants
- Construction of River Training Works

- Construction of roads and green belts along the banks of the river and
- Public awareness programmes

Most recently on 6, March 2014, a financial agreement for the implementation of the Bagmati River Basin Improvement Project (BRBIP, which is part of the overall BAP project) was signed between the Government of Nepal and the Asian Development Bank. These are the long term issues related to the *ecological* sustainability corresponding to the ‘Green Agenda’. However this project also has its ‘Brown’ side. According to the chairperson of BCIDC, the biggest challenge to effective implementation of the BAP was the problem of *illegal* encroachment along the river banks. Hence the government’s response to this came in the form of Bagmati clean – up campaign which included plans to evict squatters living alongside the Bagmati and its tributaries.

#### 4.3 The ‘Brown’ agenda: eviction of informal housing along the riverbanks

According to the recent report by DUDBC, there are approximately 35 riverside squatter settlements within Kathmandu Valley. Some of these squatter settlements are located on the riverbed and pose immediate environmental impact on the inhabitants (Refer to Figure 2 and 3 below).



Figure 2 and 3: Riverside squatter settlement: Bansighat (established date: 1981)  
Source: author 2011

On November 29, 2011, the Government of Nepal published an eviction notice for all the riverside squatter settlements within Kathmandu Valley in the local newspaper, Gorkhapatra. The Government blamed the inhabitants of this riverside squatter settlement of polluting the river next to live stocks. Following this eviction notice on 8 May, 2012, few months later, 250 squatter houses and a school were demolished from the banks of Bagmati River in Thapathali as part of the first phase of the eviction notice. This first phase of eviction was initiated by this high level committee comprising of representatives from the Home Ministry, Ministry of Physical Planning and Works, HPCIDBC and KMC. Kathmandu Valley Town Development Committee (KVTDC), an autonomous body under the Ministry of Physical Planning and Works was also one of the main state institutions assigned this task. Following the eviction, the Government had also allocated a sum of NRs. 15, 000/- for each genuine evicted squatter household as rent for three months until the resettlement strategy was in place. Out of the 250 households, only 58 registered themselves as genuine landless squatters and came forward to claim this sum of money.

As an immediate response to the eviction, amidst severe opposition from the local residents, the Department of Urban Development and Building Construction (DUDBC) managed to build 23 bamboo huts as the first phase of temporary resettlement. Within seven days these temporary bamboo huts were built in supervision of the local police and officials from the DUDBC (interview with DUDBC official). However, these huts had to be dismantled as the families refused to move demanding homes for all the 250 evicted squatter households. In terms of a more permanent solution, the government had already purchased seven ropanis<sup>1</sup> of land at Ichangu Narayan (Village District Council (VDC) of Kathmandu Valley) to resettle registered squatter families. According to the DUDBC, ninety million rupees has already been allocated for the construction of houses for

<sup>1</sup> 1 ropani = (74\*74) square feet

approximately 200 families. However, there is no guarantee for this plan as it could also face resistance from the local residents and squatter families may not agree to relocate.

Despite reservations from the HPCIDBC, the KVTDA has started the process of relocating evicted squatter families to unoccupied houses in three other riverside squatter settlements. Even this temporary solution faced resistance from the squatters residing in these three settlements as they did not want to accommodate new – settlers. However, few evicted families have been temporarily resettled in one of the assigned riverside squatter settlement. In the most recent fieldwork conducted by the researcher during January 2013, some of the evicted squatter families have moved back to occupy the same strip of land from which they were evicted (Refer to Figure 4 and 5 below).



Figure 4 and 5: Re - occupancy of land in the Thapathali riverside squatter settlement  
Source: author, 2012

#### 4. ANALYSIS AND DISCUSSIONS

##### 4.1 ‘Sustainability of what?’ and ‘who decides?’

In the above case, the main sustainable development argument is that of cleaning – up of the Bagmati river. Although nearly all of Kathmandu’s sewage flows untreated into the river system, the riverside squatters are often disproportionately implicated in declining water quality. Moreover, few of the squatter households<sup>2</sup>, also claimed that the government used the issue of Bird Flu (which broke out near one of the riverside squatter settlement in the capital a week prior to the publication of the eviction notice) as part of a bigger propaganda to evict all riverside squatter settlements. In this present era, the government could not have carried out the mass eviction of all riverside squatter settlements; hence this was part of a strategic, incremental action as a relatively new, previously evicted (Bagmati Riverside eviction, 2002) squatter settlement was chosen.

During the Thapathali eviction, a school and 250 squatter housing units were demolished in the name of cleaning – up the river. How justified and sustainable was this action? Did the quality of the water in the river become any better after this eviction? On the contrary, as also mentioned above, a few months after the eviction, the same inhabitants re – occupied the river bank. The eviction response by the government focuses only on the ‘Green Agenda’ (cleaning – up of the river) and completely ignores the ‘Brown Agenda’ (the immediate environmental impacts for low income inhabitants living along the river banks). As in this case the concept of sustainable development most often compromises the immediate needs of the more vulnerable groups.

The dominance of the ‘Green Agenda’ in the sustainability rhetoric is a clear illustration of the skewed nature of the argument. In a similar manner, within the rapidly urbanizing developing countries, there is a demand for sustainable, economic development even if it is at the cost of compromising the immediate needs of its citizens (in most cases the low income citizens). The action of government only targeting the urban ‘poor’ living in squatter settlements along the Bagmati River as the main reason for pollution of the river is a skewed view of sustainability as a whole where neither the ‘Green’ nor the ‘Brown’ agendas were achieved through this action of riverside squatter settlement eviction case.

<sup>2</sup> Focus group discussions with households of Khadga Bhadrakali squatter settlement (December, 2012)

Therefore, within the sustainable development argument one can raise questions addressing core structural issues such as ‘*sustainability of what?*’ and ‘*who decides?*’.

#### **4.2 Ecological versus Social Justice**

Justice is often looked upon as a subordinate to sustainability [18]. This argument is also illustrated in the above case where the dominance of ecological sustainability of the river compromises the issue of social justice for 250 squatter households. Redclift (2005) argues that the move from emphasis on ‘needs’ to that of ‘rights’ (Post Rio 1992) also marked the shift from broadly a Keynesian paradigm of international economic relations to the neo – liberal dominance of market. Here it is important to note that within the neo – liberal agenda, everything is expressed through the market forces even the ‘rights’ based sustainable development argument; hence further reducing the emphasis on justice.

The above case clearly illustrates two sides of the same coin, on one side there is the ‘*Green*’ question of *ecological* sustainability of the river whereas on the other side there is the ‘*Brown*’ question of addressing immediate needs of the urban ‘poor’ encroaching land along the riverbanks. For a holistic approach to sustainable development, both the ‘Green Agenda’ catering to the ecological sustainability of the developed countries and the ‘Brown Agenda’ focusing on the immediate needs of the rapidly urbanizing developing countries need to be addressed equally. Sustainable development must address issues of social justice and equality (at all levels) in order to achieve its real objectives.

## 5. CONCLUSIONS

Although the global discussions on sustainable development have moved from simply taking into consideration the ecological sustainability of the ‘green’ agenda towards a more holistic approach of both the agendas. McGranahan argues that it is important not to create a ‘false dichotomy’ since at a broader level ‘a concern for equity’ is central in both [19]. Nevertheless as also seen in the above case there is a tendency to overlook the issues of social justice related primarily to the ‘brown’ agenda in order to try and achieve ecological sustainability. Therefore, within the global discussion on ‘sustainable development’ there is still the need to bring forward issues of social justice surrounding the ‘brown’ agenda.

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# A SYSTEMS-BASED METHOD FOR EVALUATING REGIONAL CLIMATE ACTIONS

**Christofer SKAAR<sup>1,2</sup>, Johanne HAMMERVOLD<sup>1</sup> and Hogne Nersund LARSEN<sup>1</sup>**

<sup>1</sup>MiSA AS – a subsidiary of Asplan Viak AS

<sup>2</sup>Department of Industrial Economics and Technology Management, NTNU

## ABSTRACT

Developing a climate action plan at the level of regional government is a balancing act. The county council is responsible for its own climate footprint, in addition to the responsibilities of following up national goals and strategies and coordinating climate action at the municipal level. Identifying which climate actions the county council should prioritise requires an integrated approach that can take into account the effect on the climate footprint and the concerns of the involved stakeholders. A method is presented here for evaluating regional climate action. The method has been developed for Hordaland County Council, and is based on a combined use of environmental revision, systems engineering and stakeholder analysis. The main results are: 1) an evaluation and weighting methodology, 2) identification of a significant discrepancy between goals and actions and 3) the overall positive response from stakeholders, even in light of the discrepancy between goals and actions. The weighting methodology can be applied by regional governments in order to evaluate climate action plans.

*Keywords: Climate action plan, carbon footprint, systems engineering, evaluation methodology, case study*

## 1 INTRODUCTION

While global climate agreements have lost some momentum in recent years, there has been an increasing focus on climate change at the regional and local levels. In Norway, there has been a particularly strong focus on county and municipal authorities, initiated in part by Local Agenda 21, and further fuelled by the development of energy and climate action plans. There have been a lot of positive outcomes out of these “first generation” climate action plans; putting climate on the agenda, begging to set goals for emission reductions, establishing organisational units working with climate and environment, and it has a positive influence on the commitment at the regional and local levels. A key factor in the time ahead, from a continual development perspective, is the systematic evaluation of current and future action plans and appurtenant actions. To avoid problem shifting from one geographical area to another, these evaluations should have a lifecycle perspective.

The carbon footprint of Hordaland County is mainly due to private consumption, public sector consumption and private sector consumption. The County Council’s own activities affect greenhouse gas emissions, both directly (transport, energy) and indirectly (purchases of goods and services). Moreover, the County Council has a responsibility as a force for regional development and coordinated planning, for example of land use and transport planning. Key points for households, communities and businesses are:

- Households: Private consumption, housing, energy, transportation (plane, car, boat, bicycle, public transport, etc.), food (in particular meat) and overall consumption growth. Preparation and dissemination of knowledge will be relevant here.
- Municipalities: Energy, transport, food and outsourcing. Services accounts for the majority. The county serves as an advisor to municipalities as municipal sector will be a key part of a county strategy.
- The private sector: The picture here is more complex, as there are both direct and indirect contributions. For service industries, there will usually be energy, transport and procurement. For other types of industry (industry, agriculture) it can be also direct emissions of greenhouse gases.

An analysis of the carbon footprint of Hordland County Council compared to other municipal counties revealed that Hordland had the highest footprint in total [1]. However, there is large variation in county population from one county to another. Looking at carbon footprint per capita, Hordland County Council ranks 6 of 19.

## 2 METHODOLOGY

The method for evaluating regional (in the case study: county level) climate action plans is based on a combined use of environmental revision principles [2], systems engineering [3], and stakeholder analysis and weighting [4]. Each action in a climate plan is evaluated against a defined set of criteria (e.g. time perspective, target group, type of action, effect on the climate footprint for actions that have a quantifiable effect on CO<sub>2</sub> emissions). Effect on climate footprint is calculated using the Klimakost methodology [5,6]. Furthermore, a focused stakeholder analysis based on interviews will be performed. Stakeholders include representatives for state government, regional government, local government, inhabitants and industry. The results are combined using a weighting methodology, with five weighting schemes reflecting various strategies and value bases. Strong and weak climate actions are identified, with strong climate actions being those that score well in at least four of the five weightings schemes. Finally, the climate actions are mapped on a variant of the DPSIR framework, in order to perform a gap analysis and identify if there are significant aspects that are not addressed by the regional climate plan.

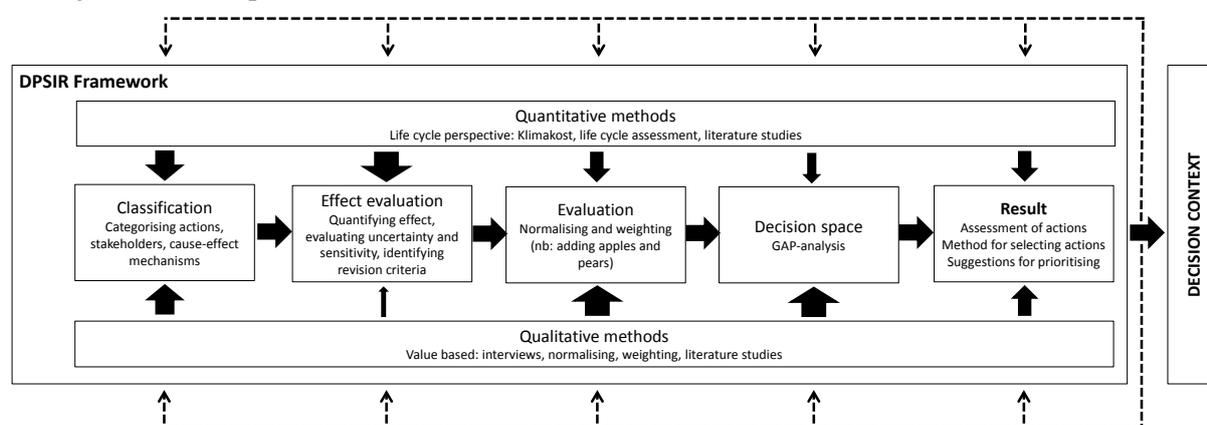


Figure 1. Methodological framework.

Impact assessment is done in a lifecycle perspective. It is thus emissions throughout the life cycle and not from a particular geographical area. For each action there will be established audit criteria. The audit criteria are related to goal identification, best effect and minimum acceptable efficacy. For direct measures it is natural that the audit criteria are based on the calculation of CO<sub>2</sub>-equivalents in a lifetime perspective (emissions, reductions, increases). For indirect actions the challenge will be to identify good audit criteria. Assessment of what will be the best effect is based on existing knowledge and experience, as well as literature review. Audit criteria will also be established with the aim to assess how well the actions are supported by stakeholders (municipalities, county authorities, business, industry, interest groups and the general population). To see the actions in a larger perspective they will furthermore be considered in relation to the DPSIR framework [7].

Audit criteria are indicators that actions will be measured against. This can for example be the number of kg reduction in CO<sub>2</sub> emissions per year or the number of environmentally certified public enterprises in the county per year. The audit criteria are intended to describe both the efficiency and the effect of the actions. These measures are of diverse nature and it is a challenge to compare one action to another.

The purpose of the evaluation is first to make the assessment of each action comparable to assessments of other actions (using normalisation) and assessing the overall performance of an action (using weighting factors). This is a value-based process, there is not one correct answer (but there are still countless answers that are incorrect). Impact assessment and evaluation form the basis for a gap analysis of the county climate actions. The objective is the identification of actions that should be prioritised and actions that should be downgraded to achieve a coherent policy at any stage of the

DPSIR framework and the identification of opportunities for new initiatives. Gap analysis will take into account the need for a broad approach to be able to address households, public sector and private sector.

### 3 MATERIAL AND RESULTS

#### 3.1 Classification and effect evaluation

A number of criteria have been selected that each climate action will be evaluated against. These will provide an initial assessment of each climate action. A selected subset of criteria will furthermore be used in weighting schemes when evaluation actions against each other.

*Table 1. Evaluation criteria.*

<i>Classification</i>	<i>Description</i>
Direct or indirect	Initial assessment of whether the action has a direct effect on emissions or whether it is an indirect measure ('degree of direct effect' below addresses the same, but it quantifies it on a scale from 1 to 5).
Quantifiable (in GHG or otherwise)	Is it possible to quantify the results of the action in GHG-equivalents? If not, it is possible to quantify it in another way?
Target audience	Who is the target audience for the action?
Responsible	Who is responsible for implementing the action?
Suggested assessment criteria / audit criteria	Possible indicators to quantitatively measure the effect of the action or the success of the action.
Category	Three categories: Assessment actions, competence building actions and direct actions.
Direction (targeting areas with high climate impact)	If the action is directed at an area where there is a large impact on the climate? (efficiency)
Power (estimated effect of the measure)	Will the action provide a major effect on your audience? (effectiveness)
Degree of direct effect	Will the action provide direct effect on greenhouse gas emissions if the project is carried out as planned, or is an indirect effect?
Progression weighting (possibility to implement)	If the action is easy to implement or is it an 'ultimate goal'?
Overlap with other measures	The extent of overlap between actions. A high degree of overlap leads to a low score (redundancy).
Horizon	What is the time horizon?
Rebound	Rebound effects can cause the action to provide a lower impact than initially thought. These have not been quantified here, but it is included in recognition of the relevance of rebound effects. These effects can be difficult to identify and quantify, so the default value here is the same for all measures.
kg CO <sub>2</sub> avoided	Quantitative calculation of the effect of the action, either by means of process-based life cycle analysis, input-output analysis or a combination.
Share of the relevant category	Every action is directed against a type of stakeholders, a type of organisations, etc. When it is possible to quantify the effect of the measure, it will also be possible to calculate the proportion of the relevant category's total emissions.
Percentage of total emissions of Hordaland	When it is possible to quantify the effect of the action, it will also be possible to calculate the effect's share of total emissions of Hordaland. This will give an indication of whether the measure is significant or insignificant in relation to the footprint of the whole of Hordaland.
Costs	County council's costs of implementing the measure. Note: This is not a socio-economic assessment of costs and benefits.

Biodiversity	The impact on biodiversity, from negative to positive.
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### 3.2 Stakeholder analysis

The county council's activities affect and may be affected by a variety of actors, both within the county and externally (national, international). The purpose of the stakeholder analysis in this evaluation has been to shed light on selected key stakeholders' perception of climate plans, the actions in the action programs and the process around climate planning. A total of 13 telephone interviews (of 16 requests), with 2-3 respondents in the following stakeholder groups: state government, regional government, local government, inhabitants and industry.

It is intentionally used a biased selection method to identify stakeholders and respondents in each group, with the goal of identifying stakeholders that are engaged in climate questions. The selected groups are thus not a representative average for all stakeholders in Hordaland. Likewise, no selection within each group can be considered a representative average for each group in whole, both because of the biased sampling method and the limited number of respondents in each group. Providing an average has not been the purpose of the analysis. The purpose was to gather information from those who are involved in climate work (though not necessarily at the county level or directly linked to county actions).

The process of preparation of climate plan and associated action programs has been well received. Typical response includes keywords such as inclusive, academically sound and transparent. It is in particular the administrative part of the County Council that is described in a positive manner. The assessment of the actions themselves is mixed. There is great variation in responses, especially when it comes to the types of actions that are considered to be effective and in terms of the types of actions that stakeholders believe the counties should take responsibility to implement (and thus also affects the feedback on the measures for which the county should pursue). A slight majority would focus on measures that have an effect on emissions, while a minority would focus on measures that provide a signal effect. Climate adaptation and thus resilience is also drawn by several as an important area.

There is a general perception that there are no clear criteria for the selection of actions, nor for evaluating and prioritising among measures. Several stakeholders want a stronger link between climate and economy, and the need for a binding climate budget/fiscal climate budget is also mentioned. Stakeholders that focus on emission reductions also request more cost/benefit assessments.

There were no interested parties that considered the actions sufficient to achieve the overall goals of the climate plan. Furthermore, there was expressed scepticism about the link between actions and overall goals. The feedback was mainly in the negative direction, varying from "unclear" and "slow" to "think of a number" and "failure". Several comments were made that the efficacy of climate actions are often cancelled by decisions in other areas (e.g. zoning development and road planning).

### 3.3 Weighting model and evaluation results

Prior to the stakeholder analysis, it was believed that there would be differences between stakeholder groups in terms of the criteria and actions that were considered to be important. The results of the stakeholder analysis did not support this assumption, and thus provided no basis for making weighting schemes based on stakeholder types. But the results show that there are certain traits that recur across groups. Based on this, a weighting model was made in Excel. In this model it is possible to weight the criteria and measures separately. The weighting model could include a large number of criteria in the evaluation, if needed. But initially only the first four criteria were included in the weighting model, as these were considered most important. The weighted score for an action is calculated using Equation 1, with  $I$  is the indicator score. For a set of actions from 1 to  $i$ ,  $Q_i$  is the entry value,  $N_i$  is the normalization factor and  $V_i$  is the weighting factor for each action.

$$I = \sum_{i=1}^n (Q_i * N_i * V_i) \quad (1)$$

For each weighting scheme there is a specific weighting of criteria and measures. The differences between variants of weighting criteria are rather small; there are only certain criteria where the

weighting varies between varieties. The weighting schemes developed are: 1) baseline (all criteria have identical weighting, all actions are weighted equally), 2) focus on emission reductions, 3) focus on County Council carbon footprint (higher weight for in-house actions), 4) focus on signal effect of the County and 5) focus on influence and power (higher weight for actions where the County is considered to have strong influence).

In the review of actions, each action has been considered by a number of criteria. The following criteria are considered for each action, but is not included in the weighting model (i.e. they have a weight of 0): horizon, rebound, costs and biodiversity. The reason why these are not included, is twofold. Time horizon is not included because the focus has been on the whole climate action in a long term perspective. Rebound effect and biodiversity are not included as these have fairly complex cause-effect relationships that are difficult to express consistently on a scale of 1-5. Costs are not included, because the cost is calculated from an economic perspective for the County Council itself (i.e. not in a socio-economic perspective). The weighting model is created in such a way that these criteria can easily be included when necessary and when evaluated consistently. The results are shown in Figure 2.

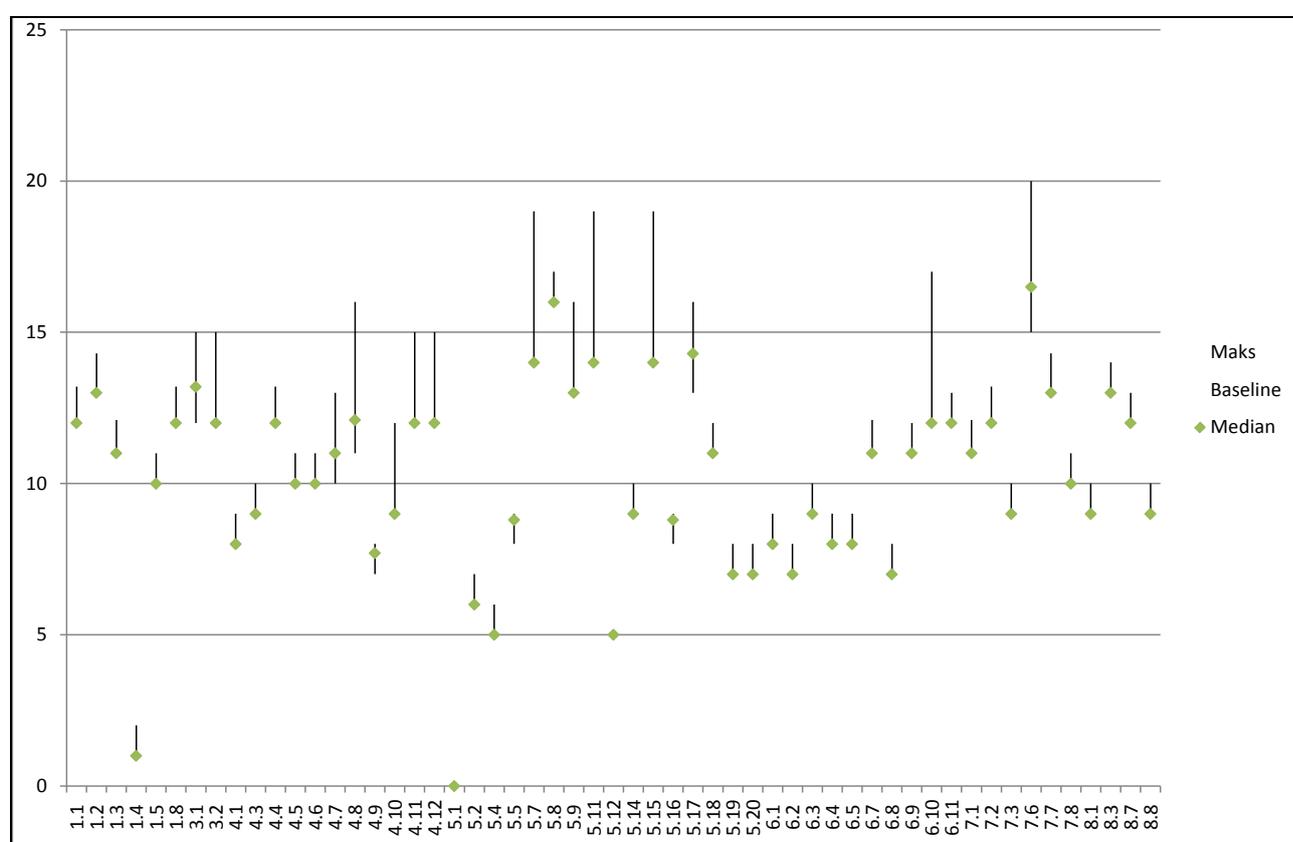


Figure 2. Results of weighting. Length of line indicates minimum and maximum values. Green indicates the median value for the 5 weighting schemes.

Figure 2 shows the results of the evaluation. Here it is clear that there are large differences between actions, as well as large differences in variation between schemes. Some actions are fairly consistent between weighting schemes, whereas others vary a great deal. The results show that actions directed at transport in general have a high score, whereas actions directed at agriculture in general have a low score. In addition, 9 of the 57 actions have not been possible to quantify on all criteria. Furthermore, only 28 have been possible to quantify in terms of kg CO<sub>2</sub>-equivalents.

## 4 DISCUSSION

### 4.1 Sensitivity and uncertainty

The actions in the Hordaland County's climate plan are varied, and there are major differences from action to action. Differences include the target audience, type of action, time horizon, etc. This allows assessment of the actions' impact on greenhouse gas emissions / climate change will have different sensitivities and different ranges of uncertainty. It will not be possible to give an absolute answer to uncertainty, but it is useful to provide an estimate of how large the difference must be before one can be reasonably certain that one action will have a greater effect than another. There are several types of uncertainty that can affect the results [8]. Some types of uncertainty are systematic (bias, will always give a distorted result) and other types of uncertainty is entirely coincidental. A selection of key types of uncertainty that will affect the calculation of measuring the effect, are:

- Data uncertainty (how good is the data input?)
- Model uncertainty (how well do the models describe reality, for example: DPSIR and causal mechanisms of action to effect? )
- System uncertainty (do we have information about the whole system?)
- Uncertainty due to selection (criteria, normalisation, weighting)
- Uncertainty due to time (what will the world be like in the future?)
- Uncertainty due to variability (what is the probability distribution for the parameters, is there a great difference between the groups in the same target?)

In some cases it will be possible to estimate the uncertainty, for example in terms of normalisation and weighting models. Here it will be possible to do sensitivity analyses to assess how large differences there are in the results by changing the normalization and weighting. The uncertainty in the quantification of greenhouse effect of the measures will vary from measure to measure. It is not conducted a systematic survey of the uncertainty, but the uncertainty is generally high for these types of calculations. It is estimated that an uncertainty of up to about a factor of 2 can be expected (i.e. the effect is likely to be between 50 % and 200 % of the estimated value).

### 4.2 Rebound effects

When implementing an action there will be reducing or reinforcing side effects. Such side effects are called rebound effects (or ripple effects) [9]. Rebound effects can broadly be classified as follows:

- Direct effects: Substitution, such as: energy conservation leads to higher energy use. Income effect, such as: energy savings spent on other types of consumption.
- Secondary effects: E.g. technical improvement when a manufacturer increases energy efficiency in industry. This results in cheaper products and thus an increase in demand. Consequently, overall a greater energy consumption due to increased production to meet increased demand.
- Market power (also called tertiary effect): E.g. energy-saving measures for reduced energy consumption in society. This makes the price drops and the market ensures that energy is used elsewhere.
- Transforming Power: Technological advances changing social structure, thus the pattern of production and consumption.

Many of the feedback effects of acts neutralising for energy and climate change. This applies to both direct effects, secondary effects and market effects - since they all somehow assume that the market will make sure to adjust demand with production, or that savings are taken out in other consumption. Here we will not go into this in detail. Nevertheless, we can point out that the mechanisms that come into play are significant and that it is necessary to discuss how these reflected the measures chosen.

### 4.3 Evaluation of climate actions

The assessment of the actions provides an initial ranking of the measures, but we caution against using this ranking as the single way to prioritise between actions. The ranking provides a starting point for further discussions, e.g. discussing which actions are fundamental to be considered in relation to other aspects (such as feasibility and acceptability) and other means outside the county's responsibility. We

would like to point out that the assessment of the actions is done in a lifecycle perspective. This means that emissions related to export industry is only included to the extent of the products that are not exported. This also means that the numerical values in this report are not directly comparable with the objectives of the climate plan, which is 22% reduction in emissions by 2020 compared to 1991, within the geographical region of Hordaland.

Furthermore, each action is to a large extent evaluated individually. For actions that are part of a larger package of actions thus parts of the effects may not be included in the assessment. Such reviews can either be done afterwards, for example taking into account if such measures are low out of the assessment, or they can be included in the model by adding additional criteria. The weighting model is flexible to include additional criteria and measures weightings.

#### **4.4 Policy implications**

The County Council is responsible for the statutory duties and services. This includes coordination of planning in the county, secondary education, planning of public transport and regional development. The county has a large degree of independence in how it deals with its statutory tasks and services. This is also reflected in the climate work, there is a large variation between county councils in what they include within their scope of responsibility.

A gap analysis of the actions has been performed, from three different angles: in terms of the DPSIR framework, as seen from the stakeholders' perspective, and through a comparison with other counties. The results of these three perspectives point essentially in the same direction. The overall assessment is that the Hordaland County Council has a broad climate policy, addressing the County organisation, municipalities, businesses and households. Furthermore, the impact assessment reveals that the actions of the climate plan is not sufficient to achieve the long term goals. This is supported by the stakeholder analysis.

Climate plans furthermore consists of a number of actions that do not have a direct effect on climate reduction, such actions are intended to promote networking, dissemination of knowledge and to build awareness. The results of the stakeholder analysis also show that the process of selecting actions at the political level may appear to be arbitrary. To reduce the number of actions and to see partly overlapping measures (in DPSIR context) as a whole, these may be grouped into one or a few actions. The advantage of this is that the totality of the effort can be considered together, but this will, to some extent at the expense of political control.

As noted above, the County Council has large independency in defining how it uses its authority. This provides strength and flexibility in climate action, but is also a disadvantage in the sense that the county can take action in other areas (for example in industrial or transportation) that contribute negatively. A binding climate budget tied to the financial budget can be a means to avoid this. Furthermore, there is a need for a holistic approach to rank and prioritize mitigation. The weighting model presented here may be a starting point for this.

## **5 CONCLUSIONS**

Developing a climate action plan at the level of regional government is a balancing act. The county council is responsible for its own climate footprint, in addition to the responsibilities of following up national goals and strategies and coordinating climate action at the municipal level. Identifying which climate actions the county council should prioritise requires an integrated approach that can take into account the effect on the climate footprint and the concerns of the involved stakeholders (e.g. national, regional and local government, inhabitants and industry).

The main result is an evaluation and weighting methodology that can be applied by regional governments in order to evaluate climate action plans. Applying the methodology to the Hordaland County Council climate action plan resulted in three key findings. The first is the identification of robust and less robust climate actions. The second is identification of a significant discrepancy between goals and actions. The third is the overall positive response from stakeholders, even though the discrepancy between goals and actions were perceived by all stakeholders, implying a general understanding that overall goals are not connected to climate action in practice.

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# SUSTAINABLE DEVELOPMENT CITIES: THE ROLE OF ZONING POLICY IN INDIA

P M Prasad<sup>1</sup>, Amrutanshu<sup>2</sup>, Sebastian Villasante<sup>3</sup>, and Jacobo Feás, Manel Antelo<sup>4</sup>

<sup>1</sup> Indian Institute of Technology Kanpur (IIT Kanpur)

<sup>2</sup> IIT Kanpur, <sup>3</sup> University Santiago de Compostela (USC), and <sup>4</sup> USC

## ABSTRACT

Agglomeration economics contributes to existence of Cities. Indian Cities compete with one another to lure the industrialists to establish their industrial units within city's territorial jurisdictions for generations of employment and revenue. The firms with profit maximization will adopt intensive and extensive method of production practices which imposes negative externalities. Moreover, the price mechanism doesn't provide motivation to firms to internalize the externalities. The competition among Cities, further will lead to *race to the bottom* in terms of environmental quality. Cities formulate Zoning Policy (Master Plans) to mitigate externalities. However, the industries violate the policy systematically and contaminate the resources. As a result, industrial pollution imposes opportunity cost to the households. Thus, the study focused on scientific, economic and policy evaluation of Euclidean Zoning violations, ground water contamination and its opportunity cost to the households in the Cities of New Delhi, Bangalore, Chennai and Hyderabad. The study suggests that the Government shall formulate and implement Zoning Policy to promote civilized form of life by employing the insights of the professionals concerned with Cities' Challenges; Generation and dissemination of information to the households about heavy metals concentrations in their premises' ground water resources; establishment of water supply system for distribution of sufficient water to the households; and a City-specific intensive and extensive study to contribute to Sustainable Development Cities (SDCs) in India.

*Keywords: Urban Land Use, Zoning Policy, Water Resources, Opportunity Cost of Pollution, Sustainable Development.*

The write up is divided into five parts. They are: Part-1 refers an overview of zoning, Part-2 deals with Scientific analysis of ground water contamination, Part-3 evaluates the opportunity cost of ground water contamination, Part-4 A few suggestions, and Part-5 summary and conclusion.

## 1. ZONING-AN OVERVIEW

Land Use Plan will alter human and natural systems globally and regionally [1], [2], [3]. Land use is unregulated in the early stages of City development. *The final Report of the Library, City Planning and Zoning Committee of the Chicago Real Estate Board on Zoning in Chicago* cites (1923, p.12) "innumerable instances of the invasion of residential property by objectionable building and uses (which shows) the importance of prompt action in the prevention of such nuisances in the future" [4]. Over the time period, the use of urban land is subject to engineering, scientific, socio- economic and legal aspects of neighbourhood problems. Hence, challenges of incompatible land uses could be resolved by formulation of zoning policy which in turn promotes Sustainable Development Cities (SDCs). Zoning had its beginnings in common law nuisance and has quickly moved to be the mechanism for curing all urban problems. It is an exercise of the state's police power and has right to make regulations without payment of any compensation [5]. The Local Bodies make zoning decisions and set forth the rules and master plans in the form of a zoning policy [6]. This form of zoning has been called *Euclidean Zoning* and is designed to separate different land-uses that are incompatible [7].

Why do cities exist? "Agglomeration economics- the higher productivity of conducting business in close physical proximity to other businesses- is the reason that cities exist and arguably the reason that modern economies are productive" [8]. According to World Urbanization Prospects population of cities with 10 million inhabitants or more were 2, 10, 23, and 37 in 1970, 1990, 2011 and 2025 respectively. Developing

countries will have 29 of the 37 mega cities [9]. Cities do provide incentives to commerce and industries to locate the units within their boundaries in order to promote local employment and improve local tax base. The established firms will provide incentives for workers to migrate. Hence, firms and workers benefit from being together. The competition among cities for industrial property however, will create a *race to the bottom* in terms of environmental quality. Economic theory predicts that the market produces too much of a good with external costs. The normative theory which underlies the economics of externality zoning was sketched out nearly a half century ago by Martin Baily: Laundries (L) which dry clothing in the open air and Smokestacks (S) which emit soot in to the air. The co-location of L and S firms reduces the economic output of the L firm. A (Zoning) rule which segregates the firms geographically increases the output of the L firm without reducing the output of the S firm [10]. Thus, the theory of zoning implies that the regulations are imposed to enhance the value of property and quality of life.

Urban Local Bodies (ULBs) in developing countries like, India were unable to formulate and implement the zoning policy efficiently due to grand father provisions, agglomeration economics, and interest group strategies. Thus, hazardous industrial activities in residential zone on rise which will *per se* impose adverse affects on natural resources and quality of life. For instance, Industrial effluents will contaminate ground water resources (with heavy metals) in residential zones and in turn imposes opportunity cost on households. So, Industrial development together with rapid urbanization and its uncontrolled externalities justifies zoning policy. Thus, the paper identifies and measures the impact of ground water contamination and its opportunity costs to the households of zoning violated areas in the Cities of New Delhi, Bangalore, Chennai and Hyderabad.

## 2. SCIENTIFIC ANALYSIS OF GROUND WATER CONTAMINATION

Harappa Civilization (3000 BC-1500 BC), Harappa and Mohenjo-Daro have provided well-developed social life with efficient city plans. The adopted urban sanitation systems were first in the world. Indian cities, post industrial revolution, have adopted industrial promotional activities to generate employment and revenue within their territorial jurisdictions. The uncontrolled urban sprawl<sup>1</sup>, poor infrastructure, lenience of ULBs towards polluters, and lack of civic sense contributed to degradation of natural resources. These may lead to conflict with the Constitutional provisions of *right to profession* (Article 19) and *right to life* (Article 21). For instance, the country has experienced the Bhopal Gas Tragedy because of violation of zones, non-compliance of safety standards and non-implementation of statutes by the concerned ULBs. The ULBs of Delhi, Bangalore, Chennai and Hyderabad have empowered to formulate, implement and review of Master Plans (Zoning Policy). They aim at mobilization, allocation and management of resources for promotion of Sustainable Development Cities (SDCs). The Plans have proposed that the industries which are functional in residential zones shall shift to industrial zones between a three to six years period, depending upon the degree of hazardousness. However, the profit motivated industries inclined towards non-compliance of zoning policy.

A Public Interest Litigation (*M. C. Mehta v. Union of India*, WP 4677/ 1985) was filed in the Supreme Court of India against the illegal activities of industries in residential zone in Delhi. The Court issued directions (May 7, 2004) to the concerned authorities by stating that except household industry all other industrial units which have come up in residential zone in Delhi after 1<sup>st</sup> August 1990 have to stop their activities within six months. Accordingly, some of the hazardous industries have closed down their units and some have shifted to industrial zone (s). Similarly, water resources in Durgaram Cheruvu at Jubilee Hills, Hyderabad, was contaminated with leather tanning industry and nearby residential colonies effluents. In an another PIL (*T. Ramakrishna Rao v. Hyderabad Urban Development Authority*, Writ Petition no. 36929/ 1998) was filed in the High Court of Andhra Pradesh against Durgaram Cheruvu Lake pollution. The Court has directed the concerned authorities to protect and safeguard the environment in

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<sup>1</sup> The population of Mega City like Delhi has increased from 0.4 million in 1901 to 17.75 million in 2011. Similarly, the population of potential Mega Cities namely Bangalore, Chennai and Hyderabad has increased from 0.16 million, 0.59 million and 0.45 million in 1901 to 8.61 million, 8.78 million, 7.84 million in 2011, respectively. According to World Urbanization Prospects (the Revision 2011), Bangalore by 2015, Chennai and Hyderabad by 2020 will be in the list of Mega Cities.

and around the Lake. Land Use Maps of 1973 and 2026 developed by Chennai Metropolitan Authority (CMDA) and the Map of 2015 developed by Bangalore Development Authority (BDA) indicate that the violation of zoning prevails in and around residential and industrial Zones [11], [12].

A Study has compiled data about heavy metal concentrations in the ground water in different blocks of Delhi in 1998 [13]. It has collected ground water samples from different locations of Delhi and tested for heavy metals and other parameters in the laboratory of CGWB, Chandigarh. The report indicated that heavy metals namely, Cadmium, Chromium, Lead and Nickel were present in the ground water resources of Shahdara. The block of Alipur, Mehrauli and City's ground water resources were contaminated with the heavy metals of Chromium, Lead and Nickel. The ground water resource of Najafgarh was contaminated with Lead which was very high compared to rest of the blocks. It has motivated us to examine the heavy metals concentrations in ground water in zoning violated areas of the cities namely, New Delhi, Bangalore, Chennai, and Hyderabad.

## 2.1. Data, Test Results and Analysis

The scientific analysis of ground water contamination in the zoning violated areas of the cities necessitated us to collect secondary data from agencies like Ministry of Urban Development, Ministry of Environment and Forest, Central Ground Water Board, Pollution Control Boards, Supreme Court, Urban Development Authorities (UDAs), Water Supply and Sanitation Boards, and Metropolitan Industrial Development Corporations. Google Earth and the maps developed by the UDAs have been used to identify the areas where zoning policies were violated (i.e., industries and housing mixed locations) and sites to collect ground water samples in Delhi, Bangalore, Chennai, and Hyderabad. In addition, field investigators have conducted on spot observations and interacted with a few households on zoning violated areas at the time of collection of ground water samples. Accordingly, they have collected the samples and classified them on the intensity of pollution. Laboratory tests were conducted for the first 10 ranked samples of each City. The limited sample tests were primarily because of scarcity of resources like manmade capital. The samples were tested in laboratory to find out the concentration of heavy metals in ground water resources of the selected zoning violated areas of the cities.

### 2.1.1. Sample Collection and Preparation

Ground water samples, each, have been collected in brand new Tarson bottle of 1L capacity. Before collection of the sample, hand pump was run for 2-3 minutes to get actual ground water representation (As recommended by CGWB in their study). The sample collected bottles were firmly sealed. They were preserved by acidifying with 5 mL of 1+1 conc. HNO<sub>3</sub> in 1 L of sample volume. This process preserves samples for a period of 6 months to 1 year. In addition, each acidified sample was filtered with 45 micron GFC filter paper and then with 0.22 micron filter paper (Method no. 3010B for metal analysis by AAS, Standard Methods for the Examination of Water and Waste Water, 1995).

### 2.1.2. Testing Procedure

Tests have been carried out on 10 samples out of 20 samples collected<sup>2</sup> from each city for concentrations of heavy metals of Cadmium (Cd), Chromium (Cr), Lead (Pb) and Nickel (Ni). The testing of filtered samples was done using Graphite Tube Atomizer-Atomic Absorption Spectroscopy (GTA-AAS) model: Varian GTA-96 follow standard procedure as specified by the manufacturer. The minimum detection limits of these metals on available model of GTA are given in the following table 1.

Table 1: Detection Limit of Heavy Metals Concentration by GTA

Metal(s)	Cadmium	Lead	Nickel	Chromium
Detection Limit( $\mu\text{g/L}$ )	3.000/ 0. 250	3.500	6.000	1.875

Source: Manufacturer's Manual.

### 2.1.3. Results

The test results reveal that the concentrations of heavy metals over and above drinking water standards of World Health Organization (WHO-1996) in the zoning violated areas of the Cities. Cadmium concentrations were found in 2 and 6 areas of Chennai and Hyderabad, respectively. The heavy metal concentrations were found 16 times above the standards in the areas of Chrompet (Chennai).

<sup>2</sup> In the case of Delhi and Hyderabad only 19 and 19 Samples were collected, respectively. Moreover, only 9 samples were tested in the case of Delhi. The samples were collected and tested for Delhi in the year 2007 and in Bangalore, Chennai and Hyderabad in 2009.

Concentrations of Chromium were found in 4<sup>th</sup> Phase- New Town, Yelhanka (Bangalore) and found 2 times above the standards. Lead Concentrations were 17 and 15 times above the WHO drinking water standards, 1996, in the areas of Chrompet (Chennai) and 2<sup>nd</sup> Chowrasta of Balanagar (Hyderabad). Similarly, Nickel concentrations were found 9, 18, and 15 times above the standards in the areas of Maniamman Koli Street (Chennai), 2<sup>nd</sup> Chowrasta of Balanagar (Hyderabad), and Phase III- IDA of Jeedimetla (Hyderabad), respectively. (For further information, see **Appendix-I: Location of Water Samples and the Concentration of Heavy Metals in the tested Water Samples of the Cities**)

After shifting/ closedown of the hazardous industries in the residential areas in Delhi, the test results (2007) shows that the concentrations of Lead were found in the selected three water blocks namely, Alipur, City and Shahdara. Moreover, the intensity of the metal has shown increasing trend in the blocks, over a decade. However, the test results reveal that the Nickel has been found in Alipur but its severity has reduced.

The scientific test overall indicates that the activities of hazardous industries in the residential zones of the cities have contaminated the ground water with heavy metals. Hence, the ground water is unfit for human consumption as per the drinking water standards of WHO (1996). Accordingly, households of the cities have been deprived of ground water resources for their day-to-day consumption. Hence, the study evaluated opportunity cost of ground water contamination to the households in the zoning violated areas of the cities.

### **3. OPPORTUNITY COST OF GROUND WATER CONTAMINATION**

Water security is an integral part of human security. Hence, the Millennium Development Goals [14] provide a benchmark for measuring progress towards “The Human Right to Water” [15]<sup>3</sup>. Constitution of India in its 12<sup>th</sup> schedule empowers Cities’ Water Supply and Sewerage Boards (WSSBs) to mobilise, manage and supply water for domestic, industrial and commercial purposes. Initially, households of the Cities have accessed the water from pounds, lakes, tanks and wells. Over the decades, the WSSBs necessitated to invest huge amount of money to mobilize the water not only from Rivers within its State’s jurisdiction but from neighbouring States. For instance, Chennai city draws water (12 TMC) from neighbouring state’s (Andhra Pradesh) river resources i.e., Krishna River under Telugu Ganga Project. The cost of water supply per KL to the Chennai Metropolitan Water Supply and Sewerage Board (CWSSB) was Rs. 45.75 (US\$ 1.06) in 2004-05 and Rs. 45.65 (US\$ 1.01) in 2005-06 [16]. It was due to water crisis. The Board has supplied water to the households through the mobile water supply mechanism. The water tariffs for the domestic connection are much below the actual costs of supply. It is estimated that the per unit cost of water supplied and water charges collected by the Delhi Jal Board (DJB) for domestic users as approximately Rs. 13.60 per kL (i.e., 0.31 US\$) and Rs. 4.50 per kL (i.e., 0.1 US\$)<sup>4</sup>, respectively. Domestic tariffs are sufficient to cover only 10 per cent of Operation & Maintenance costs in cities with metered consumption and 15 per cent in cities with un-metered consumption [17]. Moreover, 50 per cent of the total supply of water is not billed because of leakage and unauthorized consumption. The water supply is inefficient in terms of quality and quantity. Usually, two or three hours of water supply per day will be considered as standard in the Cities. This may result in fixation of water tariffs below the true costs. The less revenue to the DJB may result in inefficient water supply which in turn provides incentives to domestic users to pay less [18]. This is a vicious circle of water security. Similar experiences holds good in the potential Mega Cities namely, Bangalore, Chennai and Hyderabad.

The supply-demand gap of public water distribution and the concentration of heavy metals in the ground water resources necessitate households of the zoning violated areas to purchase drinking water from Informal Water Markets (IWMs) at high prices. In addition, a few households’ inability to purchase drinking water at high prices from IWMs, and asymmetric information about the concentrations of heavy

<sup>3</sup> According to UN Committee on Economic, Social and Cultural Rights (2002), the human right to water “entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use”.

<sup>4</sup> At exchange rate Rs. 44 per USD (approximately), in December, 2006.

metals in the ground water resources *per se* consume contaminated water. Thus, there will be an opportunity cost<sup>5</sup> of ground water contamination to the households of the areas.

### 3.1. Data and Analysis

The study carried out primary survey to obtain the information from the selected respondents on water accessibility, sufficiency, quality, and the purchase of water at high prices in the Informal Water Markets. The preliminary survey was limited to the Zoning Policy violated areas of potential mega cities namely, Bangalore (2011), Chennai (2010) and Hyderabad (2011). We have collected the data from 99 respondents those who are staying in the Zoning Policy violated areas of the cities between 1-50 years and across income groups (LIG, MIG and HIG). The survey is based on the stratified random sampling, structured questionnaire and personal interviews.

The estimation of opportunity cost of ground water contamination is based on the following criteria:

Opportunity cost of ground water contamination for the households =  $p*w*c$

(i.e., Number of people consuming purchased drinking water-p)(Per capita consumption of water-w)(Average cost of canned water per liter-c)

Census of India, 2011 provides data on population and the number of households in Municipalities/Wards [19]. The primary data has been collected on: percentage of the households' purchase of drinking water from the Informal Water Markets (IWMs), number of water cans purchased per week and per unit price, households' income status, and utilization of ground water resources. We have assumed that the households consist of on an average four members. The number of people who purchased drinking water has been estimated based on the average number of family members (i.e., 4) times the number of households drinks purchased water. We have also assumed that a minimum of 3 liters per capita water per day is required per person<sup>6</sup>. Accordingly, we have calculated drinking water consumption in liters per day by factoring the per capita water daily per person (i.e., 3 liters) with the number of people consumed purchased water. Based on the sample survey data we have estimated average cost of drinking water in Informal Water Markets (IWMs) that is Rs.1.25 (0.03 USD) per liter in Chennai and Hyderabad; and Rs.0.83 (0.02 USD) per liter in Bangalore.

### 3.2. Results

The analysis of the opportunity cost of ground water contamination indicates that the households have incurred expenditure on drinking water USD 0.93 millions, USD 22.75 millions and USD 4.15 millions per year in Bangalore, Chennai and Hyderabad, respectively. The heavy metal concentrations in Maruthi seva Nagar (Bangalore) are within the WHO's drinking water standards. However, 20 percent of the households incurred expenditure of USD 0.17 million per year on drinking water. Similarly, households in Vasantha Nagar (Bangalore) receive 24 hrs water supply from Bangalore Water Supply and Sewerage Board (BWSSB) hence they haven't incurred expenditure on drinking water [20]. The ground water resources in Yelahanka (Bangalore) and Balanagar (Hyderabad) were contaminated with Lead, Nickel and Cadmium. Similarly, Hegganahalli (Bangalore) ground water resources were contaminated with Lead. According to survey, the households in these areas haven't incurred expenditure on drinking water. Thus, a few of households in the areas consumes available ground water resources with or without purification devices (For further information, see **Appendix-II: Opportunity Cost of Ground Water Contamination**).

### 4. SUGGESTIONS

(a). Industrialists uses State power to establish their hazardous plants in residential zones and violates the zoning policy in Cities in India. Zoning promotes a civilized form of life if we employ the insights of professionals concerned with urban challenges. Thus, the Government shall evolve a mechanism to identify

<sup>5</sup> The money spent on drinking water will not be available for next best alternative use i.e., for kids education. Similarly, money spent on treating for water borne diseases may not be available for next best alternative use. Moreover, premature deaths, Productivity loss and income loss due to illness impose costs on individual households and in turn over all economic growth and development of India.

<sup>6</sup> In developing countries, Whiteetal. (1972) and Gleick (1996) suggest that a minimum of 3litres per capita per day is required for adults in most situations, in Guy Howard and Jamie Bartram, Domestic Water Quantity, Service Level and Health, World Health Organization, Geneva, Switzerland, 2003.

professionals and uses scientific know-how while formulation and implementation of zoning policy to promote Sustainable Development Cities (SDCs); (b). Scientific tests of the study reveal that the heavy metals concentration in the ground water resources in zoning violated areas of the cities witnessed over and above WHO's drinking water standards. The contamination will contribute to water scarcity and imposes opportunity cost to households. The households who were unable to purchase water at high prices from Informal Water Markets (IWMs), and asymmetric information among households about the ground water contamination will consume the contaminated water. So, they will suffer from water borne diseases and in turn results in morbidity and mortality. In the long run, they incur health costs, productivity loss and income loss. Hence, the authorities shall adopt a Capacity Building Mechanism (CBM) to test water for heavy metals concentration and disseminate the information to households which prevents them from consumption of contaminated water; (c). Water Supply and Sewerage Boards of the Cities are empowered to mobilize, distribute and manage water supply. However, prevalence of unaccounted water losses, revenue-expenditure gap, and demand-supply gap of water results in water distress cities. Thus, the Boards shall evolve Sustainable Development Mechanism (SDM) to supply water sufficiently to the households; and (d). The inferences of the study is preliminary analysis in nature so there is need for a City-specific intensive and extensive research study to contribute to Sustainable Development Cities (SDCs) in India

## 5. SUMMARY AND CONCLUSION

Agglomeration economics is a reason that cities exist. Competition among cities to lure the industries to establish their plants within its territorial jurisdictions to generate employment and revenue which results in *race to the bottom* in terms of environmental quality. Thus, the study focused on examination of *Euclidean* Zoning violations, ground water contamination and its opportunity cost to the households in Cities (Delhi, Bangalore, Chennai and Hyderabad) in India. Zoning as a viable technique to prevent incompatible urban land use and enhance value of property and quality of life. Cities in India established Urban Local Bodies (ULBs) to formulate Zoning Policy (Master Plans) in order to allocate urban natural resources efficiently. However, uncontrolled urban sprawl, agglomeration economics and lenient attitude of ULBs against polluters have contributed to establishment of hazardous and heavy industries in the residential zones. According to the Plans, the hazardous industries either shift from residential zones to industrial zone or closedown within three to six years depending up on the degree of hazardousness. However, hazardous and heavy industries were located and functional in residential zones of the Cities for decades. Public Litigation Cases (the illegal activities of industries in residential zone of Delhi and the Durgaram Cheruvu Lake pollution in Hyderabad), Land Use Maps of 1973 and 2026 of Chennai City, and the Map of 2015 of Bangalore City clearly reveals prevailing of zoning violations.

The scientific tests of the ground water samples of zoning violated areas of the cities evidenced that the concentration of heavy metals present were over and above the WHO's drinking water standards. Hence, the ground water is unfit for human consumption. In addition, the Cities Water Supply and Sewerage Boards water supply to the households was inadequate. The scarcity of fresh water and contamination of ground water resources necessitated the households to purchase water at high price from the Informal Water Markets (IWMs). So, there is an opportunity cost of ground water contamination to the households. The Preliminary Household Survey analysis shows that the households have incurred expenditure on drinking water USD 0.93 millions, USD 22.75 millions and USD 4.15 millions per year in Bangalore, Chennai and Hyderabad, respectively. The Survey also shows that the concentration of heavy metals is within the prescribed WHO drinking water standards in Maruthi seva Nagar (Bangalore) but 20 percent of the households incurred expenditure on drinking water. However, households in Vasantha Nagar (Bangalore) receive 24hrs water supply so they haven't incurred expenditure on drinking water. The ground water resources in Yelahanka (Bangalore) and Balanagar (Hyderabad) was contaminated with Lead, Nickel and Cadmium. Similarly, Hegganahalli (Bangalore) ground water resources were contaminated with Lead. According to survey, the households in these areas haven't incurred expenditure on drinking water. A few of households in the areas consumes ground water resources with or without purification devices. Hence, they will suffer from water borne diseases and results in morbidity and mortality. In the long run, they will incur health costs, productivity loss and income loss. This will in turn hamper over all economic growth and development of India. Overall, stake on quality of life and human resource development stresses the need for Sustainable Development Cities (SDCs) in India.

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**Appendix-I: Location of Water Samples and the Concentration of Heavy Metals in the tested Samples.**

City	Sample No.	Sample Blocks/ Areas	Sample location	Cd( $\mu\text{g/L}$ )	Pb( $\mu\text{g/L}$ )	Ni( $\mu\text{g/L}$ )	Cr ( $\mu\text{g/L}$ )
New Delhi	2	City	Chandni Chawk		39.763	9.079	7.36
	4		Trinagar		31.639	7.068	6.673
	7		Shastri Nagar		54.479	13.608	6.403
	12	Shahdra	Gokulpuri	1.587	37.56	11.896	3.116
	14		Gandhi Nagar	1.886	44.141	11.05	3.146
	15		Kanti Nagar	1.917	46.582	12.412	4.552
	16	Alipur	Prehladpur		39.865	39.256	14.607
	17		Samaypur Badli		56.437	36.799	13.494
18	Jharoda			57.688	46.87	14.264	
Bangalore	8	Jalahali Cross	Jalahali Village	1.075	15.114	12.904	3.514
	19	Yelahanka	4th Phase, New Town	1.706	29.624	30.091	3.292
	20		4th Phase, New Town	1.195	22.426	28.396	153.61
	16		New Town	0.975	12.233	10.983	4.674
	13	Whitefield	Basavanagar Village	1.235	38.861	16.994	8.003
	15	C.V. Raman Road	C.V. Raman Road	0.838	11.477	6.589	5.121
	10	Maruthi Seva Nagar	Kammanhali	0.802	9.187	6.479	4.342
	3	Peenaya	Tumkur Rpad	1.309	26.113	29.92	15.867
	1	Dasarahalli	T Dasarhalli	1.62	33.993	59.927	BDL
	2	Hegnnahali	Lakshman Nagar	1.431	27.402	18.733	2.025
Chennai	3	Thiruvottiyur	Wimko Nagar	1.043	27.402	26.498	6.165
	2		Thiruvottiyur	0.979	19.945	29.587	3.502
	6	Manali	Manali	1.448	30.538	55.265	4.895
	5		Manali post	2.591	50.233	138.95	2.933
	16	Chrompet	Nagalkeni	1.174	189.555	36.636	4.051
	19		Chrompet	52.145	41.641	23.677	18.143
	8	Ambattur	Pattavakkam	1.974	54.082	76.476	8.941
	9		pattavakkam	8.88	77.508	201.205	11.602
	24		Mannikkam Pillai St.	1.109	18.857	24.947	14.488
	23		Mannur pet	1.154	21.999	39.179	6.566
Hyderabad	14	Jeedimetla	Phase-III	2.165	26.147	61.68	BDL
	13		IDA Phase III	4.203	51.993	323.64	4.602
	4	Balanagar	Apie	8.05	86.8	129.775	4.549
	1		2nd Chowrasta	15.745	143.805	384.915	17.509
	2		2nd Chowrasta	14.95	167.895	264.56	18.586
	3		2nd Chowrasta	3.614	51.608	153.175	9.898
	9	Patan Chervu	IDA Phase I	0.906	17.238	18.548	2.37
	6		Patancheru	1.728	32.722	69.285	3.631
	7		IDA	1.315	41.259	30.935	4.612
12	IDA, Phase-III		4.189	54.735	149.155	6.012	
<b>Dinking Water Standards, WHO-1996</b>				<b>3</b>	<b>10</b>	<b>20</b>	<b>50</b>

**Appendix-II: Opportunity Cost of Ground Water Contamination**

Cities	Zoning Violated Areas	Population2011	No.of HHs	% of HHs DPW	HHs DPW+	No. of PDPW	DWC lpd\$	HHEDWdRs.^	HHEDWyUSD		
Bangalore (35)	Dasarahalli (5)	33042	8849	20	1769	7076	21228	400.43	146157		
	Jalahalli Cross (5)	37959	9191	60	5514	22056	66168	1248.16	455578		
	Peenya (5)	36879	9524	20	1904	7616	22848	430.98	157308		
	Maruthiseva Nagar (5)	40362	10113	20	2022	8088	24264	457.70	167061		
	Heavy Metals Concentrations are within the WHO Drinking Water Standards										
	Hegganahalli (5)	66314	18438					0	0		
	Yelahanka (5)	41986	10583					0	0		
	Vasanthanagar (5)	22815	5304	24 hours water supply by WSSB							
	<b>Total</b>							<b>2537.27</b>	<b>926104</b>		
Chennai (27)	Ambattur (12)*	478134	119533	100	119533	4,78,134	1434396	40749.89	14873710		
	Chrompet (8)	216308	54077	62.5	33798	135192	405576	11522.05	4205548		
	Manali (2)	35248	9331	50	4665	18660	55980	1590.34	580474		
	Thiruvottiyur (7)~	248059	62014	40	24805	99220	297660	8456.25	3086531		
	<b>Total</b>							<b>62318.52</b>	<b>22746263</b>		
Hyderabad (37)	Patan Chervu (15)	114559	28076	93	26110	104440	313320	8901.14	3248916		
	Jeedimetla (14)	67032	17160	42	7207	28828	86484	2456.93	896779		
	Balanagar (8)	567996	139848					0	0		
	<b>Total</b>							<b>11358.07</b>	<b>4145695</b>		

Source: Compiled from the Primary Data Collection.

Note:

\*Ambattur includes Mannurpet (4), Patravakam (3), and Mannikkam Pillai St. (3)

~Thiruvottiyur includes Wimko Nagar (3)

Figures in parentheses are the number of respondents

HHs PWD+: Households Drinks Purchased Water (On an average 4 members per HHs)

PDPW: People Drinks Purchased Water

DWC lpd\$: Drinking Water Consumption Litres Per Day (3 litres per person daily)

HHEDWdRs.^: Households Expenditure on Drinking Water daily in Rupees (@Rs. 1.25 per (0.03 USD) Litre in Chennai & Hyderabad and @Rs. 0.83 (0.02 USD) in Bangalore.

HHEDWyRs.: Households Expenditure on Drinking Water yearly in Rupees (Rs.44 per USD in July, 2011)

# INERTIA AND PRACTICE CHANGE RELATED TO GHG-REDUCTION

Herman STÅL<sup>1,2</sup>

<sup>1</sup>RiseB, Research Institute for Sustainability and Ethics in Business

<sup>2</sup>Umea School of Business and Economics, Umea University, Sweden

## ABSTRACT

The gap between existing GHG emissions and the reductions science tells us are necessary to avoid “dangerous climate change”, is increasing. One reason for this could be the existence of inertia, a disinclination to enact radical change, for instance in GHG intense industrial practices. Utilizing an institutional perspective, this dissertation addresses GHG reduction by advancing an understanding of related inertia, as well as change, in industrial agri-practice. Two interrelated case studies, linked to policy making in the Swedish agri-field, are explored and the change ideas within this emergent logic are analysed. The results show that GHG reduction is used in support for convergent changes within the industry, for instance to motivate increased efficiency and yields. Hence, inertia is generated by the change orientation of potential institutional entrepreneurs. Moreover, there are influences, carried by different stakeholders, which further explain this change orientation.

*Keywords: GHG-reduction, agriculture, institutions, inertia, institutional entrepreneurship*

## 1 INTRODUCTION

Emissions of greenhouse gas emissions are contributing to global warming which introduce tremendous and unmanageable effects on ecosystems and societies alike [1], [2]. Today, a compelling scientific consensus maintains that climate change is occurring, and that it is attributed to anthropogenic emissions of GHGs [1], [2], [3].

The gap, between existing GHG emissions and the reductions science tells us are necessary to avoid “dangerous climate change”, is increasing [4], [5], [6]. One reason for this could be the existence of inertia; a disinclination to enact change, in GHG-intense practices [7]. While there is much in the literature to explain inertia at the individual level [8], [9], at the organizational level [10], [11] or at societal level [12], [13], [14], explanations that focus on the industrial level are lacking. This is troublesome as there are patterns of industrial activities that result in substantial GHG emissions and, if they were substantially changed, important reductions could be the result. Examples are for instance life-stock farming [15], air travel [16] and energy production. Activity patterns within agriculture are particularly important to consider given the double pressure of increasing food production, to feed a growing population, while at the same time substantially reduce GHG emissions [17]. Hence, this study focuses on the agri-food industry.

Although there are several theoretical perspectives that could be suitable for analyzing what cause inertia and change in industrial activities; institutional theory provides a particularly useful alternative [7], [18]. This is because unlike much business theory, based upon the assumptions within neo-classic economics, institutional theory does not assume that firms are rational, monolithic, actors but include collective ideas, values and beliefs in the analysis. Such factors are of particular importance given the role that deeply held beliefs and values play regarding issues such as climate change [19], [20]. Hence, institutional theorists view activities, causing GHG emissions, as meaningful to the actors involved, e.g., the producers within an industry. Drawing on Lounsbury and Crumley [21: p. 995] “activity patterns across actors that are infused with broader meaning” are defined as *practice*. In relation to its context, that is the particular industry in which the practice is performed, it is considered as meaningful and legitimate although outsiders may question it [22]. Hence, while GHG-intense practices such as life-stock farming is legitimate within the industry, the questioning by groups outside industry may over-time change the meaning that industrial actors prescribe to it [18]. Such outside

influences may enable institutional entrepreneurship [23]: activities aimed at changing practices. In light of these potential mechanisms to explain inertia and change in industrial activities, the purpose with this paper is to, from an institutional perspective, address GHG reduction by advancing the understanding of related inertia, as well as change, in industrial practice. This is achieved by exploring two change initiatives within the Swedish agri-food industry.

## 2 THEORETICAL FRAMEWORK

Originally introduced as an alternative to organizational theories based on the assumption of rational actors [e.g., 24], institutional theory has matured into a well-established theory rich with concepts and models. Three concepts are particular central for the analysis in this paper, i.e., *practice* [21], *institutional logics* [c.f. 25] and *institutional entrepreneurship* [23].

### 2.1 Practice

Institutional theory emphasizes the role that practices perform in relation to their context, e.g., the meaning and the values they are infused with by those concerned. Hence, practices such as fertilizing, cattle feeding, grazing or cultivating fields have meaning within the agricultural context. The more taken-for-granted, or diffused, a particular practice is within its context, the more of an institution that practice has become [26]. An institution is something that has endurance, a social fact that is maintained even if the actors within its context change [27]. Viewing practice as a kind of institution also means that the link to the norms and beliefs underpinning that practice; that “makes it robust”, are theoretically relevant [28: p. 880]. For instance, there are discourses that rationalize and infuse practice with meaning [22], [29]. Hence, it is not only that it is standard among industrial producers to perform activities in a particular manner; there are also systematic arguments for that particular practice.

### 2.2 Institutional logics

These arguments for practices are derived from the institutional logics that prevail in the particular industry. Institutional logics are basically defined in two broad ways in the literature that reveal different opinions of analytical level [25]. Friedland and Alford [26] originally introduced institutional logics to define those macro-structures, e.g., family, religion, the market economy, that in turn underpin field-level institutions. However, subsequent scholars have instead suggested that institutional logics are particular to “their” organizational fields [25], [31], [32]. They include for instance prescriptions regarding the type of actors that can be considered members of a particular profession [33] or within an industry [31]. I position myself closer to the latter camp, however institutional logics should not be seen as independent of broader societal influences, for instance the sustainability agenda in many industries are influenced by ideas of eco-efficiency and eco-innovations [34]. Such ideas are generic and influence the arguments and ideas within industry-specific logics. Following Battilana, Boxenbaum and Leca [35, p. 69] I define institutional logics as the more or less shared belief among industry actors regarding “the goals to be pursued and how to pursue them”.

The Swedish agri-food industry is characterized by the coexistence of conventional farmers and organic farmers, performing different practices and drawing on different institutional logics. Conventional farmers follow an industrial model; rely on chemical inputs, specialization, pursuit of efficiency and scale. Organic farmers, on the other hand, attempt to mimic nature’s way of producing, rely on renewable or reused inputs, small scale, diversification and multi-functionality. In relation to the different logics, practice is prescribed different meaning. A conventional farmer will typically criticize the “messiness” of organic production, where weeds are growing freely, while an organic farmer views synthetic fertilizers and pesticides as harming the environment.

Prevailing institutional logics explain the inertia that exists in a field, if new issues are unable to problematize the rationality behind practices. To understand these processes where a new issue emerges in an industry, I conceptualize this as an *emerging* logic. Such logic is characterized by a new goal; here GHG-reduction, and practice changes to address that goal.

## 2.3 Institutional entrepreneurship

To promote an emerging logic that is divergent; i.e., breaks with the prevailing logics within the agri-food industry, the literature argues that institutional entrepreneurship is necessary [35]. Such a break is here understood as establishing GHG reduction as a prioritized industrial goal, recognized by industrial producers, as well as promoting substantial change in prevailing practices. In particular agricultural practices identified as major emission sources need to be targeted for change, these include life-stock farming, cultivation of organogenic soils, imported soy and synthetic fertilizer use. This is also aligned with the propositions within so-called strong sustainability, where the scale of production, not only its eco-efficiency, needs to be addressed [36], [37]. At the industry level, reducing scale could be interpreted as abandoning practices that are particularly emission intense.

Since institutional entrepreneurs; actors that attempt and invest effort into pursuing divergent change [35], are subject to the same prevailing institutional logics that constrain other actors in the industry, particular enabling conditions are needed to precipitate them to act [31]. Here, the literature has just started to explore what conditions that enable actors central to industry networks to act as institutional entrepreneurs. Much of the previous literature has instead explored fringe actors, such as social movements or business entrepreneurs [23]. The problem with this type of change agents are that fringe actors have less influence within their industries and hence a harder time affecting prevailing logics. Central actors, such as regulatory agencies or leading producers, have both normative and coercive influence and participate in many of the channels for industry debate that affect prevailing values and norms [31]. Influences across industry boundaries, for instance from politics or science, could, by making central actors aware of, open and motivated to pursue divergent alternatives, constitute an enabling mechanism.

## 3 METHODS

### 3.1 Research setting

Like many industries, agri-food has seen an increase in change initiatives explicitly addressing climate change and the need to reduce GHG emissions [e.g., 38]. However, many development programs aiming at changing industrial activities strive to increase the intensity of production, fertilizer usage etcetera, particularly in Africa [39]. On the other hand, in ecologically modernized countries such as Sweden [14] one might expect a somewhat different mix of change ideas, e.g., of organic, multi-functional or small scale production, existing alongside conventional approaches [40], [41], [42]. For instance Sweden is within the global top when it comes to organic production [44]. As a part of EU CAP it has come relatively far in linking financial support to environmental performance. Hence, Sweden is an interesting empirical context where a diverse set of ideas regarding activity changes prevail.

### 3.2 Case studies

This study utilizes a case study-methodology to advance knowledge regarding inertia and change related to industrial practice. Case studies are useful for exploratory research, and given the lack of previous research with this focus, the approach is relevant [45]. In choosing cases the following considerations were made: change initiatives were considered suitable cases as inertia and change are likely to be most clearly noticeable within these. Change initiatives were defined as formal projects aiming to suggest how GHG reductions could be implemented in the agri-food industry. They had to go beyond simply mapping out the emission sources within the industry [46] and arrive at some form of suggestions of desirable changes.

Furthermore, the suggestions produced within a potentially interesting change initiative had to be coupled with ideas of how these suggestions were to be implemented. Institutional entrepreneurs are actors that mobilize resources for change. Thus institutional entrepreneurship involves putting resources on the line for promoting change rather than simply producing a list of desirable changes [35].

Two initiatives that appeared suiting, given the time frame from the study, involved the regulating agency responsible for the agricultural sector – the Swedish Board of Agriculture (SBA). SBA is the designated expert authority on agriculture; as such it investigates various agri-environmental issues. Such investigations are both carried out on request by the government and at SBA’s own discretion. Hence, SBA appeared highly relevant when it came to GHG reduction as it could be expected to respond to existing political pressure and rising interest that accompanied the climate change-issue in the Swedish political debate. Moreover, if politicians were looking to do something about GHG emissions from agriculture – they would likely turn to SBA.

The first case consisted of a SBA-led project to create at an Action Plan (AP): a policy suggestion regarding strategies to reduce emissions from agriculture. The strategies were supposed to be implemented from 2011 to 2020, but the action plan was also expected to constitute a tool for a long-term effort to reduce GHG emissions [47]. In comparison to SBA’s earlier attempts to deal with GHGs [46], the project was by far the most comprehensive attempt in terms of number of investigators involved and time invested.

The second case indirectly involved the SBA, by focusing on its co-owned agricultural extension service “Greppa Näringen” (GN). More specifically, the case consisted of the climate advice module within this service. GN is set up as a public-private partnership, shared between SBA and the Federation of Swedish Farmers (LRF). While the AP project involved stakeholders such as agricultural researchers, agency officials, LRF representatives and NGOs, the second change initiative involved agricultural advisors and farmers. Hence, the link to industrial practice was more direct, as those performing the practice, the farmers, were targeted directly. The GN case added stakeholders (and processes) within the agri-field, and hence another aspect of the institutionalization process could be explored.

The two cases are related as many of suggestions, e.g., to replace imported soy, from the AP became part of the module’s advice. This was considered an additional reason for selecting this case. This would make it possible to explore the process of implementing suggested change ideas. Other AP-suggestions would require more time to be implemented as they had to go through EU-CAP legislation process (see table 1).

*Table 1: case studies*

Case	Description	Organizational setting	Methods	Respondents	No respondents
#1	SBA led project aimed at creating an action plan to reduce GHG emissions	Swedish Board of Agriculture (state agency)	Interviews, document studies	Agency officials, policy makers, agricultural researchers, LRF-representative	18(2) *
#2	Climate counseling directed toward farmers	GN - Public-private partnership project	Interviews, observations, document studies	GN-staff; climate consultants, farmers	28 (4) *

### 3.3 Data collection

Qualitative methods were used in both case studies. Focusing on changes within institutional logics warranted a qualitative method that would capture the reflections and decisions of the respondents [48]. Institutional logics are abstract entities that are difficult to assess without providing respondents with a space to reflect and discuss particular issues, e.g., problems and potential solutions. Hence, qualitative methods were used because the relevant information was predominantly qualitative [49]. Semi-structured interviews were used as the primary tool for collecting data in both studies. All but three interviews were audio-taped and fully transcribed.

\* Number in parenthesis shows number of respondents interviewed twice.

In addition, for both case studies, archival data, i.e., reports and memos produced within the AP project and GN documents, constituted a valuable source of revealing how potential institutional entrepreneurship was evolving. For instance, in the AP project, minutes from a meeting with stakeholders displayed the ideas that were on the table at an early stage in the project. Moreover, to understand the political background relating to GHG reduction in general, and in particular the political process that had preceded the request for the AP, I explored various political reports (related to GHG reduction) produced after the 2006 election.

In case study 2 participant observations were also used. The purpose was mainly to verify that consultants' descriptions of their activities, and their talk, corresponded to what occurred during the visits. I participated in five such farm visits and in one group meeting between farmers and consultants. The counseling visits were audiotaped and fully transcribed; whereas field notes were taken during the group meeting (it was technically difficult to record). Moreover, it also enabled me to observe reactions from the participating farmers. This was important as it appeared from these observations that farmers varied in their interest of climate change, appearing sometimes even hostile to the issue, and preoccupied with their own economic concerns.

### **3.4 Data analysis**

In the analysis the policies were conceptualized as an emerging logic. The analysis focused on the content of the emerging logic, consisting of the change ideas put forth in the two initiatives. First, interview quotes were used to group data regarding the different change ideas. Interview quotes regarding e.g., organogenic soils, fertilization, cattle etcetera were grouped together. A second analytical step utilized the concept divergent change; operationalized as the introduction of new goals (GHG reduction), and new, or radically changed, practices to address those goals to an organizational field. In this step change ideas were analyzed to determine whether they represented examples of such change. Mechanisms that could explain those findings were then explored and discussed. Finally, the content of change is related to inertia and discussed.

## **4 CASE FINDINGS**

### **4.1 The AP project**

Empirically, the AP project consisted of SBA staff collecting, evaluating and writing up suggestions for policy to reduce GHG emissions from Swedish agriculture. Ideas were collected through contacts with researchers as well with producers and entrepreneurs in the industry. The evaluation was a rather closed process, where a small set of agricultural researchers participating through an advisory board had quite a large influence. During the project process, which lasted two years, some of the more controversial ideas were removed. For instance, an idea to reduce cultivation on organogenic soils, which was criticized both by the industry representative and a researcher, was dropped.

Table 2 shows the evaluated change ideas and the analysis of these ideas:

*Table 2: Descriptions of ideas within the AP project [50]*

<b>Ideas for low carbon agriculture discussed</b>	<b>Comprehensiveness of change</b>	<b>Effect on GHG emissions</b>	<b>Divergent/non-divergent</b>	<b>Involved agents' positions</b>	<b>Outcome of project process</b>
A. Carbon storage in farm land <ul style="list-style-type: none"> <li>• carbon storage in pasture land and other grass lands</li> <li>• carbon storage in cultivated soils</li> <li>• adding of bio coal</li> </ul>	Carbon storage in land for grazing would require little to no change in cattle grazing. Increased carbon storage in cultivated soils would entail several smaller changes in e.g., tilling practices, choice of crops, fertilizing etcetera. Adding of bio coal would also require a number of changes.	Grazing lands store too little carbon to reduce GHG emissions. Reductions from carbon storage in cultivated soils or the adding of bio coal were never quantified.	Towards non-divergent change	SBA investigator & MA dismissive, cattle producers hopeful	No immediate action – further inquiries suggested. Adding of bio coal more or less dismissed.
B. Decreased output	Would imply large changes in terms of ceasing production or shifting towards less intense production practices, e.g. organic farming.	Effects never quantified but are likely to be the most reliable way to reduce emissions even if some background emissions would remain.	Towards divergent change	SBA project management & MA dismissive	Explicitly removed, early on, by delimiting the purpose of the project.
C. Organic farming	Includes several changes in major activities at the farm, e.g., type of inputs, certification, pesticide use, etcetera.	Effects never quantified in the project but shown in other reports.	Towards divergent change	SBA investigators & researchers dismissive; advocated by environmental organizations and organic farmers	Explicitly removed by framing organic farming as a “package” of practices rather than as one single idea.
D. Optimizing use of nitrogen	Implies a number of smaller changes when it comes to how, when and where fertilizers are applied.	Effects positive but not quantified.	Towards non-divergent change	Promoted in MA’s written request, SBA investigators & researchers uncertain concerning effects.	No additional suggestions besides changes already implemented through current agricultural policy.
E. Changes concerning organogenic soils <ul style="list-style-type: none"> <li>• decreased intensity in cultivation</li> <li>• cultivation of energy crops</li> <li>• creation of wetlands</li> </ul>	If implemented, a large change for certain farmers, who would switch from cash crops to fodder crops. Effects on prior investments made and overall operations, i.e., several major activities, at those farms.	Effects initially thought to be substantive – put forth as the “big scoop”. Quantified in earlier project [46].	Towards divergent change	SBA investigators positive, researchers & industry representative protesting	Suggestion of creating a particular financial support for practice change was removed from the final report
F. Replacing imported soy	Would imply a number of smaller changes among several actors, e.g., input purchasers, dairy farmers and crop cultivators.	Quantified but small effects.	In between non-divergent and divergent change (small GHG impact).	SBA investigators, researchers & industry representative positive	Suggestion to set aside funds to finance joint projects with industry actors.
G. Changes in production of meat and milk <ul style="list-style-type: none"> <li>• increased yields</li> <li>• change feeding practices</li> <li>• food additives</li> </ul>	Would imply a number of unspecified smaller changes among cattle farmers.	Quantified but small effects.	Towards non-divergent change	Researcher forwarding ideas, SBA investigators positive	Suggestions to finance counseling directed towards dairy farmers.

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H. Increased energy efficiency	Would require a combination of changes from smaller behavioral changes to investments and replacements of energy systems.	Quantified effects depend on type of change.	In between non-divergent and divergent change (differs according to the magnitude of the changes implemented).	SBA investigators positive	Suggestions to increase counseling efforts directed towards farmers.
I. Production of renewable energy <ul style="list-style-type: none"> <li>• crops for biogas</li> <li>• crops for liquid fuels</li> <li>• crops for solid fuels</li> </ul>	Would require a change in what farmers cultivate e.g. having to learn about new types of crops, but also entering into other supply chains.	Quantified and substantial effects.	Towards divergent change	SBA investigators & researcher positive, indicated by MA strategies	Suggestions to increase and maintain different financial supports under new RDP.
J. Decaying of farm yard manure	Would require investments in biogas plants as well as entering into new supply chains. However would require small changes in agricultural practice.	Quantified and substantial effects.	Towards divergent change	SBA investigators positive, researcher positive, indicated by MA strategies	Suggestions to increase and maintain different financial supports when the current RDP expired.
K. Reduced tillage	Would affect at least one major activity, i.e. pesticide use.	Quantified but small effects.	In between non-divergent and divergent change (small GHG impact)	SBA investigators positive	Suggestions to include in existing counseling modules already offered to farmers.
L. Change in choice of synthetic fertilizers used	Would likely require very small changes.	Quantified but small effects	Towards non-divergent	SBA investigators positive, environmental organizations and organic farmers protesting against this as an alternative to organic farming.	Suggestion to include in existing counseling modules already offered to farmers; suggestion to finance projects together with industry actors to investigate possible certification/labeling.

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The analysis showed that the only divergent ideas suggested were the ones related to bioenergy production, which was less controversial as it did not entail any change in prevailing practice (see table 2). It would seem that SBA's propensity to engage in institutional entrepreneurship and promote divergent change was slight.

To explain this outcome, enabling mechanisms that could have precipitated SBA's institutional entrepreneurship were analysed. The analysis focused on extra-field influences, channelled by researchers and politicians that were interacting with the SBA staff. Previous findings suggest that influences from other fields can increase the scope for institutional entrepreneurship by increasing awareness, openness and motivation in relation to divergent ideas [31]. This analysis revealed that although extra-field influences increased the awareness of ideas, it also reduced the openness and motivation to pursue divergent alternatives. Scientists pointed to complexities and voiced resistance against certain suggestions; politicians refrained from setting clear reduction targets and appeared mainly interested in the cost-efficiency of suggestions. Thus influences exacerbated uncertainties and contributed to make the SBA less willing to try controversial and challenging path-ways.

Hence, two interlinked explanations for inertia were revealed. First, an actor central to its field, that possess instruments for implementation, generates inertia by showing a reduced propensity to act. GHG reduction is used to motivate convergent, rather than divergent, change within the field. Second, this can in turned be explained by the extra-field influences that the actor is subjected to, that reduce the openness and motivation to pursue divergent change.

#### 4.2 Provision of climate advice

Provision of advice could be an effective instrument for change within the agri-field as it could raise the capacity among farmers to comply with the regulation, i.e., by instructing the how to reduce their emissions. Moreover, as it is a participatory and voluntary instrument, it could be positively influenced by farmers who may have their own motives for pursuing a more climate friendly practice. As primary producers farmers are dependent upon climate and may therefore be more motivated to pursue climate mitigation.

The analysis of the case focused on the activities of the consultants, and analysed how they constructed and promoted change to agricultural producers. It revealed that, rather than promoting substantial change in practices, the climate issue was discursively constructed as "being about efficiency". Since efficiency already is a major concern for producers, consultants' discourse seems to support this prevailing focus, including various efficiency-increasing practice changes. This discourse provide a new meaning for prevailing practice; where efficient farmers are labelled as climate friendly, as well as a new meaning for efficiency-increasing modifications, as increasing climate friendliness (see table 3).

*Table 3: Approach to change within provision of climate advice [51]*

Approach to change:	Description	Themes	Example quotes
<b>Efficiency – not changing what is done but how it is done</b>	Production at the farm is taken as given but can always become more efficient.	T1: Emissions unavoidable due to, e.g., biological processes.  T2: Win-win situation  T3: Economic pressure  T4: Monetizing emissions	"You cannot criticize the production in any way but rather (have to) see its possibilities."

<b>Relabel – not changing what is done but how it is described</b>	Since Swedish farmers are highly efficient, they are already engaged in climate friendly production and there is no need to feel accused or depressed regarding the issue.	T1: Emissions are unavoidable	“So it is about finding those opportunities for improvement – or point at what they are already doing – already are improving – what the climate impacts of that are.”
		T2: Efficiency is the way	
		T3: Feel accused	
		T4: Already highly efficient compared to international competitors	

Subsequently, climate advice appeared less feasible as a policy instrument to reduce inertia and promote divergent change. Rather, there is a risk that the type of arguments and descriptions disseminated by the consultants may facilitate resistance, as responsibility for change is placed elsewhere.

The chosen approach to change can be explained by the influences from farmers, whose narratives are permeated with tales of economic hardship and profitability problems. Consultants are economically dependent upon farmers’ demand for their advice and are less prone to upset or challenge them. However, the focus on increased efficiency may constitute one, albeit small, part of substantially reducing GHG emissions from agriculture. From that perspective provision of advice could be effective to reduce farmer stress and thereby facilitating that they can continuously improve their efficiency.

## 5 DISCUSSION

The purpose with this paper was to, from an institutional perspective, address GHG reduction by advancing the understanding of related inertia, as well as change, in industrial practice. The analysis of the two cases does this by exploring the content of change promoted within policy in the agri-field, and by discussing the mechanisms that explain this particular outcome. The results show that the type of change advanced by the emergent logic appears convergent, rather than divergent. Modifications of prevailing practices, aligned with many pre-existing goals, are promoted rather than radical practice changes. Moreover, the new goal is not allowed to crowd out other goals, despite the seriousness of climate change. Subsequently, the emerging logic is less of a divergent break with the prevailing logics and more of a co-mingling containing changed, reused and new ideas aligned with pre-existing, as well as the new, political goals. Hence, GHG reduction is put forth as a new policy goal, albeit in relation with many of the pre-existing goals. At the micro-level some consultants engage in more comprehensive translations as efficient farming, resulting in high yields, is being relabeled as “climate friendly”. This is clearly a convergent change, were ideas that are motivated by efficiency increases are also aligned with the goal of reducing GHG emissions. In addition, it could be interpreted as a strengthening of conventional, rather than organic, farming as the former usually produces higher yields.

The results contribute to institutional theory, more specifically to debates concerning institutional entrepreneurship and institutional logics. Regarding the former, the paper elaborates upon the concept divergent change, as put forth by Battilana et al., [35] and shows how this concept can be used to analyze the content of change within potential institutional entrepreneurship. This is useful for trying to understand institutional entrepreneurship in fields where there are institutional complexity and change initiatives conflict or align with a plethora of goals [52]. In addition, the study contributes to the debate regarding embedded agency, by exploring enabling mechanisms described in the literature [23], [31]. The results show that although mechanisms put forth as enabling may reduce the constraint of logics prevailing within the field, they may nevertheless function as a constraint and limit the openness and motivation to pursue divergent change. Different professional groups, enjoying different legitimacy, affect how influences are refracted at the field level [51].

The study contributes to debate regarding institutional logics in the following ways: first by introducing the concepts emerging and prevailing logics the first paper shows how change in the

composition of institutional logics within a field can be analyzed. This is addressed through the idea of how logics can be related to each other through analysis of templates. Second, the link between institutional logics and practice is elaborated in the two last papers, where meaning and discourse is analytically to explore the link between practice and the logic that provide it with legitimacy. Hence, the papers contribute to the debate by showing how an outsider-driven issue is translated to fit with prevailing logics.

Moreover, the study contributes to the sustainable development-field by providing an analysis of inertia and change at the industrial level. It introduces institutional theory as a tool for shedding light upon this, and shows how divergent change can be used to capture the notion of strong sustainability at this analytical level. Through this approach, concepts such as practice, institutional entrepreneurship and institutional logics can be used to analyze change in other industries, also related to other environmental issues besides GHG reduction.

### 5.1 Limitations

One limitation is that the AP case study relied on interviews partly carried out in retrospect. Hence there are some difficulties in reconstructing the processes involved. Remedies included relying on different written material and cross-checking between respondents' accounts. The second case study could have benefitted from a broader sample of respondents that included more farmers, but this was difficult to arrange. Here, participant observations were utilized instead to capture the reactions and influence from farmers during the provision of advice. Overall, there are limitations to the conclusions that can be drawn from case studies, but there are also many arguments for choosing this methodology, as it provides a richer, more nuanced account of policy [53]. A general limitation stems from the emphasized focus upon meaning at the field level, which may obscure resemblances with more wide-spread ideas, e.g., eco-modernization. I have tried to remedy this by discussing these influences in the papers, but such considerations could have informed the data collection more.

Transferability of the results could be relevant/desirable, either to other domestic, GHG-intense, industries, e.g., transport, or to the agri-food industry abroad. Due to the differences between GHG-intense industries results cannot be easily transferred. Agri-food involves primary production, emissions are caused by biological processes and the industry has a lower profitability than other domestic industries. Technological innovation could for instance be more important in other industries were this can push down emissions. Similarities may however be found regarding the use of work machines, vehicles and fossil fuels. The agri-food industry in some modernized countries may resemble that of Sweden, although production is more intense for instance on the European mainland. There are differences in regulation and norms between countries concerning the environment although EU-CAP may slowly even out some of these. Many modernized agricultural production systems have coexisting organic and conventional producers, and perhaps more diversity tied to different food brands or regions. In Sweden, given the relative small size of the agri-food industry, this diversity is restricted.

Rather than transferring the results to other empirical arenas, the conceptual approach utilized in the study could be reused to analyze other industries. As discussed above, the link between divergent change and strong sustainability could be utilized to conceptualize other change processes, were logics addressing sustainability issues emerge. There is a need such a conceptual frame that can handle both the complexity that already prevail in fields, how this affects the translations of an emerging issue, what divergent change would mean, and what mechanisms that could enable such change.

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# NON-WOOD FOREST PRODUCTS VALUE ADDITIONS TO SUPPORT LIVILIHOOHS OF FOREST LIVING COMMUNTIES: W.R.T. ANDHRA PRADESH, INDIA

**Prof. Dr. Teki Surayya**

Professor and Head, Department of Management Studies  
Adikavi Nannaya University

(Autonomous body under Government of Andhra Pradesh, India)

Rajahmundry-533105, India. website [www.nannayauniversity.info](http://www.nannayauniversity.info)

Phone: 91-8121692457 and +91-883-2472616-17, email: [tekisunny@gmail.com](mailto:tekisunny@gmail.com),

## ABSTRACT

Eco-friendly technologies (EFT) and microfinance provide impetus for securing livelihoods of forest living communities (FLCs). Use of EFTs arrests degradation of forests besides enhancing people livelihoods. Forest living tribal people adopt unsustainable harvesting methods due to lack of access to EFT and unaware of EFT. Sustainable harvesting of forest produce by employing EFT reduced harming forest by 40% - 50%. Microfinance accessibility is essential for the adoption of EFTs at community level for value addition to Non-Wood Forest Products (NWFPs) that enhanced livelihoods by 200% to 300%. Main objective of the paper is to investigate how EFT and microfinance provides impetus to NWFPs Value Addition and securing livelihoods of tribal and rural area dwellers.

The government livelihood enhancement programmes/schemes should emphasis on extending greater accessibility to NWFPs value addition eco-friendly technology and microfinance rather giving monitory subsidies. With a Microfinance provision of Rs. 5,000 per member for group of 5 -7 members and federating such 5 groups that come to INR. 90,000/, and they can go collectively for adopting scientific honey harvesting EFT. The NPV of this interventional investment of INR. 95,000, works to be @ 10% - Rs. 1,10,000 and IRR was reckoned to be 29.5%. Similarly, with INR. 60000/- EFT for value addition to Bauhinia vahlii leaf plate making NPV of the project is at 10% discount rate is Rs.92364/- and IRR is 42%, are very positive financial indicatives. If four persons contribute Rs. 15000 each and take up the venture they will get benefit Rs. 6000, per annum for ten year, besides each member getting employment for 200 days in year Apart from making available required EFT and microcredit to forest dwellers for NWFPs base micro enterprise, the catalyst role can be played by some agencies / NGOs to provide the required market linkages for success. There has to be proper incentives / benefits can be provided by developmental agencies to FDs for adopting NWFPs value addition technologies by FDs. Market ensured value additions certainly enhance livelihoods of forest dwellers. Forests produce NTFPs, which contribute significantly to poverty reduction. Global efforts should be geared up to facilitate NTPF value additions at primary level and building capacity of forest dependents to undertake value additions, and also provide microfinance and access for formal financial system, to improve their livelihoods.

*Keywords: NWFPs, Tribal people, Value additions, Microfinance, Livelihoods, EFT*

## 1 INTRODUCTION AND STATEMENT OF THE PROBLEM:

India is a nation where 70% of its people live rural area and or in and around forest. Local resources considered to be lifeline of people to source their livelihoods. Lack of access to formal financial system and conventional technology based local resource value addition leaves people with inefficient output. Which in turn many a times lead to unsustainable harvesting of Non-Wood Forest Products (NWFPs) and environmental destruction? Besides this, these systems do not stimulate the local communities to undertake any substantial value additions to locally available natural resources like NWFPs. If these forest living communities (FLCs) are supported with efficient and effective NTFPs value addition technologies which are at the same eco-friendly. The FLCs are indeed motivated to

undertake NWFPs value addition. This in turn expected to increase income levels and quality of life. Apart from providing eco-friendly technology (EFT), which do not cause destruction to ecosystem and enhances yield level of harvested and value added NWFPs. In addition to this, it is equally necessary to provide accessibility formal financial system through instruments like microfinance. That would enable them to procure EFT for NWFPs and other local resources value addition, but also take care of maintenance of EFTs and meeting working capital requirement for value additions. Therefore main objective of the study is to investigate how Eco-friendly Technologies (EFT) microfinance can provide impetus to the application of EFT and securing livelihoods of tribal and rural area dwellers. Forests are major component of conservators of Environment. Employment of EFTs can arrest degradation of natural resources like forests besides enhancing livelihoods to the dependent people. Forest living tribal people sometimes adopt unsustainable harvesting methods due to lack of access to EFT and or partly non-aware of EFT. Forest dwellers cause destruction to the forests not for luxurious life but for their sheer basic needs of forest produce and economic gains. The harvesting of forest produce in sustainable manner by employing EFT will not harm the forest. However, for economic gains alternatives have to be found to shift pressure from forest. The role of EFT can not be denied. Need for accessibility to microfinance becomes essential for the adoption of EFTs at primary level to increase the value addition to Non-Wood Forest Products (NWFPs). Due to lack of access to microfinancial assistance to adopt EFT, thereby enhancing the income levels, the forest living communities continue to exploit the forests for their needs in unsustainable manner. Therefore, extending EFTs and microfinance to forest living tribal people is expected to enhance livelihood opportunities to them.

## RELEVANCE OF THE STUDY

1. Alternative means of livelihoods generation through adoption of EFT with access to microfinancial supportive system will divert the pressure from forest dwellers for their economic gains which will ultimately pave a way to save the forests and
2. Simple EFTs would help the forest living tribal people to increase income levels of local people.

## OBJECTIVES

Main objective of the study is to investigate how Eco-friendly Technologies (EFT) microfinance can provide impetus to the application of EFT in the process of NWFPs Value Addition and securing livelihoods of tribal and rural area dwellers. Hence, extending access to microfinance to forest living tribal people for adopting EFT will result in enhanced livelihoods to the tribal people living in forest and rural areas.

## RESEARCH METHODOLOGY

The study was conducted in three forest divisions of Andhra Pradesh. Three villages, in each forest division were selected on direction sampling technique base. Identified the main actors primarily engaged in harvesting NWFPs, explored the scope of EFT adoption with micro-financial assistance. Means of alternative income generation activities; NWFPs value addition adopting EFT and poultry farming, piggeries, bee keeping, dairy farming, handicrafts, leave plate making, sericulture, horticulture etc. augmented.

This research embodies both primary and secondary data sources. To collect the required primary data, a structured schedule was canvassed amongst the sample within the Universe. First, an extensive literature review on role of EFT and Micro finance system in upliftment of rural poor in general and its impact on socio-economic efficiency of forest dwellers economic development in particular was undertaken. In the next stage primary data collection were collected. Different methods such as PRA, discussion with people, review of secondary sources of data, questionnaire and surveys were used for data collection. Various sources of income generation and proportionate income accounted for NWFPs were estimated.

Secondary data on NTFP harvesting, consumption etc. were collected from the forest department and forest dwellers of selected Districts/Forest Divisions. This data include total income accounted from NTFPs to the forest dwellers survival. Apart from the above, field tours of the study area, were under taken by the researchers.

**Geographical area:** Three forest divisions, Eluru forest division, West Godavari District, Nirmal forest division, in Adilabad District and Atmakur forest division in Kurnool District were selected based on forest cover and activities of Microfinance in three regions of Andhra Pradesh state. Three villages, in each forest division were selected on direction sampling technique base.

**Selection of respondents:** Ten respondents in each selected village was the sample size by using random sampling technique. Moreover, mass meetings were held in selected villages to glean the required data.

## LITERATURE REVIEW

NWFP/NWFP/MFPs have been defined by FAO as all goods for commercial, industrial or subsistence use derived from forests and their biomass, which can be sustainably extracted from a forest ecosystem in quantities and ways that do not downgrade the plant community basic reproductive functions.

Minor Forest Products (Shiva et al 96) are forest usufructs obtained from fruits, flowers, leaves, twigs, bark, root and wood of plants (except timber) and other products from animal and mineral origins. They are grouped into following twenty-six categories as per the "Standard NWFP Classification and Documentation Manual"

Non-Wood Forest Products (NWFPs) are goods of biological origin other than wood, derived from forests other wooded lands and trees outside forests (FAO 1999)

## NWFP IMPORTANCE

For millennia, (Kim W. and Craig E., 1999-2001) non-timber forest products have been essential for subsistence and economic activities all around the world. Today, efforts to promote more eco-friendly goods use of forests has led to increased interest in NWFP collection and marketing as an instrument for sustainable development. NWFPs represent income opportunities from forests and forestry that do not involve cutting down trees for wood products. In forests with low timber production potential, NWFPs represent the major actual or potential source of income.

Domestication of forest species (Wickens-1991) the reported that for NWFPs for which there is a strong commercial demand, there is a strong commercial demand, cultivation or rearing of the wild species provides a sure way of relieve in pressure on natural forest stocks. At the same time it can provide income and employment in rural areas thereby improving rural welfare. Thus the NWFPs renders benefit to the forest in form of shifting pressure from forest to cultivation of NWFPs and thus enable them get employment and survival requirement. Which in turn will have positive impact on swiftly degrading environment that is dire need of the hour.

Timber products (FAO 1995) have overshadowed NWFPs as major commodities in modern times. However, the important contribution of Nontimber forest products to food and resource security and to financial well being is gaining increasing recognition. In fact, in some areas, the financial impact of NWFPs may be even greater than that of forestry. For example, a study in Zimbabwe revealed that small-scale NWFP-based enterprises employed 237,000 people, compared to only 16,000 employed in conventional forestry and forest industries in the same year.

Future developments (Hammet 1999) of NWFPs offer good potential for increasing income, expanding opportunities, and diversifying enterprises in rural areas. In local, urban, national and international markets, forest foods and medicines contribute substantially to national economic

growth. The NWFP sector is been estimated in over a billion dollars US, and is growing rapidly, perhaps faster than the timber industry. For example, the market for NWFPs has grown by nearly 20% annually over the last several years and the related herbal medicine market at a rate of 13-15% annually.

As per (Arnolds) the NWFPs plays vital role in a situation where population growing faster than per capita incomes, growth in non-farm employment reflects its function as a sponge; absorbing people unable to obtain employment or sufficient employment, in agriculture in labour-intensive low-return typical house hold based, activities such as collecting and mat making.

Non member forest products (FAO 1995) are basic cash and subsistence commodities in many cultures. Many local populations continue to have a fundamental reliance on NWFPs. In many cases these products are of far greater importance than the irregular cash income gained from commercial logging. While the preservation of NWFPs is fundamental to the maintenance and continuation of many traditional ways of life, deforestation and land development activities increasingly threaten these NWFP sources.

#### NON-WOOD FOREST PRODUCTS VALUE ADDITIONS:

Primary (C. Chandrasekharan, FAO) and downstream processing of NWFP adds value to the product, provides local employment and helps increasing the retention of value in the country of origin. However, in developing country situations, harvested products reach the market, local or foreign, either after some intermediate processing in the form of cleaning and grading or after primary processing.

Market oriented downstream processing, for export markets, is highly specific on quality and stresses on reliability of supply. But due to the lack of technology, skilled manpower, management expertise, capital for investment and marketing arrangements, coupled with inadequate information on resource and resource development, sophisticated or refined downstream processing is rarely done in most developing country situations

The processing taking place uses a range of technology and equipment - semi-mechanical or mechanical processes with equipment mostly locally fabricated to those with improved processing technology and equipment. The following are indicative of the range: crude extraction of palm oil from fruits of *Elaeis guinensis* using wooden presses; simple distillation for essential oil involving passing of steam through a charge of fresh or partially withered grass or leaves and condensing the vapours; making ornamental baskets, bags, etc. from palm leaves at cottage level; fairly sophisticated processing of wattle bark for producing tannin. There are also facilities established in the Africa region, especially in the bigger countries, for producing medicinal preparations/pharmaceuticals from phytochemicals, for manufacturing fragrances and toiletries using essential oils and so on. These productions essentially meet local and national demands.

Producers (L. Lintu edit) of NWFPs include the gatherers who collect the products from the forests. They also comprise those primary-level processors who buy the basic raw materials from the gatherers and convert them into primary products. Producers are also the ones who convert the semi-processed primary products to value-added, semi-finished products or to final consumer products at the successive stages of processing and marketing.

Individual producers/gatherers are numerous and small and thus have little power in the market place. Clay and Clement (1993) noted that, in the case of Brazil nut operations in the Amazon region, the gatherers cannot provide quantities of product that even a small manufacturer would need. The Xapuri Brazil-nut shelling factory, for example, produces 70 metric tons of Brazil nuts per year, but M&M Mars uses 70 metric tons of peanuts per 8-hour shift in Snickers candy bars. Individually, local Brazil-nut shelling cooperatives could never convince large companies like M&M Mars to use their nuts. By working together, producer groups can control larger market shares, exerting considerable influence over entire markets (Clay and Clement, 1993).

The (Paul V) most important NWFP of India are edible plants, fibres and flosses, bamboos, exudates (gums, resins and oleoresins), medicinal plants, essential oils, tans and dyes, wrapper leaves and animal products (e.g lac and silk). All usufructs/utility products of plant, animal and mineral origins except timber obtainable from forests or afforested lands are defined as non-timber forest

products (NWFP) or non-wood forest products (NWFP) or minor forest products (MFP). Services for tourism and recreation are also considered to be MFP.

NWFP in India are derived from over 3 000 species. According to the Centre of Minor Forest Products, 325 species producing NWFP are very common, commercial and have a base in major industry – they are exported or imported; 879 species are used locally; 677 species are potentially useful only locally; and 1 343 species can be described as "others lesser known". Nearly 60 percent of all the recorded forest revenue in India comes from NWFP. Most of India's 50 million tribal people receive a substantial proportion of their cash and in-kind income from NWFP (NWFP are estimated to generate 70 percent of all employment in the Indian forestry sector), while about 200 to 300 million village people depend on products from forests to varying degrees (Shiva 1995). The forestry sector, with 23 percent of the country's geographical area, provides 2.3 million person-years of employment. Of this total, 1.6 million person-years are related to NWFP. Most NWFP often provide employment during only part of the year because the processing of NWFP is still poorly developed (Gupta 1994).

#### METHODS NWFP OF VALUE ADDITION:

It has been observed by the researcher during the field survey that the value addition done by the villagers can be described in the following ways. Value addition can be done at various level in variety of ways, which can further classified into a) simple (human base) b) complex (technology base). Based on field survey observation the simple value addition methods are described as follows.

**Grading:** segregating the entire harvest (produce) into two to three categories taking account into size, color, weight, etc. which will enable the harvester earn better incrementally.

**Cleaning:** cleaning with water or cloth especially products up rooted herbs, gums etc. can fetch more price to the primary collector, which has practiced. e.g. in some of the survey conducted villages, it was observed that the primary collector rinsing the gum with washing powder, which is increasing the brightness of the color and purity thus can be rated and sold at grade I level which otherwise would have grade II could have fetch about 60% of the grade I price.

**Cutting:** some products especially medicinal herbs require proper sizing of the up rooted plant. This can be done at the level of primary collector, which tantamount to good value addition.

**Drying:** drying soars the life (longevity) of some NTFPs like, aonla, mohua, gum etc. this small effort helps the harvester reaping in multifold benefits.

**Boiling:** boiling is necessary to remove (detach) unwanted parts of an NTFP. e.g. aonla and bel by way of boiling inner seed of aonla and outer shell of be removed to extract required pulp which can be dried and than stored.

**Storage:** NTFPs generally occur on seasonally, but they are consumed throughout the year e.g. mahua flowers can be harvested 2-3 three months, if sold at immediately after harvest the price is obviously less due to high supply during the season. The price of it soars gradually. Hence one can store it till the price reaches an attractive level and then can be sold out. **De-seeding:** Removing seeds of some NTFPs like Imli is essentially whether at harvester/trader/consumer level. if this is performed at primary level that will enable the primary collector get more price and self employment for himself/herself.

**Threshing:** the inner pulp of mohua / vipa seeds and sal seeds, chironjee can be extracted by way of threshing the hard shell with stick or bamboo and thus getting desired output from these seeds that can be sold at better price.

**Stitching:** making mohal / adda leave plates for dining purpose can be done by way of fastening the loose leaves with the help wooden nails, the lion share of price spread accounted for laboring process. Alternately Adda leaf plates value addition can also be done with the help eco-friendly technology, sewing machine to stitch three to four loose small leaves to make big plate like leaf and compressor

machine to make an edge and laminate with paper (cost benefit analysis of has been done later in this chapter).

**Grinding:** powder/dust can be made from soap nuts/ seekakaiah and trifala (aonla / *Emblica officinalis* Gaertn, harra / *Terminalia chebula*. and behara / *Terminalia Chebula* Retz) shurn, with the help of stone grinder, which can fetch more prices to the local tribal NWFP collector. This processing can be undertaken grinding can be done at village level and an NGO can pack and brand it and thus can market it.

**Burning:** it is necessary to get the desired output from some NTFPs like sal seeds to remove wings of sal dried flower it is to burnt, like wise charcoal can be made from dead wood by of burning. Which will enable the villager to more prices.

**Microfinance:** It has been observed in the field survey that, distress on account of meeting acute necessities of the villager many a times compels the villager to resort to sell the NTFP at a throw away price. at this point of time if they are catered with micro finance as per their requirements, they can with hold the inventory till appropriate time to get better price.

#### VALUE ADDITION AT DIFFERENT LEVELS

It has been observed during the field survey that value addition to NTFPs usually takes at various stakeholder levels, who add value in different forms. The value additions that are taking place at different levels are described here below.

**Primary value additions (at local forest living tribal people level):** Proper (right period, time, correct method) harvest, removal (leaves, fiber, seeds, stems, etc.) of unwanted parts, cleaning, shaping, bundling, drying, grading, storing, boiling, peeling, pulping, threshing, cutting hedges, packaging, physical mixtures preparations (pickles, Trifala powder etc.) extracting, or preserving, selling at appropriate time, collecting and selling in bulk quantity of NWFP, branding etc.

**Secondary processing (at middlemen level):** grading, drying, storing, packing, purifying, threshing, transportation, cold storage, warehousing.

**Consumer industry (industry level):** processing, adding essences, mixing, packing, and separating by-products, wrapping, branding etc.

#### RESULTS AND DISCUSSIONS:

Cost benefit analysis of nannari (*hemidesmus indicus*) value addition with eft

As exhibited in 1 Sarabath Gaddalu (roots) harvest and collection: a tribal person male or female on an average can harvest 3 to 4 kg per day. The harvested root to be dried in the sunlight for few days, loss on account moister is reported to be 40% to 50 % so that net dried root is estimated to be 1.925 (Kg) or approximately 2 kg. An average price tribal person gets is Rs. 125 (GCC price is Rs. 100 per kg and traders / distance market price Rs. 250). Assuming a tribal person sells 50% of his stock to GCC and remaining 50% he/she sells in the distance market place. A group of four tribal people can start the value additions to

Table 1 Sarabath Gaddalu (SG) / Nannari (*Hemidesmus indicus*) cost sheet

Particulars	Amount Rs.
Cost of raw material (SG) @ Rs.125 kg	125
Sugar @ Rs. 40 x 2	80
Labour cost (boiling)	25
Prime cost	230
Overheads (bottle, water, fuel for boiling)	20
Cost of production	250
Selling and distribution overhead @ Rs 10 per 1 bottle	30
Cost of sales	280
Profit / mark up	200
Sales @ Rs. 140 per1 liter bottle X 3	480

Source: field survey 2013-14.

*Hemidesmus indicus* to make bottled juice that gives them an incremental (480 – 255 (125 + 80 +20+30) benefit of Rs. 235 per kg *Hemidesmus indicus* value addition which will substantially increase income levels and quality of life of the tribal people.

**Cost benefit analysis of processing value addition to gooseberry (*emblica officinalis gaertn.*) as chewing gooseberry (*pachak aonla*):**

*Aonla, Emblica Officinalis*, is (I.S. Singh et al.) commonly known as "Indian Gooseberry" which is Indigenous to India. It has been used as a valuable ingredient in various medicines in India and the Middle East for centuries. It is the best of all fruit acids and the most useful for general health improving. Aonla is valued for its mineral and vitamin content. Aonla is the highest natural source of Vitamin C, which is reported to be a heat stable form and is not disturbed by processing.

Aonla fruit is (Jain, S.K et al.) an important indigenous fruit of India. It is highly nutritious and therapeutically important. Five varieties (Banarasi, Chakaiya, Francis, Kanchan and Krishna) of Aonla were evaluated for their productivity, physio-chemical characters and organoleptic quality of the products. The variability studied indicated the possibility of selecting varieties suitable for processing of Aonla fruit. Kanchan and Krishna were found suitable for candy and Jam and Banarasi for drying. Chakaiya variety showed desirable attributes and higher score for pickle, chutney and syrup.

Aonla extract is prepared from Aonla fruit by means of hydro-alcoholic extraction process. This extract retains all the qualities of Aonla. It helps in rebuilding new tissues and increases the red blood cell count. It is also helpful in prevention of respiratory disorders and effective in controlling diabetes. Aonla extract is a general health tonic!

Juice from blanched and unblanched *Emblica officinalis* fruits was extracted by crushing and pressing or by using centrifugal juice extractor. Blanching significantly increased juice recovery and the juice had higher values of TSS, acidity and tannin content but lower vitamin C content. Mixing water with fruit in 1:1 ratio increased the juice recovery significantly but diluted the juice. Extraction from blanched segments of Aonla, without mixing water and the use of centrifugal extractor, was found to be the best among all the methods investigated.

**Financial Reckonings:** financial reckonings for setting a micro-enterprise unit for undertaking value additions to Aonla with eco-friendly technology have been outlined here. The availability of Aonla is good in Atmakur forest range, Andhra Pradesh and hence conveniently such micro-enterprise units can be commenced at village level. As a first step in the value addition process, Aonla is to be boiled, dried and deseeded. The dried and deseeded Aonla will be made into small pieces then will be mixed with spices made with black pepper, ginger powder and Ajwain (cumin seeds). It is envisaged that this mixture will be packed in small pouches like Pan Masala Pouches and will be sold through the Pan Shops. However, for the project, the project team at village may contact the agents for bulk supply through a government agency or NGO as partner in the marketing the Aonla pouches. The final price for the pouch estimated to be Rs. 2 per Pouch of 8 gm for end user.

A small pouch-making machine along with some utensils and required paraphernalia is estimated to cost about Rs. 55,000/-. The temporary shed will also cost around Rs.75, 000. Thus with the initial investment of Rs.1,30,000, on fixed asset (packing machine + shed) such unit can be started. It is estimated that in a month (15 working days) about 40,000 – 45,000 pouches can be packed. Considering the two-month availability of Aonla, total pouch produced will be approximately 75,000. The village level Self-Help Groups (SHG) can easily take-up this kind of processing unit. It is assumed that the boiled, dried and deseeded Aonla (by the local tribal communities themselves) will be purchased at the rate of Rs. 25 per Kg. by the project. It is estimated that every day about 20 Kg of Aonla can be processed.

Production of chewing Aonla per day (Mixing , packing, marketing etc.)	20 Kg
Per month production (15 days per month X 20 kg X 2 months)	600 Kg
<b>A. Costs to be incurred for making chewing aonla pouches</b>	
Purchase of raw martial (boiled, dried and deseeded Aonla) 800 Kg @ Rs. 25/Kg	20,000/-.
Spices (black pepper ginger powder and Ajwain) 100 Kg @ Rs.85/ Kg	8,500/-
Labour cost 2 mandays x 15 days x 2 months @Rs 200 per manday	6,000/-
<b>Prime cost</b>	<b>34500/-</b>
Depreciation charge @ 10% on 1,30,000	13000/-
Factory cost	<b>47500/-</b>

Overheads, electricity, Packing material, labour transportation and marketing expenses 60,000/-

Total cost per season (Annum)

**B. Benefit Analysis**

Total Production (2 Months) 700 Kg.

(Aonla wt. 600 kg. + Spices 100 kg)

Total Pouches (each 8 gm weight) Packaging in two months 78,750 Nos.

(Considering approximate 10 % Processing loss)

Expected revenue realized = 78750 pouches @ Rs.2 per pouch 2,36,250/-

C. Net Cash-in flow per season (annum) (A- B) = **1,28,750/-**

Net Present Value @ 15 %

Net Present Value @ 18%

Internal rate of return

Payback period

From the above reckonings it can be inferred that the project has Net Present Value @ 15 % Rs. 11,5000, and @ 18% Rs. 4,45,243. Internal rate of return = 98.9 %. Payback period 1 year 1 month, which is very reasonable for a rural enterprise like this. Apart from generating 60 mandays employment the project also enhances the economic gains of the forest living tribal people. If in a particular area / region 4 SHGs can pool Rs. 33,000 each and undertake the venture beside getting employment the venture will pay off Rs. 42916 p.a. for each group. If one SHGs has 10 members then each member require Rs. 3300 microfinance contribution that will pay off Rs. 4291 approximately p.a. at least for next 10 years. This will in turn stimulate the forest dwellers to adopt sustainable harvesting of so as to ensure the quality of the end product (pachak aonla). All these eventually lead to conserving the environment directly or indirectly.

**Bauhinia vahlii (Adda) leaves value addition:** In the survey area, FLCs are harvesting adda leaves and selling leaves unprocessed form, @ Rs. 10 for one bundle of 100 leaves. With interventions from concern Government Department training to FLCs for making leave plates with the help of compressor (eco-friendly technology) machine having value Rs. 75,000 (assumed). The incremental cost benefit of this technological intervention is as follows.

**Incremental cost benefit analysis:**

Before value addition selling price of 200 Adda leaves bundle was Rs. 20/-

After value addition selling price of 100 Adda leave plate bundle is Rs. 130/-

(for making one adda leaf plate , two add leaves are required)

Cost of value addition for one bundle/unit of 100 leave plates: Rs.

a) Cost of raw materials (adda leaves) 20.00

b) Labour (stitching, compression, packing etc.) 40.00

I) Prime cost ( a + b ) 60.00

c) Electricity, wrapper, old news paper, plastic lamination etc. 18.00

II) Factory cost ( I + c ) 78.00

d) Selling and distribution expenses (Transportation and handling charges etc.) 12.00

III) Cost of sales (II + d) 90.00

IV) Profit (incremental benefit\*) 40.00

V) Sales (one bundle/unit 100 leaf plates) 130.00

Incremental benefit = (Selling price - Total cost) Rs. 130 – 90 = 40

Cash flow per annum is Rs. 40 x 4 x 200 = Rs. 32,000/-

It can be inferred from the above analysis that, if, on an average a person can make one unit/bundle per day he will earn Rs. 80 (incremental benefit Rs. 40 + labour charges Rs. 40). The same task can be also performed by a SHG group of consisting 4 members and one machine can provide sufficient work per day for all 4 members enable the group to earn by and large Rs 320 per day. And the Adda leaves available most part of the year in the study. However assuming in a year there would be maximum 200 working days and the total incremental benefit would be (Rs. 40 x 4 x 200) Rs.

32,000 p.a. Assuming the project lasts for 10 years, payback period of the project is reckoned to be 2 year 3 months , NPV @ 10% Rs. 1,10,570 @ 15% Rs. 74435, and IRR is 41%, which is very reasonable investment in any rural enterprise. If these four members contribute Rs. 18,750 each and take up the venture they will get Rs. 8000, per annum for the contribution of Rs. 18,750/-, besides providing employment. This in turn will help in conserving the forests, sustainable harvest of add leaves and also contributing to get enhanced livelihoods to FLC. However it was observed in the field surveyed area (Lakshmipur village, Kadem range) that an adda leaf plate making unit / project with compressed machine (EFT) was commenced by a woman but the project could not survive for long, due to lack of market linkages and change in the consumption trend as the consumers have been switched over to using paper / plastic plates, which are not environmental friendly. This change in consumer preference for paper / plastic plates largely unaware of environmental repercussions of plastic plates consumption and easy accessibility to the consumer. Hence, it is suggested that, the concerned Government agencies not only provide technology and training but at the same time support the FLCs in providing market linkages to sell the value added NWFPs including adda leaf plates and cups. A publicity campaign in mass media (print and audio-visual) to create awareness and / or educate the consumers / people about repercussions of plastic consumption and benefits of using leaf plates / cups that not only good for the health and welfare of the consumer but also helps the FLCs to increase their income level through sale of leaf plates and other NWFPs.

All above inferences are made assuming that there would be market available for the total quantum of output. But it is “easier said than done”. Many a times the most vulnerable problem of the rural enterprise is availability of the market for its finished products. Therefore apart from the making available required micro credit to forest dwellers for NWFP base micro enterprise, the catalyst role has to be played some agencies/ NGOs to provide the required market linkages for success. It has been observed in the field study that in some villages Adda leaf plate making compressor machines have been installed, training was imparted and FLCs were adding value in form making leaf plates. However due to lack of market linkages to the value added leaf plates and emergence of plastic and paper plates in the market consumption of leaf plates has been declined that has been deterring FLCs in making leaf plates with the help of EFT (compressor machine). But FLCs are keen to revive the already established leaf plates making microenterprise and commence new units for leaf plate making subject to, they are supported with market linkages from time to time. Hence, it is suggested that the concerned Government agencies should evolve a vivid leaf plates and other value added NWFPs consumption promotion mass media camping and push demand for the value added NWFPs. To provide cost effective market linkages committed NGOs may be roped in collaboratively to ensure the market for FLCs value added NWFPs.

#### **Seeded Tamarind ( Tamirindus Indica Linn.)**

In A.P. FLCs are harvesting tamarind from the forest areas during its season. tamarinda fruit may also be eaten raw. Different stages involved from harvesting to marketing of tamarind that are outlined below:

**Stage I:** This stage can be possible at the small village level, it includes:

**Harvesting:** a small group of friends and family members go for gathering. One person of the group climbs on the tree and others remain on the ground. The person, who climbs the tree, strikes the fruits with the long sharp stick while the other persons standing on the ground collect that fruit. Normally a male member climbs the tree and the female members gather the fruit from the ground. After gathering they put the fruit into the gunny bag or baskets and take it to home.

**Fiber/shell Separation:** At the home, ladies and children remove the shells of the fruit.

**Drying:** After removing the shells, the tamarind is exposed to sun for drying for about one week, one or two members of the family are engaged in the drying of the same.

**Stage II:** This stage can be possible at the medium village level, it includes:

**Deseeding:** tamarind is then deseeded, i.e. some times FLCs add value by way of removing the seeds of the tamarind before selling in the market. Deseeding is one of the primary value additions process.

**Storage:** The storing of the deseeded is done till the fruit is ready to be disposed in the market (weekly bazars) latest technologies like cold storage are used at different places to keep tamarind colour intact and enhance the value.

In the field survey conducted in the Atmakur forest division the local forest living tribal people are harvesting tamarind, mostly selling without value addition (with hard shell) 10 kg basket @ Rs. 250 (@ Rs 25 kg). Whereas local Girijan Cooperative Corporation (GCC) procures value added (removal

of hard shell and deseeded) tamarind (flower variety) @ Rs. 50 kg and that of distance market price is about Rs. 75 kg. An innovative technology like sharp knife instrument be evolved and provided to tribal people to remove hard shell and deseed. Impasto facto (thus) income level of tamarind harvesting tribal people two to three times, which in turn improves the quality of living with the increased level of income.

#### **Value addition with EFT to Ippa puvvu (*Madhuca latifolia*)**

*Madhuca latifolia* is available in surveyed villages, small to medium quantity available and there is not much value addition is being done. In fact FLCs can undertake the value addition as discussed here;

#### **Processing**

*Madhuca latifolia* is one of the NWFPs of the study area. The points that are to be noted about the processing of *Madhuca latifolia* flowers and fruit by the FLCs of the study area.

#### **A. *Madhuca latifolia* flowers (*Vippa puvvu*):**

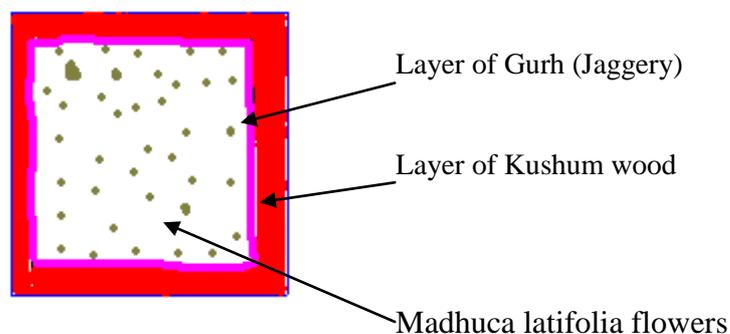
- The processing of the *Madhuca latifolia* is generally associated with women and children.
- The flowers are spread out in the sun for only 2-3 days for drying because they would like to sell out as earlier possible to earn cash income. Some FLCs who are not in hurry and who want better price will make little more value addition in form of drying for more day's i.e. 5-6 days and cleaning anther.
- Drying is done to reduce the moisture content in the flower and to check the spoilage in storage.

#### **Trading**

- The *Madhuca latifolia* flower and fruit are one of NWFPs available in the study area. It has been observed this NWFP is sold to GCC @ Rs. 14, per kg and local traders @ Rs. 20 – 22 per kg.
- After 2 or 3 days drying the *Madhuca latifolia* flowers, primary collector sells to the village shopkeeper or trader without grading it in any way.
- *Madhuca latifolia* flowers are harvested at a time when the villagers are hard pressed for food and money in summer (March – April) season. Therefore, in order to meet there immediate

#### **Box**

The middlemen purchase *Madhuca latifolia* flowers from FLCs The price is dependent on the quality of flowers. Generally peoples were selling flowers 2 days after ground collection. Middlemen collect small quantities and store the flowers after completely dried. The middlemen remove all the anthers from the flowers. This is a sort of value addition. The middlemen make a temporary big chamber for storage of *Madhuca latifolia* flower. The structure of temporary stores rooms is shown the below figure (*Mishra and Teki - 2002*).



\*100 quintal *Madhuca latifolia* mixes with 1-quintal Gurh Jaggery

\* Kushum wood use of inside the room

needs, they sell the produce at low price to the middlemen, just after harvest.

- It is reported that FLCs get about 30% price of the consumer price, the remaining 70 % goes into the pockets of the middlemen.

As shown in box, *Madhuca latifolia* flowers storage can be done in wooden box that can be made with local available wood is an example of indigenous EFT. With the help of small amount of Rs.200 microfinance assistance to procure Jaggery (Gurh) and prepare wooden structure. Value addition by way of storing *Madhuca latifolia* flower for two to three months in the wooden box, income level / livelihoods level of FLCs can be increased by somewhere 45% - 55%, when sold without the said value addition.

*.Value additions to Gum (Sterculia urens)*

Gum is one of the valuable NWFPs available and harvested in the study area. It has been observed that there are different grades of gum available in the study area.

Grade- I

The colour of this type gum is purely whitish with clean without any dust, bark, small stones etc. This gum is harvested from fresh deep blazing, which may damage the tree.

Value Addition:

FLCs are taping the gum from forest and drying it for about three days and thereafter it is sold to GCC. But little value additions like washing with washing powder for getting white colour, which will fetch them better price. It has been observed that washing of gum results in glazing white color.

**Separating impurities:** when FLCs separate impurities like dust, tree bark etc., from the harvested gum. This will help them in getting little extra (Rs. 50 per kg) after removing impurities, this value addition is not reducing significant amount of weight of the gum. Therefore it will be resulting in net gain to the FLCs in terms of money.

Grade II

The color of this type of reddish along with mixed other waste materials like small particle of soil, tree bark etc. This gum is harvested by shallow blazing, and/or old blazing that may not damage the tree. No value addition is made to the grade II, the FLCs sell it as it is harvested from the tree. The possible value addition can be purifying the gum by removing dust, bark etc., that may fetch Rs. 40/kg extra, but this may be offsetting with reduced weight of the gum. That is why value addition process is not giving any impetus to the primary collector.

*Table.2 : Prevailing Purchasing and selling price of selected NWFPs in the study area*

Name of NWFP	GCC procurement price (Rs.)	Local trader procurement price(Rs.)
Honey	130 per liter	150 per liter
<i>Tamarindus indica</i>	50 per kg	55- 60 per kg
Gum white	270 per kg	-
<i>Gum light white</i>	220 per kg	-
<i>Bauhinia vahlii leaves</i>	-	10 per kg
<i>Emblica officinalis</i>	-	15 per kg
<i>Terminalia chabula</i>	-	
<i>Terminalia bellerica</i>	6 per kg	
<i>Madhuca indica Flowers.</i>	10 per kg	12 per kg
<i>Madhuca indica fruit</i>	14 per kg	

Source: GCC price list (2013) and field survey 2014

Table 2, NWFPs prevalent selling price at FLCs level in the study area, gcc procures most NWFPs that are being harvested by FLCs. as seen in the table the gcc procurement price less than the local traders price and local traders some time going to FLCs door to door that gives easy access to FLCs to sell their NWFPs. but local traders procure select item as per his / her requirements.

*Table 3 Annual livelihoods amount in terms of money and family size of forest living tribal household in selected forest ranges in the study area*

Name of the range & (Division) / District	Minimum amount of money for supporting livelihoods per household *	Family size (No. of persons)
Atmakuru (Atmakur) / Kurnool	36500	4.33
Pembi (Nirmal) / Adilabad	38600	4.54
( W) / West Godavari	37500	4.25
Mean	37533	4.37

*Sources: Estimated based on field survey 2002*

\* *Minimum amount of money required for supporting livelihoods of forest living tribal people interns of money includes minimum cash out flow required for their survival consisting of all expenses towards three square meals for the family, clothes, groceries, shelter, some traditional essential medicines etc. and the equivalent amount of the agriculture/NWFP produce consumed by the respondents from their own sources which worked out for family. subsidized rice has been factored @ Rs. 25 per kg)*

To meet the Tribal people livelihood amount the sources of income include, income NWFP harvest and sale, agriculture labour, government works labour, and other sources including own agriculture output consumption. As has been calculated above table 3, the forest dwelling tribal people undertake sustainable and eco-friendly based technology supported NWFPs value additions, income levels can be enhanced substantially and quality of life can be improved. It in turn also fills the gap between income and expenses, thus lifting the poor forest living tribal people out of poverty.

*Table 4 Various components of equivalent livelihood sources*

Name of the range and (division) / District	Income from NWFP		Income from agricultural sources (including subsistence)		Income from MGNREGA		Agriculture labour and other source		Total Rs.
	Rs.	%	Rs.	%	Rs.	%	Rs.	%	
Atmakuru (Atmakur) / Kurnool	7154	19.6	13797	37.8	7811	21.4	7738	21.2	36500
Pembi (Nirmal) / Adilabad	7801	19.7	13587	35.2	6832	17.7	10380	27.4	38600
Polavaram (Eluru) West Godavari	7800	20.8	13612	36.3	8175	21.8	7913	21.1	37500
Mean	7585	20.0	13665	36.4	7606	20.3	8677	23.6	37533

source: field survey 2014.

From the table 4 it is inferred that average amount of money required for FLCs in the study area to obtain three square meals and other necessities including purchase of two to four pairs of new cloths in a year, celebrating important festivals, Pongal, Diwali and other endemic festivals. out of total average amount Rs. 37533 required, 36.4% amount is accounted from agriculture including subsistence, followed by agriculture labour accounting for 23.6%, and NWFPs and MGNREGA works accounting for about 20% each. The amount of money being accounted from NWFPs harvest and sale can be increased by way promoting NWFPs value additions using EFT, so that dual objectives of providing enhanced livelihood opportunities and conserving the forests for achieving overall objective of sustainable development.

**Status of microfinance practices in the study area:** an attempt was made to ascertain the status of microfinance practices that are prevalent in the stud area, that are outlined in this part of report.

*Table 5 sources for microfinance of FLCs in the study area*

Name of the range	Atmakuru (Atmakur) Kurnool		Pembi (Nirmal) / Adilabad		Polavaram (Eluru) / West Godavari		Total	
	Score*	% of score	Score*	% of score	Score*	% of score	Score*	%
Moneylender	17	25.0	21	30.9	16	23.9	54	27.8
Banks/ Government	06	9.0	08	10.3	07	10.4	12	6.2
SHG	35	51.0	27	42.6	29	43.3	91	46.9
Relatives and friends/others	10	15.0	12	16.2	15	22.4	37	19.1
Total	68	100	68	100	67	100	194	100

*Score\*- Individual responses for a particular source for meeting microfinance requirement including multi responses.*

From the above table 5 it can be interpreted that, in Atmakur range, SHG is accounting for 51% of the total microfinance needs, followed by money lender accounting for 25%, relatives and friends / others 15% and the rest 9% is accounted from Banks/Government schemes. in Pembi range, SHG is accounting for 42.6% of the total microfinance needs, followed by money lender accounting for 30.9%, relatives and friends / others 16.2% and the rest 10.3% is accounted from Banks/Government schemes. In Polavaram range, SHG is accounting for 43.3% of the total microfinance needs, followed by money lender accounting for 23.9%, relatives and friends / others 22.4% and the rest 10.4% is accounted from Banks/Government schemes. In the entire study area, the SHG combined accounting for 46.9% share, money lender is also accounting for 27.8%, followed by relatives friends / others - 19.1% and the rest accounting for 6.2% from banks / government schemes. It can be concluded that gradually the SHG groups are proving to be better a source to finance the forest dwellers' microfinance needs and thus paving an exit path to the moneylenders.

*Table 6 Purpose of Microfinance required for FLCs*

Name of the range	Atmakuru (Atmakur)Kurnool		Pembi (Nirmal) Adilabad		Polavaram (Eluru) / West Godavari		Mean value of study area
	Score	% of Score	Score	% of	Score	% of Score	
Purpose							

				Score			
Subsistence	18	21.7	21	22.3	17	21.3	21.8
Health	22	26.7	26	27.7	19	23.8	26.0
Education	09	10.8	05	5.3	04	5.0	7.0
Pilgrim	10	12.0	13	13.8	12	15.0	13.6
Marriage	15	18.0	19	20.2	17	21.3	19.8
Others	9	10.8	10	11.7	11	13.6	12.0

(source: field survey 2013-2014)

From the above table 6, it can be inferred that the major purpose of microfinance to the FLCs is for health purpose which is accounting for 26%, followed by subsistence accounting for 21.8 %, and marriage accounting for 19.8%. People also borrow for pilgrimage, accounting for 13.6% and other purposes like observing rituality etc. accounts for 12%.

The researcher has interacted with FLCs and gathered the impressions about the extant NWFP value addition practices, the extent of awareness about the emerging NWFP value addition technologies, their readiness to undertake various NWFP value additions, use of EFTs and the associate benefits/problems in activating these EFTs. Though the impressions gathered seems to be little subjective.

### CONCLUSIONS AND SUGGESTIONS

As was observed in the field survey of study that, value addition to NWFPs normally commences at FLCs level itself ( removal of unwanted parts like leaves, stems twigs etc., cleaning, shaping, bundling, drying, grading, storing, boiling, peeling, pulping, threshing, cutting hedges, packaging, physical mixtures etc. And also extracting, or preserving, selling at appropriate time, collecting and selling in bulk quantity of NWFP these type primary value additions conventionally being done by FLCs to bring harvested NWFPs to salable condition). These small steps should have enabled the FLCs to reap significant financial gains by way of high price for their NWFP inventory. But due to poor/non accessibility of formal financial system, they are compelled to trade such primary level value added products at very low price to local NWFPs traders cum money lenders due to timely and easy accessibility of credit requirements from them. Hence, it is suggested that the FLCs should be supported with access to microfinance assistance and EFT availability and capacity building of the FLCs sustain viable running of EFT for NWFP value addition.

Evolution and distribution NWFP value- addition EFTs is going to be crux of the development of FLCs. This has to be supported with the accessibility of microfinance to make development of FLCs a reality. However reduction in the availability of NWFP is an impediment of the development process. NWFPs value additions should considered as vivid strategy and EFT evolution alone may no bring the success unless evolved EFT dovetailed with microfinance assistance for adopting such technology. FLCs should be incentivized by way of conducting capacity building programme, reorganization, market linkages and logistics support for undertaking NWFPs value addition with the help of EFT.

*Hemidesmus indicus* / Sarabath Gaddalu (roots) value addition unit being undertaken by a group of four tribal people to make bottled juice that gives them an incremental benefit of Rs. 235 per kg *Hemidesmus indicus* which will increase income levels and quality of life of the tribal people.

It can be concluded that with an investment of Rs. 33000 for value addition to aonla (gooseberry) in form of making chewing aonla (pachak aonla) tablets and packing project that has Net Present Value @ 15 % Rs. 11,5000, and @ 18% Rs. 4,45,243. Internal rate of return = 98.9 %. Payback period 1 year 1 month. Apart from generating 60 mandays employment is being generated thus it enhances the economic gains of the forest living tribal people. If in a particular area / region 4 SHGs can pool Rs. 33,000 each and undertake the venture besides getting employment the venture will pay off Rs. 42916 p.a. for each group. If one SHGs has 10 members then each member require Rs. 3300 microfinance contribution that will pay off Rs. 4291 approximately p.a. at least for next 10 years. This will in turn stimulate the forest dwellers to adopt sustainable harvesting of so as to ensure the quality of the end product (pachak aonla). All these eventually lead to conserving the environment directly or indirectly.

It is concluded that FLCs for making leaf plates with the help of compressor (eco-friendly technology) machine having value Rs. 75,000 (assumed) investment, on an average a person will earn Rs. 80 (incremental benefit Rs. 40 + labour charges Rs. 40). The same task can be also performed by a SHG group of consisting 4 members and one machine can provide sufficient work per day for all 4 members enable the group to earn by and large Rs 320 per day. Assuming in a year there would be maximum 200 working days and the total incremental benefit would be Rs. 32,000 p.a. project is expected life is 10 years, payback period of the project is reckoned to be 2 year 3 months , NPV @ 10% Rs. 1,10,570 @ 15% Rs. 74435, and IRR is 41%, which is very reasonable investment in any rural enterprise. If these four members contribute Rs. 18,750 each and take up the venture they will get Rs. 8000, per annum for the contribution of Rs. 18,750/-, besides providing employment. This in turn will helps in conserving the forests, sustainable harvest of add leaves and also contributing to get enhanced livelihoods to FLC. However it was observed , due to lack of market linkages and change in the consumption trend as the consumers have been switched over to using paper / plastic plates, which are not environmental friendly. This change in consumer preference for paper / plastic plates largely unaware of environmental repercussions of plastic plates consumption and easy accessibility to the consumer. Hence, it is suggested that, the concerned Government agencies not only provide technology and training but at the same time support the FLCs in providing market linkages to sell the value added NWFPs including adda leaf plates and cups. A publicity campaign in mass media (print and audio-visual) to create awareness and / or educated the consumers / people about repercussions of plastic consumption and benefits of using leaf plates / cups that not only good for the health and welfare of the consumer but also helps the FLCs to increase their income level through sale of leaf plates and other NWFPs.

Apart from the making available required microcredit and EFT to FLCs for NWFP base micro enterprise, the catalyst role has to be played some agencies/ NGOs to provide the required market linkages for its success. It has been observed in the field study that in some villages Adda leaf plate making compressor machines have been installed, training was imparted and FLCs were adding value in form making leaf plates. However due to lack of market linkages to the value added leaf plates and emergence of plastic and paper plates in the market consumption of leaf plates has been declined that has been deterring FLCs in making leaf plates with the help of EFT (compressor machine). But FLCs are keen to revive the already established leaf plates making microenterprise and commence new units for leaf plate making subject to, they are supported with market linkages from time to time. Hence, it is suggested that the concerned Government agencies should evolve a vivid leaf plates and other value added NWFPs consumption promotion mass media camping and push demand for the value added NWFPs. To provide cost effective market linkages committed NGOs may be roped in collaboratively to ensure the market for FLCs value added NWFPs.

In the field survey FLCs are harvesting tamarind, mostly selling without value addition (with hard shell) 10 kg basket @ Rs. 250 (@ Rs 25 kg). Whereas local Girijan Cooperative Corporation (GCC) procures value added (removal of hard shell and deseeded) tamarind (flower variety) @ Rs. 50 kg and that of distance market price is about Rs. 75 kg. An innovative technology like sharp knife instrument be evolved and provided to tribal people to remove hard shell and deseed the fruit. Impasto facto (thus) income level of tamarind harvesting tribal people can raise income by two to three times, which in turn improves the quality of living with the increased level of income.

*Madhuca latifolia* flowers storage can be done in wooden box that can made with local available wood is an example of indigenous EFT. With the help of small amount of Rs.200 microfinance assistance to procure Jaggery (Gurh) and prepare wooden structure. Value addition by way of storing *Madhuca latifolia* flower for two to three months in the wooden box, income level / livelihoods level of FLCs can be increased by somewhere 45% - 55%, when sold without the said value addition.

Value addition to gum (*Sterculia urens*) can be done by way of drying, cleaning, purifying and grading that would fetch two to three time increase in trade price to the FLCs.

Average family size in the study area is 4.37 ( three to six members ) members which corroborates the common trend of nucleus family and it is partly to secure Government welfare scheme benefits including ration card, MGNREGA work card etc. To meet the tribal people livelihood amount the sources of income include, income from NWFP harvest and sale, agriculture labour, government works labour, and other sources including own agriculture output consumption. Augmenting NWFPs value addition with EFT contributes for increased quality of life FLCs and conserving the forests.

Average amount of money required for FLCs in the study area to obtain three square meals and other necessities including purchase of two to four pairs of new cloths in a year, celebrating important festivals, Pongal, Diwali and other endemic festivals. Out of total average amount Rs. 37533 required, 36.4% amount is accounted from agriculture including subsistence, followed by agriculture labour accounting for 23.6%, and NWFPs and MGNREGA works accounting for about 20% each. The amount of money being accounted from NWFPs harvest and sale can be increased by way promoting NWFPs value additions using EFT, so that dual objectives of providing enhanced livelihood opportunities and conserving the forests for achieving overall objective of sustainable development.

In the study area, the SHG accounting for 46.9% share of microfinance assistance sources, money lender is still accounting for 27.8%, followed by relatives friends / others accounting 19.1% and the rest is accounting for 6.2% from banks / government schemes. It can be concluded that gradually the SHG groups are proving to be better a source to finance the forest dwellers' microfinance needs and thus paving an exit path to the moneylenders.

Major purpose of microfinance to the FLCs is for health purpose which is accounting for 26%, followed by subsistence accounting for 21.8 %, and children marriage accounting for 19.8%. People also borrow for pilgrimage, accounting for 13.6% and other purposes like observing rituality etc. accounts for 12%. It is suggested that an awareness / education campaign through mass media publicity amongst FLCs to reduce and avoid unproductive expenses including pilgrimage, marriage and on rituality so that FLCs do not need to run after moneylender to borrow money at exorbitant interest rates.

The researcher has interacted with FLCs and gathered the impressions about the extant NWFP value addition practices, the extent of awareness about the emerging NWFP value addition technologies, their readiness to undertake various NWFP value additions, use of EFTs and the associate benefits/problems in activating these EFTs. Though the impressions gathered seems to be little subjective.

An integrated network tagging all stakeholders to provide increased livelihoods to FLCs is a comprehensive strategy and involvement of all systems (lateral integration, forward / market linkages) and stakeholders including FLCs Public Policy makers, Government, NGOs / Civil societies is essential to achieve sustainable development of FLCs. A network with all stakeholders and systems for enhancing livelihoods through NWFPs processing with EFTs and provision for microfinance. NWFPs processing underpins FLCs to get enhanced income levels and welfare. Sustainable NWFPs value additions warrants eco-friendly technologies that would have multi pronged impact on reducing environmental / forest degradation, increased levels incomes to FLCs, which will in turn stimulates the FLCs in conserving forests that provide raw material (NWFPs) for processing / value addition with the help of EFT. Scientific research organisations like APCOST should conduct field survey to appreciate indigenous NWFPs value addition technologies that are being employed by FLCs and quest for improvements and efficiencies in the extant technologies, methods and system, so as to streamline the existing system with EFTs.

Policies that are being evolved to support enhanced livelihoods to FLCs should invariably have provision for strengthening infrastructure and logistics that connects FLCs value added NWFPs product to the end user market and microfinance that would stimulate individual/group asset building (microenterprise). NGOs / Civil societies should be roped into the system to facilitate NWFPs processing, capacity building, linking processed NWFPs with upmarket. NGOs / Civil societies role is crucial in linking value added NWFPs to upmarket and evolving microfinance system through SHG driven approach. Involvement NGOs / civil societies in providing microfinancial services and processing NWFPs to the FLCs a will indeed helps the process of providing enhanced livelihood to the FLCs

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# SUSTAINABLE BUSINESS MODELS - THE CASE OF CAR SHARING

**Taneli Vaskelainen<sup>1</sup>**

<sup>1</sup>Jyväskylä School of Business and Economics, University of Jyväskylä

## ABSTRACT

Replacing actual ownership of a commodity with a service that allows for temporary customer use of the commodity has been shown to be a good way to make industries more sustainable while retaining or even improving customer experience. However these kinds of services are often unsuccessful, because breaking the existing regimes requires systemic change involving enabling technologies, favourable governmental regulation, a successful market adoption strategy and a profitable business model. This study examines sustainable business models using the case of car sharing services. Using public sources a descriptive study is conducted on the business models of leading car sharing services in Europe and North America. From this data three different business model archetypes are derived: the freeflowing model, the traditional car sharing model and the peer-2-peer model. The three archetypes are fairly stabilized and there is little variation between the operators with the B2B-market probably being the next field to mature. Car sharing services also probably have a role in the diffusion of electric cars, because they work as a living laboratory for the car manufacturers in this respect and enable the building of charging infrastructure to new areas.

*Keywords: Car sharing, Business model*

## INTRODUCTION

Car sharing services that allow consumers to rent a car on a minute or hourly basis are gaining momentum in the transportation markets. Although still relatively small compared to the car manufacturing industry these new ventures are starting to be a force to be reckoned with. In year 2013 the amount car sharing service users globally is 2.3 million and is estimated to climb up to 12 million by the end of the decade [1]. These estimates reflect similar growth trajectories as studies made in 2006, 2008 and 2010, which have shown year on year user base growth of approximately 38% [2].

Before the turn of the millennium car sharing players were small companies and cooperatives that operated on a national basis. In recent years things have changed however. For example Zipcar, a company founded in 2000, has grown to operate a fleet of more than 10000 vehicles in USA and Europe and has a turnover of hundreds of millions. Multinational companies from different industries are increasingly entering the arena as well. Car manufacturers Daimler, BMW, Peugeot have running car sharing programs, Honda has made a pilot on the field and Toyota, Mitsubishi is entering the market through partnerships [2]. General motors and Suzuki have declared plans to provide vehicles with technology needed specifically by sharing services [2]. Car rental companies are also in the game. Avis acquired Zipcar in 2013 thus becoming one of the largest players in the field [3]. Also Enterprise Carshare by Enterprise Holdings and Hertz 24/7 by Hertz are growing rapidly. Public service operators are experimenting in the field and Flinkster owned by the German train operator DB operates in some one hundred locations serving 250 thousand users.

According to Johnson and Suskewicz [4] the key to replacing the current unsustainable technologies with better ones stems from understanding “*that technologies don’t replace other technologies. Rather, systems replace systems.*” The authors argue that creating a superior technology is not enough, but a market adoption strategy has to be planned to ramp it up, profitable business model has to be built around it and government has to help the adoption with favourable regulation. Car sharing provides an excellent case for studying such a systemic transformation. Cities and municipalities have been actively subsidizing car sharing companies in the form of free or discounted parking [2].

Daimler's market adoption strategy was to test its sharing concept Car2go in the relatively small German city of Ulm [5]. From this pilot it has grown into a global organization in operating in 26 cities in five countries many of which are already running profitably [6]. Thus the business model is already mature for large scale roll-out.

Car sharing services have been found to increase sustainable behavior among its users [7,8]. Car substituters and second car drivers have been noted to decrease the use of car after joining a car sharing scheme, whereas car usage of the people who do not have a car has not increased [7]. In addition to the environmental aspects car sharing has been studied to understand user motivations and behavior [7,9-11] to estimate its demand [9,12] and to understand its benefits to society [13]. However the business side of the services has received little attention. This article attempts to fill this gap by analyzing the business model archetypes i.e. generic industry models that many car sharing players use. The goal is to understand the mechanics of the car sharing business and to evaluate the strengths and weaknesses of the different models.

### **Underpinnings of business model research**

During recent years, business models have been studied widely motivated mainly by rapid growth of e-commerce, which is demonstrated by the fact that in a review done by Zott, Amit and Massa [14] fourth of the 49 studies concentrated on issues concerning it. Previous theories have been ill-suited for understanding their value creation. Amit and Zott [15] demonstrate this by showing the deficiencies of value chain analysis, Schumpeterian innovation, resource-based view of the firm, strategic networks theory and transaction cost economics, when trying to understand it.

E-commerce is not the only driving factor to the on-march of business models however. They have received interest above all, because of the fundamental change in the way companies make money. In industrial era value creation was based on manufacturing a desirable product, packaging it and selling it to the customer. Because of the destructive power of the Internet and increasingly knowledgeable powerful consumers many industries need to reconsider how they create value. Indeed, these factors have driven the earning logic of some industries such as for example the music recording industry into deep crisis. [16]

### **Defining business models**

Defining what is meant with business model is problematic. According to Zott, Amit and Massa [14] the concept of business model is used "to address or explain three phenomena: (1) e-business and the use of information technology in organizations; (2) strategic issues, such as value creation, competitive advantage, and firm performance; and (3) innovation and technology management." Thus unsurprisingly the term is used ambiguously. To achieve clarity Zott, Amit and Massa [14] emphasize the importance of defining what is included and what is excluded on the model in each paper that uses the concept.

This research follows the definition of business model described as follows by Teece [16]:

*"A business model articulates the logic, the data, and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value. In short, it's about the benefit the enterprise will deliver to customers, how it will organize to do so, and how it will capture a portion of the value that it delivers."*

Clear elements for conceptualizing the business model are thus *value proposition* to the customers and the company's *value capture* model. Organizing to deliver value is a bit more abstract. This is divided into internal organizing in the form of *key assets* and external organizing in the form of *value network*. This is in line with other business model conceptualizations made by Morris, Schindehutte and Allen [17] and by Demil and Lecocq [18]. The resulting business model is presented in Figure 1.

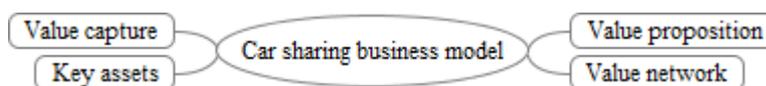


Figure 1. The high level business model framework.

Business model conceptualization allows researchers to identify business model archetypes that are used across company and industry borders [14,17]. Probably the most commonly known of these is the razor-and-blade model used in many industries such as for example gaming and printer industry, where a platform is sold with low or no profits and the profits are made with add-ons to the platform such as games or printer cartridges. This is an industry level study examining the business model archetypes of the car sharing industry. However the goal is not to create broader conceptualizations across industry borders.

### Sustainable business models in the automotive industry

Hockerts and Wüstenhagen [19] have developed a framework for sustainable entrepreneurship, where small green entrepreneurs ‘Emerging Davids’ begin a sustainability transformation of an industry followed by the large incumbents ‘Greening Goliaths’. When the transformation reaches maturity some of the small companies have grown to be new incumbents and the existing players have permanently made their behavior more sustainable. The authors raise a fundamental research question, whether this has actually ever happened in any industry. The automotive industry does show a lot of potential for it with many sustainable business initiatives including hybrid cars, fuel-cell cars, electric cars and car sharing services.

The path to sustainability transition has not been easy. Pioneer car manufacturers have begun their first experiments with low and zero emission vehicles already in the eighties, but many projects concerning them have been discontinued. The problem is that the innovations needed for the industry transition are systemic in nature and require the cooperation from many technological players as well as public subsidies to set up of the infrastructure. Furthermore electric cars, fuel-cell vehicles and hybrids have been significantly more expensive than gas powered vehicles. Lack of interest among consumers to pay the ecological mark-up cost has resulted in car manufacturers dumping the low emission vehicle prices and selling them at a loss. [20]

The running costs of electric vehicles are lower than those of gas powered cars [21]. However it still entails a higher initial cost reducing its attractiveness to the consumers [22]. This has led the electric vehicle manufacturers to search for alternative business models to change the cost structure of the EVs [23]. These include providing customers with a battery exchanging service, selling the car but leasing the battery, or giving the car away and charging a per kilometer cost [22]. Interestingly the business models of electric cars are connected to those of car sharing. BMW’s Drive-Now and Daimler’s Car2go car sharing initiatives both have electric vehicles within their fleet. These are mentioned by Bohnsack, Pinkse and Kolk [23] to be a radical exception to the other electric vehicle producers’ product centric approaches.

### METHODOLOGY

Because car sharing business models have not been studied extensively before, this study is explorative in nature. Therefore the concepts of the business model emerge from the collected data. The data is qualitative and it is gathered piece by piece to a common table representing the different attributes of the business models. The table shell is similar to “checklist matrix” described by Miles, Huberman and Saldaña [24], which is used to explore the attributes attached to a particular variable. Attributes are added to the matrix as new ones are found until saturation is reached.

Webpages of the companies work as the first dataset of this study. This data is complemented by selectively making news archive searches on the companies, which do not describe their business model extensively on their web pages. To increase the reliability of data gathering all online data sources that are used for the study are documented with the dates, when the data was captured. Thus each data item can be linked to a source later on. This data is available on request. The second dataset

consists of some five expert interviews. To increase validity through triangulation the business models created with the first dataset are presented to the interviewees for commenting. The models created for this paper however presents results only from the first dataset.

The organizations that are included in this paper are listed in Appendix 1. The primary interest of this paper is to examine sustainable business models. Thus the research focused on services that strive to replace a private car. Car sharing services are shown to have a significant effect on people either giving up their own cars or abstaining from acquiring one [2,7]. Traditional car rental companies were not included in the study. They have a different business model focusing usually on supplementing private car by providing the access to specialty cars such as vans or placing their fleet close to traffic hubs like airports and serving travelers [2]. The main separating factor that was used to scope out the rental services was that the minimum rental period provided by the services included in the study was one hour or less. Table 1 presents other distinguishing factors that were present in almost all the services with the exception of some peer-2-peer car sharing services:

	<b>Car sharing company</b>	<b>Rental company</b>
<b>Registration fee</b>	Yes	No
<b>Monthly/annual fee</b>	Usually	No
<b>Fuel included in the rental price</b>	Yes	No
<b>Reservation can be done</b>	Spontaneously	One day in advance

*Table 1. The distinguishing factors between car sharing companies and car rental companies.*

The secondary interest of this paper is to focus on business models that are matured to the point, where they can be run profitably. This scopes out many players in the field, because numerically most operators in Europe are small organizations with fleets of a couple of cars that are being run by people that as a hobby. Although some of these might have a mature business model they do not have the pressure to ensure profitability, because the employees often do not get paid. To out scope the recreational players, only companies with a fleet of 200 cars or more are included in the study. This number is somewhat arbitrary, but seems to include less than 10% of the companies that clearly run the business seriously. Additionally some companies whose numbers are not public have been added to the study because they are being run by large corporations so they can be expected to be fairly big and to have growth aspirations. To limit the scope of the study further only certain countries were included in the study. USA, Germany, Switzerland, United Kingdom and France were concluded to be the biggest countries in car sharing according to the work by Shaheen and Cohen [2].

## RESULTS

Three distinct business models can be identified from the results. Each model with relevant figures is presented in Table 2. The companies using the different models are quite similar with each other, but between the models there are distinct differences as will be demonstrated in later chapters. Companies using freeflowing model allow their users to make one-way trips within the area of their operations. Thus unlike in the other models the cars do not have to be returned to the same place, where they were rented. In P2P-rental the car sharing company works as a market mediator and a partner to the individuals owning the cars. Thus unlike in other models the cars are not owned by the car sharing company.

The business models require different strategies. From the users perspective in order for a freeflowing model to work there has to be enough cars to ensure availability, when a car is needed. A couple of cars scattered around the city would probably not be an attractive value proposition to the customers. However in other models geographically well positioned (e.g. in a university parking lot) cars serve a distinct user group who live near or frequently visit the location. Therefore freeflowing car sharing operators show significantly higher number of how many cars there are in one location of operation. In P2P-rental the primary function of the vehicles to their owners is usually not profit making as is in the other models. The cars belong to individuals, who themselves use the cars and sell the

overcapacity to other users for a price. Thus since listing a car to the services is usually free of charge fleet size is not an important investment decision like it is in the other models. This can be seen in the fact that the number of members per car is lower as is in the other models.

Business model	One-way trips	Car owner	Members/Car	Cars/Location
Freeflowing	Yes	Service provider	12-60	135-2000
Traditional carsharing	No	Service provider	21-81	6-111
P2P-rental	No	Individuals	9	

Table 2. The different business models and relevant figures.

### Generic business model of car sharing

Figure 2 presents the generic elements common to all business models derived from the data that are connected to the high-level elements - value proposition, value capture, value network and key assets - derived from the literature study. The value proposition is the largest element of the business model including the issues directly linked to delivering the service to customers. It includes three kinds of elements. Firstly it involves operational elements included in each rental. These include, when the cars have to be booked and who fuels up the car. Secondly it includes elements concerning the boundaries of an individual booking. These include whether one-way trips are possible, what is the minimum rental period and how wide the span of the membership is i.e. can a member subscribed in one city use the service's fleet in another city. Thirdly it includes elements describing the service from the company's side. These include the customer segments the service is directed to and the B2B-services that are provided specifically to business customers.

The value capture portion includes the mechanisms of how the car sharing company makes money. These include the different elements of pricing and the possible additional revenue sources not directly linked to the car sharing business. Key assets are primarily connected to the fleet including who owns the car, what is the fleet variety based on and whether there are electric cars on the fleet. Value network includes the primary stakeholders other than the customer. These include the important partners of the car sharing company and its owner.

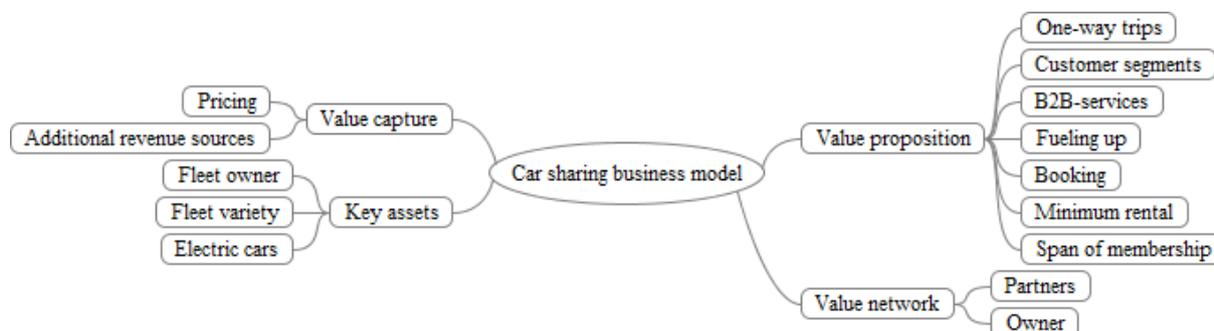


Figure 2. The different elements of the observed business models.

### Traditional car sharing business model

The traditional car sharing business model is presented in Figure 3. The basic value proposition is based on hourly car rental with bookings that are done in advance and whose length has to be decided during the time of the booking. After the rental the car is returned to the same parking spot, where it was picked up. Customer is responsible for fueling up the car when the gas tank is less than ¼ full. Thus the service requires little attention from the company personnel. The span of membership is usually countrywide. Zipcar and Hertz 24/7 make an exception by offering global memberships meaning that a registered member is entitled to use companies' services anywhere in the world.

The car sharing services target primarily individuals although many have service proposals also for families, universities and companies. The value proposition for families is usually common invoicing although some services provide discounted or even free registration for additional family members.

Universities are usually offered a car sharing stations near the campus to provide easy access to the shared cars for students. Businesses are provided more services including aggregated and itemized invoicing discounted pricing and possibilities for membership administration

The pricing consists of many elements. Possible elements include one-time registration fee, security deposit, annual or monthly fee, an hourly usage fee, and kilometer fee that can be calculated after a certain quota or starting from the first driven kilometer. The pricing scheme varies quite a lot between the different operators, but all of them have a time dependent usage fee and most also include a periodical fee that is invoiced either monthly or annually. The most common way of making additional revenues for customers is by offering deductible reduction with increased monthly cost. Few car sharing companies also have other additional revenue schemes such as selling advertisements space on the cars (City Car Club) and selling the fleet management technology for businesses (Mobility car sharing).

The fleet is owned by the car sharing company or it is leased from a capital partner. Some of the larger operators have electric cars in some locations, but in all cases they are a minority in the fleet. Most commonly the fleet variety is categorized according to the size of the vehicles and also pricing is classified accordingly each car size having certain usage fee despite of the model of the car. Usually this also means that the pricing is uniform to the user independent of the location, where the car is used. Interestingly the car sharing schemes owned by the car rental companies make an exception to this rule. Their fleet variety is dependent on the location and when reserving it is presented according to car models. Also the pricing is based on the location and particular car model.

Many car sharing companies are private, but increasingly especially the bigger companies are being owned by bigger more established transportation industry players. Car rental companies and public transit operators are especially active in the field. All car sharing organizations are not private companies, but cooperatives, whose shares customers can buy. Although this is more common among the smaller players Switzerland's only operator Mobility car sharing uses this organization form. Public traffic operators, car rental companies and other car sharing companies are the most important partners. Periodical subscribers of public traffic operators are often offered discounts, when joining a car sharing club. Car rental companies complement the business model by offering long term rentals, which often in car sharing companies is not possible. They usually offer beneficial terms to the customers of their partner organization. Car sharing companies also partner with each other to create a larger network of locations. The fleet of other companies can be used by registering to only one service. In Europe this trend is especially strong. There two large clusters have been formed, one by Cambio-Stadtmobil and the other by Flinkster-Mobility-Car2go.

On the face of it the business models of the different car sharing players using the traditional business model are quite similar. Although the terms and pricing schemes vary between companies the value proposition for the customers is more or less the same. The biggest differences come from B2B-capabilities, where there seem to be quite big differences. Some companies only offer possibility to common invoicing, but for example Mobility car sharing has standard packages offered according to the size of an organization. They are not restricted only to providing access to Mobility's fleet, but also fleet management outsourcing is on offer using either Mobility's car or the existing fleet of the company.

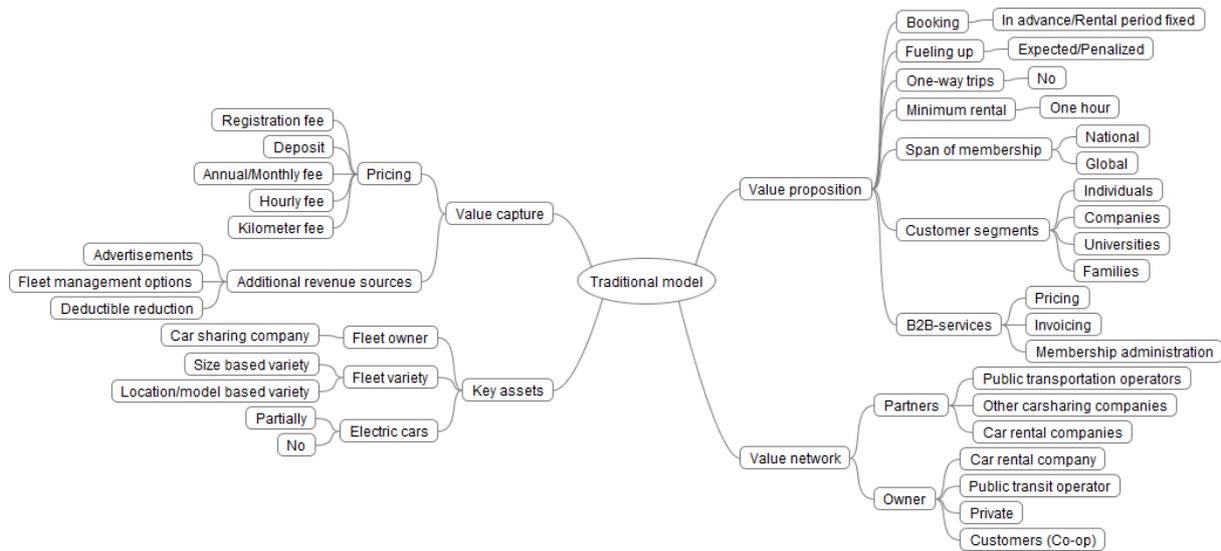


Figure 3. The traditional car sharing model

### Freeflowing business model

The freeflowing business model is presented in Figure 4. What is particular about it is that it allows one-way trips and thus rental cost is calculated on minute not hourly basis. Usually the booking is open-ended and the time of the rental and the place of return do not have to be known in advance. With the exception of Autolib there is no annual or monthly payment for belonging to the car sharing club lowering the threshold of joining.

Unlike in other business models the fleet of the freeflowing car sharing companies is usually standardized and thus cars of different sizes or vans are not on offer. All operators except Quicar also have electric cars within their fleets and Autolib and Multicity operate only with them. The electric fleets make a slight variance to the logistics of the general freeflowing model. The cars with combustion engines can usually park anywhere on the roadside within the area of car sharing company's operations. Electric vehicles however have to be parked on charging stations and plugged in to ensure that the vehicles can be used by the following users. The fueling up of the non-electric vehicles is included in the service and customers are rewarded with free miles for doing it.

From the customer's viewpoint the value proposition of the different operators is quite similar. Although electric fleets bring some constraints for the customer's journeys, because cars parking spots are fixed, dense charging networks ensure that one-way travel is quite similar as with cars with combustion engines. The main differences between the operators would seem to come from the size and seriousness of the operation. Multicity and Quicar appear to be pilots as they are fairly small and operate only within a single city. Autolib is expanding within France and is taking first steps to internationalization by going to Minneapolis. Car2go and DriveNow are major international operations with Car2go growing very aggressively.

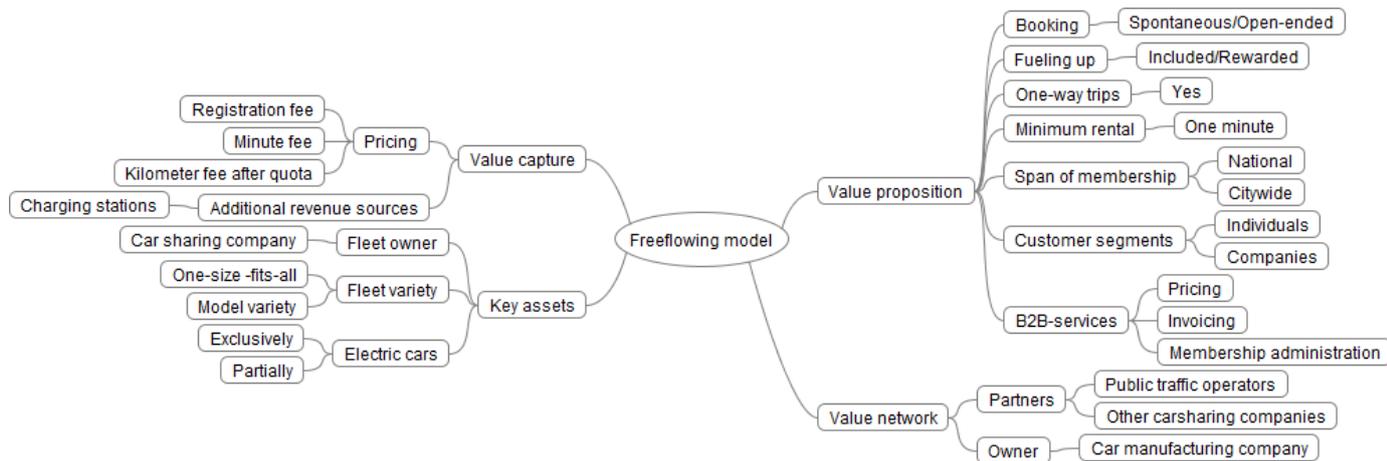


Figure 4. The freeflowing business model.

### P2P business model

The P2P business model is presented in Figure 5. The P2P business model deviates quite significantly from the other two. There the company enabling car sharing does not own the vehicles at all, but only works as a marketplace where individuals can rent their cars to other individuals. Besides car booking there are a lot of functionalities that the P2P operators provide to the car users and especially to the car owners. The platforms have a bidirectional recommendation system, where owners and users can rate each other according to the success of the transaction. The renters' identity is ensured as well as the fact that they have a valid driver's license. The company also provides insurance for the rental periods.

From the users point of view the value proposition resembles that of the traditional car sharing model. However the transactions are not quite as effortless, because they usually require that the car owner accepts the booking and that the owner and the user meet for key handover. Getaround however also provides technology that enables trusted users to reserve and use the car automatically, but it costs extra for the car owner. The span of membership is the whole area of operations of the service, however it should be noted that none of the P2P car sharing service work on international level. The fleet consists of any cars that are registered on the service and is only constrained on terms dictated by the insurance. There are no or only a few electric cars available as not many individuals own them.

In addition to the familiar hourly and kilometer fee some of the P2P-services also have a booking fee and an insurance fee that is charged from the user. Unlike in the other business models fuel is not included in the rental price, but the user must pay for it himself/herself. The car has to be fueled up to the same capacity, where it was when it was rented. The value capturing of the model is mainly based on the commission that is collected from the car owner for each successful transaction, which is in the ballpark of 30-40% of the earnings received by the owner. All P2P car sharing companies are so far private and judging from the descriptions of the companies they are still in the start-up stage.

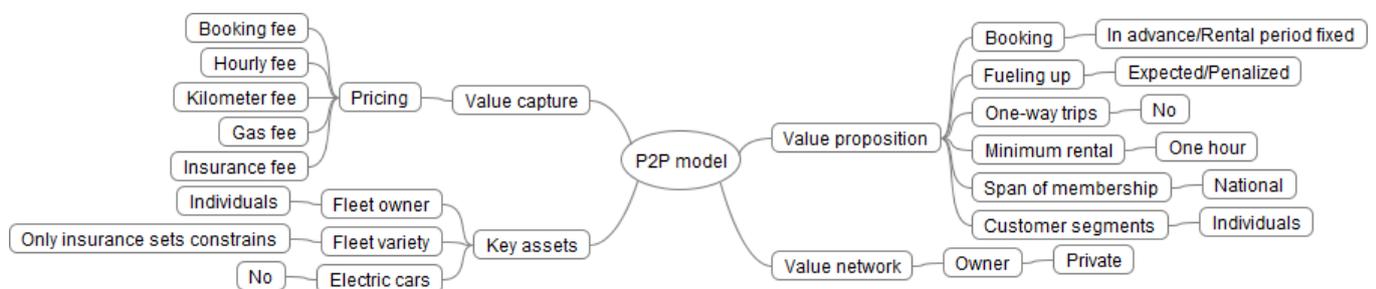


Figure 5. The P2P business model.

### Cross model analysis

Similarity of the business models of different players indicates that the freeflowing model and the traditional model are reaching maturity. P2P model does not seem to have reached its maturity and it is

questionable, whether the model works in short term rentals at all. The differences within companies using the same business model are quite subtle and it is likely that customers are starting to have certain expectations on how the models should work. The similarities go to detail level. For example with an exception of one service all the traditional car sharing model operators expected the customers to leave the fuel tank  $\frac{1}{4}$  full. This kind of operational similarity enables quick learning curve for old car sharing customers moving to a new location where there is another service available. Another sign of maturity are the signals of competitive elements. The partnering between car sharing companies in Central Europe and clusters formed consequentially indicate that they are no longer competing only against car ownership, but also amongst each other. City Car Club also gives free registration for users that resign from another car sharing club.

The maturity of the basic business logic does not extend into additional revenue sources and B2B proposition however. Almost all the traditional and freeflowing model operators have some kind of a B2B proposition, but their versatility differs substantially. It is likely that companies in many countries are not yet used to using car sharing services and thus the market is just emerging. The offerings are also likely to evolve as business customers' interest in the services evolves. For example until now there is no operator offering car sharing services directed exclusively to B2B-customers, but given increased market growth and complicating demands from the companies, this could change.

Electric vehicles are present within car sharing services much more than they are generally in traffic. This is understandable, because of the environmentally conscious user base and the focus on total cost of ownership. It is likely that electric cars can work as a competitive advantage since the users might be interested in vesting in a service according to its environmental friendliness. The initial cost is also probably not as big an issue to the car sharing companies, who see the cars more as an investment and quite often have some kinds of lease arrangements to finance the vehicles.

## CONCLUSIONS

The three business models all have their up and downsides, when considering their value proposition to their customers. Although freeflowing model's value proposition can easily be considered superior, because there are no monthly fees, customers only have to pay for the time that the car is actually used and one-time trips are possible, it can only work on highly dense populated areas. For example the smallest city, where freeflowing model is present Car2go's pilot city Ulm excluded is Minneapolis, which is a city of some 400 thousand inhabitants serving a metropolitan area of 3.4 million people. Traditional car sharing model can thrive in much smaller communities. It only needs large enough local demand, because the cars are always returned to their pick up spot. For the same reason it is also fairly easy to set up personalized pick-up points for major customers. The same is true for P2P model, which can thrive in even smaller communities than the traditional model, because there is no profitability demand for the vehicles. Also pricing and value proposition is pretty much the same for longer rentals that take-off from and return to the same place.

Dominant design is a central topic in industrial evolution referring to a technology that gains the de-facto standard position within an industry forcing all the current and future players to adhere to it in order to survive [25]. According to Teece also the requirements to business models change upon its emergence [16]. For now it would seem that when considering the more mature car sharing business models - the traditional model and the freeflowing model - that neither of them clearly dominates over the other. Both have large customer bases and compete in the same cities for example Berlin. Time will tell whether P2P model for hourly rental is feasible or whether the whole market moves towards long term rentals. This will probably depend on a number of factors. These include at least on how P2P players manage to integrate technology to enable opening the car for the renter automatically, whether the car owners and the renters on a larger scale appreciate interaction with each other or not and the prices the car owners want for renting their vehicles.

The interplay of 'Emerging Davids' and 'Greening Goliaths' described by Hockerts and Wüstenhagen [19] can be seen in a quite clear way in car sharing services. The authors have characterized the take-off and maturity of diffusion of more sustainable products as the emergence of 'High-growth Davids' who eventually become Goliaths themselves and industry Goliaths entering the markets eventually

resulting in sustainability innovation becoming an industry standard. Although small compared to the size of the automotive industry in total the presence of many of the big car manufacturers is a clear indication of their interest in the market. Car2go has clearly grown beyond a pilot phase with a fleet summing up to ten thousand vehicles and a goal to making a billion dollar turnover with the concept by the end of the century [26]. On the other hand one of the pioneering players Zipcar has grown from a start-up into the biggest player in the field with a turnover of hundreds of millions.

The connection between electric vehicles and car sharing services is interesting. They have the potential of being major contributors to their adoption. For the car manufacturers and the battery manufacturer Bolloré owning Autolib the services work as living laboratories, where the technologies can be tested. Also as mentioned before they create demand that is not as dependent on the initial investment as the consumer markets. Commercial and business fleets have shown their significance in the diffusion of sustainable innovation in the case of the hybrid car Toyota Prius, which was at first very successfully sold to these particular customer segments and has up until now sold more than a million units [20]. Also it has been shown in earlier studies that one significant psychological barrier for the consumers to buy an electric car is the non-existence of charging infrastructure, which creates a fear of running out of power and being stranded on the road [22]. A potential solution for this could be provided by electric car sharing operators. Bolloré is already offering individuals a possibility to use its charging poles for a cost.

## LIMITATIONS AND FURTHER RESEARCH

This research has several limitations most significant of which are connected to the used data sources. Because the data is gathered from public sources it is likely components of business models that the companies consider trade secrets are not revealed by it. Especially the cost side of the profit model is practically non-existent. For example there is no information of how parking is arranged with the municipalities and how insurance for the cars is negotiated, which are known to be important issues in the car sharing business [2]. This research does give however a rather extensive picture on the visible value proposition, which can be expected to reveal the business model quite extensively, because the service is largely co-created with the customer. The expert interviews collected as a second dataset is likely to shed some light on the back-office activities, but to the most part they are an issue for further research. It would be interesting to consider the interplay between the service front and back-office to see, whether same value proposition can be delivered with different back-office configurations.

Another interesting topic for further research is to observe the interplay of the business models of car sharing companies and their owners. Competing with two business models has raised a lot of interest among researchers recently [27,28] and car sharing industry provides an interesting arena for this sort of research as many players with different interests are entering the field. To car manufacturing companies there are clear risks of conflicts since one car sharing car is calculated to replace 12 owned cars [7] and thus there is a clear risk of conflict and cannibalization of existing business. On the other hand for public service operators there are clear synergies as car sharing usage has been shown to correlate positively on the usage of public transportation [7].

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## APPENDIX 1: THE CAR SHARING COMPANIES CHOSEN IN THE STUDY

Name	Country	Cars	Loc.	Memb.	Memb. /car	Cars /loc.	Owner	Car ownership	Fleet logistics model
Multicity	Germany	350	1	4500	13	350	Citroen and Flinkster	Owned cars	Freeflowing
Autolib	France	2000	1	105000	53	2000	Bollore	Owned cars	Freeflowing
Quicar	Germany	270	2	7000	26	135	Volkswagen	Owned cars	Freeflowing
Car2go	International	10000	26	600000	60	385	Daimler	Owned cars	Freeflowing
Drive-Now	International	2350	6	88000	37	392	BMW	Owned cars	Freeflowing
Cambio Carsharing	International	1600	44	58000	36	36		Owned cars	Round-trip rental
Citeecar	Germany	442	4			111		Owned cars	Round-trip rental
Greenwheels	International	2000	125			16		Owned cars	Round-trip rental
Mobility car sharing	Switzerland	2650	470	105000	40	6		Owned cars	Round-trip rental
City Car Club	United Kingdom	720	16			45		Owned cars	Round-trip rental
Uhaulcarshare	USA		40				U-haul	Owned cars	Round-trip rental
Hertz 24/7	International						Hertz	Owned cars	Round-trip rental
Enterprise Carshare	International		130				Enterprise Rent-a-car	Owned cars	Round-trip rental
Zipcar	International	10000	170	810000	81	59	Avis budget group	Owned cars	Round-trip rental
Flinkster	International	3800	100	250000	66	38	Deutsche bahn	Owned cars	Round-trip rental
Stadtmobil	Germany	1800	77	38000	21	23		Owned cars	Round-trip rental
Ford car sharing	Germany							Owned cars	Round-trip rental
teilAuto	Germany	500	15	17000	34	33		Owned cars	Round-trip rental
Getaround	USA		5				Private	P2P	Round-trip rental
Nachbarschaftsauto	Germany						Private	P2P	Round-trip rental
Buzzcar	France	7764		72410	9		Private	P2P	Round-trip rental

# IDEOLOGICAL TRANSFORMATION WITHIN CAPITALISM – NEOLIBERALISM AND SOCIAL ENTERPRISE

**Toni Ruuska**<sup>1</sup>

<sup>1</sup>Aalto University, Helsinki

[toni.ruuska@aalto.fi](mailto:toni.ruuska@aalto.fi)

## ABSTRACT

In this article I illustrate how neoliberalism can be understood and analysed as a political-economic ideology but also as a contextual ideology of capitalism. By adopting two concepts from Gramsci I study how the hegemonic neoliberal discourse is disseminated and reproduced. My theoretical contribution lies in a process of ideological transformation. I argue that ideological transformation differs from ideological revolution, and follows when a contextual ideology is colonized by another. This process has two dimensions: direct and indirect. Direct ideological colonization occurs when alternative ideological discourses and practices are extended to new social domains for example through legislation. The indirect dimension is more complicated as a process including voluntary rhetoric choices to incorporate meaning in messages to gain recognition.

*Keywords: ideology, capitalism, neoliberalism, social enterprise, hegemony, common sense*

## 1 INTRODUCTION

The neoliberal capitalism has been characterized above all by the ‘free markets’ (or more specifically a notion of freeing markets from state intervention and regulation) and attempts to narrow down the scope of social justice and collective responsibility. It has involved restructuring of relations between the economic, political, and social realms, and focusing the role of the state and government on strengthening markets, economic growth and competitiveness. After thirty years of neoliberal policymaking we are witnessing unparalleled global social inequality and economic uncertainty, while ‘the market’ is dictating actions of politicians, companies and individual citizens.

As a partial potential solution, social enterprise and social entrepreneurship (later to be used interchangeably under abbreviation SE) has recently become an increasingly significant cultural phenomenon (Dey, 2006). According to its international informal definition social enterprise is an organization that applies commercial practices as a resolution to a certain social or environmental problem, rather than maximizing profits or shareholder value. SE has in some circles been celebrated as a new pathfinder: a potential change-making tool for conscious and socially aware people who have grown sceptical about the governments and conventional businesses to solve difficult social questions and environmental crisis (Harding, 2007; Wilson, 2008).

Without taking anything away from the spreading SE phenomenon, have pleas for more critical perspectives towards SE been increasing lately (see e.g. Cho, 2006; Dacin, et al. 2011; Steyaert and Dey, 2010; Dey and Steyaert, 2012). Particularly there seems to be a confusion regarding the purpose of SE and its role in a contemporary society. Is social enterprise for example replacing or taking over government duties, non-profit sector or some irresponsible private sector actors or complementing each and every one?

Raymond Dart is one of the few scholars who have attempted to tackle these questions. In his article *The Legitimacy of Social Enterprise* (2004) he argues, that the moral legitimacy of SE is deeply rooted and connected neoconservative, pro-business, and pro-market political and ideological values. This finding served as the starting point for my analysis. On a general level, my aim in this paper is to

analyse the relation of social entrepreneurship and neoliberal ideology – although putting more emphasis on the latter. With this said, it is important to mention that my intention is not to explore the question whether social entrepreneurship is explicitly neoliberal or not, but more to explain how neoliberal discourse and practices are extended into new social domains and more precisely to analyse what kind of rhetoric is used to communicate the benefits of SE and what are their relation to neoliberal ideology? But before doing so, I'm compelled to make a detour. This is because I want the reader to understand my theoretical framework and my conception of ideology.

The article structures as follows: I begin by describing my theoretical framework. After this I introduce two concepts developed by Antonio Gramsci to be able to analyse and understand neoliberalism as an ideology. Then, I'm going to shed a light on how neoliberalism rose to the political hub during the 1970s and 1980s and has in many ways replaced social democracy to back up my argument. Then by using rhetorical discourse analysis I demonstrate how social entrepreneurship is promoted in a media text and how the claims made in the text are linked to ideology.

## 2 THEORETICAL FRAMEWORK

Capitalism, as Marx and Engels in the *Communist Manifesto* remark, is in constant need of expansion: *'It must nestle everywhere, settle everywhere, establish connexions everywhere'* (2002, p. 223). In similar fashion Tomlinson (1991) claims that capitalism implies a cultural totality of technical-economic, political, social-relational, experimental and symbolic elements. Said (1993) on the other hand has stated that imperialism is not only a relationship of domination but also committed to a specific ideology of expansion.

Tying these knots together Tomlinson has defined in his book *Cultural Imperialism* that one of the discourses of cultural imperialism is concerned with the questions or process of global dominance of capitalist culture. Moreover according to him this interpretation of cultural imperialism has two strands: the push towards homogenization and the spread of an ethos of consumerism. I shall focus on the former, which basically implies that capitalism is an expanding and spreading homogenizing cultural force. The observation here is that everywhere in the world is beginning to look and to feel the same (Tomlinson, 1991). The basic logic behind this cultural convergence is the systemic imperative of capitalism: excitable production based on added labour resulting in constant expansion towards a world market driven by the profit motive – again identified by Marx and Engels already in the middle of the 19th century (see also Salminen and Vadén, 2013).

If we compare cultural imperialism in this fashion to the 'Washington consensus' or structural adjustment programs of IMF and World Bank or to the extension of neoliberal discourse and practices to international organizations and governments of the nation states, we might indeed see a pattern of homogenization and global capitalist market creation (see e.g. Dunn, 2004; Harvey, 2005 and Stedman Jones 2013). From this perspective it's difficult to see social enterprise being anything else than part of this same progression i.e. expansion of capitalism and capitalist culture (see Elyachar, 2005).

Recently, several studies have been conducted to analyse how neoliberal policies and discourse is propagated and how it disseminates both globally and locally, what is to my understanding a part of this very same process. These studies have sought to explain how politicians and elites promote neoliberal policies (Bohle, 2006; Rückert, 2007; Rutland, 2013), to analyse how media participates to mediate neoliberal discourse (Peet, 2002; Kariiri and Kareithi, 2007; Mayher and McDonald, 2007; see also Herman and Chomsky, 2002) and to study how corporations promote neoliberal ideas for policymaking acting for their benefit (Dunn, 2004; Ahmed, 2010). Yet, what remains unclear is how neoliberalism 'takes over' a new phenomenon or how it 'extends its arms' into novel societal domains, and especially how ideologically charged claims are produced and reproduced.

Capitalism in the general sense has been historically remarkably flexible in adopting various forms (Boltanski and Chiapello, 2005). To be able to understand this phenomenon more thoroughly, I lean onto the analysis of Karl Marx (1970) and claim that capitalism has both a *base* and *contextual* dimension. The base serves as bedrock for its variations. It is the core of an ideology, its material and institutional foundation i.e. the structure of a modern industrial society and means of production (e.g.

machinery, workers). Integrally linked to this, I claim that for example social democracy and neoliberalism are contextual ideologies of capitalism, or more precisely ways to organize capitalism (see Campbell, 2005). Thus, both neoliberalism and social democracy function as contextual ideologies or in similar manner to what Marx (ibid.) referred as the superstructure of a society. However, I have chosen to use the term contextual over superstructure, because I see that it demonstrates more accurately the changing nature of capitalist ideology, meaning that contextual ideology is shaped by the socio-political situation of a society, and is adjusted to the context-specific conditions of a nation state for example. Moreover, why I have chosen to use this dichotomy is because I see, similarly to Althusser (1984), that ideology has both a material-institutional (base) and a social-political (contextual) dimension. Ideology is reproduced in both of these dimensions; in the material means of production and institutions, but also in law, politics, art, discourse and everyday talk.

A base ideology in general can be replaced, again as Marx suggested, by another base ideology like for example after the Cuban revolution 1959 or in Russia after the collapse of Soviet Union 1991. Or base ideology can have a hybrid form or structure like the Chinese post-communist capitalist-totalitarianism demonstrates. This same goes to contextual ideologies, however, what seems to be the difference here from my point of view is that when a base ideology is replaced by another, it seems to require a revolution of some kind. But in the case of contextual ideology, the change is caused by a crisis in contextual ideology (it no longer has the same legitimacy), but even more importantly power, and domination of the dominant bloc. Another clear difference is that this transformation can happen ‘behind-the-scenes’ and gradually in course of time. Thus, I argue that ideological transformation is a process in which a contextual ideology is replaced by another contextual ideology. In this particular article I’m discussing one of these transformations within capitalism i.e. the change from social democracy to neoliberalism. During the past three or four decades this ideological shift has been happening step by step, but regardless of this new organization, the base ideology has remained in place. Although, neoliberalism has in many ways changed the social and moral dimensions of capitalism, the very core institutions of capitalism i.e. capital accumulation, profit maximization, wage-labour, private property, and the material means of production – based largely on fossil fuels – have remained somewhat stable, though their orientation might have shifted. This also implies that the relation between base and contextual is hierarchical but also dialectical.

In another words, capitalism has changed its form, when the alternative version of it has ‘colonized’ the other. Linked to this, I claim that when an ideological transformation occurs, this process has two dimensions: on one hand we’re dealing with direct ideological colonization, in which a hegemonic discourse and practices are extended to novel societal domains for example through legislation and policymaking. In this case ideological colonization may be linked not solely to power and domination but also to an inability to contest or challenge the hegemonic discourse and practices (for example an alternative language may be lacking). To my understanding, the studies I mentioned above, which describe the spread of neoliberalism, demonstrate how the process of direct ideological colonization takes place.

Yet, on the other hand also the opponents (or ideologically neutral) of a particular ideology can engage in the process of indirect ideological colonization. In this dimension ideological colonization is linked to the common sense of a particular culturally and historically specific context. My study suggest that ideological colonization is not only facilitated for example by media, politicians or transnational corporations like the previous research demonstrates, but to some extent also societal actors that aren’t necessarily advocates of neoliberalism but rather looking for alternatives to the business-as-usual.

### 3 IDEOLOGY AND NEOLIBERALISM

Hall (1982) has stated that any theory trying to explain both the monopoly of power and the dissemination of consent, the question of the place and role of ideology becomes integral. He also has concluded that Antonio Gramsci’s conception of ideology indeed well suited to the analysis of neoliberalism because it considers the central concept of consent of the masses. More generally he summarizes Gramsci’s perception of ideology as ‘*the mental frameworks – the languages, the*

*concepts, categories, imagery of thought, and the systems of representation – which different classes and social groups deploy*’ (Hall, 1996, p. 26).

Gramsci himself emphasized particularly the central role of ideology as hegemony over society by historical bloc and the concept of *common sense*, in a situation when bourgeois norms and values were adopted throughout society and domination needed no longer be maintained by force and violence (van Dijk, 2011). Gramsci (1979) referred to common sense as a custom of practical activity in which an ideology/world view is enclosed as an implicit expression in art, in law, in economic activity and in all manifestations of individual and collective life. In other words ideology is in Gramsci’s conception an ‘implicit philosophy’ that is part of the practical activities of social life. Thus, many claims that are in reality ideological are, have been back-grounded or have become taken for granted. Accordingly for Gramsci, common sense is defined by its often conflicting and incoherent composition, of which people are usually unaware (Gramsci, 1979).

Other important concept in Gramsci’s formation of ideology is hegemony. According to Gramsci hegemony is dominance based on cultural leadership rather than ideological compulsion (Hall, 1982). Hegemony is power over society as a whole of one of the fundamental economically defined classes in alliance (dominant bloc), with other social factors, but it is never achieved more than partially and temporarily, as ‘unstable equilibrium’ (Gramsci, 1971). Crucial point about this that hegemony is understood as accomplished, but primarily by means of manufacturing consent (see also Herman and Chomsky, 2002) of the subordinate classes (Hall, 1982). As a conclusion, to be able to argue that neoliberalism is an ideology these two Gramscian concepts turn out to be truly helpful, since the breakthrough of neoliberalism clearly has entailed that ideas, interest or worldviews of the elites have become naturalized in the common sense of the general public, as we will see. However, to validate this claim, we have to now turn to post-war Britain and United States.

### **3.1 Neoliberalism and its rise to the political spotlight**

Neoliberalism is a capitalist political-economic ideology standing for economic liberalization, free markets, privatization, deregulation and re-regulation, minimal state intervention. Its advocates seek to increase the influence of the private sector while seeking to decrease the role of public sector as a provider of social welfare and justice, which also implies increased individual responsibility of one’s own actions.

If one would describe the neoliberal project anything else than an elite-driven ideological undertaking, it would be inaccurate. Since the recent scholarship has showed compellingly (Stedman Jones, 2013) that the main proponents of neoliberalism were from the very beginning mostly academics, politicians, corporate executives, and journalists. This ideologically driven elite cohort sought right from the start to influence other politicians, policymakers and government officials through publications, events, lectures, research, think thanks and consulting. These endeavours required generous funding, which the neoliberal movement often got from wealthy business executives and foundations. However notwithstanding its elite profile, the advocates of neoliberalism found a simple political language that resonated throughout the strata of societies. This political rhetoric offered an alternative to the stumbling New Deal and social democratic policymaking, which by the 1980s had turned sour. However, this shift was nothing but sudden.

According to a detailed analysis of Daniel Stedman Jones (2013) – whose conclusions I elaborate below – after the founding moment of Mont Pelerin in 1947, neoliberals in UK, Europe and the United States responded to the large-scale social, political and economic catastrophes of the interwar years and the arrival of the Cold War and fear of communism by deepening and broadening their ideological project. This meant countering New Deal and social democracy with a political guideline or ideology based on free markets, deregulation, and limited government. But this was easier said than done. Because above all, among the general public and policymakers alike, the collective ordeals of economic depression and World War II had nurtured a strong belief in the welfare state and Keynesian economic policies to curb the excesses of capitalism.

However, during the late 1960s and early 1970s, the trend in Britain and the US toward the bigger government and greater economic interventions started to recede. Consequently, the appropriateness of Keynesian demand management and higher welfare spending as policy responses to the economic problems of the 1970s were called into question. But this wasn't only because the shortcomings or crisis of neo-Keynesian policies but also due to increasingly persuasive attacks on Keynesian theorizing by neoliberal theorists and ideologists.

Meanwhile, neoliberalism turned from its specific anti-totalitarian and anti-New Deal roots to become a successful transatlantic political movement during 1960s. Led by Friedrich Hayek and Milton Friedman it was defined by a simple message: the superiority of markets over all forms of government interventions, or collectivism. The result of neoliberal intellectual and ideological groundwork (mainly by Hayek), economic theorizing (Friedman, Buchanan, Stigler among others) and eager political activism, was a combination of technical policies for example monetarism with ideological assertions such as superiority of free markets and individual freedom. This political and economic doctrine was then successfully disseminated by scholars and business schools both sides of the Atlantic (especially Uni. of Chicago and Virginia in the US and LSE in Britain), ideological entrepreneurs, journalists, transatlantic neoliberal networks, think tanks and foundations (such as the FEE, IEA, AEI, Atlas foundation and Cato Institute) to the political arenas of UK and USA.

Nevertheless, and more importantly for the purposes of this study, what the neoliberal movement was able to do, was to offer an alternative, but more importantly transform the commonsensical assumptions of policymakers and general public. Comparing this to Gramsci, the myth about the superiority of the markets was recreated, and then disseminated through various channels. After a couple of decades of hard work, historically favourable conditions and some lucky coincidences the neoliberal market ideology was suddenly the guiding star of the mainstream politicians and government officials alike. But the market ideology turned hegemonic only after it was 'rammed down' to the general public as the only choice. Thus, in the course of time what used to be just an alternative became slowly but surely 'the only alternative', the new common sense.

In conclusion, the similarly ideological social democratic class compromise was slowly colonized by the neoliberal free market ideology during the 1970s and 1980s – change itself happened within the base ideology. This change materialized partly because the Keynesian social democratic version of capitalism had run into trouble, and based on the needs of increasingly international and globalized capital, but also because a ready-made alternative was in place due to the ideological legwork done by the neoliberals.

However, after thirty or forty years of neoliberal policymaking, the legacy of pro-market and pro-business policymaking is troubling: social and economic inequality in soaring, global economy is suffering from recurrent financial crisis and we're witnessing global dissatisfaction among the publics (see e.g. Hahnel, 2005; Patomäki, 2012; Ortiz et al., 2013; Oxfam, 2014). Nonetheless, it's important to note that the blame of these reversed trends can't be put only to neoliberal politics. There is little evidence that for example the social democratic organization of capitalism would have dealt better with natural resource depletion, because the logic of expansion is a built-in feature of capitalism, or any other system that treats the material reality only as resources for production.

#### 4 DATA AND METHOD

Social entrepreneurship and social enterprise, as it is internationally referred to, is a relatively new phenomenon in Finland. Finnish legislation recognizes a social enterprise, but this definition varies from the international version of SE. In Finnish context social enterprise has traditionally meant a company that employs otherwise unemployable citizens. To make this story straight, this paper focuses on the international version of SE meaning an organization operating in commercial market, not maximizing profits but seeking resolutions to social and environmental problems.

My interest on the recent 'emerging' of social entrepreneurship in Finland lies on its newness as a phenomenon, but especially in what way the image or benefits of SE are promoted and constructed. To be able to analyse this I'm going to use rhetorical discourse analysis to study a media text written by

altogether nine representatives from various interest groups commenting and promoting social enterprise as a change-maker and producer of future societal well-being.

*Finland needs social entrepreneurship* is the title of a 280-word expression of opinion of nine representatives of various interest groups promoting social enterprise. The text was published in 3rd of February 2013 in *Suomen Kuvalehti*, which is one of the largest political weekly magazines in Finland, and in their official webpages claimed to be politically independent. Five of the authors of the text represent social enterprises and non-profit organizations, and co-ops depending on definitions. One of the authors is a member of Social Business International association and other is a member of the British Council. In addition, one of the writers belongs to the Association for Finnish Work, and one to the Finnish Settlement association.

In the analysis discourse analysis was applied. Discourse analysis according to Hardy et al. (2004) is a methodology for analysing the social that is qualitative, interpretive, and constructionist. It seeks to explore how the socially produced ideas and objects were created and how they are held in place. Discourse analysis varies from other qualitative methodologies that try to understand the meaning of social reality for actors in that it attempts to reveal the way in which that reality was produced (Hardy et al., 2004). In the analysis I'll especially focus on the authors' rhetoric. I define rhetoric here as an art and act of persuasion (see e.g. Billig 1987; Potter 1996; Jokinen, 2006a) and point out to the school of new rhetoric (see e.g. Perelman, 1996; Summa 1996) which explains that a difference between rhetoric and reality cannot be made but rather rhetoric is a part of socially constructed reality. In rhetorical analysis the focus is more in the formation of statements, whereas in discourse analysis the production of the social and language is analysed in contrast to the cultural context and dialectical social interaction. When these two approaches are combined, one can speak of rhetorical discourse analysis (Jokinen, 2006b, 46-47).

## 5 ANALYSIS

Stedman Jones (2013) has called the 'third phase of neoliberalism' an era during which the influence of neoliberal ideology was extended from nation states to international institutions such as IMF, World Bank and WTO and other regional and global organizations. Finland is one the countries where the neoliberal restructuring of the social and economic has taken place since the mid 1980's. And although the Finnish society is so far still identifiable as a welfare state, the same systematic structural changes that first took place first in USA and UK have been happening here since the middle of the 1980's. According to Patomäki (2007) the liberation of the financial market started the neoliberal era in Finland in the beginning and mid 1980's, and as the country was hit by a severe recession in the beginning of the 1990s, neoliberalism had already become the dominant ideology. He claims also that this ideological transformation has been executed mostly behind-the-scenes and in pure technical manner without much public debate.

### 5.1 Hegemonic discourse of entrepreneurship

Where the critical studies of social entrepreneurship remain few, the case is much similar regarding entrepreneurship, as da Costa and Saraiva (2012) have pointed out. Similarly to SE, entrepreneurship holds ever widening set of meanings, even to the extent that it has become an empty label: '*a word that can mean everything and nothing*' (Walker, 1989, p.164).

Regarding this an excerpt from the text suggests: "*We hold strongly that all kind of entrepreneurial activity is good for Finland, ...*". Two paragraphs later, after the authors have explained what they mean by social enterprise and social entrepreneurship, they repeat the claim: "*All kind of entrepreneurial activity is good for the Finnish society.*" At this point, I'd like to now highlight the ideological, but also at the same time commonsensical rhetoric – in our time – the authors use. As the hegemony of neoliberalism has progressed, individualism has replaced many of the old ideas of collectivism (Cohen and Musson, 2005). As a part of this process entrepreneurship has become the model code of conduct (da Costa and Saraiva, 2012). Accordingly, neoliberal ideology suggests that everyone can be an entrepreneur (Kruger and Brazael, 1994). In fact, it seems that entrepreneurship is held as one of the primary vehicles of the socio-economic restructuring of neoliberalism.

But what are left untold are the stories of the negative impacts of competition (Kohn, 1992), rising economic uncertainty (Standing, 2011), isolation and alienation (Sennett, 1998) of those who are unable to measure up. As du Gay (2000) has argued the kind competition mentality fosters a Darwinian logic of all against all, which might benefit some companies while causing negative social repercussions. Although, in principle, all men are equal under the law when operating in ‘the markets’, the law does not consider the different features of human beings (Sennett, 2003), nor the moral aspects of power in relation to competition and competing.

Furthermore, the hegemonic discourse of entrepreneurship hides what Rehmann (2013) calls the ‘real dilemma’ of neoliberal ideology. The contradiction lies precisely in the notion ‘one becoming master of one’s fate’. Neoliberal ideology is built on an idea of individual freedom, and this idea entails in practice a stronger commitment to personal responsibility. The real dilemma rises precisely from this notion since the spontaneous market organization is actually in conflict with it. Friedrich Hayek, one of the neoliberal masterminds, proposed to replace the customary term ‘economy’ with the term ‘catallaxy’, which means that the market-order is a ‘system of numerous interrelated economies’ without a unitary goal (Hayek, 1976, p. 107). It also produces a spontaneous order by the market ‘the game of catallaxy’, by excluding state intervention and planning. As a result the market-economy becomes ‘fate’ (Rehmann, 2013). But what this retains is according to Rehmann (ibid.) the danger that the objective fatalism of the market game leads into subjective fatalism of the individuals. He continues by claiming that even Hayek himself was aware of this contradiction (p. 286):

‘On the one hand, energetic and efficient individuals need to believe ‘that their well-being depends primarily on their own efforts and decisions’. On the other hand, this might lead to an ‘exaggerated confidence’, which must appear to those who lose in the market-game as ‘a bitter irony and severe provocation.’

It may well be that in the times of individualism and economic restructuring entrepreneurship resonates as well as in the politicians minds but as well as it generates consent among masses, although it is clear that not everyone can success or prosper in a dog eat dog system. However, this kind of incoherence is characteristic for the functioning of the ideological in general (Rehmann, 2013). Against this backdrop, Stuart Hall has noted (1988, p. 46) regarding an ‘organic’ ideology is ‘not what is false about it but was about it is true’, and specifically not even what is true but what makes good sense, which according to Hall is enough for an ideology. Moreover, Hall maintains (1987, p. 3) that it is an illusion that an ideology has to be coherent, when ‘the whole purpose of what Gramsci called organic, (i.e. historically effective) ideology is that it articulates into a configuration different identities, different projects, different aspirations. It does not reflect, it constructs a ‘unity’ out of difference.’ This makes one ask that isn’t this exactly what the discourse and praise of entrepreneurship does? Since, it doesn’t really matter whether the free markets produce wellbeing or not. It doesn’t matter that everyone can’t become entrepreneurs, or more importantly succeed in it. What an ideology does, it provides a rhetorical lifeline that doesn’t really hold, but serves the purpose.

## 5.2 Ideology of signification

The discourse concerning entrepreneurship offers us an example of how the neoliberal hegemony influences the aims and targets of what is being pursued in the political arena but especially in economic policy. In present-day Finland for example this means generous funding for start-ups, innovation centres and growth clinics etc. Yet, this doesn’t necessarily explain how ideology is being produced and reproduced. Or answer to the questions why the authors of this particular text have accompanied their message with the dominant neoliberal discourse of entrepreneurship but also with, growth and competitiveness like this excerpt suggests: “*Companies create jobs, produce growth of GDP and enhance the competitiveness of Finland.*”, when could have taken another course emphasizing for example the innovative and alternative business model of SE.

Stuart Hall claims that because there is no shared understanding of what things actually mean, ‘the world has to be made to mean’ (Hall, 1982, p. 121). He especially draws our attention how texts in media is identified and contextualized, by what he calls the signification process (Hall, 1996). But what makes this particular commentary interesting is the fact that this is not a typical news article, but

an expression of opinion. Notwithstanding, the authors use similar kind rhetorical tools than the media to communicate their message in a commonsensical way, without perhaps realizing that this 'common sense' is loaded with numerous ideological connotations, and consequently engage themselves in indirect ideological colonization.

Hall (1982, p.121) states that '*things and events in the real world do not contain or propose their own, integral, single and intrinsic meaning, which is then merely transferred through language. Meaning is a social production, a practice.*' Hall claims that the world hasn't only have to be made to mean, but also the meaning has to be struggled. Thus, for one meaning to be regularly produced, it has to be successful in establishing a certain credibility, legitimacy or taken-for-grantedness for itself. Some of the contested meanings of events and messages eventually become signified, or in another words based on shared assumptions and conventions. Equally this means that a new message, which is inconsistent with society's current common sense, has to be linked with the shared assumptions in order to make sense (Hall, 1982).

Hall et al. (1978) argue that signification both assumes and helps to construct 'consensus' in a society. In a sense one could think of it as means to avoid chaos. However, Hall (1982) also claims that the power involved in the signification process is ideological power. It is the power to signify events in a particular way. Following Hall's and Gramsci's line of thought, one gets hold of how an ideology works, since an integral part of modern day hegemony and power is consensus. Consensus on the other hand requires consent of the masses. And consent of the masses on the other hand has to be continuously manufactured. This manufacturing is only possible if the meanings that shape the common sense are signified in a particular way. Thus, in my case, in order to be understood and to explain why social enterprise is worth considering the rhetorical meanings attached to it have to 'make sense' according to the current common sense. In the time of neoliberal hegemony this seems to imply, entrepreneurship, markets and competitiveness, when in the times of social democracy it could have meant equal of opportunity. But although from this perspective it makes sense to incorporate social enterprise with neoliberal discourses, it also transforms the meaning of social enterprise itself.

## 6 CONCLUSIONS

In this article I have demonstrated how neoliberalism can be understood as a contextual ideology of capitalism. I have also argued that social entrepreneurship, although is not necessarily a neoliberal phenomenon, but more a side effect of neoliberal policymaking, is coupled with neoliberal discourse. This process is a part of a bigger picture: the global capitalist market expansion and cultural homogenization, which social enterprise is also part of. In addition I have demonstrated the process of ideological transformation by portraying the case where the neoliberal version of capitalism has colonized the social democratic version of it. Based on my suggestion the process of ideological colonization has two dimensions: on the other hand direct ideological colonization occurs when a hegemonic discourse is extended to novel social domains for example through legislation and policymaking. The other dimension, indirect ideological colonization, has been touched in this article. In contrast to direct ideological colonization, it may occur at least somewhat voluntarily and unconsciously. In my analysis indirect ideological colonization was linked to hegemony and common sense of today as part of a quest of promoting the benefits of social enterprise to the general public.

Finally I want to point out that although some of the rhetorical choices the authors have made might not serve their purposes and simultaneously attach SE with neoliberal meanings and associations, in some cases indirect ideological colonization might be hard or even impossible to avoid. Because in contrast, the statements that seek to challenge the current hegemony face a high probability of becoming marginalized or ignored. This is precisely because they lack the commonsensical legitimacy that for example neoliberalism at the moment possesses. Likewise it is the 'exclusive right' for signification of the prevailing ideology why we seem be living in a world where 'there is no alternatives'. The definite strength of Gramsci's concepts, is that they offer an explanation why this might be so, which is not only plausible but makes sense.

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# IDENTIFYING THE INTERACTION BETWEEN LANDFILL TAXES AND NIMBY. A SIMULATION FOR FLANDERS (BELGIUM) USING A DYNAMIC OPTIMIZATION MODEL

Rob Hoogmartens<sup>12\*</sup>, Maarten Dubois<sup>2</sup> and Steven Van Passel<sup>1</sup>

<sup>1</sup> Research Group of Environmental Economics, Centre for Environmental Sciences, Hasselt University, Agoralaan – Building D, 3590 Diepenbeek, Belgium

<sup>2</sup> Policy Research Centre for Sustainable Materials, KU Leuven, Kasteelpark Arenberg 44, 3001 Leuven, Belgium

\* Corresponding author, Tel: +32 11 268750; rob.hoogmartens@uhasselt.be

## ABSTRACT

In the past, landfills were emerging at an increasing pace in order to deal with growing waste generation. The negative externalities that are caused by these landfills however, together with the emergence of what is nowadays called the NIMBY (Not In My BackYard) syndrome, led to the awareness that volumes of landfilled waste had to decrease. As a result, restrictions on remaining landfill capacities emerged which causes remaining capacity to be regarded as a non-renewable, scarce resource. In this paper, a dynamic optimization model is constructed to assess the evolution of landfill volumes and landfill prices in time. Carrying out a simulation for Flanders (Belgium), landfill paths and price paths were constructed for two different scenarios. In the first scenario, landfill taxes are taken up in the model, whereas these taxes were omitted from the model in scenario two. As the results show, when landfill taxes are levied, it takes 42 years for landfill exhaustion to occur. When no landfill taxes are being used, this period would be shortened to only 20 years. Therefore, it is clear that a landfill tax has the effect that yearly landfilled volumes decrease considerably. In addition, when landfill taxes are used, discounted total welfare increases significantly. So we can conclude that, from a broad societal perspective, the added value of a landfill tax is considerable in terms of welfare gains.

*Keywords: Exhaustible Resources, Extractive, Landfill tax, NIMBY*

## 1 INTRODUCTION

In the 1960s, as a result of mass production and growing consumption that led to a steep incline in waste generation, landfills were popping up everywhere. Starting in the 1970s, public attitude towards waste started to change as people realized the negative environmental externalities caused by landfilling and the valuable space it occupies [19], [20], [21]. A well-known and often used instrument to internalize external effects such as noise, odor, groundwater pollution and air emissions, is a landfill tax.

In Europe, as it is moving towards an open market for waste management, calls are made to harmonize waste policies across borders. Considering that several front runners in waste management have high landfill taxes, the arguments for high and harmonized landfill taxes in Europe seem strong. In addition, landfill taxes directly target the lowest level of the Waste Hierarchy. Indeed, the landfill tax increases the cost of landfilling such that other waste treatment methods become more attractive [3], [8], [12]. Although there is some evidence on the effectiveness of a landfill tax to reduce landfilling [2], [15], [16], not all economic scholars are convinced that high landfill taxes are justified [7], [9], [10], [13]. These scholars argue that external costs of modern sanitary landfills with methane extraction are rather low (5-30eur). A Pigovian landfill tax would therefore be positive, but typically lower than landfill taxes such as in Belgium or in the UK (50-90eur) [5]. The question that then arises, is how to reconcile the economic perspective with policy discourses.

A historic element that has determined waste policies is the ‘Not In My BackYard’ syndrome (NIMBY), which is caused by spatial scarcity concerns [14]. Although this syndrome has not been a

conscious policy decision, its occurrence has actually avoided new permits for landfills. Considering that NIMBY has had the same effect as a moratorium on new landfill zones, landfill volumes have become a scarce good in densely populated regions in Western Europe. Economic theory predicts that scarce non-renewable goods will increase in price such that consumption will be restrained. Remarkably, this effect is also the aim of a landfill tax, so attention has to be paid to the interaction between both instruments.

In view of the above, this paper handles following research questions:

- What are optimal landfill and price paths, and when will landfill capacity be exhausted?
- Knowing that NIMBY has made new permits for landfills impossible, what has been the added value of the landfill tax in terms of social welfare gains?
- Can a landfill tax above the landfill externalities be justified?

To answer these research questions, a dynamic economic model was developed to identify the relationships between all relevant variables such as landfill volumes, landfill prices and landfill taxes. As the model should identify the best allocation of landfill volume over time, the model was set up as a dynamic optimization problem. Focusing on the simulation of economic models, the paper does not address non-economic factors other than the potential impacts of applying landfill taxes. When supporting decision-making in practice, also non-economic and societal factors should normally be included. As a case study, the Flemish region of Belgium was chosen to illustrate the theoretical approach.

In the second section, all elements of the dynamic optimization model are discussed and a theoretical model is built up. Based on these theoretical underpinnings, a simulation is carried out in the third section, using Flanders as illustrative case study. The article concludes with a discussion and an overview of the most important findings.

## 2 DYNAMIC OPTIMIZATION MODEL

Numerical optimization problems are known to serve at least two functions. First, they make theory and methods less abstract and more meaningful and secondly, they can serve as a bridge from theory and general models to actual analyses of real-world allocation problems [6]. Figuring out optimal landfill and price paths, and effects of influencing variables, requires a dynamic optimization model to be elaborated. Below, all elements the optimization model is based on, are discussed.

### 2.1 Landfill demand

To map the aggregate landfill volume demanded to market price, an inverse demand curve is used. In general, we write  $p_t = D(S_t)$ , where  $p_t$  is the price per ton landfilled in period  $t$  given that an aggregate landfill volume of  $S_t$  is supplied to the market. We will assume that price decreases with increases in  $S_t$  (so  $D'(S_t) < 0$ ). In our model, a linear inverse demand function is used, which is given by:

$$p_t = D(S_t) = A - bS_t \quad (1)$$

with:  $p_t$  = price in year  $t$  (eur/ton)

$S_t$  = volume landfilled in year  $t$  (million ton)

$A$  = choke-off price, intercept on price axis (eur/ton)

$b$  = slope of the inverse demand function

An important characteristic of the linear demand curve is the implied maximum choke-off price at the intercept  $p_t = A$  when  $S_t$  is equal to zero. Such an upper bound may result from the existence of a substitute, available at constant marginal cost  $MC = A$ . In scheduling landfill volumes, each competitive firm is assumed to know about this backstop substitute and to know what price will reach the intercept when the full remaining landfill volume has been exhausted. As substitutes for Flemish landfilling, one can think of an increase in waste export or an increase in the waste recycling rate. In the model, we assume exhaustion occurs in  $t = T$ . At that time, remaining landfill volume falls to zero ( $S_T = 0$ ). The date of exhaustion,  $T$ , is unknown and must be determined along with the competitive landfilling and price paths.

## 2.2 Landfill demand

In the model, it is assumed that there exists a competitive landfill industry facing a linear inverse demand curve for aggregate landfill volume,  $S_t$ . The landfill companies are maximizing their profits, so they will try to offer landfill volume so as to:

$$\begin{aligned} \text{Maximize}_{S_t} \pi &= \sum_{t=0}^T \beta^t * \pi_t = \sum_{t=0}^T \beta^t * [p_t - c - l] S_t \\ \text{s. t. } \sum_{t=0}^T S_t &= \bar{S}_0 \end{aligned} \quad (2)$$

with:  $\pi_t$  = profit in year t (eur)

$c$  = landfill cost (eur/ton)

$l$  = landfill tax (eur/ton)

$\bar{S}_0$  = Remaining landfill capacity in year 0 (million ton)

$\beta = 1/(1 + \delta)$  and  $\delta$  is the discount rate

The Lagrangian for this problem may be written as:

$$\text{Maximize}_{S_t} L = \sum_{t=0}^T \beta^t * [p_t - c - l] S_t - \lambda [\sum_{t=0}^T S_t = \bar{S}_0] \quad (3)$$

The first-order-conditions require:

$$\frac{\partial L}{\partial S_t} = \beta^t * [p_t - c - l] - \lambda = 0 \quad (4)$$

$$\beta^t * [p_t - c - l] = \lambda$$

Considering that we work with an inverse linear demand, it is straightforward to determine the choke-off price  $A$ . The price in period  $T$  (the last period of landfilling) will be equal to this choke-off price. So:

$$p_T = A \quad (5)$$

Equality (5) can then be inserted into (4) to determine  $\lambda$ , the shadow price of volume restriction (NIMBY).  $\lambda$  can be regarded as an economic measure of resource scarcity which is different from standard measures based on physical abundance. From an economic point of view, scarcity should reflect marginal value net of the marginal costs associated with landfilling. Filling in (5) into (4) gives us:

$$\beta^T * [A - c - l] = \lambda \quad (6)$$

In order to assess the yearly volumes landfilled, we insert (1) into (4) and we get:

$$\beta^t * [A - bS_t - c - l] = \lambda \quad (7)$$

If we rewrite (7), we get:

$$S_t = \frac{A - c - l - \lambda \beta^{-t}}{b} \quad (8)$$

Again, rewriting (8) (with  $\lambda > 0$ , i.e. NIMBY) results in:

$$S_t = \frac{[1 - \beta^{T-t}] * [A - c - l]}{b} \quad (9)$$

With:

$$\bar{S}_0 = \sum_{t=0}^{T-1} \frac{[1 - \beta^{T-t}] * [A - c - l]}{b} \quad (10)$$

Making use of equation (10), we can calculate a value for  $T$ , so we can estimate how long it takes before all remaining landfill volume will be exhausted.

### 2.3 Societal point of view

From a societal point of view, there are two major problems related to landfilling. First of all, landfilling has some negative externalities, like for example noise, odor, groundwater pollution and air emissions. As these externalities have an impact on society, they carry a cost with them, which is called an externality cost. In the model, the unit externality of landfilling is presented by parameter  $e$ , whose value is strictly larger than zero. The second problem relates to the Marginal Cost of Public Funds (MCPF). Government revenues are typically expensive for society because of tax dodging and administration [1], [11], [18]. In contrast, landfill taxes are way easier to monitor, especially in developed regions such as Flanders. Indeed, there are only a few landfill sites and landfill monitoring would happen regardless of the fact whether taxes apply or not. The Marginal Cost of Landfill Taxes (MCLT) is therefore low. This gives:

$$\chi = MCPF - MCLT > 0$$

With  $\chi$  representing the relative benefit of using landfill taxes instead of other, more expensive taxes like for example a labor tax.

Based on all preceding equations, total welfare can be calculated with  $B = 0$  as the residual benefit of landfill volume after year  $T$ :

$$W = \sum_{t=0}^T \beta^t * [D(S_t) - c - e + \chi l] S_t + B$$

In the next section, all of the foregoing formulas will be used in an illustrative simulation. With these formula, values are defined for  $T$ ,  $p_t$ ,  $S_t$ ,  $\pi_t$  and  $W$ . All other variables are defined exogenously.

### 3 CASE STUDY: LANDFILLING IN FLANDERS

Carrying out a simulation to illustrate the theoretical approach, data from the Flemish part of Belgium were used. Making use of equation (10) and using exogenously determined values for parameters  $A$ ,  $c$ ,  $l$ ,  $b$ ,  $e$ ,  $\delta$ ,  $\chi$  and  $\bar{S}_0$ , a value can endogenously be determined for parameter  $T$ . The exogenous values that were used, are presented in Table 1.

Table 1. Exogenous parameters.

Parameter	Value	Parameter	Value
A	100	e	50
c	15	$\delta$	0,05
l	60	$\chi$	0,2
b	50	$\bar{S}_0$	12

Using the choke-off price and taking into account landfill volumes and prices from previous years [4], the linear inverse demand function was estimated to be:

$$p_t = 100 - 50 S_t$$

Based on a study carried out by OVAM, the remaining landfill volume in period 0 was taken to be 12 million tons, so the value of parameter  $\bar{S}_0$  was set to 12 [17]. Below, the simulation results are given for two scenarios, one with and one without using landfill taxes.

#### 3.1 Scenario 1: simulation with landfill taxes

By assigning parameter  $l$  a positive value, a landfill tax is directly taken up in the simulation exercise. By solving the dynamic maximization problem and using equation (10) to define a value for parameter  $T$ , results like presented in Table 2 can be obtained.

Table 2. Simulation with landfill taxes.

$t$	$S_t$	$p_t$	$\pi_t$ (discounted)	$W_t$ (discounted)	$\lambda$
0	0,43	78,33	1.442.349,28	15.675.116,13	3,33
1	0,43	78,49	1.431.276,22	14.848.151,02	3,33
2	0,43	78,67	1.419.649,51	14.060.024,74	3,33
3	0,42	78,85	1.407.441,46	13.308.860,79	3,33
4	0,42	79,04	1.394.623,00	12.592.870,68	3,33
5	0,42	79,25	1.381.163,63	11.910.349,67	3,33
...					
38	0,08	96,25	249.674,83	530.221,44	3,33
39	0,05	97,31	178.968,04	366.227,93	3,33
40	0,03	98,43	104.725,92	206.592,46	3,33
41	0,01	99,60	26.771,69	50.934,97	3,33
42	0	100	0	0	3,22
$\sum_{t=0}^T$	12		39.931.451,13	239.109.115,1	

As can be deduced from Table 2, the value of  $T$  satisfying equation (10) is  $T = 41,33$ . In a discrete-time problem such as this, where  $T$  must be an integer, we round  $T$  up to 42. This means that it takes 42 years for exhaustion to occur. The bottom row in Table 2 shows the total landfilled volume, the discounted total profit of the landfill companies and the discounted total welfare. Remember that  $\lambda$  can be regarded as an economic measure of resource scarcity. In the above model,  $\lambda$  is the value of marginally loosening the constraint, that is, increasing the landfill capacity. Given the results in Table 2, one could numerically plot the time paths for landfill volume and landfill price. These paths are respectively shown in Figure 1 and Figure 2 and show how landfill volumes and landfill prices change in time.

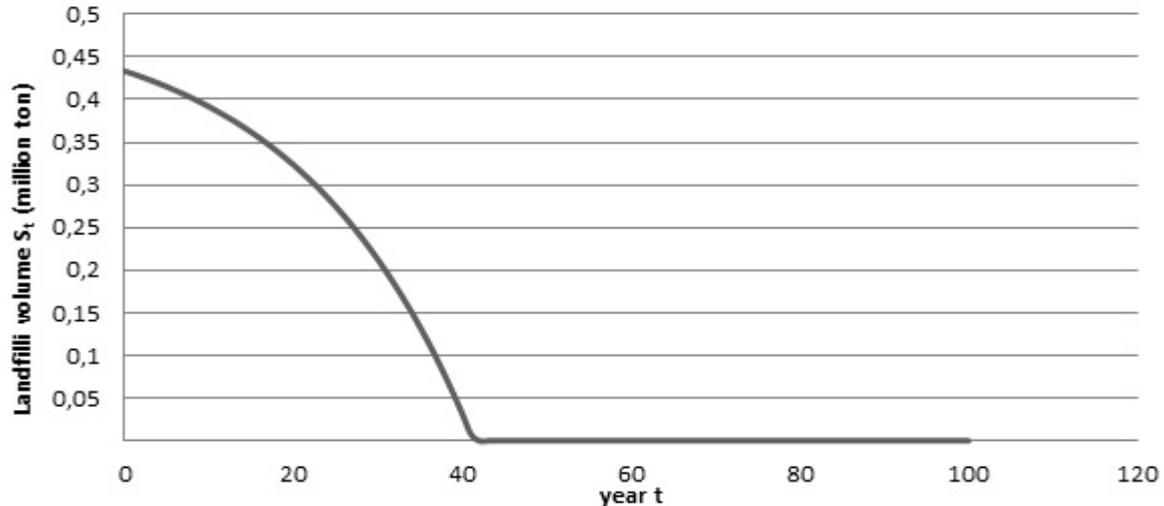


Figure 1. Landfill path when using landfill taxes.

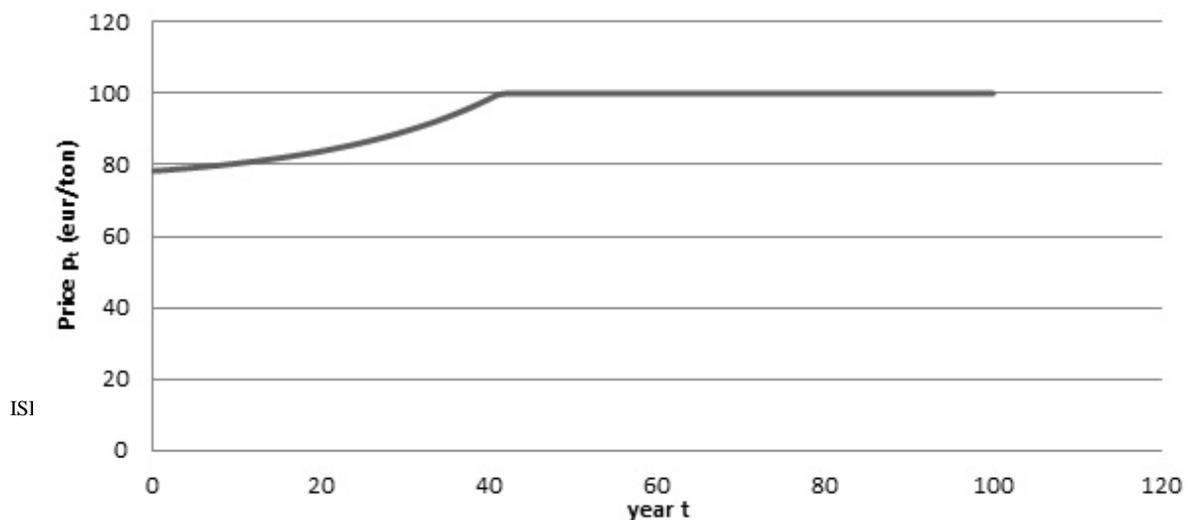


Figure 2. Price path when using landfill taxes.

### 3.2 Scenario 2: simulation without landfill taxes

By setting the value of parameter  $l$  equal to zero, landfill taxes are left out of the model. When we then solve the dynamic optimization problem and use equation (10) to define a value for parameter  $T$ , results like presented in Table 3 are obtained.

Table 3. Simulation without landfill taxes.

$t$	$S_t$	$p_t$	$\pi_t$ (discounted)	$W_t$ (discounted)	$\lambda$
0	1,03	48,27	34.419.977,41	9.450.015,63	33,27
1	1,00	49,93	33.313.294,35	9.503.816,96	33,27
2	0,97	51,68	32.151.277,15	9.501.039,65	33,27
3	0,93	53,51	30.931.159,08	9.441.677,08	33,27
4	0,89	55,44	29.650.035,11	9.325.587,93	33,27
5	0,85	57,46	28.304.854,94	9.152.495,77	33,267
...					
16	0,25	87,62	8.238.632,16	3.268.421,10	33,27
17	0,18	91,25	5.822.881,85	2.338.685,08	33,27
18	0,10	95,06	3.286.344,01	1.335.310,58	33,27
19	0,02	99,06	622.979,29	255.908,62	33,27
20	0	100	0	0	32,04
$\sum_{t=0}^T$	12		399.202.148,3	132.563.771,7	

Looking at Table 3, we see that the value of  $T$  satisfying equation (10) has decreased from  $T = 41,33$  in the case of using landfill taxes, to  $T = 19,23$ . As before, we round  $T$  up to 20. This means that it takes 20 years for exhaustion to occur. When we compare Table 2 with Table 3, we see that a landfill tax substantially reduces the volumes that are landfilled each year. For example, when a landfill tax would be applied, the total volume landfilled in the first six years would add up to only 2.547.316 tons, whereas this total volume landfilled would add up to 5.674.436 tons when no landfill tax is levied. When landfill taxes are used, prices start at a much higher level than when no landfill taxes would be applied, but they move less rapidly to the choke-off price level. As expected, the landfill companies' discounted total profits are much higher when no landfill taxes have to be paid. However, when we look at discounted total welfare, we see that from a societal point of view, the use of landfill taxes is preferable. Discounted total welfare is much higher in the scenario where landfill taxes are applied. This difference is mainly related to the parameter  $\chi$ , which takes into account that the MCPF is larger than the MCLT. The parameter  $\lambda$  can still be regarded as the value of marginally increasing the available landfill capacity. In this scenario where no landfill taxes are applied, the value of this scarcity indicator is higher than in the case where landfill taxes were used. This is quite logical, taking into account that the remaining landfill capacity is depleted at a higher rate when no landfill taxes are being used, making the remaining stock more scarce and valuable.

Given the results in Table 3, the time paths for landfill volume and landfill price can numerically be plotted. These paths are respectively shown in Figure 3 and Figure 4 and show how landfill volumes and landfill prices change in time, when no landfill taxes are applied. Based on these paths, and by comparing them to Figures 1 and 2, the same conclusions can be drawn as were discussed in the description of Table 3.

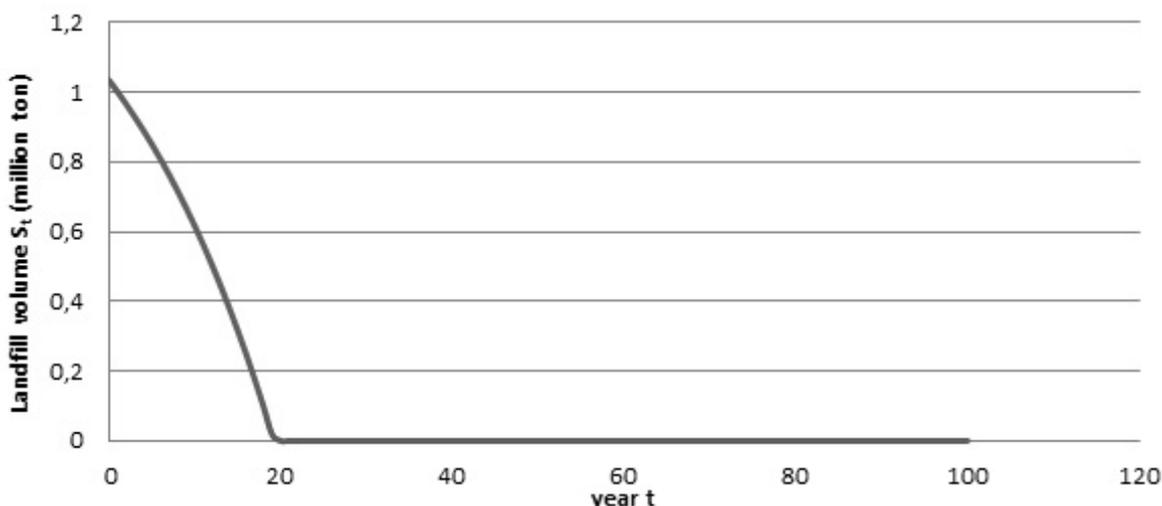


Figure 3. Landfill path without using landfill taxes.

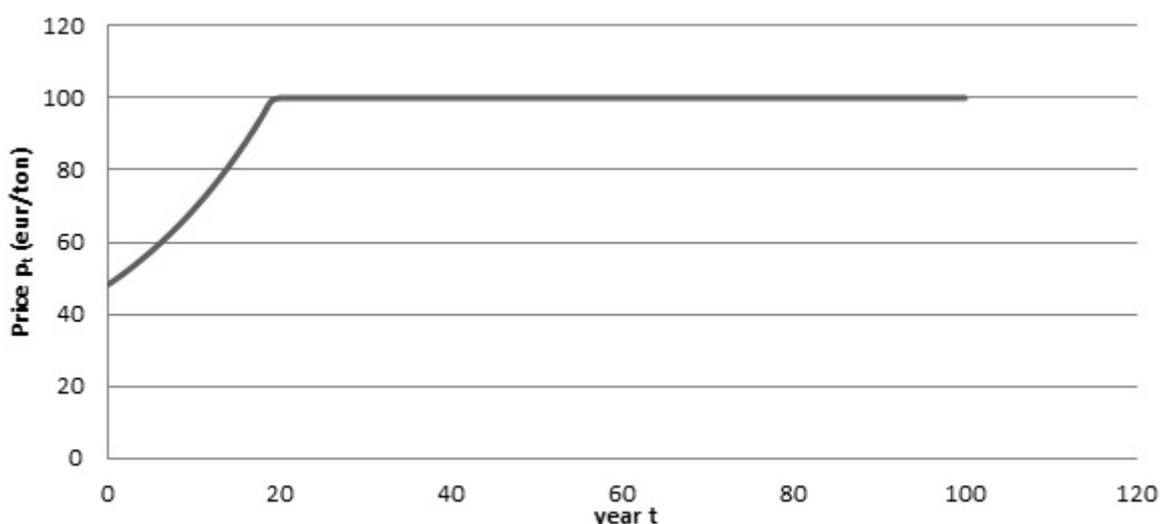


Figure 4. Price path without using landfill taxes.

#### 4 DISCUSSION AND CONCLUSIONS

As remaining landfill capacity is scarce, care has to be taken to deplete the remaining capacity in the most optimal way. Landfill taxes form an instrument that can be used to increase the cost of landfilling such that other waste treatment methods become more attractive. Although there is evidence that a landfill tax can be effective in reducing landfilling, not all economic scholars are convinced that high landfill taxes are justified [7], [10], [13]. Next to landfill taxes, there is another, more indirect instrument that can cause an increase in the price of landfilling. This is the so called NIMBY syndrome, whose existence avoids new permits for landfills to be created. Given this, landfill prices rise through the fact that landfill volume can be seen as a scarce, non-renewable good. A phenomenon that also emerges when using landfill taxes.

By gradually elaborating a dynamic optimization model, optimal landfill and price paths could be defined by running the algorithm which includes maximizing the profits of the landfill companies taking into account that the sum of all volumes that are landfilled yearly should equalize the initial remaining landfill volume. Flemish data were used to give a simulation example, and to answer the three research questions that were stated at the beginning of the paper. Using data of Flanders, landfill paths and price paths were defined for both a scenario where landfill taxes are being used and a scenario without landfill taxes being applied. These paths were presented above in Figures 1, 2, 3 and 4. Starting with a remaining landfill capacity of 12 million tons in year zero, the scarcity of landfill capacity, which can partly be explained by the NIMBY syndrome, was taken into account. By solving the dynamic optimization problem for different scenarios where the value of the landfill tax was strictly positive or equal to zero, different landfill paths and price paths were constructed. As could be

seen, when landfill taxes are used, the volume that is landfilled each year will drastically decrease. When landfill taxes are used, it takes 42 years for full exhaustion to occur, whereas this period would be shortened to 20 years would no landfill taxes be levied. Besides this, although discounted total profit falls when landfill taxes are used, discounted total welfare increases considerably (from 132.563.772eur to 239.109.115eur). This difference is mainly achieved by the value of the MCLT being smaller than the value of the MCPF. To conclude we can say that, from a broad societal point of view and knowing that NIMBY has made new permits for landfills impossible, the added value of a landfill tax is considerable in terms of welfare gain.

Another research question that could be answered using the dynamic optimization model, is whether a landfill tax above the landfill externalities would be justified. One could expect, looking at the MCPF, that a landfill tax above the landfill externalities can be justified. As the simulation model showed, this effect is not as large as expected. Only when minor tax increases are implemented, discounted total welfare increases. However, a turning point will be achieved from where discounted total welfare starts to decrease. Eventually, discounted total welfare will be lower than the value initially started from. It should be obvious that an increase in the parameter  $\chi$  (MCPF-MCLT) increases discounted total welfare and prolongs the period until the turning point is reached.

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# 3-D SUSTAINABILITY AND ITS CONTRIBUTION TO GOVERNANCE ASSESSMENT IN LEGAL TERMS: EXAMPLES AND PERSPECTIVES

**Author VOLKER MAUERHOFER<sup>1</sup>**

<sup>1</sup> Faculty of Life Sciences, University of Vienna, Austria; UNU IAS - United Nations University Institute for the Advanced Study of Sustainability, Japan; PRIMAFF - Policy Research Institute of the Ministry of Agriculture, Forestry and Fishery, Japan

## ABSTRACT

Sustainable Development as a process as well as outcome is heavily dependent on how its three internationally recognized environmental, social and economic dimensions are balanced day by day. This integration of these dimensions establishes a challenge for decision making also under the rule of law. Legislation, implementation and enforcement are requested on all geo-political levels to address a wide range of thematic issues in a sustainable manner. The paper includes the newly developed application possibilities of a conceptual framework called 3-D Sustainability and explores potential future improvements and extensions of its use. 3-D Sustainability is a concept to assess priority setting in the relationship between the three dimensions. It introduces a preliminary order of six criteria (sufficiency, eco-effectiveness, ecological equity, socio-effectiveness, eco-efficiency, socio-efficiency) for the assessment of hierarchies and conflicts of interests between these dimensions. The theoretical application of the criteria of 3-D Sustainability on several real examples of legal acts indicates its usefulness in practice. Recently, the concept also provided the basis for the application of a tool called the Legislation Check assessing legal norms as the “rules of the game” as well as for another tool called the Governance Check which focuses more on the analysis of governmental organizations as “players of the game” and their mutual relationship. After revisiting the concept of 3-D Sustainability and these Checks, the further potential is critically explored. This analysis leads to a more detailed description of the criteria and their relationship. This fosters the theoretical and practical application of the concept.

*Keywords: compromise, legislation, governance, politics, policy*

## 1 INTRODUCTION

Sustainable Development got one of the main global buzzwords of the past thirty years [1,2,3]. Early starting points for this status constitute the ‘World Conservation Strategy’ of 1980 [4,5] and in particular the famous definition in the report on ‘Our Common Future’ of the World Commission on Environment and Development reading such as following: ‘Humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future to meet their own needs’ [6].

Based thereon the term got a core issue of the World Summit of Rio 1992 and became strongly integrated into the main documents adopted there. This is especially true for the Rio Declaration and its implementing legal vehicle for the local level, the Local Agenda 21 [7]. In 2002 the term provided then the denomination as well as the central content of discourse for the World Summit in Johannesburg. Furthermore, ‘ensuring environmental Sustainability’ became integrated into the Millennium Assessment as the 7<sup>th</sup> of eight Millennium Development Goals to be achieved by 2015 [8]. International, regional, national and subnational environmental law didn’t seal off from this tendency [9-11] but actively followed which is indicated through a steady increase of the legal use of ‘sustainable development’ or similar terms [12]. Just recently at the international Rio+ 20 conference all members of the United Nations reconfirmed in the outcome document their commitment to

Sustainable Development and its environmental, social and economic dimensions [13]. In any way, how the three different dimensions of Sustainable Development are interrelated, how the trade-offs should be made and which priorities set, remains often rather vague in those policy documents; imprecise attributes such as ‘integrated’, ‘balanced’, ‘inclusive’, ‘coherent’, and ‘consistent’ for the solution of the inherent conflicts of interest constitute the rule [13].

This paper is in particular dedicated to these questions from the legal perspective. In the sense of ‘de lege ferenda’ it aims to provide innovative approaches to address these trade-off situations mainly based on a concept called 3-D Sustainability which provides structured but flexible decision support guidance. Based thereon, the paper concentrates on the role of the law for two central aspects of environmental sustainability, namely 1) for fixing the ecologically sustainable scale and 2. for laying down flexible trade-offs mechanisms with the social and economic dimensions of sustainable development. Finally, the paper provides some perspectives for the improved implementation and enforcement of international environmental law without necessarily modifying the ‘de lege lata’ situation.

## 2 SUSTAINABLE DEVELOPMENT AND THE LAW: THE CONCEPT OF 3-D SUSTAINABILITY

Starting point for the following explanations is a concept called ‘3-D Sustainability’ developed by the author with particular focus on the ‘de lege ferenda’ situation and sustainable development [10].

### 2.1 The Overall Picture Regarding the Ecologically Sustainable Scale

Many concepts try to pictorially describe the interrelationship between the three dimensions of sustainable development, namely the environmental, social and economic sustainability, within a single figure. In general, this seems an adequate way in order to make the sustainability concept better accessible and comprehensible for a wider public. However, four main shortcomings of prior widely used pictorial descriptions of Sustainable Development have already been identified earlier by the author. These are (1) misinterpretation of embeddings, (2) misjudgement of equity between these three dimensions of sustainability, (3) a lack of expression of limitations and (4) a lack of adequate decision support [10]. The 3-D Sustainability concept explained in the followings strives to solve all the four shortcomings mentioned above [10].

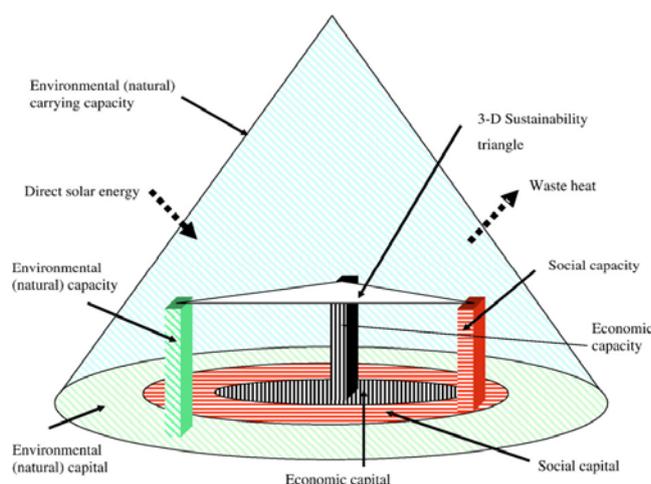


Figure 1: 3-D Sustainability [10]

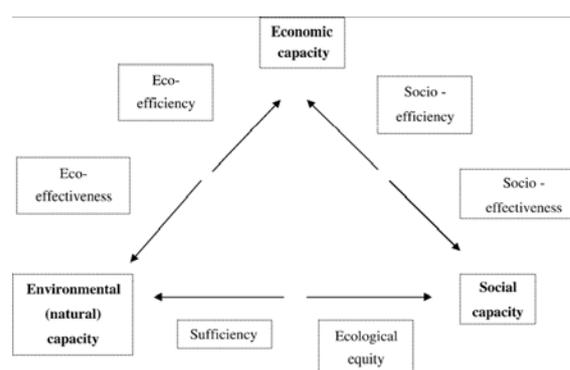


Figure 2: 3-D sustainability triangle [15]

The 3-D Sustainability triangle balanced on the columns of Fig. 1 is presented in more detail with its separate elements in Fig. 2. It is closely related to the triangle of corporate sustainability [15].

## 2.2 Definitions and Objectives for the Six Criteria of 3-D Sustainability

In the following, the six criteria of 3-D Sustainability are more in-depth explored in order to increase its meaning for their potential application. An overview is developed for each of the six criteria including a shortened definition respectively and the characteristics of their objectives (Table 1).

*Table 1: Shortened definition ad quantitative characteristics of the objectives of the six criteria of 3-D Sustainability [16]*

Criterion	Definition	Characteristics of its objective
<b>Sufficiency</b>	Individual's decision to consume/produce no unit (more) or even unit's less	Absolute, quantitative and/or qualitative, but sustainability depends on current consumption/production level;
<b>Eco-effectiveness</b>	Capacity of an action to achieve its expressed ecological objectives	Absolute, at least >50% improvement, no rebound effects
<b>Ecological equity</b>	Intra- & intergenerationally acting under the 'veil of ignorance'[17]	
<b>Socio-effectiveness</b>	Capacity of an action to achieve its expressed societal objectives	
<b>Eco-efficiency</b>	Input & output ratio (per time) of energy/waste for product/service	Relative, 0-99 % improvement per unit (product/service/person), rebound effects in longer run
<b>Socio-efficiency</b>	Input & output ratio (per time) of an action concerning persons	

In Table 1 the emphasis is put on quantitative characteristics of the objectives in order to make them measurable. An individual decision towards sufficiency does not mean automatically sustainability as the decision to produce/consume less could be made at an already unsustainable level and then could still stay unsustainable even after a reduction. The decision to produce or consume no additional unit or ever less units than during the period before should definitely lead to a constant or decreased throughput respectively of energy and matter. Otherwise, also increases of the qualitative manner of the unit can consume the savings deriving from the quantitative limitation based on the rebound effect [18]. With eco-efficiency and socio-efficiency a rebound effect always happens sooner or later under the premise of a growth of the number of units produced or people addressed. Also with sufficiency rebound effects can happen [19], but this is not necessarily a following effect when deciding for sufficiency as others may decide for sufficiency too. Sufficiency due to its voluntary character is not mainly determined by prescriptive norms. But it has insofar a legal context as actions leading people to sufficiency such as publically sponsored campaigns or incentives do regularly have their basis in the rule of law.

## 3 LAW AND FIXING THE ECOLOGICALLY SUSTAINABLE SCALE

This chapter will deal with general preconditions and questions rising up when trying to fix the ecologically sustainable scale by means of international environmental law. While how to lay down flexible trade-offs mechanisms by the rule of law to support will be dealt with in particular in the next chapter. When trying to fix the ecologically sustainable scale (the 'carrying capacity') of using environmental assets (the 'capital'), the main focus should be to achieve this in absolute terms on a safe time scale and within the respectively appropriate geographic scale. Issues of scale were already deeply assessed in institutional policy analysis [20]. In this paper, the author in general follows Gibson et al.'s broadly applicable definitions of scale and level where 'scale' is defined as 'the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon', and 'levels' are defined as 'the units of analysis that are located at different positions on a scale' [21]. Cash et al. indicate seven different types of scale as of importance for policy studies, namely – additionally to the commonly used spatial and temporal scales – the jurisdictional, institutional, networks, management, and knowledge scales [22]. Del Monte-Luna et al. defined ecological carrying capacity as 'the limit of growth or development of each and all hierarchical levels of biological integration, beginning with the population, and shaped by processes and interdependent relationships between finite resources and the consumers of those resources' [23]. This definition is applicable for each

biotic or abiotic attribute with a potential for human use as a source or a sink (such as a plant species, a mineral, water, air).

Table 2: *Reduced qualitative methodology of the Legislation-Check* [12]

Overall objective	Interrelationships	Specific questions for geo-political legislative level
Ecologically sustainable scale of critical natural capital (ecological carrying capacity) achieved	Dependent on geographical level	Is the scale known? <ul style="list-style-type: none"> <li>• Can the known scale be geo-politically addressed? <ul style="list-style-type: none"> <li>○ Can the known scale be geo-politically addressed by competent authority/-ies? <ul style="list-style-type: none"> <li>▪ Can the known scale be geo-politically addressed in a proper way?</li> </ul> </li> </ul> </li> </ul>
	Dependent factor(s) influencing ecological carrying capacity	Is the scale unknown/uncertain?
	Dependent on time	<ul style="list-style-type: none"> <li>• Can the unknown/uncertain scale be addressed in a precautionary way?</li> </ul>

The approach presented in Table 2 also takes stronger into consideration the spatial aspects of the term 'scale' such as emphasized by Jordan and Fortin [24] in comparison to Daly's original more throughput oriented definition [25]. The identification of this scale level is a precondition for the identification of the correct measures not exceeding the carrying capacity. This applies to the social as well as to the ecological (environmental) carrying capacity.

Among the general obstacles that hinder already from the beginning the establishment of an ecologically sustainable scale in legal terms, are situations where the geopolitically competent authority is not able to regulate the problem-related benchmarks for the whole geographic scale of the problem. Such a clear mismatch between the relevant geographical scale and the institutional scale [22,26] could be for example found in Austria with regard to the competence for biodiversity conservation [12,10].

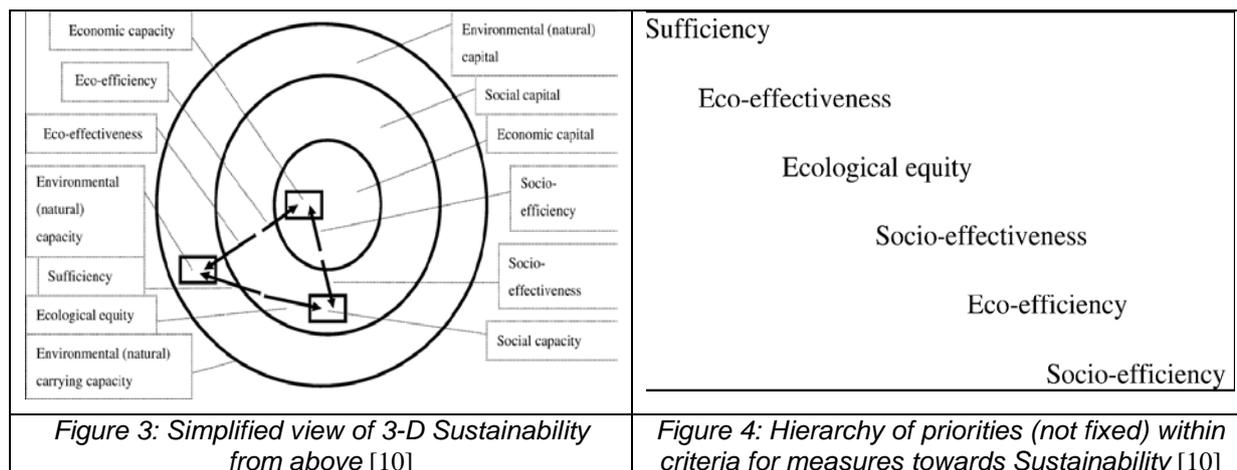
One case where such a mismatch is avoided on the EU-level constitutes the establishment of the protected area network NATURA 2000 based on biogeographical regions as starting points for the criteria-based selection of particular sites ensuring the protection of certain species and habitat types [27,28]. Based on this selection, afterwards the environmental carrying capacity in the sense of the restoration or maintenance of the legally defined favourable conservation status is determined [10]. A second EU-case constitutes the so called Water Framework Directive (WFD)[29] which orients its actions on river basins covering the territory of often more than one Member State and being managed by one competent authority that had to be commonly designated [30,12]. Among the pitfalls and problems with fixing an ecologically sustainable scale are also general exemptions that are included from the beginning into law. Another initial problem happens if the scale is not fixed from the beginning in the right qualitative and quantitative extent. In comparison to these cases, the trade-offs described in the following are mainly influencing a scale already established by law.

#### 4 LAW AND LAYING DOWN FLEXIBLE TRADE-OFFS MECHANISMS

This chapter shows in particular how flexible trade-offs mechanisms for the rule of law towards a sustainable development can be derived from 3-D Sustainability and also applied in practice.

##### 4.1 The Flexible Hierarchy Between the Criteria and their Relevance for Legal Trade-Off Decisions

The exploration of priority setting by 3-D Sustainability starts from a different view point namely from above, whereby a simplified figure can be gained (Figure 3). Looking regarding dependencies and the probability of reaching the social as well the environmental carrying capacities within Fig. 3, a general, but not fixed, hierarchy within the six criteria influencing the triangle has been derived by Mauerhofer [10] to identify the more sustainable solution(s) (Figure 4).



In this way, 3-D Sustainability clearly indicates which actions should preliminarily be given priority in order to maintain the whole system. This not fixed hierarchy is therefore in line with the principles of ‘prudent decision making’ [31], according to which both, the ends and mean(s) of an action are: (a) acceptable, (b) in line with each other and (c) not in conflict with any other end that is considered as more or equally important. The preliminary priority attributed to sufficiency in Fig. 4 is also in line with other authors [32], and it is correctly pointed out that [19] ‘(P)ersonal behaviour change is furthermore not a substitute for international political efforts’. This hierarchy expressed in Fig. 4. can then be applied on practical legislative examples in order to firstly identify the state and secondly recommend changes. Changes in the hierarchy can be done by means of a shift of a burden of proof. In the earlier paper, examples for in particular for the regional and international legal level were geographically differentiated and provided where 3-D Sustainability is respectively applied on real-life situations in order to show the usefulness of the concept [10]:

#### A. Global examples

1. UNFCCC [33] and the Kyoto Protocol
2. Mean’s and burden of proof under WTO rules
3. WTO negotiations — the principle of ‘less than full reciprocity’ (LTFR)
4. WTO ruling concerning the European Community-Hormones Case
5. WTO Appellate Body’s interpretation of Article 5.7 SPS Agreement in Hormones Case
6. Fishery — rules concerning the right scale of catches

#### B. Regional examples

7. EU — decoupling of economic growth from resource use and environmental degradation
8. European Court of Justice — conservation by double-reversing of the burden of proof

In each example the shift of the burden of proof is argued to be a key element when the above mentioned preliminary hierarchy within the six criteria should be changed [10].

## 4.2 Changing the Hierarchy and the Burden of Proof

Such as already mentioned, the hierarchy of priorities in Fig. 4 is not fixed, but subject to change. To justify a change in this hierarchy, it is proposed to place the burden of proof on the proponent interested in the change [34]. In other words, if a lower ranked criterion should be given priority, the burden of proof has to be reversed regarding the question of whether the environmental and/or social carrying capacities are endangered [10]. Such an approach fosters a precautionary way [35] to prevent or to solve conflicts of interest between the economic, social and environmental dimensions of sustainability based on sound science and rationality. Of course, the term ‘burden of proof’ can be understood in different manners. Kokott and other scholars highlighted already various meanings of the ‘burden of proof’ in different legal systems [36,37,38].

## 4.3 Flexible Trade-Off Mechanisms and Organizational Conflicts of Interest within the Law

Since sustainable development is discussed there have always been also approaches to assess and improve institutions in the sense of the rules of the game [39-41]. However, criticism has been raised

that the discipline of Ecological Economics has not developed sufficient influence on improving decision-making processes in the field of Sustainable Development [42-43]. Thus, in the following, two simple cases will be provided for the application of 3-D Sustainability on the assessment of administrative organizations based on a 'Governance Check' [44]. While the first example deals with a conflict of interest within one public authority, the second refers to conflicts of interest between public authorities.

The first case occurs for example if one minister is responsible for both, the environmental capital and its capacity such as in a practical situation change of an Austrian Ministry in 2000 [44]. Compared with the former situation, one and the same Ministry is beginning with the year 2000 responsible for the environmental capital as a source (and its carrying capacity as a limit) as well as the exploitation of that capital in the sense of 'capacitating' it through agriculture, forestry and water economy [44]. This situation could be seen as chance for better, because closer, coordination among Environment on the one side and Agriculture and Forestry, Environment and Water Management; while in practice the mix between capital (including carrying capacity) responsibilities and capacity responsibilities does not promote transparent decision making and, therefore, hinders public participation when it comes to conflicts of interests (e.g. with regard to the choice of measures concerning greenhouse gas reduction, renewable energy sources, afforestation and agri-environment funding) [44].

The second situation of conflicts of interest between public authorities has been also already described by the case of a single legal act and the distribution of rights when coordinating among different *capital authorities* and *capacity authorities* therein [44]. This example of the Austrian water act shows that for several activities the federal ministry competent for natural capital 'water' (including its carrying capacity) has in several cases to gain in advance the consent of other ministries mainly competent for the use ('capacitating') of water or for other forms of capital. Based on these legally fixed veto rights, these other ministries could – in contradiction with the principles of 3-D Sustainability – refrain from providing their consent without having any burden of proof in each particular case about whether their interests will not adversely affect the natural capital 'water' [44].

The examples above were concentrating on the national level and on regulating conflicts. Nevertheless, an extension of the application of the approach to public organizations of higher geographical levels could be a fruitful idea to be envisaged.

## 5 PERSPECTIVES FOR INTERNATIONAL ENVIRONMENTAL LAW AND ITS IMPROVED IMPLEMENTATION & ENFORCEMENT

The lack of implementation and enforcement of MEAs and related transnational initiatives is widely considered a major obstacle for stopping negative environmental trend or even reaching improvements [45,46]. Thus, to develop and execute for existing MEAs and initiatives more effective implementation and enforcement mechanisms appears to be of paramount interest without necessarily needing to change their wording. Examples for this are voluntary approaches [45], are increased capacity building measures in particular about the direct effect of MEAs on behalf of judges or civil servants [47-49] extending the application scope of MEAs through 'Accession of Regions' [50] and re-interpretation of existing MEAs towards more scientific content [51].

## 6 CONCLUSION

3-D Sustainability provides a challenging approach for decision support with its distinction between capital and capacity as well as with its six criteria. The analysis above shows that the main functions of international (as well as regional, national and subnational) law in collaboration with other instruments (e.g. economic ones, public awareness) with regard to a sustainable development could be defined based on 3-D Sustainability such as following:

1. Fix the ecologically sustainable scale of capacitating environmental capital in absolute terms on the safe time scale
2. Lay down flexible trade-offs mechanisms by the rule of law to support 1.
3. Implement & enforce 1. and 2.

Additionally, further perspectives such as more voluntary bottom-up approaches for the improved implementation incl. enforcement should be stronger taken into consideration as well as implementation approaches that do not need a word change of international environmental law.

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# GREEN PROCUREMENT AS A MEANS TOWARD RESILIENT PUBLIC ORGANIZATIONS

Hogne Nersund Larsen<sup>1</sup>, Christofer Skaar<sup>1</sup>, Christian Solli<sup>1</sup>, Johan Pettersen<sup>1</sup>, Simon Loveland<sup>2</sup>

<sup>1</sup> MiSA AS – a subsidiary of Asplan Viak AS

<sup>2</sup> The Municipality of Trondheim

## ABSTRACT

This paper describes the development of a carbon footprint-based inventory to be used for green procurement strategies. The project was initiated by the city of Trondheim and aims to support their ambitious climate mitigation strategies. The inventory developed for the service provision by the city of Trondheim shows a contribution of direct emission (scope 1) to the total carbon footprint of only approximately 2 %. If we include the greenhouse gas (GHG) emissions related to the purchase of energy (scope 2: electricity and district heating), this fraction increases to about 19 %. This leaves the vast majority of the carbon footprint to be counted as indirect scope 3 GHG emissions. In order to target these indirect scope 3 emissions, green procurement strategies need to be implemented. A second part of the project is therefore to support Trondheim in implementing such strategies in the organization. An analysis of the footprint in relation to the organizational structure revealed that 3 of Trondheim's 276 units accounted for approximately 50 % of the footprint, whereas an average small unit was responsible for 0.1-0.2 % of the footprint. This calls for a diversification in climate mitigation strategies, with one direction focusing on the three large units and a second direction focusing on groups of small units with similar challenges (e.g. schools or nursing facilities). Furthermore, recognizing that current approaches on their own are insufficient to reach the targets, we also recommend a third direction focusing on identifying and implementing innovative solutions across the organization.

*Keywords: Carbon footprint, Green Procurement, Local climate action, Public services, Innovation*

## 1 INTRODUCTION

The introduction of life cycle based calculation at the municipal level has clearly identified the carbon footprint largely to consist of indirect upstream GHG emissions embodied in the purchase of goods and services [1, 2]. Because municipal and other governmental purchases constitute a significant part of the economy (33% in Norway), there is clearly a need to address the potential of green purchasing strategies for reducing the carbon footprint of public services. The municipality of Trondheim is currently developing a consumption-based carbon footprint inventory covering all municipal purchases. The aim is to effectively use the inventory to target the main contributing elements, and to address the responsible department/units of the municipality. Such a targeting of actions will hopefully better direct mitigation strategies, focusing on the hot-spots in the inventory and build the foundations for a focused green procurement strategy.

Although green procurement [3-5] has been on the agenda for some time, it has proven challenging to implement such strategies [6, 7]. There are probably several reasons why the implementation has proven challenging, including: 1) Increased workload for the purchaser to evaluate the environmental performance of products and services, 2) Lack of competence in requiring/assessing the environmental performance in tender invites, 3) Lack of suitable data on the environmental performance of products /suppliers. Hence providing reliable data efficiently and clearly communicated is important. A part of the project is therefore to develop an online interactive calculator to help efficiently illustrate and communicate the significant amount of data involved. . This interactive calculator can also be used in a management perspective, identifying significant environmental aspects related to individual units and related to types of procurement.

Despite the importance of indirect scope 3 emissions, most municipalities tend to only focus on scope 1 and 2 (according to the GHG protocol [8]) emissions. Resilient municipalities, however, must expand beyond technology and include organizational aspects such as consumption and procurement. All of the larger cities in Norway have low direct GHG emissions within their geographical boundaries. The main reason for this is because of removal of industry activities in these areas. In the old days, cities were the natural location of industry due to labour availability. This is certainly not the case now, with the high labour costs. In addition, local pollution issues make large cities in Norway less attractive for industry establishments. However, despite the decrease of direct emissions from industry in larger cities, public and private consumption is increasing significantly. Hence, the carbon footprint is increasing, but emissions are being moved outside the municipal – and often also national – borders. This is known as carbon leakage. In Norway, these emissions embodied in trade are well established [9, 10]. This has also led to increasing discussions on production- versus consumption-based accounting [11-13]. The two concepts are summarized in Figure 1, relating them to the municipal level. While the traditional production-based inventory focus only on the emissions occurring inside the municipal boundaries, the consumption-based inventory includes all upstream emissions resulting from activities and consumption of that municipality. Note that in a consumption-based perspective, emissions from industry whose output is exported should be allocated to the consuming municipality, and not the location of the industry. This is why a consumption perspective is able to capture carbon leakage, and is therefore a better measure of sustainability.

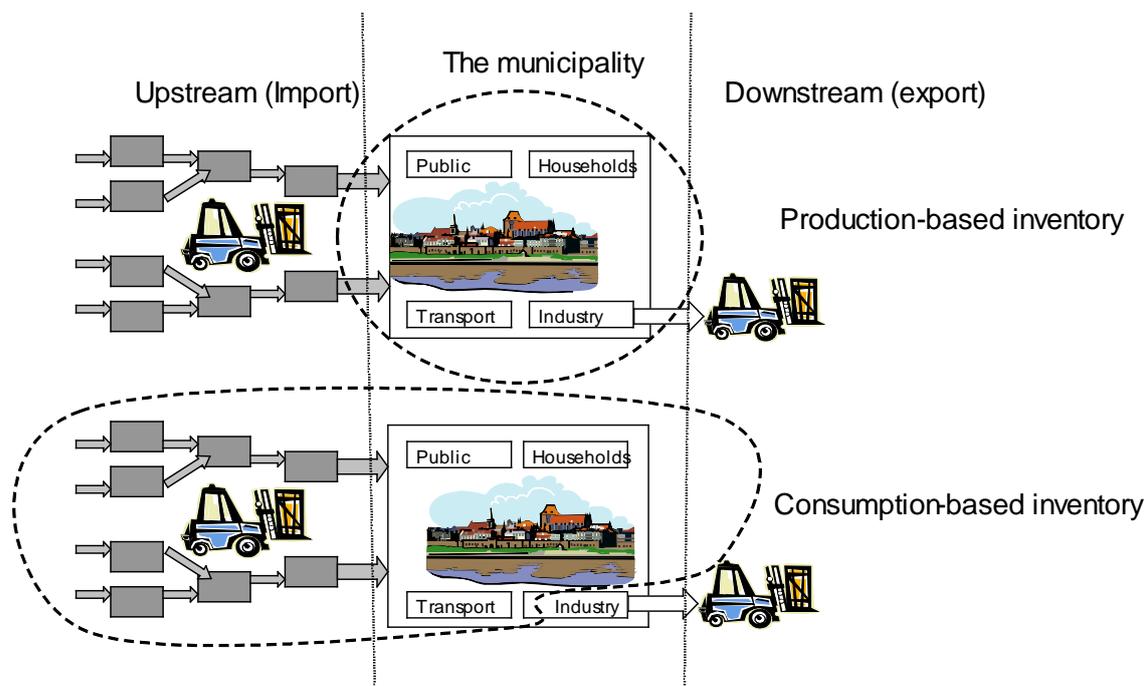


Figure 1. Production versus consumption-based accounting

The purpose of this paper is to outline how a carbon footprint inventory of a municipality can function as a foundation for developing green purchasing strategies. An important part of the analysis is not only to calculate the largest GHG contributing purchasing elements, but also identify who is responsible.

## 2 METHODOLOGY

The carbon footprint [14-16] is the most promising consumption-based [12, 17] indicator focusing on greenhouse gas (GHG) emissions. Carbon footprints are usually derived using life cycle assessment

(LCA) [18, 19], environmentally expanded input-output analysis (EEIOA) [20, 21], or a combination of the two, called hybrid LCAs [22, 23]. These hybrid LCAs are often the preferred choice as process-based LCAs require relatively specific types of data and have been criticized for leaving out significant portions of the emissions that occur in the system. This issue is referred to as cut-off and is particularly true for processes far upstream and service-based activities [24]. On the other hand, EEIOA is ideal for including emissions from all types of activities without any cut-offs, since it is based on an aggregated model of all existing sectors of the economy. However, it lacks the detail provided by LCA. Because of this, several authors describe the use of LCA and IOA in a hybrid approach, trying to utilize the benefits of both approaches, thereby retaining the completeness associated with EEIOA as well as the specificity offered by process-based LCA. Various approaches are described by several authors [22, 25-27]. The Trondheim projects is such an example of a hybrid-LCA approach; LCA data is applied for most scope 1 and 2 contributions, while EEIOA is used to cover the wide range of scope 3 contributions. The Klimakost model used for deriving the carbon footprint is developed by MiSA – Environmental Systems Analysis [28].

Although life cycle assessment is often targeted towards analyzing products or functions, the very same techniques may just as well be used to analyze the impact of entire companies or municipal organizations. Klimakost uses LCA in combination with EEIOA for its calculations. A main requirement for Klimakost is an EEIO model of the background economy for the studied entity. For this, we have constructed an EEIO model of Norway using national accounts data for Norway from 2007 [29], and emissions data from the same year [30]. Although a few complete multiregional EEIO models [31-33] exist, these models usually suffer from issues related to lack of data and updateability. Klimakost therefore applies a simplified EU27 import assumption regarding imports to the Norwegian economy; the EU27 data are frequently updated and in the same format as the Norwegian EEIO model. For the characterization of emissions, we use factors from the well-recognized method CML 2 Baseline 2000 v.2.04 [34] to calculate impact potentials such as global warming expressed in CO<sub>2</sub>-equivalents.

Several studies have identified a large fraction of indirect (scope 2 and 3, according to the GHG protocol [8]) GHG emissions [13]. The importance of green purchasing strategies [35] is hence identified. However, studies report barriers in implementing such strategies [6, 7], and further work is needed in both calculating better GHG inventories, addressing inventories more efficiently, and to help translate the analysis into green procurement strategies. Norwegian public procurement directives state that environmental considerations should be made in all public purchases. We consider green procurement a vital element of the municipalities' approach toward CSR and a necessary step in developing resilient public organizations and a green economy.

Today's procurement practices are not sustainable in the long term. Furthermore, it is likely that sustainable procurement differs in type and extent from today's procurements. However, it is not possible to know in advance what sustainability is, but we know we must reduce our resource consumption and our emissions to air, land and water. Green procurement and low carbon procurement can be regarded as strategies towards sustainable procurement. Here it is important to be aware that not all green procurements are likely to be sustainable and not all low carbon procurements are green procurements (e.g. when leading to problem shifting instead of problem solving). Still, for a number of products, there is a correlation between climate footprint and overall environmental impact.

Carbon footprint can in many situations be regarded as a proxy for green procurement, especially if the possibilities for problem shifting are kept in mind. General elements of a strategy towards sustainable procurement are shown in Figure 2: 1) reduction of purchases that are not green or low carbon, 2) increase in green and low carbon procurements and 3) increase in novel and innovative procurements.

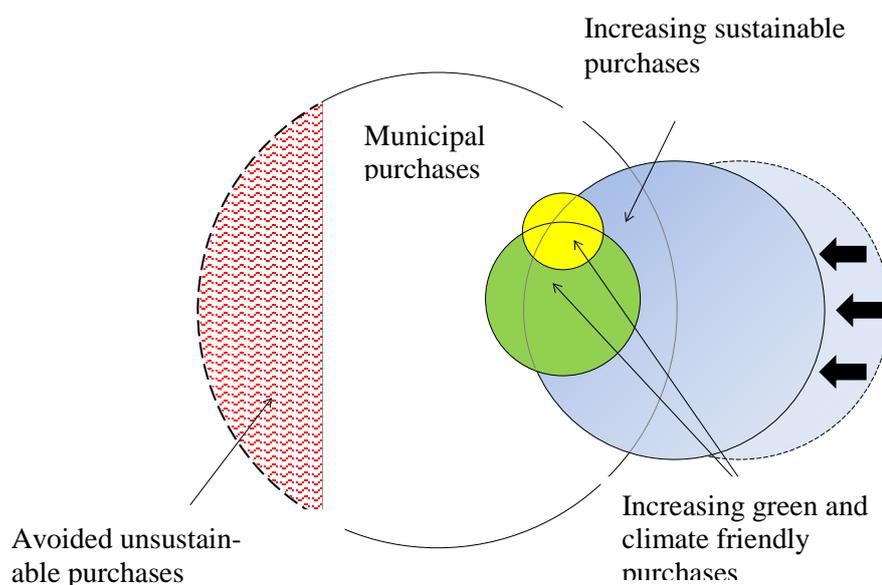


Figure 2. Green procurement strategy: shows the overlap of climate friendly (yellow), environmentally friendly (green) and sustainable (blue) purchases. The aim is to maximize the overlap and area covering all municipal purchases (white).

Based on the carbon footprint of Trondheim, the next step is analyzing how a low carbon procurement strategy can be implemented in the organization. A number of management systems that can support such an implementation are available, for example the European Eco-Management and Audit Scheme (EMAS, REF), the Norwegian Eco-Lighthouse scheme, and ISO 14001. To avoid redundancy, the low carbon procurement strategy should be integrated in the existing management system. As Trondheim is already ISO 14001 certified and ISO 14001 is an internationally recognized environmental management standard, this has been selected as the starting point.

### 3 Results and conclusions

Results for the municipality of Trondheim summarized in Table 1. In total, the CF of providing municipal services in Trondheim is approximately 1 tonne per capita. Results are in line with previous studies showing a low fraction of direct scope 1 emissions at only 2 %. This number has decreased continuously because of the substitution of renewable energy sources for heating oil. Direct emissions are now mainly connected to the use of fuel for transport. A contribution of 16 % indicates that scope 2 GHG emissions connected to the purchase of energy is quite significant. Providing services is quite energy intensive as most services require buildings and other energy-consuming infrastructures such as street lighting, pumping stations, etc. We assume a Nordic mix of electricity use at 186 g CO<sub>2</sub>-eq/kWh in the project.

The vast majority of the CF is associated with indirect scope 3 GHG emissions. These emissions are caused by the production of products and services purchased by the municipality. The results clearly indicate the need for green procurement strategies. The Klimakost model also enables us to investigate time series. As illustrated in Table 1, there has been a significant increase in the CF since 2001. Some of this is caused by a population increase, however, large investments in new buildings are also responsible for this, as all GHG emissions from construction processes and materials used are allocated to the year the investment was made. Hopefully, these newer buildings with improved energy efficiency will contribute to lowering the CF in the future. This could be one reason why per capita GHG emissions have actually decreased slightly from 2007 to 2012. The main reason, however, is probably the financial crisis in 2008, causing the municipality to spend money more carefully after 2007.

Table 1. summary of results

Trondheim 2012	#
Population	~ 180 000
Carbon Footprint (CF) [tonnes CO <sub>2</sub> e.]	~ 185 000
CF per capita	~ 1 tonne
Direct scope 1 GHG fraction	~ 2%
Indirect scope 2 GHG fraction	~ 16%
Indirect scope 3 GHG fraction	~ 82%
Increase in CF from 2001	~ 57 %
Increase in population since 2001	~ 17 %
Increase in CF from 2007	~ 8 %
Increase in population 2007	~ 9 %
Available organization levels in the project	Departments ( 6 ), service areas ( 19 ), units (276)
Available levels of detail on the activity/purchase contributions to the CF	Aggregated (5 or 7), detailed (13) and maximum detail (34)

In Figure 2, results are divided into the most aggregate level of detail, to provide an overview of the CF structure. Regarding activities/purchases, contributions are quite diverse with significant contributions from consumables (13 %), transport (11 %), energy (16 %), construction (25 %), maintenance (16 %) and outsourcing of services (16%). One example of outsourcing of services is the use of private kindergartens. The importance of construction shows that there is still a high investment rate in new buildings and other infrastructure contributing to the CF. Regarding the most important departments, we find healthcare (18 %) and education (20 %). The city development department is by far the largest, however, as it is responsible for building and infrastructure investments and all water-, waste- and road-related activities.

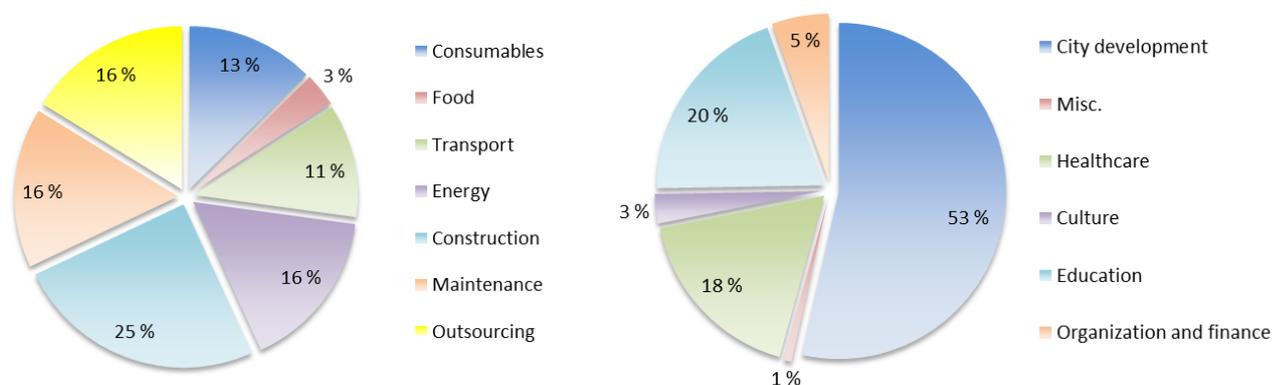


Figure 2: Carbon footprint per activity/purchase (left) and department (right)

By matching the two dimensions illustrated in Figure 3, we are able to investigate the CF structure of each department according to activities and purchases, as illustrated in Figure 3. By doing this, we are able to aim mitigation strategies more efficiently. For instance, the city development department is responsible for all construction and maintenance activities for buildings and infrastructure, and the CF associated with consuming food is allocated to the education and healthcare departments. This two-dimensional illustration of the CF is available for all level of details from 5x7 (as illustrated here) to 276 x 34.

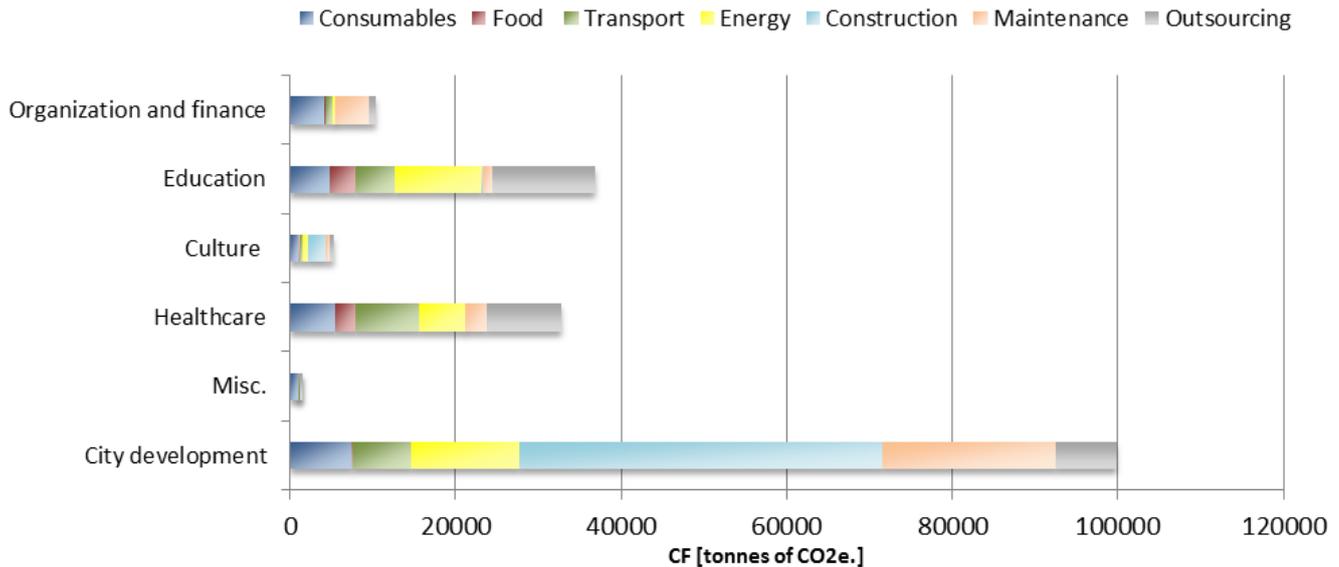


Figure 3. CF structure of each department

The novel part of this project is to efficiently distribute the GHG inventory on different organisational structures of the municipality, including a unit level consisting of 276 units, e.g. individual schools, kindergartens and nursing homes. Results show that differences are found not only between different service areas, but also amongst the different units of each service area. The complexity of the GHG inventory resulting from these results indicates a need for visualization tools that efficiently and clearly displays results. A screenshot of an interactive calculator developed in this project is displayed below (Norwegian only). Using this tool, the municipality can investigate the CF structure of departments (left pie chart), service areas (right pie chart) and results at the unit level available in the a specific sheet ("Per enhet"). Results are also benchmarked in spider charts and normalized by relevant indicators.

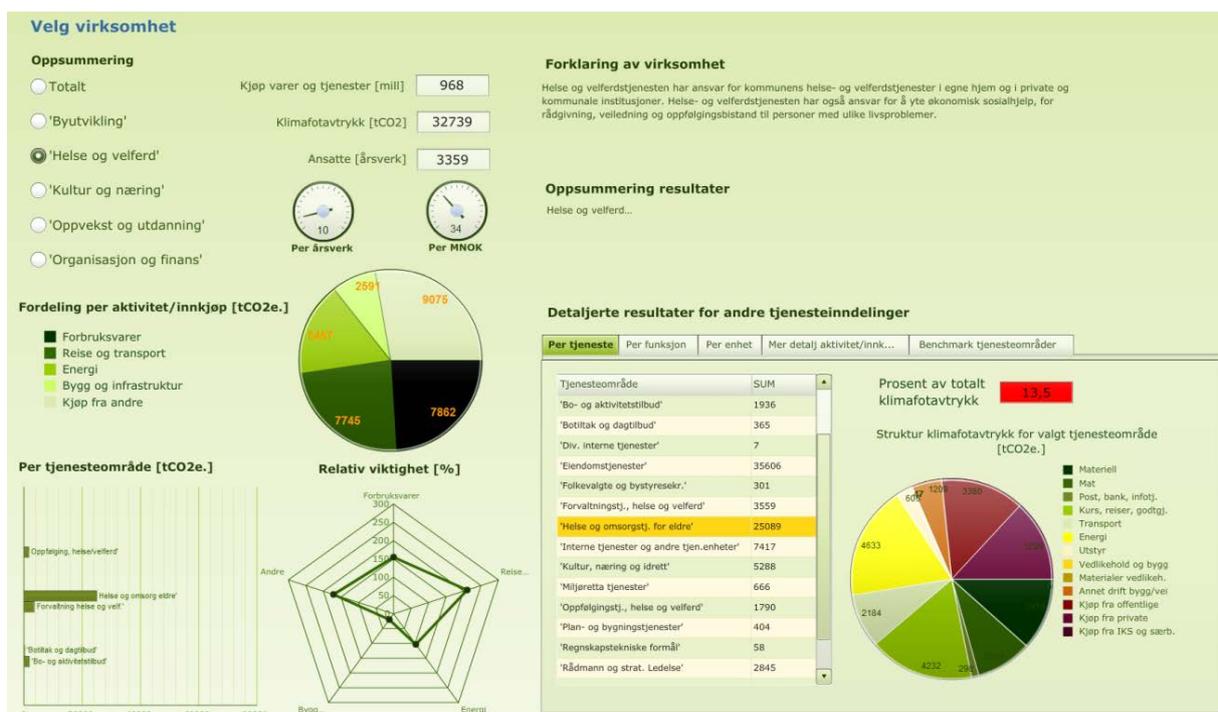


Figure 4. Screenshot of calculator developed in the Trondheim project (available in Norwegian only)

The results per unit for the municipality is presented in Figure 5. The results show that there are three units that are responsible for approximately half of the total climate footprint. The rest of the units have a significantly lower contribution, for example is the climate footprint of an average school approximately 0.1-0.2 % of the climate footprint. However, many of these are possible to group in similar units (e.g. schools, kindergartens, nursing facilities). Although each unit is responsible for its own climate strategy, grouping of units can facilitate the amount of support these can receive from supporting units such as the environmental unit.

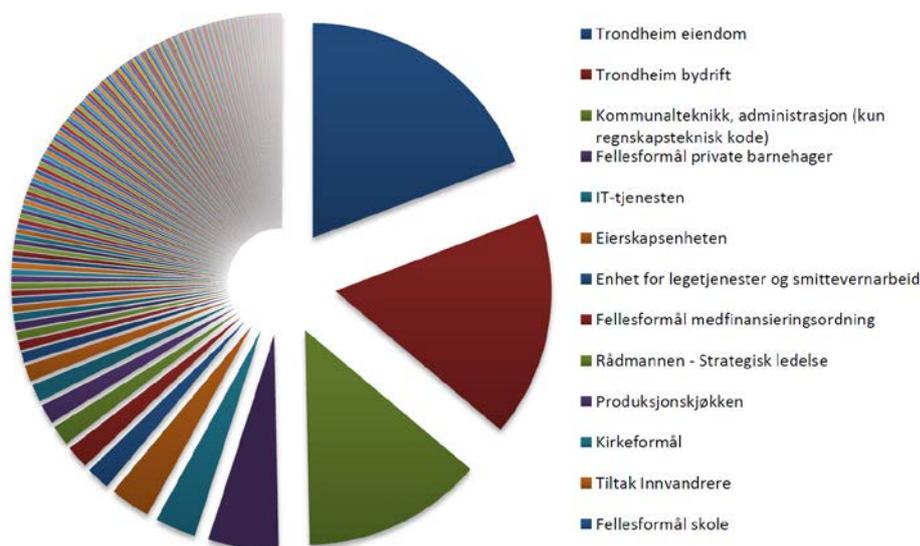


Figure 5. Carbon footprint of the 276 units in Trondheim.

The results of the carbon footprint imply that Trondheim has two distinct challenges. The first is related to the three large units and the second is related to the many small units. A third challenge that can be identified, is the need for innovative solutions for low-carbon procurement. Together, these provide the foundation for a three-pronged climate procurement strategy. Also two units have a central supporting role in these three strategies; the environmental unit and the procurement unit.

Integrating climate footprint in the existing environmental management system will require new procedures in at least four areas. The first is in identifying environmental aspects. Today, the significant aspects are defined as energy, transport and waste. However, 82 % of the climate footprint of Trondheim is related to scope 3 emissions. Based on this, procurement is a significant environmental aspect. The second area is objectives and targets, both for the overall organization and for the individual units. Here the strategic area of innovative solutions is of particular importance, as it goes beyond the current environmental organization. The third area is competence, training and awareness, with a need to disseminate the results of the climate footprint (total and at unit level). Finally, the fourth area is in monitoring and measuring. This area is in particular important for the tasks of checking and corrective action, as well as management review.

#### 4 DISCUSSION AND CONCLUSION

The GHG inventory developed in this project clearly demonstrates the importance of including indirect scope 3 emissions. The novelty of the work, however, lies in how the inventory is implemented in the organization by developing unit-specific GHG inventories. This will result in actions being more efficiently aimed at the departments/units responsible for inducing the emissions, as the results show that the structure of the CF varies significantly between departments, and even more between units. Because of this, results will not only help better direct mitigation strategies, but also avoid unnecessary focus on insignificant contributions to the GHG inventory. Much too often, strategies for reducing scope 3 emissions are quite randomly picked based on previous studies and/or

the available data. Paper use and air travels are two very common scope 3 contributions to include in GHG inventories only covering selected scope 3 contributions. However, for municipal service provision, these only contribute to >>1 % (paper use) and >5 % (air travel). This indicates that a much broader scope 3 assessment is necessary to cover the total carbon footprint.

The use of energy is important for all departments, and most units. Providing services requires buildings and other infrastructure (street lights for roads, pumping stations for water supplies, etc) that rely heavily on energy. Energy efficiency is thus a natural focus area. This is to some degree already the case, especially for newly constructed buildings, where there has been a focus on energy efficient design. There are however still further potential in improving the CF of public buildings, not only in reducing the use of energy, but also in more sustainable material use. The challenge in further improvement is also connected to the increased costs that this may incur, especially in the construction phase. It is therefore important that life cycle costing (LCC) is applied to ensure cost effectiveness of the action.

In addition to energy and infrastructure related CF, there is a significant part of the CF embodied in the wide range of products and services purchased. Here, green procurement systems play a particular important role in addressing which product/service to focus on, and also which department/unit is responsible.

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# THE NEED FOR PARTICIPATION IN GREEN INFRASTRUCTURE PLANNING - EVIDENCE FROM NORTH-WEST EUROPE

**Christine RYMSA-FITSCHEN<sup>1</sup>, Karsten RUSCHE<sup>2</sup> and Jost WILKER<sup>2</sup>**

<sup>1</sup> ILS – Research Institute for Regional and Urban Development; christine.rymsa-fitschen@ils-research.de

<sup>2</sup> ILS – Research Institute for Regional and Urban Development; karsten.rusche@ils-research.de; jost.wilker@ils-research.de

## **ABSTRACT (250 WORDS MAX)**

Sustainable development and environmental protection as long-term spatial planning and integrative stakeholder processes require strategic alliances between administrative levels and local parties. This need occurs because of the impact of green infrastructure investments on a wide variety of local stakeholders. Green infrastructure plays a crucial role for urban communities in terms of climate change mitigation and adaptation, also regarding issues of health and well-being. This paper outlines the need for participation in strategic green infrastructure planning across Europe. To understand transnational differences in spatial planning approaches and to highlight the overall need for more participation, this paper distinguishes between different “families” of spatial planning cultures. After introducing these, the overarching need for more participation, especially in green infrastructure projects, is defined in more details. The empirical section then focuses on presenting results from stakeholder workshops that were conducted in six different cities across North West Europe. Here it became obvious, that seen from a bottom-up perspective, people strongly express their requirements for more participation. This holds even for more abstract phases of strategic planning, where stakeholders expressed a high willingness to be engaged more fully.

*Keywords: green infrastructure, strategic planning, participation, planning cultures*

## 1 INTRODUCTION

Traditional land-use planning follows different planning principles affected by the diverse planning cultures across North-West Europe where the case studies of these articles are located. According to the variety of the planning systems also the instruments framing participation and the ways of how participation is embedded in policy [1] differ a lot. However, beside all disparities, statutory land-use planning reached its limits when coping with spatial challenges such as intense structural change. A new paradigm of strategic planning arose due to the need of more complex, open and flexible ways of planning related thinking and acting based on efficient governance structures [2]. These are especially required for implementing the strategic concept of green infrastructure (GI). GI can be generally defined as “a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings” [3]. It plays a crucial role for urban communities in terms of climate change mitigation and adaptation, also regarding issues of health and well-being. Quality of life for cities’ inhabitants is one of the biggest decision points in urban planning and to achieve these long lasting impacts, GI has to be planned based on people’s needs and perceptions as land-use competition is increasing and public GI investments call even more for economic and social justification.

This paper outlines the need for more participation in GI planning in order to better combine top-down thinking with local bottom-up engagement for the delivery of sustainable and resilient communities. Therefore, based on the concept of North-West European planning families, the necessity for strategic planning including a stronger stakeholder involvement in planning is described.

This request is linked to the concept of GI and investigated by a comparative approach exemplarily analyzing different applications of participatory methods and tools to engage local stakeholders in

north-western European city regions. Thus, participation workshops with relevant stakeholders related to GI investments were facilitated in Belgium, Germany, the Netherlands and UK to evaluate how participation is carried out and to identify lacks and opportunities for innovative approaches.

## 2 PLANNING FAMILIES AND PARTICIPATION

To understand transnational differences in spatial planning approaches and to highlight the overall need for more participation, this paper distinguishes between different “families” of spatial planning cultures. The way of how participation is embedded in planning processes and implemented in practise depends on the planning culture of the different countries analysed in this paper.

European planning systems have been developed in relative independence from each other and many of them changed a lot in the last decades [4]. Their planning approaches depend on the administrative system of each country since planning mechanisms, processes and formal / informal relations between administrative sectors shape up and enable each planning implementation [5]. Cultural, institutional, and legal differences, but also the specificity of the purposes for which formal spatial planning systems were originally introduced, produced a wide variety of planning systems and traditions [6]. Consequently, planning can be considered as been derived from legal and administrative structures to control land-use. By describing legal and administration systems most authors end up with more or less five categories or as Newman and Thornley (1996) named them, families. As this article focuses particularly on North-West Europe only the British, the Napoleonic and the Germanic are described.

In its administrative system, Britain was strongly centralized with limits on local government autonomy which was also reflected in its planning system [7]. The 1997th government moved quickly to devolve government for instance in terms of more local and civil society influence on decision-making. The government`s intent was on breaking down the insulation of government departments, improving coordination, strengthening local government and engaging communities in decision-making [8]. From 2000, local authorities were given a duty to create a ‘local strategic partnership’ involving different stakeholder interests. The objective was to fundamentally improve local leadership and the engagement of local people in decisions that affected them [4].

In the Napoleonic family there was a tendency to prepare national codes of planning regulations and to create a hierarchy of plans. The combination of centralized control plus responsiveness to local pressures created a complexity of interactive arrangements. The recent moves to decentralization and a greater regional presence influenced planning, which often takes place within an array of arrangements for vertical and horizontal cooperation [9]. In this family there are variations in planning systems of the member countries. For example, the Netherlands present a systematic approach where planning procedures and characteristics and tasks of participants are clearly described. The Netherlands has had a high tradition of participative approaches and this participation processes had a considerable impact on the planning decisions [10]. In the other case, Belgium has embodied a federal element in their planning systems, because of pressures for regionalism. Following this change, spatial planning went from a mainly central state frame to a regionalized frame and became a separate responsibility for three Regions: the Flemish, the Walloon and the Brussels Capital Region [11]. The three regions defined their individual planning frames by law and developed instruments for planning which is organized and developed on the regional, provincial and municipal level along the principle of subsidiary.

An important feature of the Germanic family is the importance given to the written constitution [7]. Here, the comprehensive consistence of law is expressed in the planning system by the rigorously formulated planning regulations. The strong constitution and the national system result in a strong federal level (Länder) of planning. It has its own laws and plans and guidelines and agreements in order to achieve consensus between and within levels of hierarchy. The German federal and local government tries to engage citizens in different matters. They work closely with private companies to organize citizen participation processes. The focus of these processes lies on urban planning, infrastructure development and, partly, investment decisions [1].

The nature of public participation in the European states varies as much as spatial planning systems, and is equally affected by the specific historical, cultural and governance issues in the different countries [4]. In the last 30 Years all listed planning systems changed a lot from top-down to bottom-up approaches and back. Concluding, all systems should become more open and flexible in

determining precise land uses to respond more quickly and adequately to changing social and economic circumstances [6].

### 3 STAKEHOLDER ORIENTATION IN STRATEGIC PLANNING

These shortcomings of traditional land-use planning to cope and guide spatial changes, such as thinking in administrative levels, focus on land-use control, its formality and the neglect of public participation highlighted the need for a new planning principle [see 2, 12, 6]. As an answer to these lacks strategic planning arose in the 1990s and aimed at combining strategic visions with short-term actions. Today, a more stakeholder oriented approach is taken, but there is no agreed general definition for strategic planning [2]. Based on former definitions from Healey (1997) and Kunzmann (2000), Albrechts and Balducci (2013) define strategic spatial planning “as a transformative and integrative public-sector-led co-productive socio-spatial process through which visions or frames of reference, justification for coherent actions, and means for implementation are produced that shape, frame and reframe what a place is and what it might become” [13]. They clearly point out that one emphasis of strategic planning is to involve relevant stakeholders in order to embed their knowledge and engagement in the planning process to make planning legitimate and comprehensive [2]. Strategic planning must plan and manage at the same time to deal properly with spatial changes in a specific context, scale, time, and a tailored combination of stakeholders. Thus, strategic planning should frame the process and react flexible to changes and is therefore an essential part of resilient thinking [2]. This contains, that the important characteristics of a strategic planning process are not only fixed in a set or sequence of certain rules, but also tailor-made [6;2;14;12].

A territorial focus for policy definition in strategic planning provides the basis for a wider range of stakeholders involved in planning processes with new governance structures and partnerships [6;12]. Therefore, the basic principle of strategic planning is to guide the activities of actors involved and to manage spatial changes together [6]. Today, strategic planning can be linked to the concept of sustainable development as yonder describes a beneficial strategy for ecological, economic and social issues related to spatial development. This underlines the current need to address new issues such as environmental questions, quality of life and social cohesion within new types of multi-level governance and an increasing complexity of the decision-making process” [2;12]. Key principle must be inclusiveness of all relevant stakeholders in the democratic process to foster an “open dialogue, accountability, collaboration and consensus” [15] The inclusiveness of strategic planning allows involving all actors who have a stake in the issue (co-production) even up to the point to let relevant actors take part in planning with the clear goal of empowerment, ownership and acceptance. This is required in order to specify strategies and to get support as well as legitimacy [2]. The heart of strategic planning is to develop a guideline to walk the tightrope “between openness and fixity, comprehensiveness and adaptation, technical rationality and interaction, top-down and bottom-up” [16]. In this context, short-term results are essential to achieve credibility among the actors and to foster sustainable, continuous change, which reveals the high implementation orientation of strategic planning [12].

There is no doubt, that strategic planning is mostly related to a voluntary movement, while land-use planning has a statutory character and that for any democratic process regulations and rules are needed, strategic planning can only provide insufficiently. However, even when land-use planning is seen as a necessity while strategic planning may be seen as an opportunity, between both exists an interdependency [14;17]. Strategic planning is done inside governance structures and policy-making is interactive not linear and experimental. Strategies do not “live” and are not reflected in land-use planning [18]. Thus, we require both, because strategic planning is to frame the statutory strategic planning relationship and it impossible to choose “between a legitimate rigidity of statutory planning and an illegitimate flexibility of strategic planning” [19;2;12]. Our aim must be to get close to find the best mixture of both principles [14]. These findings on strategic planning are especially relevant for the implementing of the strategic approach of green infrastructure as it has the potential to make important contributions to sustainable development and resilience.

#### 4 THE IMPORTANCE OF PARTICIPATION IN GREEN INFRASTRUCTURE PLANNING

On the one hand GI, as a strategically planned network of high quality natural and semi-natural areas, is a typical principle of strategic spatial planning. On the other hand participation takes into account actors preferences and concerns and therefore guides urban planning and its high importance in urban transformation processes, in which GI plays a relevant role [20]. This chapter will describe how both elements should be combined. Participation with all its different methods as part of a GI planning process can be the key for the delivery of sustainable and resilient communities.

Participation can be conducted using a wide range of methods each having its advantages and disadvantages at a certain stage within a strategic planning process. An overall issue is to include not all actors, but the relevant [21]. Participation must be kept clear and transparent based on a commonly developed vision, with a precise relation to a certain invention, different communication approaches for different stakeholders must be carried out and relevant results must be filtered out by the planners [20;21]. Finally, outcomes need to be made visible to make actors feel they can move a place forward by their engagement [2;20]. Thus, the feeling of ownership of the final product may become very strong and creates responsibility.

This is especially essential for GI strategies, as their projects need to be strongly legitimated and efficient in order to deliver sustainable and resilient communities. Thus, there is desperate requirement to make results more relevant to the public by involving them and to provide planners with local knowledge and concerns to make decisions more tailored [20].

Positioning GI at the forefront of the planning process emphasizes that it is not just an amenity but essential to the functioning of the community. With strategic planning and early local participation of all sectors, strategic alliances can be settled and can influence the planning of projects and avoid conflicts before they appear [22]. Therefore, the function of participation is to legitimate decision-making, to enhance democracy, and to enlarge engagement [see 23;24;25;26]. The benefits of participation accrue to both, decision-makers and the public [27]. Successful GI efforts forge alliances and interrelationships among various organizations - both public and private [28].

The practice of GI falls under the purview of various professions, including urban planning, landscape architecture, civil engineering, parks and recreation and architecture itself. To successfully create GI, these professions must overcome conventional thinking and instead pursue an integrated approach to planning, design and implementation [21]. One major key is to fix a common approach across disciplinary and organizational boundaries. The implementation elements of comprehensive and functional plans should specify actions, priorities and responsibilities for implementing GI approaches. The following six planning and design principles provide a framework and direction for applying GI in planning practice and across different disciplines and scales of professional practice [21]. Emphasizing the tangible benefits GI can provide is the key to successfully communicating its importance to all kinds of relevant stakeholders:

- Multifunctionality: built on the concept of the triple bottom line – the environmental, economic and social benefits provided by GI – also called ecosystem services
- Connectivity: GI is most effective in providing services and benefits when it is part of a physically connected system across the landscape
- Habitability: positions GI as visible space that provides outdoor habitat for people, flora and fauna (e.g. outdoor recreation)
- Resiliency: defined as the ability to recover from or adapt to disturbance and change (of the ecosystems) GI can increase community resiliency over short or long timeframes
- Identity: Design of landscape elements to create a perceptible identity and sense of place. GI to contribute to the visual definition of a place
- Return on investment: calls on planners and designers to demonstrate how GI can reduce costs and yield positive financial outcomes for governments, institutions, businesses and citizens

As the public-sector resources has to deal with the growing scarcity of resources and resistance to prescriptive regulations increases, three overall implementation approaches will grow in importance: 1) partnerships among the public, private and non-profit sectors, voluntary and 2) incentive-based agreements with private landowners and developers and 3) ways to monetize GI [21]. The challenge

lies in fostering meaningful collaboration among all professions because they are trained to think in different ways, addresses different sets of problems and operate independently.

Building community support will depend on a consistent effort to communicate what GI is and the benefits it can provide in terms that people can understand. It is important to involve people by participation in the creation of a shared vision that can help drive the process and forge consensus. To create great dynamics thought the GI strategic planning process participation should start right at the beginning [20]. The community should be engaged in seeking ways to build on its history and existing assets and to extend the benefits into underserved and growing areas. Doing so will help develop a constituency for GI approaches and ideally “champions” [21] will emerge from the community and its stakeholder organizations.

The following chapter will concentrate on highlighting most relevant aspects of participation and showcasing peoples’ needs and perceptions in participatory planning processes. For this, participation methods are briefly summarized. After this, results of case studies are presented in which stakeholders were surveyed about how they think participation should be integrated into green infrastructure planning.

## 5 PARTICIPATION IN GREEN INFRASTRUCTURE PLANNING: CASE STUDIES ON STAKEHOLDER INVOLVEMENT

The overall importance of participation in strategic green infrastructure planning is linked to the question of how to best implement participation and which methods to use. Therefore, before elaborating on the empirical results, it is important to structure ways in which participation can be done. According to Arnstein (1969), the principle of participation is best described using the metaphor of a ladder. There are many possible rungs on that ladder, but for our purpose we concentrate on the three major categories of participation: Information, Consultation and Cooperation [29]. The intension of participation increases with each step. Informing citizens of their rights, responsibilities and options is one-way communication and does not constitute public participation, but it remains an essential component, the base of an effective public participation program [30]. The most frequent methods used for such one-way communication are news, media, announcements, pamphlets, posters and responses to inquiries. But there are also forms and procedures that encourage the formation of opinions like surveys and blogs [31]. Consultation already provides a more intense, two-way communication process among the actors. At the last step there exists a two-way communication, cooperation between many actors [32]. But consultation needs to be combined with other modes of participation in order to assure that stakeholders concerns and ideas will be taken into account [30]. Typical consultation methods are round tables, site visits and focus group interviews. Tools like geographic information systems and visualizations may be used to make planning comprehensible for citizens, e.g. in charrettes [31]. At the cooperation level, citizens have a certain degree of influence on planning [30]. Cooperation is a negotiation and decision-making process between many actors from the spheres of market, state, and private households. They create together - with different roles and weights – a collaborative process [31]. The degree of cooperation ranges from common development of proposals up to extensive decision rights of the involved people [29]. The steps and methods of participation are not clearly selective, so that there are overlaps in the levels of participation, as methods are often differently interpreted and implemented.

To get further insight in these issues, several case study surveys and workshops were conducted throughout North West Europe. Green infrastructure projects within six different cities, that are all partner cities within the Interreg IVb project VALUE ADDED, were used as examples. In each city, stakeholders that are involved or affected by the projects were invited to take part in a participation workshop, in which surveys and discussions took place. The main focus was to collect information on what people like and dislike about participation, which tools they use and which methods they prefer. Table 1 lists the locations and stakeholder groups that were part of the empirical approach. In addition, the type of green infrastructure investment is described in the third column. Here, the wide range of what green infrastructure can be comprised of becomes obvious.

Table 1. Participation workshops

Location	Stakeholder group	Type of investment
Belgium, Bruges	Citizens and planners	Creation of a Green corridor along a large scale infrastructure development
Belgium, Liege	NGOs and planners	Conversion of a former military area to a new green space
Germany, Stuttgart	Planners of municipalities involved	Regional route of industrial and cultural landscape heritage
Netherlands, Amersfoort	Planners and NGOs	Park enhancement through conversion of a hospital site
United Kingdom, Sheffield	Group of Students living in the neighbourhood	Neighbourhood Park renewal
United Kingdom, Manchester	Planners and project partners (NGOs)	Urban food growing as meanwhile use of brownfields

By means of the stakeholder workshops the aim was to get a deeper insight in peoples' needs and perceptions concerning participation in GI planning and to improve it in the long run. All participation workshops had a particular reference to a GI investment in each city, which are at different stages of completion. All projects are embedded in GI strategies referring to a wider scale. Two main pillars structured the participation workshops: Firstly, stakeholders were surveyed with the help of a predefined questionnaire and later a guided discussion was hold. Each of these two pillars of the participation workshops was constructed to give quantitative and qualitative information on three different aspects of participation in GI planning related to the investment sites in Belgium, Germany, the Netherlands and the UK:

1. current state of participation,
2. required state of participation,
3. current and required state of interactive methods and tools usage in participation processes.

1. Looking at results of the first section of questions, some interesting aspects are worth highlighting. At first, choosing from a list of methods, participants clearly showed that they know and have been involved mainly in standard participation measures like Round Tables, Workshops and Site Visits. So, planning approaches in NWE seem to follow a rather structured approach that focuses on standard ways of participation. Following this, stakeholders had to rate each listed method in their capability of achieving constructive results. Interestingly, the approaches rated the highest, Charette and citizen's jury, are not measures often taken referring to the two questions before. So, people seem to accept non-standard ways of participation in green infrastructure planning. Conversely, when asked what participatory measures should be taken in a similar GI project, people stick to their standard preferences (Round Tables, Workshops and Site Visits). This might hint to a changing pattern of participatory methods in the future. People like contemporary methods of participation, but seem not to be used to them.

2. The second section dealt with issues related to required methods and approaches. Respondents stated that they would like to have more influence on implementation, content and design issues of green infrastructure projects. Interestingly, implementation and content are quite early stages of planning and clearly belong to the field of strategic planning. Finance and timetable are topics that seem not to be relevant for participatory approaches. Contrastingly, when looking at the differences in country-specific results, the lists are slightly changing. While Belgian and English participants comply with the top three listed measures, Dutch and German respondents differed. In the Netherlands stakeholders preferably want to influence implementation, results and design, while German stakeholders prefer implementation, results and content.

When asked on which stage of planning people want to participate in GI projects, the top three stages are collection of ideas, planning and implementation. These are again rather early steps within strategic planning. This result highlights the general need to integrate participatory steps into the first stages of GI planning. Nevertheless, maintenance and design are still rated to be important. Country-

specific results explain this in more detail. Since the German local meeting was dominated by a high share of public body representatives, the strong interest in more influence on the planning stage is originated here. Looking at the results from Dutch, Belgian and English respondents only, the ranking would be collection of ideas, design and maintenance, followed by implementation. This again showcases the differences in each planning culture and the differences in preferences of stakeholders. Still, the conclusion of an early integration of participation in green infrastructure planning holds.

3. Thirdly, people should state which tools they know, use and want to be integrated in participatory measures. Here, e-participation and social media ranked highest as methods that people know and use. Interestingly, when rating a list of possible tools, stakeholders did not rate those two approaches the highest. Instead, 3D-visualisations ranked second behind social media approaches. Again, people seem to accept contemporary, technically driven methods. This again mirrors the capability of people to interact with planning bodies in a more abstract stage of strategic planning.

Summarizing the results of the participation workshops, two results were dominant in discussions and survey results. On the one hand people confirmed the general need of participation in early stages of green infrastructure planning. As discussed in the theoretical chapters, green infrastructure planning affects many different stakeholder groups, being direct beneficiaries or indirect users. Linked to this, people's answers in our workshops show that already when collecting ideas, stakeholders want to have their say. On the other hand, participants stated quite obviously that they are used to being involved in participatory processes in standard approaches. Interestingly, people have a strong preference to use contemporary, technical methods and tools of participation like social media or GIS support.

## 6 CONCLUSION

Although most planning families and systems across Europe formally consider the need for participation, the culture of stakeholder engagement varies and is highly dependent from the specific frame conditions. Thus, strategic planning as a wide, multi-level governance approach, which embeds broad and efficient participation, is essential. Especially GI planning, as a typical strategic planning principle, requires the legitimization, organizational and design capacities delivered by high quality, tailor-made actor involvement in order to communicate and activate local benefits and get on the political agenda.

The presented research investigated this issue by surveying and interviewing relevant stakeholders related to different GI projects in city regions in Belgium, Germany, the Netherlands and the UK. The aim was to find out how participation is carried out and should be conducted in the opinion of the participants within a GI approach. This allows comparing participation cultures of the countries and gives hints to optimize and tailor-made future participation within GI approaches. The results show, that mostly standard participation methods were used at rather practical planning phases to engage stakeholders, while those would like to be involved earlier and would like to know other methods, when properly. This confirms the idea of strategic planning to engage stakeholders at the beginning of the process. However, the topics participants are interested in vary from country to country. Regarding tools, social media and 3D-visualisations which strongly focus on interaction, seem to have high potential for participation in the future.

Our paper outlined the need for participation in GI planning and the results of the participation evaluation workshops are in line with the issues that are identified in mostly theory-based literature. Furthermore, it addressed the room for improvement in participation processes within GI approaches, which is crucial to explore further to increase governance, sustainability and thus resilience.

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# PROPERTY RIGHTS AND THEIR EMBEDDING: CONCEPTIONALIZING A GLOBAL FRAMEWORK FOR PARTICIPATION IN ENVIRONMENTAL COMPENSATION SITUATIONS

Volker MAUERHOFER

Visiting Professor, UNU IAS - United Nations University, Institute of Advanced Studies, Japan

[mauerhofer@unu.edu](mailto:mauerhofer@unu.edu)

## ABSTRACT

The paper provides a new conceptual framework based on property rights and financial compensation in different nature conservation situations in order to provide a globally applicable system for the assessment of participation of public and private stakeholders in envisaged changes within those situations.

These situations of change represent a modification from conservation toward non-conservation and vice versa. The framework distinguishes further between governance systems based on command and control as well as on negotiation. Within these main change situations and governance types, the framework allows the distribution of change situations into 8 main sections. These main sections are further separated into 32 sub-sections by means of different property right and compensations situations among public and private stakeholders.

The theoretical utility of this new framework is then demonstrated by testing it by means of a random sample of 74 papers [25%] out of representative 297 papers from the academic literature dealing with property rights. These 74 papers provided practical examples for situations of change in conservation as evidence for the vast majority of the 32 sub-section. Several papers provide examples for more than one sub-section. The allocation of papers to these different subsections is described and discussed in detail. This widely possible allocation proves in general the global applicability and usefulness of the new framework. The framework also proved to be appropriate for formally (rule of law based) and informally (customary law based) institutionalized situations where rights are given to public and private stakeholders for other practical cases of public participation.

*Keywords: environmental protection, negotiation framework, legal position, ownership, proprietorship, disaccord*

## 1 INTRODUCTION

Property rights are seen nowadays to be paramount in contributing to solve environmental problems [1,2,3,4]. The vast literature on property rights appears to concentrate rather on the description of particular property rights (e.g. [1]) and provides less focus on the overall legal situation how these rights (and corresponding duties) are distributed among the stakeholders when it comes to situations of envisaged additional environmental depletion. This is even more astonishing as this framework wherein these rights and duties are embedded is of major importance for the outcome of such a situation of intended depletion, especially when it comes to disputes among participants about the extent of environmental protection.

Formal institutions provide rights such as property rights to people and they define also the relationship among the right holders [5]. Each right means also duties for other people, for example the duty to respect other rights [1]. A restriction of the right means also a duty for the right holder and can provide for an opportunity to receive compensation [6].

The identification of the holders of the rights over the natural resources and the rights to compensation is essential to analyse any situation of change related to conservation and people. Situations of change represent a modification from conservation toward non-conservation, whether toward an situation of overuse of (actual and potential) resources or an situation of an underuse, or vice versa.

The paper aims to contribute to this analysis in a structured way such as following. First, two conceptual approaches are briefly discussed and then combined to the new assessment framework. This new

framework is afterwards theoretically tested by applying it on a representative sample out of 297 papers from the academic literature dealing with property rights in the sense of [1]. The papers of the sample were assessed towards whether it can be allocated to the different categories and subcategories in the new framework. Each allocation is in detail qualitatively described and also a quantitative overview is given. In the following, I substantially discuss the scope and the limits of the new framework and explore future application fields.

## 2 COMPENSATION SITUATIONS AND PROPERTY RIGHTS: TWO CONCEPTUAL APPROACHES

In the following, the concept of [1] on property rights as well as a new concept based on [7] about compensation situations are described respectively. They provide the intellectual basis for and are then combined to the new framework.

[1] presents an approach to explain resource management in regimes usually categorized as common property, describing different situations where multiple stakeholders have diverse bundle of rights over a natural resource (Table 1).

*Table 1: Bundles of Rights and positions associated (adapted from [1] page 252)*

BUNDLES OF RIGHTS ASSOCIATED WITH POSITIONS				
	Owner	Proprietor	Claimant	Authorized User
Access and Withdrawal	X	X	X	X
Management	X	X	X	
Exclusion	X	X		
Alienation	X			

The explanations for the different rights in Table 1 are such as following (adapted from [1] page 252):

- Access: The right to enter a defined physical property.
- Withdrawal: The right to obtain the products of a resource
- Management: The right to regulate internal use patterns and transform the resource by making improvements.
- Exclusion: The right to determine who will have an access right, and how that right may be transferred.
- Alienation: The right to sell or lease either or both of the above collective-choice rights.

These authors also emphasize that different bundles of property rights, whether de facto or de jure, influence incentives for individuals, the types of actions they take, and the outcomes they achieve.

Beside the property rights regime also the compensation situation is crucial as it reflects the distribution of different interests and positions regarding natural resources in connection with rights. Furthermore, it determines the formal power distribution from the beginning that may influence the outcome of negotiations about payments for any environment-related rights. [7] based on [8] distinguish between five negotiation situations that are extended for the means of this paper into eight compensation situations in conservation (Table 2).

*Table 2: Binding rules and negotiation opportunities in situations of change affecting rights holders*

Rights holder and situation of change (extended based on [7])	Binding rule	Negotiation
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Conservationist has to accept change without compensation	Yes	No
Non-conservationist has to accept change without compensation	Yes	No
Conservationists has to accept change with compensation opportunity	Yes	Yes
Non-conservationist has to accept change with compensation opportunity	Yes	Yes
Conservationist may accept change with compensation opportunity	No	Yes
Non-conservationist may accept change with compensation opportunity	No	Yes
Conservationist does not accept compensation at all	No	No
Non-conservationists does not accept compensation at all	No	No

Table 2: Binding rules and negotiation opportunities in situations of change affecting rights holders

The situations 1. to 4. involve some sort of formal (or even informal) binding social rule which is of course only as strong as its enforcement. The consequences of its non-compliance may be sanctions [e.g. sentence to prison] or – in the worst [illegal] informal case – killing. While the cases 5. to 8. reflect voluntary situations not underlined by pressure but solely by one or more financial offers. The situations 5. and 6. usually provide substantial space for negotiations and, of course, also determine the positions of the offeror and the acceptor. This is of quite utmost importance in negotiations.

The situations 1., 2., 7. and 8. do not provide any space for negotiations and the two latter ones fall under the “rule of inalienability” [7]. Each of these cases can base either on a formalized legal regime grounded on laws issued according to institutionalized procedures by the competent legislative body; or the cases can have their origin in informal (customary) law regimes. All the eight cases can also reflect a combination of these two different legal regimes.

While a description of compensation situations highlights the relationship among stakeholders, property right systems concentrate more on the position of the individual stakeholder.

### 3 TOWARDS A SYSTEMATIC FRAMEWORK

In the following, I present a framework that incorporates bundles of property rights as described by [1] into compensation situations as described by [7] to distinguish sixteen different situations to better understand negotiation positions when a form of compensation can be negotiated with the holders of rights over natural resources (Table 3).

Table 3: Situation of change for rights holders and their legal position

<b>Rights holder and situation of change (extended based on [7])</b>	<b>Rights holder's legal position (from [1])</b>
1. Conservationist has to accept change without compensation	a. Owner
	b. Proprietor
	c. Claimant
	d. Authorised user
2. Non-conservationist has to accept change without compensation	a. Owner
	b. Proprietor
	c. Claimant
	d. Authorised user
3. Conservationist has to accept change with compensation opportunity	a. Owner
	b. Proprietor
	c. Claimant
	d. Authorised user

4. Non-conservationist has to accept change with compensation opportunity	a. Owner
	b. Proprietor
	c. Claimant
	d. Authorised user
5. Conservationist may accept change with compensation opportunity	a. Owner
	b. Proprietor
	c. Claimant
	d. Authorised user
6. Non-conservationist may accept change with compensation opportunity	a. Owner
	b. Proprietor
	c. Claimant
	d. Authorised user
7. Conservationist does not accept compensation at all	a. Owner
	b. Proprietor
	c. Claimant
	d. Authorised user
8. Non-conservationist does not accept compensation at all	a. Owner
	b. Proprietor
	c. Claimant
	d. Authorised user

This framework describes in each case a negotiation situation where a wide range of stakeholders could be considered conservationists as well as non-conservationists depending on different interests over natural resources, and where the right to receive compensation is disentangled into the bundle of rights of each stakeholder over the resource. It provides a theoretical and conceptual basis to better analyse the costs and assess cost-effectiveness of the conservation actions.

The sole opportunity or the definite duty to accept a compensation for the partial or full restriction of a right can correspond in negotiations in different ways with the sole opportunity or duty to offer such compensation. The whole negotiation situation is also influenced by which type of right is on stake at all. The explicit expression of these relationships often predetermines the costs of implementation, monitoring and enforcement, and decision-making regarding a conservation action.

In the following I show results of the theoretical application of the new framework on a sample of 297 papers from the academic literature dealing with property rights in the sense of [1]. The sample was gained by a survey in the Web of Science (WoS) where all papers were extracted that cite [1] by 15<sup>th</sup> December 2013. I show for seven of eight basic compensation situations at least one concrete example which I found within the overall sample of 74 papers (=25%) out of the 297 papers (Table 4).

*Table 4: Situation of change for rights holders, their legal position and literature examples from sample*

<b>Rights holder and situation of change (extended from [7])</b>	<b>Rights holder's legal position (from [1])</b>	<b>References in the literature from a random sample (total n=74 [25%] out of 297 papers citing [1]).</b>
1. Conservationist has to accept change without compensation	a. Owner	[9], [2], [3], [10], [11], [12]
	b. Proprietor	[3], [13], [10]
	c. Claimant	[14], [3], [13], [10], [15]
	d. Authorised user	[14], [16], [17], [18], [13], [19]
2. Non-conservationist has to accept change without compensation	a. Owner	[20], [9], [11], [12], [18]
	b. Proprietor	[21], [22], [18], [23]
	c. Claimant	[20],
	d. Authorised user	[20], [4], [24], [25], [26], [27]
3. Conservationist has to accept change with compensation opportunity	a. Owner	
	b. Proprietor	[28]
	c. Claimant	
	d. Authorised user	[29]
4. Non-conservationist has	a. Owner	[9], [30]

to accept change with compensation opportunity	b. Proprietor	
	c. Claimant	[31,32]
	d. Authorised user	[15]
5. Conservationist may accept change with compensation opportunity	a. Owner	[33], [34], [14], [16]
	b. Proprietor	
	c. Claimant	[35]
	d. Authorised user	[17]
6. Non-conservationist may accept change with compensation opportunity	a. Owner	[20], [36]
	b. Proprietor	
	c. Claimant	[34], [20]
	d. Authorised user	[20], [37]
7. Conservationist does not accept compensation at all	a. Owner	[20]
	b. Proprietor	
	c. Claimant	
	d. Authorised user	[38]
8. Non-conservationist does not accept compensation at all	a. Owner	
	b. Proprietor	
	c. Claimant	
	d. Authorised user	

With regard to the empty fields within the basic situations 4. to 7. in the third column, it has to be kept in mind that the owner position (or in general the higher position) regularly includes all the rights and positions below (but this has not been implemented in any field in order to keep the table simple). Thirty-two papers, exactly half of the sample, could be allocated to at least one of thirty-two cases differentiated.

In the following I will describe more in detail how these cases found are fitting into our framework.

### 3.1 Conservationist has to accept change without compensation

[9] describes the Austrian state as owner of mountain forests with all rights described by [1], but restricted by some de iure and de facto access and withdrawal rights of other users who may even cause detrimental effects to these forests (see also [2] for all owners). [3] shows how two legal acts providing access rights to moorlands and forests for tourists as authorized entrants prevail – without compensation – all other property rights held by Conservationists as owners (which also include the rights of proprietors, claimants and authorized users). Similar, [13] describe regarding noise mitigation in National Parks, the Park authorities currently have regarding the soundscape only the rights of proprietors (and visitors only the rights of authorized users), but would need based on legal acts ownership rights against flight sound pollution. [10] showed a situation for the United Kingdom where all owners, proprietors or claimants of common land were burdened by the introduction of historically authorized user rights (namely grazing rights) of through simply registering those 1965 into a new law, without reassessing these rights in terms their sustainability. [11] and [12] illustrate a situation where local communities which are currently in an ownership position have to accept a change of the legal situation which allows the government to issue of logging concessions to third parties without a rule prescribing compensation.

In Indian sacred forests (kan), local communities are considered claimants, but they have to accept the State, as holder of ownership rights, to provide leasing of extraction rights to local contractors [15].

[14] describes the situation of communities related to three different forests management systems in India with different bundles of property rights even towards shutting down forests internally (in the sense of “exclusion” and proprietor positions within the systematic of [1]). However, it is explicitly mentioned that the ownership position remains with the Indian government and that mining contracts are concluded outside these forest management system (leading to conflict situations and the elimination of certain case studies from the scope of [14]’s paper).

A similar situation is described by [16] on users in common property resource systems social forests of Zimbabwe in relation to outside intruders obtaining permits from state agencies, bypassing the local village structures. Quite the same situation is shown by [17] in a comparative analysis of agricultural expansion in the Mosquitia Forest Corridor. There, a Honduran indigenous community with sole common property user rights had to accept negative changes in the forests through new settlers because of insufficient

enforcement of ownership rights by the state (while a similar Nicaraguan community holding all property rights could prevent such changes).

In Bangladesh, the state has the legal ownership as well as absolute control over natural resources such as fisheries in water bodies and enacted 2005 a newly auction of lease rights policy that lead to the loss of de-facto use rights of small local fishermen communities, to major leasing through outside investors and – following – to profit maximising and degradation of natural resources [19].

### **3.2 Non-conservationist has to accept change without compensation**

In Austria, mountain-forest owner - who usually have the right to exploit the forest - are obliged by the forest act to manage so-called protection forests (that protect for example infrastructure or human settlements against avalanches) according to special guidelines, as long as the management costs are covered by the revenues from timber sale [9]. Thus, no compensation for the change is provided. Similar would be valid if an Austrian provincial government responsible for conservation would - without any financial offer – restricts or even prohibits the use of a forest in order to protect biodiversity. [11] and [12] also describe a situation where local communities which are currently in an ownership position have to accept a change of the legal situation which allows the government to designate this land a protected area without a rule prescribing compensation for the restrictions related.

[21] describe the case of a decentralization of forest use in Tanzania providing to local communities even rights to arrest offenders in the sense of exclusions right and also discuss the possibility of re-decentralization in connection with this and other African decentralization projects if environmental goals are not reached, thus indicating that the proprietor rights can be withdrawn again without compensation.

[22] show for Ethiopia an example wherein the disclosure of a watershed protection area restricted the access and where farmers even launched armed attacks against guards to “reclaim the alienated land” (p. 137). Although in this case the right to alienate be further transferred, the importance of access and withdrawal rights is clear as without them, nobody is allowed to harvest anything, and thus, a transfer is of no immediate economic value, the own right of exclusion is restricted,

[18] show for Joint Forrest Management (JFM) in India that this only did not include the transfer of alienation rights but allowed the Forest Departments (FDs) - in 12 out of 23 states that implemented JFM - unilateral power to cancel the JFM agreements and in most cases to even dissolve the Forest Protection Committees holding those rights.

[4] describe the situation of authorized users in the Sunderbans which had to accept the establishment of reserves without compensation (but with use-rights in the also established puffer zones). The situation of users and withdrawers of individual transferable quotas (ITQs) in Canadian and US fisheries such as described by [24] is rather similar whereas the government retains the right to determine the overall quota and other fishery aspects that influence the sustainable use fish stock. Again for Canada, [25] illustrate a situation wherein a single firm was granted rights of first refusal to depurate all clams harvested from closed[polluted]beaches in a region, resulting even in the de facto privatization of all [polluted and unpolluted] clam beaches by reducing the rights of other users.

Again related to open-access ocean resources [26] show a situation where users of mussels harvested by means of floating raft cultivation in Galicia are able to obtain - access and withdrawal rights in the sense of licenses. Even these rights are legally in a narrow sense prescribed for example regarding equipment, duration (a maximum of 30 years) and geographic space. Furthermore, the law determines the management, who is excluded and under which (narrow) circumstances the rights can be transferred. After the maximum period the change happens and the authorized users lose their rights.

In Chile, a local fisherman community had to accept the legal closure of former open-access fishery regarding the main relevant species and to accept instead a spatially restricted common-pool fishery area concerning that species [27].

### **3.3 Conservationists has to accept change with compensation opportunity**

In the Bolivian Pilon Lajas Biosphere Reserve and Indigenous Territory, the State has the ownership rights of the territory but local communities are the proprietors of the land and natural resources [28]. In that case local communities are conservationists that prefer to preserve the forest around the reserve but they have to accept compensation - if offered - for new migrant settlements that arise in the buffer zone of the reserve.

In Sumatra/Indonesia an original agroforest land-use system developed by local farmers more than hundred years ago under a customary system was in 1997 first declared to a state forest land by the government [which enables the government e.g. to issue logging concessions to outsiders] and - after protests - the

government enacted in 1998 a degree acknowledging the local user rights and allowing the locals to register their traditional land use rights [29]. Although nobody registered its rights in order not to acknowledge the government's ownership, the acknowledgement help to protect the agroforestry region as the source of livelihood of the locals, as a puffer zone of a National Park and against logging ambitions of outsiders [29].

### **3.4 Non-conservationist has to accept change with compensation opportunity**

Another negotiation situation occurs on the opposite case, when non-conservationists hold the rights over natural resources but have to accept compensation for the execution of conservation activities by other stakeholders. [9] describes for Austrian mountain forests an instrument for 'banning' a protective forest under certain conditions by the forest authority. The beneficiary protected (e.g. against avalanches) by the ban of any economic use of this forest has to compensate the mountain-forest owners for the necessary forest but the forest authority always covers the transaction costs and public funds may take over the compensation [9].

[30] indicated for the Swat valley in Pakistan that the provincial government declared the forests as protected in 1975, converted them into state property and compensated the former de jure owners with a 60% share in royalty for timber extraction. However, for this example the allocation of the term "non-conservationist" to the de-iure owners could be questioned as the state authorities continued to use the forests, paid royalties – if at all – delayed and were mentioned to be corrupt, all leading to an degradation of the forests together with other factors such as tourism and increasing population.

Local communities living within the Peten region in Guatemala that have held concession rights had originally - with the feeling of being offered no benefits in exchange - to accept the establishment of a Biosphere Reserve by the State, but latter received certain user and proprietor rights in terms of forests concessions in and outside the Biosphere reserve [23]. This can be considered a sort of compensation, although the total extend of the historical rights might have been reduced.

Fishermen of Madagascar have to accept compensation (if offered) for marine preservation, as they have management rights – they are claimants - in marine parks [31, 32].

In Nepal local communities as authorized users are restricted in their withdrawal of forest products in buffer zones of protected areas, as they are limited to those forest products authorized by the fairly strict management guidelines provided to the community while this restriction does not exist in community forests outside of buffer zones [15]. However, they are allowed to certain touristic activities such as to organize Elephant rides in these buffer zones and this can be clearly seen as a sort of compensation in exchange.

In last situations described the stakeholders have to accept the change but (adequate?) compensation has to be offered. While in the following cases conservationists or non-conservationist may accept the change and, in exchange, may accept compensation, both by voluntary agreements.

### **3.5 Conservationist may accept change with compensation opportunity**

When the government of Tanzania, as holder of ownership rights over natural resources, voluntarily decides to introduce a community forest based management by transferring ownership rights to local communities in a protected area [33], it is voluntarily accepting loss of rights to preserve endangered forest species. This situation shows a case where the holder of property rights could have introduced compensation by law in the change process. Similarly, in Bangladesh, wetlands are owned by the public and the government confers exclusive use rights to individuals or groups who hold the lease, after successful bidding, mainly for fishing [35]. [14] and [16] describe situations for different countries were the government as owner of the resources respectively grants resource extraction permits to outsiders (overwhelming local user communities' rights) but in both cases it is not described that the conservation aims regarding the resources are maintained and if and in how far a compensation was involved.

[35] analyses the case of a village community which successfully governs an Andean Irrigation System for centuries based on common management and use of water. This community would have the opportunity to sell their rights to third parties such as they bought the rights of a community member family who left to town [p. 16]. Other cases for example, where local communities hold claimant rights over a forest that they plan to preserve, and where they actually can decide if accept compensation from a logging company to exploit that forest, would fit into that situation.

[17] indicates in a comparative analysis of agricultural expansion in the Mosquitia Forest Corridor that in a Honduran indigenous community with sole common property user rights some members accept by selling their rights to new settlers negative changes in the forests through them.

### **3.6 Non-conservationist may accept change with compensation opportunity**

[20] illustrate a situation where non-conservationists – a forestry cooperative -, are the owner of a forest in Tanzania. The cooperative may decide if it accepts compensation, for example from a REDD+ program, to conserve the forest. Similar situations are described in seven case studies related to Payments for Ecosystem Services (PES) by [36].

[34] find that local communities in the Hakaluki Haor wetland in Bangladesh may have willingness to participate in wetland conservation activities. They hold the right to manage the natural resources of the wetland as claimants and they may accept conservation practices under monetary or non-monetary compensation.

Pastoralist in Kenya's Maasailand who are authorized users may accept aggregate their grazing land via a voluntary agreement with other pastoralists to improve the livestock production and sustainability of the traditional practices [37].

### **3.7 Conservationist does not accept compensation at all**

[38] showed for a fishermen community at Chilika lake/India that a High Court – upon claim – “ordered the state to uphold the traditional access rights to lake resources and continue leasing to local fishermen” (p. 264) which in the following could restrict outsiders' entry and make the state to recognize of the community's role in fisheries management. It can be assumed that the fishermen would not have accepted a financial compensation of their rights, although the question of compensation to the fishermen was not directly at stake as outsiders did not pay lease fees to the fishermen but to the state as owner.

### **3.8 Non-conservationists does not accept compensation at all**

It is rather not astonishing that I did not find any case for the eighth category. This fits well into an overall picture of an 'economic person'<sup>1</sup>. This type of human does likely accept money in exchange to depletion of nature. Nevertheless there are situations imaginable which do fit into this 8<sup>th</sup> category. These could be cases where people based on social, cultural or religious reasons do not accept compensations, no matter how much is offered. These could be called a socio-lexicographic behaviour [39].

## **4 DISCUSSION**

### **4.1 Discussion of the method**

The method of the selection of the papers assess was – despite random – not optimal as it was observed that the list with 297 papers provided by the WoS did not include every WoS-listed paper that cited [1] (e.g. [40]). While papers of the same journal published in the same year were included (e.g. [41]). In any way, this issue was only found related to one journal and one year. The focus on the Thompson Reuters Web of Science of course excludes all journals and articles not included in this data base but cite [1]. On the one hand, the choice of [1] as the selection criteria excludes many potentially relevant papers which do not cite [1]. On the other hand, many papers that cite [1] do not concentrate on that scheme but could be – nevertheless use for the categorization done in Table 4, thus the overall sample of 297 papers does not seem to be somehow biased.

Our approach also – due to the focus on [1] – does not include those papers that only refer to later publications of these authors where they elaborated their framework more towards a clearer distinction between access and withdrawal, leading to five types of rights holders (instead of four).

Whereas authors of papers described the practical situation and made an allocation to property rights as wells as positions, this allocation was reordered if the practical situation indicated a different allocation. The new framework is well applicable for both, de jure or de facto rights [1, 23, 30].

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<sup>1</sup> Globally spoken, this economic centrism might be considered another scheme that has been created to improve the human conditions but is likely to fail (see Scott, J.C., 1998, Seeing like a state – How Certain Schemes to Improve the Human Condition Have Failed, Yale University Press, New Haven and London; I owe this thought an anonymous reviewer).

## 4.2 Discussion of the theoretical application

The system is not applicable when alienation rights for individuals are not legally in place. The allocation within the proposed Table is not possible if the right holder is the Community but an individual person “sells” this right. Legally spoken, such a sell is invalid as usually nobody can transfer a right which this person does not have but de facto the transfer happens especially if enforcement is weak or not existent (see e.g. [42]). The allocation is also not possible as in these situations one and the same right holder often belongs to both groups, the conservationists and non-conservationist (if a distinction is possible at all). A distinction cannot be made if the envisaged conservation outcome cannot be identified and/or the direction of the change, whether an situation of overuse of resources or an situation of an underuse, or vice versa, cannot be – from the conservation point of view - detected. Thus, the distinction between conservationists and non-conservationist is hardly possible if papers lack to describe the conservation outcome of a situation of change or the outcome is not visible yet. One example occurs, when the legally imposed or facultative transposition of use rights of agricultural land and forests in collective ownership to individuals happened recently [43] and therefor does not provide information on the outcome in terms of conservation of these natural resources. In the opposite, [44] compare five studies of different ownership situations and show that the communally managed reserves in both studies, where local residents held sole decision-making authority to make rules regarding the access, use and management of forest lands, showed more positive forest conservation outcomes than the other three cases where residents held minimal or no forest rulemaking rights.

[3] describe legal restrictions of conservation organizations as owner through access rights on behalf of tourists. The same legal restriction is in this study valid for ownership positions of water companies, forestry (state/private), agriculture and owners of moorland dedicated to grouse hunting. With regard to these user groups and their relationship to tourists the allocation of the terms “conservationists” and “non-conservationists” is for example rather difficult.

The scheme in the table also has limited applicability in situations of change between two non-conservationists or two conservationists.

The differentiation proposed does also not properly work if the paper lacks the information whether compensation has to be offered or not. Also those cases are difficult to allocate into the scheme where for example the public authority gives away rights and – in exchange – other benefits are derived than direct compensation (e.g. higher employment, revenues from taxes or export customs).

This paper only accesses immediate change situation, e.g. the permission about an envisaged project and whether e.g. a conservationist/non-conservationist has to agree or agrees to the change. Papers that only show a certain position but do not refer to a concrete situation of change are not included.

The application of the scheme presented in the Table 4 has another limitation, namely in the cases where it is unclear whether an activity towards a change is voluntarily or not, such as in cases of resettlements due to conservation reasons.

Many changes in resource use schemes are usually happening slow as they do go with socio-cultural changes (in values, power etc.) in society at large; in these situations it might be also hard to decide when a certain user that prior maintained an intensity of use supporting conservation aims (and therefor being considered “conservationist”) should be better be allocated to “non-conservationist” as the intensity of use increased beyond conservation aims.<sup>2</sup> In comparison, situations based on a voluntary or compulsory action such as decentralization and privatization [45, 46] are also more difficult to allocate to the table as the law that provides the basis for the transfer of property rights from the public forestry administration to local people is usually released voluntary despite local pressure on the public legislative bodies. Also it is not easy to decide 1) to allocate the state (who initiates the change) still to the conservationists and 2) whether or not anything has in exchange the quality of compensation (e.g. fees for right transfers, higher income tax revenues, reduced costs of control). These difficulties occur always when the public is both, rule setter and right holder. Changes that happen within the substance of the right, such as the re-interpretation by the right holder of a de-jure use and withdrawal right towards a de-facto exclusion right due to an unclear legal

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<sup>2</sup> See on these slow changes in the societies as a whole e.g. see Scott, J.C., 1998, *Seeing like a state – How Certain Schemes to Improve the Human Condition Have Failed*, Yale University Press, New Haven and London as well as Thompson, M. (1997). Security and solidarity: an anti-reductionist framework for thinking about the relationship between us and the rest of nature. *The Geographical Journal* 163(2): 141-149; I owe this thought an anonymous reviewer.

formulation such as described by [27] for two fishery rights in Chile are also difficult to include into the Table developed.

The new framework described above in Table 3 and 4 has also some advantages in comparison with the concept of [1], as it in particular does make clear that every legal position can be – in theory and often in practice – restricted by an authoritative act based on democratic legitimation due to certain public interest that override private property right positions.

These authoritative acts can restrict every private property right position from its very beginning or be introduced afterwards. The introduction of these acts can be done in a formal-legally correct way, but based on illegal reasons such as bribery or other forms of corruption.

Thus, the quality of each property right is also case-sensitive upon the opportunities for authoritative acts. Hence, the position of an owner could be considered by a holder weaker than the position of a proprietor depending on the respective extent of potential authoritative acts.

Not only authoritative acts that actively weaken the property right holder position are essential, but also those which defend property right holder position. Apart of self-defence, the question whether a property right holder position can be defended against outside intruders with the help of public authorities based on democratic legal acts (“enforcement”) is crucial too. The most comprehensive property right position is of only formal value if not protected by effective enforcement mechanism. Enforcement mechanisms can be distinguished for example into legal or illegal, formal or informal and community- or individual based ones.

## 5 CONCLUSION

The paper provides a new conceptual framework based on property rights and financial compensation in different nature conservation situations in order to provide a globally applicable system for the assessment of participation of public and private stakeholders in envisaged changes within those situations.

These situations of change represent a modification from conservation toward non-conservation and vice versa. The framework distinguishes further between governance systems based on command and control as well as on negotiation. Within these main change situations and governance types, the framework allows the distribution of change situations into 8 main sections. These main sections are further separated into 32 sub-sections by means of different property right and compensations situations among public and private stakeholders.

The theoretical utility of this new framework is then demonstrated by testing it by means of a random sample of 74 papers (25%) out of representative 297 papers from the academic literature dealing with property rights. These 74 papers provided practical examples for situations of change in conservation as evidence for the vast majority of the 32 sub-section. Several papers provide examples for more than one sub-section. The allocation of papers to these different subsections is described and discussed in detail. This widely possible allocation proofs in general the global applicability and usefulness of the new framework. The framework also proofed to be appropriate for formally (rule of law based) and informally (customary law based) institutionalized situations where rights are given to public and private stakeholders. Furthermore, the results allow simple assumptions on the regularity of occurrence of situations representing the 32 sub-sections. The discussion deals with the scope as well as the limits of the new framework. It also explores the frameworks’ potential future extensions such as regarding relative predictions on the length of negotiation procedures and on the amount of the compensations to be paid by one participant to the other.

The research strives to establish a general framework to assess the legal preconditions under which the extent of environmental protection in situations of disagreement among participants can be further assessed. It therefore contributes to the assessment of the fundamental relationships regarding conservation question between public and private stakeholders as well as their roles when participating in the finding of solutions on related conflicts of interests.

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# SUSTAINABLE DEVELOPMENT AND THE GOVERNANCE GAP

**SHOBHANA MADHAVAN<sup>1</sup>, ROBERT BARRASS<sup>2</sup>**

<sup>1</sup> WESTMINSTER BUSINESS SCHOOL, UNIVERSITY OF WESTMINSTER. [madhavs@wmin.ac.uk](mailto:madhavs@wmin.ac.uk)

<sup>2</sup> ECONOMIC CONSULTANT - ENVIRONMENT & TRANSPORT. [barrass@robbar.globalnet.co.uk](mailto:barrass@robbar.globalnet.co.uk)

## ABSTRACT

The concept of sustainable development was initially manifested in the evolution of a policy agenda for initiatives at global, national and regional levels to address a variety of threats to the welfare of future generations. This has led to a variety of frameworks for action, in the form of international treaties, legislation, incentive mechanisms and projects. These have met with mixed success, both in terms of targeting and of mitigating pressures that compromise sustainability.

All policy measures have a transmission mechanism, beginning with the specification of their purpose and objectives, and continuing with the formulation of (more-or-less) specific targets and mechanisms to achieve them. The next stage comprises implementation: the incentive effects upon the behaviour of individuals and organizations. These effects are not necessarily consistent with the original objectives: in some instances there can be serious, and undesirable, side-effects, and in the extreme the measures can be significantly counter-productive.

So as in all transmission mechanisms there is inefficiency due to friction. The purpose of the paper is to analyse the sources of friction, and to propose measures to reduce and limit it.

*Keywords: Governance, policy, sustainable development, rent-seeking.*

## 1 INTRODUCTION

One fallacy of policy-making is that announcement of an initiative necessarily solves the problem to which it is addressed. While such announcements undoubtedly have a role in concentrating attention, and preparing the way for action, they should not be confused with the often laborious process of making policies work in the way that is intended.

This paper is concerned with the way the sustainable development agenda gives rise to policy measures, and the problems that can arise in the implementation of these measures. If governance structures and systems are inadequate, or function badly, the policies cannot deliver the desired results.

As the policy framework for sustainable development has evolved, the associated policy measures became more complex and wide-ranging, seeking to create incentives to incorporate environmental considerations into economic decisions. However complexity carries risks, with possibilities of unintended consequences. The transmission mechanism between the conceptualisation of policies and their implementation is subject to frictions, the severity of which depends upon the adequacy of resources and the efficiency and effectiveness with which they are utilised. It is also essential to anticipate, and as far as possible counter, malign incentives that arise as side-effects of policy measures. One particularly unpleasant manifestation of such incentives is corruption, the distorting effect of which diminishes the effectiveness of policies, and detracts from good governance.

The paper concludes with recommendations: to seek to anticipate undesirable effects, to eschew as far as possible complexity in policy instruments, and to ensure that adequate resources are made available for the implementation of policy measures.

## 2 EVOLUTION OF THE POLICY AGENDA

The concept of sustainable development was popularised in the Brundtland report, with the now-familiar precept to "think locally, act globally", to ensure that the needs of the current generation were met without prejudice to the needs of future generations. The thinking and action generated a policy agenda for initiatives at global, national and regional levels. Specific areas of interest include The UN Conventions on Biological Diversity, the UN Framework Convention on Climate Change and the Kyoto Protocol and the Montreal Protocol on substances that deplete the ozone layer. In parallel with global phenomena, concerns also developed over environmental impacts of economic activity at national and regional levels.

Similarities can be seen across jurisdictions as the sustainability agenda has developed. An evolutionary pattern can be seen in which the priorities for action have evolved as environmental concerns have come into focus. Typically the emphasis has moved from a reaction to gross environmental damage towards efforts to avoid such damage in the future, and integrate environmental concerns into mainstream policies, seeking to ensure that a structure of incentives is in place to influence decision-making in ways that are favourable to sustainable development. The similarities, and some differences, in policy evolution are demonstrated by a comparison of the European Union and India.

European environmental policies developed in a series of action programmes. Beginning in 1974 with a focus on immediate needs for legislative and administrative measures to deal with an inheritance of environmental neglect from the nineteen fifties and sixties, the emphasis turned to the development of new policy mechanisms, such as economic incentives, preventive and anticipatory approaches, and the integration of an environmental dimension into other policies. More recently, policies have sought to integrate environmental and other relevant policies with a broad range of policy instruments for control and behavioural change including greater use of market forces.

A similar evolutionary process was followed in India. The initial impetus for environmental concerns was in large part a reaction to the pursuit of economic objectives with little regard to effects on the environment. A change came about in the nineteen-eighties, with a realisation "that there can be no rational and equitable development without environmental conservation" [1, p.26], brought forcefully into focus by the disastrous accident in 1984 at the Union Carbide plant in Bhopal. The need for a change of emphasis was further highlighted in a 1996 report, which stated that "India holds the dubious honor of suffering from poverty-induced environmental degradation at the same time as pollution from affluence and a rapidly growing industrial sector" [2, p.1].

In many respects EU and Indian environmental policies have developed on similar lines. In both cases there was a reaction to the neglect of the environment in the pursuit of economic growth following the upheavals of the 1940s. There developed an awareness that environmental quality was being damaged, and - crucially - that continuing neglect would compromise economic prosperity. Environmental policy makers have recognised that economic activity must integrate the environmental dimension; there has been a growing emphasis on preventive approaches and encouragement of cleaner technologies in the pursuit of sustainable development.

There are important implications for policy and its implementation. Action in response to immediate and obvious environmental damage does not in principle pose great challenges. Evident pollution problems caused by known sources can be dealt with by legislation setting regulatory standards for emissions. In contrast the more elaborate sustainability agenda that now prevails raises issues of prioritisation in choices between options both for environmental objectives and for measures to achieve the objectives.

## 3 SPECIFICATION OF TARGETS AND MECHANISMS TO ACHIEVE THEM

The objectives of policies are realised by the deployment of policy measures, geared to targets that may or may not be subject to precise specification. The process moves from the perception of an actual or potential problem to the institution and enforcement of necessary measures, whether remedial or preventive. In the environmental context this usually involves the setting of standards with a view

to achievement of policy objectives and targets. The standards may be defined with reference to biological parameters, exposure limits, environmental quality objectives, processes, or products. When perceived holistically the system is highly complex, with various forms of human activity impacting in numerous ways on different facets of environmental quality.

Some valuation of the environment is implied in this process, even if no explicit estimates are made of costs of environmental damage. All environmental issues have a spatial dimension, and within that space action must be guided by a consensus on the environmental quality to be achieved and maintained, and ultimately – albeit implicitly – on the value of environmental resources. Where the impacts are on a global scale this can present formidable difficulties, as reflected in the differences noted above in environmental priorities. There can also be tensions in economic relations, where for instance the production of traded goods has environmental impacts that are acceptable in the producing country but would not be tolerated in the country where the products are consumed. There are legitimate reasons for variation in the trade-off between different types of environmental resources and between environmental and other resources, but this has nevertheless been a highly controversial issue. Bhagwati [3, p.141] has identified environmental valuation as the "real question": criticising environmental groups that seek to impose their own valuations of environmental resources, he argues that countries have a right through their own political processes to make choices with respect to exploitation of these resources.

A prominent example of targeting has been the EU policies to combat climate change, boost economic competitiveness and generate employment, thus realising the growth potential of the green economy (see [4]). The centrepiece is a set of targets, such that by 2020 there will be a 20 % reduction in greenhouse gas (GHG) emissions (compared to 1990), a 20 % increase energy efficiency, with renewables accounting for 20 % of energy consumption.

A strategy to achieve these targets encompasses various initiatives, including:

- Planning effective, growth-friendly use of the revenue from auctioning of EU Emission Trading Scheme allowances.
- Realising the full potential for increasing energy efficiency, particularly in the buildings sector.
- Providing a stable, coherent and cost-efficient framework for investment in green technologies, in renewable energy sources and in energy infrastructure.
- Exploiting the emissions reduction potential of transport.
- Fully exploiting possibility of shifting the tax burden away from labour to tax bases less detrimental to growth and jobs, in particular environmental taxation.
- Removing environmentally harmful subsidies.

Achievement of the targets, and hence implementation of the underlying strategy, depends upon specific implementation measures. This may be characterised as the less glamorous part of the policy process, being immersed in the detail where it is said that the devil resides. It is also subject to the uncertainty inherent in behavioural responses, both on the part of those subject to policy measures and those charged with their implementation. The remainder of this paper addresses some of the issues that arise in the course of implementation, and the reasons why achievement of objectives and targets can prove elusive.

#### 4 IMPLEMENTATION: FRICTION IN THE TRANSMISSION MECHANISMS

The policy process should be seen in holistic terms, continuing from the announcement of measures right through to the assessment of their ultimate impact. Thus the enactment of laws and regulations, and the establishment of regulatory and charging mechanisms are only the beginning of this process. The ultimate objective is (or should be) to achieve specific desired results through an implementation mechanism. There are various potential impediments, relating to understanding of what is required, assembly and deployment of the necessary resources, and anticipation of behavioural responses to implementation mechanisms.

King and Crewe [5] have made extensive studies of the lessons to be learned when policy initiatives fail to deliver the desired results. The studies cover a wide range of areas subject to governmental initiatives, including economic, social, employment, transport, health and agriculture. They identify several specific factors that contribute to these failings, as follows:

*Human errors*

- Cultural disconnect
- Group-think
- Prejudice and pragmatism
- Operational disconnect
- Panic and symbolism

*System failures*

- Fragmentation of responsibility
- Turnover of ministerial personnel
- Hyperactive politicians
- Lack of accountability
- Failings in scrutiny and oversight by the legislature
- Asymmetries of expertise
- Deficit of deliberation

Many of these failings were exemplified in the saga of the Rural Payments Agency (RPA) in England. Reforms of the EU common agricultural policy agreed in 2003 discontinued farm subsidies linked to output, which had given incentives for intensive production leading to surplus agricultural output, with damaging consequences for the environment. The reforms substituted a system of single payments based on land area that could be linked to agricultural and environmental performance. The RPA had the task of administering the Single Payment Scheme (SPS) for farmers in England (separate arrangements prevailed in other parts of the UK).

A Parliamentary report summarised the essence of the SPS as follows:

"In England farmers are entitled to payment from the SPS as long as each 'entitlement' allocated to them is matched by a hectare of eligible land and other eligibility rules are met. Payment may be reduced if farmers do not keep their land in good agricultural and environmental condition or do not comply with requirements relating to the environment, animal and public health, and animal welfare" [6, p.8].

The scheme was undoubtedly well-intentioned. The government believed that it would give farmers "greater freedom to respond to market demands for agricultural products and ... reward environmentally friendly farming practices" [5, p.173], to "end up with a system that is increasingly equitable between farm types; is much more market focused; has a greatly simplified bureaucracy; and can deliver a better landscape and environment, and a more sustainable long-term future for English farming" [6, p.16].

The key strategic decision was with respect to two options which could form a basis for setting the amount of payments:

- Historic payments, based on the average direct payment receipts of each farmer between 2000 and 2002 under the previous subsidy schemes.
- Regionalised average area payments, based on a flat rate per hectare of land.

These options were not mutually exclusive, although a combination of the two would add to the complications of managing the scheme. Both had their supporters: existing recipients of support payments were understandably in favour of the continuation of historic payments, while environmental groups were particularly keen to have an area based system [6, p.14]. In the event, the

government decided on a "dynamic hybrid" model, whereby the flat rate element, starting from a small percentage of total payments, would progressively increase year-upon-year, until it eventually accounted for the entire total. This meant that while payments continued on the historic basis, the system also had to accommodate new recipients, leading to a 50 percent increase in the number of recipients [5, p.178].

This system was extremely complex to administer, and while it operated had to adapt to evolving national and EU policies. It was crucially dependent on IT systems that had to be developed specifically for the SPS. Shortcomings in these systems led to severe failings in implementation, with delayed payments and in some instances over-payments [5, p.176]. Responsibility for these problems was a matter of dispute between the parties involved: the responsible government department, the Rural Payments Agency and the IT contractors [5, p.180]. Ultimately the failure was collective, because as King and Crewe point out no one "effectively 'owned' delivery of the scheme ... [or] really understood the scheme in its entirety (always assuming it was capable of being understood)" [5, p.181].

The parliamentary committee report commented that "this is not the first time that a major public sector business change or IT project has failed. The Government does not seem to be learning the lessons of previous failures. There is a need for greater expertise within Government in the delivery of such complex and important projects." [p.6] The committee's verdict was that the saga "was a catastrophe for some farmers, and a ... key part of the Government's sustainable farming policy was in collapse." [6, p.5]

Many of the factors mentioned above were manifested in the RPA saga.

*Group-think* The minister, the permanent secretary and the head of the RPS all "thought the most ambitious payment scheme on offer could be made to work" [5, p.263].

*Operational disconnect* "Ministers ... simply, but misguidedly [accepted] the head of the RPA's assurances that he and his staff could deliver the most complicated payment scheme on offer" [5, p.291].

*Fragmentation of responsibility* Departments are left on their own to make major policy decisions "it was left to middle ranking and junior officials to express their doubts about the workability of the scheme" [5, pp.312-13].

*Lack of accountability* The Chief Executive "went on insisting that the agency could deliver when it patently could not" [5, p.351].

*Asymmetries of expertise* No one noticed that the Chief Executive "was not up to the job" [5, p.377].

The failings of the RPA are also illustrative of a wider problem that King and Crewe categorise as a deficit of deliberation. They identify this in a quantitative sense, and as a phenomenon to some extent specific to the United Kingdom: thus "the very strength and decisiveness of British governments may be curse as well as a blessing" because "it is every bit as easy to take the wrong decision as to take the right decision" [5, p.385]. However, the deficit can also exist in a qualitative sense: no amount of deliberation will help if all parties are in denial of inconvenient truths. Such situations can arise from the planning fallacy and optimism bias identified by Kahneman. If the role of planner of projects and initiatives blends with the role of promoter there can be a degree of unrealism and overconfidence that tends to gloss over possible failings and shortcomings. To make matters worse, this can be compounded with (possibly implicit and unconscious) complicity: in Kahneman's words "experts who acknowledge the full extent of their ignorance may expect to be replaced by more confident competitors" [7, p.263].

The UK government sought to address some of these problems with the establishment of the Major Projects Authority in 2011. Part of its remit is "to ensure projects are established and delivered under optimum circumstances and are set up to succeed from the start" [8]. The Authority can undertake deliverability assessment, and it can intervene directly where projects are causing concern. This initiative is on the right lines in increasing the effectiveness of outside oversight, although its long-term effectiveness remains to be seen.

## 5 MULTIPLE INCENTIVE EFFECTS

It has long been recognised that economic activity can have negative impacts, that are not necessarily borne by those who activities generate the impacts. There are various ways to respond to this phenomenon.

One approach is to resort for those who cause damage to compensate those who suffer it. The Coase theorem states that under certain circumstances an economically efficient allocation of environmental cost is secured by bargaining between affected parties [9]. All the parties have an incentive to balance their marginal costs and benefits: the polluter has an incentive to abate the pollution up to the point where the marginal cost of abatement equals the marginal cost of compensation payments; and the victim tolerates pollution up to the point where the marginal cost of damage equals the marginal gain from compensation. Since the transaction purports (at least implicitly) to take account of environmental damage (compensated by the rewards from increased economic activity), there is an optimal outcome.

However in practice the prospects of an unambiguous economic gain are highly restricted. The Coase theorem makes crucial assumptions that the environment is subject to property rights and that the property owners are in a position to defend their rights. In practice these conditions rarely hold. Furthermore it is not sufficient for compensation merely to be assessed: it has to be actually received by the victim, so that the process leaves no party worse off after than they were before. So if compensation payments are appropriated by other parties, or are deemed to be not practically feasible, then, although the level of environmental damage may be economically efficient, there has not been a clear benefit leaving none of the parties disadvantaged. Technically, the Paretian criteria for an economic gain have not been fulfilled (see [10, p.96]).

If an efficient and equitable outcome cannot be achieved by a bargaining process, the authorities must intervene. One possibility, often characterised as the traditional approach, is to enforce regulatory standards designed to limit adverse effects to levels that are deemed acceptable, or at least tolerable. The incentives to comply with the prescribed standards are the avoidance of penalties (financial and otherwise), and of reputational damage. Polluters are further incentivised (positively) to pursue technological improvements to meet the regulatory standards at lower cost. On the other hand there are also negative incentives, to avoid, and to evade, compliance and to influence the regulatory process, both in the setting and the enforcement of standards. Furthermore there are possibilities for obtaining economic rent from the allocation of permits, unless they are allocated in a competitive and unbiased auction procedure. An inheritance of regulatory permits, so-called "Grandfather rights" can be a valuable asset. This is demonstrated by the practice of trading take-off and landing slots at Heathrow Airport, one of the world's busiest, where "in 2007 British Airways bought 102 ... slots ... for approximately £30 million" [11, p.8]. The value of British Airways' slot portfolio has been estimated at £2billion, a figure that accountants have suggested might be included in BA's balance sheet [12, p.8].

There has been extensive debate over the role of market-based economic instruments, with claims that such instruments are more efficient than "command and control" regulation. The essence of the argument is that if polluters have to pay per unit of pollutant emitted, they will abate their emissions up to the level at which the marginal cost of abatement equals the per unit charge. Consequently the system will be conducive to economic efficiency, because the polluters with the lowest abatement costs will undertake most of the abatement. It is also claimed that a charging regime has less demanding information requirements, but this is true only if economic efficiency is defined in a way that excludes environmental valuations. Otherwise, the two are in principle equivalent: as Weitzmann [13, p.695] argues "generally speaking it is neither easier nor harder to name the right prices than the right quantities because in principle exactly the same information is needed to correctly specify either".

Furthermore both pricing and regulation offer incentives for polluters to distort the system. The authorities require information on cost profiles when setting charges or standards for emissions, so

"there is clearly an incentive for self-interested producers to systematically distort information about hypothetical output and cost possibilities in the pre-implementation planning phase" [13, p.695].

Nevertheless, in a market economy the price mechanism clearly has a key role, as do measures to counter market imperfections. The European sixth environmental action programme marked a growing emphasis on price-based incentives, including a chapter entitled "Getting the Prices Right". The aim was to use economic and fiscal instruments ... to internalise all external environmental costs incurred through the whole life-cycle of products". [14, p.67]. Whereas other forms of taxation tend to cause economic distortions, green taxes and charges can be seen as correcting distortion, and thus favourable to economic efficiency. Over the past two decades environmental taxes have become increasingly common.

However these measures create unwanted incentives. The phenomena of tax avoidance and evasion have received increasing publicity as governments seek to limit the leakage of revenue and economic distortions stimulated by the complex tax regimes that they have instituted, made more complex by initiatives to combat these undesirable side-effects. Taxation thus represents a multi-faceted structure of incentives: as one expert on the subject puts it "at the margin people are willing to incur a dollar's worth of cost to save a dollar of taxes, and that cost may take the form of a distorted consumption basket, a fee to an accountant, or increased exposure to the risk of punishment for evasion." [15, p.1459]. The authorities can respond by seeking to manipulate the incentives to minimise the harm: thus "there are a variety of policy instruments that can affect the magnitude and nature of avoidance and evasion response, ranging from the activities of the enforcement agency to how tightly drawn are rules and regulations. The same kind of cost-benefit calculus applies to the choice of these instruments, implying that the elasticity of behavioral response is itself a policy instrument, to be chosen optimally" [15, p.1464]. Conversely, implementation of a fiscal measure without adequate reference to these considerations risks serious problems.

One example (among many) is the UK landfill tax introduced in 1996. The tax was designed to use market forces to protect the environment by making the disposal of waste in landfill sites more expensive, thus encouraging waste producers to produce less waste, recover more value from waste (for example through recycling or composting) and to use more environmentally friendly methods of waste disposal. Another – malign – incentive is to dispose of wastes by illegally dumping them (a practice known as fly-tipping). There is some evidence that fly-tipping increased when the tax was introduced [16, p.10], and there have recently been reports of the problem increasing, as reductions in local authority budgets have constrained enforcement efforts [17].

## 6 CORRUPTION

Incentives for corrupt behaviour stemming from regulation and public spending are a worldwide phenomenon. Environmentally-related issues have figured in reports by the campaigning group Transparency International: a 2008 report on corruption in the water sector was followed in 2011 by one on climate change. The latter report highlighted risks that corruption will impede mitigation and adaptation, for instance by slowing the adoption of renewable energy, reducing the effectiveness of investment in infrastructure such as flood protection, drainage systems and storm shelters, exploitation of people displaced by climate change, and accelerating deforestation and forest degradation.

The report [18, p. xxvi] identifies a number of factors favouring corruption:

- There are huge amounts of money involved: investments in mitigation efforts (estimated at almost US\$700 billion by 2020) will flow through new and untested financial markets and mechanisms.
- Many climate issues are characterised by complexity, uncertainty and novelty, such that there is scope for questionable conduct in establishing and implementing the regulations that govern measures that respond to climate change.
- The vulnerability and marginalisation of those most adversely affected by climate change: indigenous and rural poor communities in remote locations, the urban poor living in precarious settlements, and displaced persons who require resettlement.

The linkage between policy measures and corruption is an inconvenient truth and may be characterised as the politicians' elephant in the room. This is not to say that the problem of corrupt practices is denied: indeed it is the subject of legislation across the globe (for example the UK Bribery Act 2010), and the focus of initiatives at international level, such as the OECD Anti-Bribery Convention.

A recent EU report [19] found that measures and infrastructure development related to environmental protection feature in corruption, involving both classic forms of bribery and more diffuse exercises of political influence. Specific instances identified in the EU include:

*Greece* Corruption in various forms is widespread in various sectors, including environmental and urban planning [19, Annex 8 p.3].

*Ireland* There are risks of corruption involving developers seeking the re-zoning of areas in which they want to invest in order to increase the value of their land [19, Annex 7 pp.11-12].

*Poland* Business representatives admitted to having been asked or expected to pay a bribe in specific sectors such as environmental permits [19, Annex 21 pp.2-3].

*Romania* political favouritism often prevails over objective criteria and the public interest in allocation of funds for environmental purposes and infrastructure investment, including rural water systems [19, Annex 23 p.13].

*Slovenia* Violations of conflict of interest rules were found involving environmental issues and urban planning [19, Annex 24 p.7].

In India corruption has become a high-profile political issue, and interest has increasingly focused on its underlying causes. Some observers see part of the explanation in excessive regulation: in the words of one commentator "many entrepreneurs complain that the licence raj has returned in the form of the environmental clearance that is required from the ministry. It appears that bureaucrats and politicians have 'captured' this cause and made it lucrative ground for rent seeking" [20, p.289].

The regulation of fertiliser quality in India provides an example of explicitly corrupt behaviour deriving from the nature of regulation, and the implicit structure of incentives. The quality control mechanism has been characterised as "elaborate", and it is that characteristic that leaves the system vulnerable to corrupt behaviour in the inspection regime. The process is described by Debroy and Bhandari [21, p.95] as follows: "archaic and rigid regulations and legal provisions ... are used by the inspectors to extract side payments ... a sample 'fails' a quality control test, this is ... a warning to the producer ... after a successful transaction the sample passes at the re-testing phase". Thus the producers have a stronger incentive to buy off the inspectors than to maintain of fertiliser quality. The proposed solution is to reform the quality control monitoring and regulatory system in line with technological and organisational imperatives, and to increase the system's efficiency through investment in infrastructure and human resources to create incentives to avoid malpractice [21, p.102].

Not all rent-seeking behaviour involves corruption in the classic form of bribe taking. Sainath [22] shows how the Indian Drought-Prone Areas Programme (DPAP) was abused to channel assistance to districts "with an abundance of rainfall - but where one section, the poor, can suffer acute drought" [22, p.319]. While there was no meteorological drought, a man-made water shortage was created by production of sugar cane, a highly water-intensive crop, so that 70 percent of the irrigation water was used by two percent of the farmers. The DSAP assistance was then invoked to mitigate the resulting artificial drought.

The EU report on corruption acknowledges the limitations of legislation as a means of combating corruption: while "Member States that face serious challenges in dealing with corruption have set up complex and sophisticated legal and institutional frameworks, as well as numerous targeted strategies or programmes ... these alone do not necessarily lead to tangible results". The problem appears as much cultural as legal, such that "in other Member States where relevant regulation or strategic

programmes are lacking, corruption has been visibly reduced by preventive systems, practices, traditions involving the suppliers and recipients of public services or, in some cases, high standards of transparency" [19, p.8]. Similar sentiments were expressed in the Indian context by Debroy and Bhandari, who distinguish between tactical and strategic reforms; the former are designed directly to tackle corrupt behaviour, but are themselves open to abuse, while the latter (including the strengthening of civil society) have a useful role but do not constitute a magic bullet [21, p.148].

There is a considerable degree of unanimity on the how to address the problem of corruption. Most commentators believe that the key lies in better governance and greater transparency. These may be characterised as "demand side" measures, to diminish the attractions of behaving corruptly, and they are undoubtedly important. Nevertheless attention should also be paid to the "supply side", the nature of the regulatory and other structures that provide opportunities for corrupt behaviour. The observations of Slemrod and Yitzhaki on combating tax evasion through optimal enforcement and careful structuring of regulations [15, p.1464] apply more generally to corrupt behaviour. One danger is that heavy-handed enforcement of anti-corruption measures can impede the functioning of institutions, particularly where decision-making has a judgemental element and enforcement measures can be perceived as operating in an arbitrary manner [21, p.149]. A recent study of organised crime concluded that regulation is a key driver of criminal activity, and the best strategy is to gear regulation to take account of incentives for criminality, while tightening financial regulation to limit the scope for criminals to enjoy the profits from their activities [23, p. 394]. Ideally these complexities should be properly taken into account in the process of devising regulatory and other measures, avoiding the deficit of deliberation identified by King and Crewe [5] as a common systemic failure of the policy process.

## 7 IN CONCLUSION

Sustainable development is an important public policy issue, and one reason is that free markets have their limitations, both with respect to time and to valuation of the wider impacts of economic activities. So, in the face of market failures, intervention is needed, in the form of – inter alia – regulatory and fiscal measures.

However, even where markets display imperfections, market forces can still assert themselves, sometimes with malign results. In the case of the policy instruments mentioned above there are incentives for compliance but also for evasion. The latter lead to problems of enforcement and implementation, and ultimately detract from achievement of policy objectives. These problems have become more acute over time, as the policy agenda has evolved and widened. The regulation of obvious point-source pollution is more straightforward than the deployment of policy instruments in efforts to influence the behaviour of disparate individuals and organisations.

The assumption that policies will automatically generate the desired results (and, conversely, not have undesirable impacts) can be seen as a consequence of the causative factors behind governmental blunders identified by King and Crewe and discussed in Section 4 above, and as a factor underlying an apparent blind spot with respect to anticipation of undesirable side-effects of policy measures.

The main recommendation from the discussion in this paper is that policy measures should be subject to honest appraisal that takes full account of the multiple, sometimes malign, incentive effects that they can create. The first precondition for successful implementation is to have the right structures in place both to introduce the measures and critically to monitor their progress: to achieve this, there needs to be critical assessment of legislative and regulatory processes and the administrative machinery to avoid the failings of the past. A further, vital, condition is to follow an anticipatory approach, as far as possible to tailor the measures to avoid malign incentives. The outcomes of these incentives range from tax avoidance and evasion to outright corruption. Politicians, perhaps understandably, are reluctant to dwell upon these effects, and, especially, the role of the measures they espouse in promoting these undesirable side-effects, including the opportunities afforded to organised crime.

Nevertheless, lessons need to be learned. One is that there should be thorough ex ante assessment to anticipate the possible malign side effects, with input from "devil's advocates" who have no stake in the success of the measures. A further lesson is the desirability of simplicity: one major reason for the complexity of the tax system is that it incorporates measures to combat undesirable practices such as avoidance, evasion and money laundering, and the complexity escalates over time. Similarly, there are always temptations to add to the complexity of environmental measures, and in themselves the additional complications may be justified; but there needs to be a balance between complexity and enforceability. Finally, the mundane requirements of enforcement should never be neglected: the example of the UK landfill tax shows how the success of environmental measures is critically dependent on the availability of adequate resources.

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