Theme 5. Corporate Sustainability and Innovation

Track 5a. Corporate Sustainability Management

Track 5c. Sustainability Transitions, Innovation Systems and Social Inclusion

Track 5d. Design for Sustainability

Track 5e. Circular Economy and Industrial Ecology

Track 5f. Sustainable Supply Chains and International Trade

Track 5a. Corporate Sustainability Management

The New Zealand Voluntary Carbon Market: An Investigation at the Organizational Level

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Abstract

Atmospheric concentrations of carbon dioxide (CO2) emissions are increasing as a result of the burning of fossil fuels. This destabilization of the Earth's climate system has resulted in an increase in global average temperatures and will lead to more extreme weather events and sea-level rise, with potentially disastrous ecological and societal consequences. Policy mechanisms to entice a move to a low-carbon economy, such as taxes or trading systems, have taken centre stage in international policy discussions. As government policies evolve, organizations are beginning to engage in climate change discourse and explore their risks and opportunities in this emerging field. Participation in the voluntary carbon market (VCM) has become a preferred option for organizations looking to offset their carbon emissions. Organizations are central to the success or failure of efforts to mitigate anthropogenic climate change. Through investigation at the organizational level, this empirical research explores the successes and setbacks of organizations involved in the New Zealand VCM; this in turn provides insight into the market's ability to facilitate a low-carbon economy. In total, fourteen semi-structured interviews were carried out with managers and decision-makers from organizations in the wine, taxi and carbon service industry. Participants were investigated regarding cognitions, commitment and actions, as well as their organization's activities and interactions with a range of actors in the VCM field; and, how these evolved over time. Interview questions were formulated to identify perspectives and opinions on climate change strategies, carbon neutrality, offsetting and the interviewee's organization's involvement with the VCM. Digital recordings of the interviews were transcribed by a professional service. Transcripts were thoroughly examined, broken down into topics, ideas, or quotes and then organized into themes for analysis. Overall, findings suggest that the New Zealand VCM has had its share of both setbacks and successes. The major setback can be summarized as market stagnation, with buyers and sellers drifting away from the VCM. Communication challenges, low certification recognition, risk of greenwash exposure, policy uncertainty, the global financial crisis, and general disenchantment with the carbon market were listed as some of the causes. Successes include endeavours which focused on promoting market integrity through infrastructure (e.g. a registry, certification programmes). Networking, knowledge sharing, and influencing others to shift behaviour were also identified as successes.

Keywords: Voluntary carbon market, New Zealand, Organization behaviour, Carbon management strategies, Carbon neutral

1. Introduction

Atmospheric concentrations of greenhouse gases (GHG) are increasing as a result of the burning of fossil fuels (e.g. Hansen et al, 2012). This destabilization of the Earth's climate system has resulted in an increase in global average temperatures and will lead to more extreme weather events and sea-level rise (IPCC, 2013), with potentially disastrous ecological and societal consequences. Consequently, policy mechanisms to entice a move to a low-carbon economy, such as taxes or trading systems, have taken centre stage in international policy discussions.

As government policies emerge, organizations are beginning to participate in climate change discourse (e.g. Galbreath et al, 2014), and explore their risks and opportunities in this emerging field (e.g. Weinhofer & Busch, 2013). One main barrier impeding organisations from engaging in carbon management strategies appears to be uncertainty with respect to both the marketplace and governmental policies (e.g. Pinkse & Kolk, 2010). Businesses may not want to implement costly emission controls or carbon offsetting if their competitors do not and if no regulatory cap is set. On the other hand, businesses do not want to be left behind if governments eventually set caps, thus they may try voluntary measures. While organisations seek to distinguish themselves from rivals to gain a competitive advantage, they might also consider and manage reputational interdependence where others' actions affect the perception of the entire field (e.g. an industry or sector) (Hargrave, 2008). This contagion effect or reputational spill over can force firms to look beyond their organisational boundaries to their social network and institutional fields (Yu & Lester, 2008). Ultimately, in the face of a carbon constrained economy, keen organizations are pushing their innovative capacity (Pinkse & Kolk, 2010).

Several studies have examined organisational responses to climate change (e.g. Sullivan & Gouldson, 2013; Birchall et al, 2013; Birchall, 2014b; Wade et al, 2014), carbon markets and emissions trading (e.g. Lohmann & Sexton, 2010; Newell et al, 2013). Offsetting has also attracted debate (e.g. Milne & Grubnic, 2011). As has the voluntary carbon market (VCM), which is a principal mechanism employed by organizations (and individuals) seeking to offset their carbon emissions. A number of studies have explored behaviour around willingness to pay for carbon offsetting (e.g. Ziegler & Schwirplies, 2014; Birchall et al, 2015), the risk of offsetting promoting sustained consumption and the ethics of carbon neutrality (e.g. Dhanda & Hartman, 2011), and the value of certified versus non-certified carbon offset programs (e.g. Mackerron et al, 2009).

Although certain aspects of the VCM have previously been explored, there is a gap in the academic literature with regard to which institutions are emerging in the VCM, how they are being created, and what influence actors have in shaping and sustaining these new institutions. This research aims to address this gap. Through critical investigation at the organisational and field levels, the objective of this empirical research is to better understand the cognitions, commitments, actions and accountabilities involved in the New Zealand VCM, how and by whom they are being shaped, and what effect they have on participants. Given the gravity of the climate change problem, it is important to explore the institutional frameworks surrounding the VCM, as these provide insight into the market's ability to facilitate a low-carbon economy.

This paper is structured around five substantive sections. Building off the first two sections, which highlight the study's contribution to the discussion on the VCM and detail the research approach, the third section presents the findings in the context of three case studies: the wine industry; the taxi industry; and the carbon service industry. The fourth section discusses the findings in terms of successes and setbacks of participation in the VCM. The final section provides a summary of the case studies and concluding thoughts.

2. Methods

Qualitative semi-structured interviews were carried out with managers and decision-makers from

organizations and industries most associated with carbon neutrality in New Zealand. Participants were investigated regarding their cognitions, commitments and accountabilities, as well as their operational activities and interactions with the range of actors in the field; and, how these evolved over time. Interview questions were formulated to identify perspectives and opinions on climate change strategies, carbon neutrality, offsetting and the interviewee's organization's involvement with the VCM. A general interview outline followed four basic points:

How did your organization first become involved with climate change, carbon neutrality, and buying/ selling offsets?

How did you decide on the particular approach to adopt? How has your approach evolved over time?

What accomplishments and setbacks have you encountered? What has worked and what would you have done differently?

Where do you see the VCM and climate change strategies in general headed in the near and more distant future?

The chosen organizations represent a cross-section of offset buyers and sellers, as well as middlemen involved in the New Zealand VCM: 2 certifiers, 2 consultants, 1 registry, 1 auditor, 3 CarboNZero certified, 1 carbon neutral non-certified, 1 looking into becoming carbon neutral, and 2 CEMARS certified.[3] The wine industry and the taxi industry were chosen for case studies. Both of these industries include organizations that prominently advertise themselves as carbon neutral and are among companies most associated with carbon neutrality in New Zealand. The carbon services industry was also studied. This new industry rapidly evolved and expanded to fill any perceived needs associated with the carbon market and provide an infrastructure of skills for organizational climate change actions and emissions trading.

A senior manager or relevant environmental personnel at each selected organization was interviewed. The interviews were conducted between 2010 and 2011, and included 14 interviewees at 13 organizations for a total of 20 hours of interviews (Table 1).[4] Digital recordings of the interviews were transcribed by a professional service.[5] Transcripts were thoroughly examined, broken down into topics, ideas, or quotes and then organized into themes for analysis. Immediately after each interview, a brief summary was put together of initial thoughts and potentially important themes and ideas brought up by the interviewee. These preliminary thoughts and themes were taken into account during a re-examination of the transcripts to ensure that no initial impressions were overlooked.

Table 1. Interviews by industry.

Code Name	Comment	Interview Date	Length (min)
Wine			
Wine 1	CarboNZero certified	02-Dec-2010	70.5
Wine 2	Aspiring to be carbon neutral	03-Dec-2010	36.5
Wine 3	CEMARS certified, considered carbon neutrality but decided against it	16-Dec-2010	56
Taxi			
Taxi 1	Carbon neutral, not certified	07-Dec-2010	83.5

[3] CarboNZero[Cert] and CEMARS[Cert] are certification programmes administered by CarboNZero. CarboNZero[Cert] includes measuring, reducing and offsetting emissions, while CEMARS[Cert] (Carbon Emissions Measurement and Reduction Scheme) does not include offsetting. See Birchall et al (2015) for an analysis of disclosures of organizations that were involved in these programmes.

[4] Taxi 3 was interviewed twice: first in December 2010 (Y1) with two respondents (R1 and R2) and then a follow up one year later in December 2011 (Y2) with respondent R1. Taxi 1 and Taxi 2 were each interviewed once with only one respondent. Y1 stands for Year 1, R1 stands for Respondent 1.

[5] Transcriptions were done by the Centre for Evaluation & Monitoring [CEM (NZ)] at the University of Canterbury; they provide professional and confidential transcribing services.

Taxi 2	CarboNZero certified	29-Nov-2011	72
Taxi 3	CarboNZero certified	10-Dec-2010	111
		08-Dec-2011	183
Carbon Services			
Certifier 1	Carbon neutral certifier	06-Dec-2011	112.5
Certifier 2	Former carbon neutral certifier	01-Dec-2011	37
Consultant 1	Consultant; offset provider	05-Dec-2010	120
Consultant 2	Consultant; project developer	06-Dec-2010	109.5
Registry 1	Leading offset registry	20-Dec-2010	46
Auditor 1	Big four accounting firm; Carbon claims auditor	17-Dec-2010	83
Energy			
Energy 1	Formerly CarboNZero certified, currently CEMARS certified; offset provider	09-Dec-2010	70.5

3. Results and Discussion

Results are presented here in three sections, which represent the three case studies: the wine industry; the taxi industry; and, the carbon service industry. Each section details the major themes that emerged in the interviews, as follows:

The Wine Industry

Sustainability and Marketplace Motivations

Measure, Manage, Improve

Offsets

The Taxi Industry

Conformity and Radical Differentiation

Business Case for Environmental Action

Offsets

The Carbon Services Industry

Emergence of a New Field

Business Opportunities

Setting the Rules, Assuring Market Integrity

The Wine Industry

Wineries were among the first business organizations to become involved with carbon neutrality. Three New Zealand wineries were investigated in this study: one CarboNZero certified, one aspiring to become carbon neutral and just starting to look into options on how to achieve this goal, and one that decided against carbon neutrality but is measuring and attempting to reduce its GHG emissions.

Sustainability and Marketplace Motivations

The wine industry has a longstanding tradition with sustainability. As grape growers, the industry has a direct relationship with the natural environment. Sustainability is considered essential for survival and is embedded in organizations. According to Wine 3 (Table 1): "The organization has always been concerned about the environment; we grow grapes and we're dependent on the weather and the land. In fact, we've had a long written objective to be environmentally responsible."

Moreover, sustainability has been institutionalized within the wine industry with well-defined norms and practices regarding environmental responsibility. Sustainable Winegrowing New Zealand (SWNZ) was created in the mid-90s to provide guidance on sustainable management of vineyards and wineries and is now almost universally adhered to.

Given the industry's inclination toward environmentally friendly practices, including resource, water, and energy use management, attention to climate change and carbon emissions management was an expected next step, with the institutional foundations for actions already in place.

Further, although competition and differentiation are part and parcel of the business, there is an underlying sense that New Zealand wineries are all in it together. In regard to sustainability for example, Wine 3 (Table 1) explained their approach as follows:

"We are a fiercely competitive bunch here. We like to get out there and do things first and we like to do things really well. But I truly believe that the whole industry has to take [sustainability] on board. We need to take that message to the world."

The wine industry is predisposed for collaboration; industry seminars are common practice. Networking, not only with potential customers but also with other wineries, is integral and promotes the sharing of ideas.

As for market motivation, customers were found to be a catalyst for action by wine producers to better control emissions. Many customers have growing awareness of climate change and changing expectations regarding businesses' environmental actions, as indicated by Wine 3 (Table 1): "Certainly there is a call from our customers to be demonstratively environmentally friendly. Ten years ago they weren't really interested - they're definitely interested now."

Environmental certification was viewed as a way to stay competitive in the marketplace. Though certification may not fetch a product a higher price, distinctive branding may keep the products on store shelves.

Exporters in particular were affected by new stakeholder demands, chiefly from UK supermarkets:

"These guys [(Tesco's, etc.)] are the gate keepers – they are able to set the trends. They've set the current bulk wine trends in the wine industry. At the end of the day they're our customer; it's not the end consumer, it's the supermarket. So we have to keep abreast in what they're doing." (Table 1, Wine 1)

New Zealand wineries are aiming to serve the high-end market, which has specific and often more strenuous requirements: Wine 3 (Table 1) explained: "We want to export premium products, not commodities and if people have got the money to buy premium products, they will take having environmental credentials as a pre-requisite not as an add-on."

The food miles debate and buy-local advertising put a cloud over New Zealand exports distant from their trade market. Many wineries realize that they ignore that debate at their peril: "We are 22,000 kilometres away from our biggest customers and I mean people say, Oh, food miles are a lot of rubbish, but you know it's not. It's a long way – that's simply all there is to it" (Table 1, Wine 3).

So what is the response? For Wine 1 (Table 1), carbon neutrality was "a means of negating those claims for food miles" by accounting for and offsetting all emissions as far as the destination port. But for non-exporters the push for action is not as strong. In the New Zealand market, the majority of customers' indifference is not providing enough incentive to change. For some the motivation for mitigation is primarily financial rather than purely environmental and thus the costs are currently seen to outweigh the current market value of becoming carbon neutral: "Customers don't rate carbon neutrality ahead of price or packaging or even high quality" (Table 1, Wine 2).

But for others, environmental certification is a vital part of their business strategy: "We need to have those certifications to offer our customers. We see it as a marketing imperative for a company with our ethos and our standing" (Table 1, Wine 1).

Marketing of organizational climate change actions vary from "just a footnote on the website" (Table 1, Wine 2) to labelling every bottle (Wine 1). Certifications charge a royalty to put their brand on the label and there is doubt regarding the value of such labelling because of widespread ignorance regarding the meaning of the various certifications among consumers. The perceived consumer ignorance regarding certification even leads to counter arguments: "We felt that we would be better investing the money in reducing emissions rather than paying it for an extra logo on our bottles" (Table 1, Wine 3).

The seeming consumer confusion and low logo recognition for carbon neutral certifications, even after several years in the marketplace, is not a promising sign for organizational uptake and propagation of these certifications. Capturing the consumer is essential. According to Wine 1(Table 1), transparency's a nice word but it's crucial for being able to tell that story to the consumer; the consumer struggles to grasp carbon neutrality as a term, so the easier you can make it the better."

Measure, Manage, Improve

Emissions measurement is considered the first step toward emissions reductions. This was confirmed in the interviews with all three interviewees mentioning the importance of measurement while describing their approach to emissions management.

Quantification must be an ongoing process in order to evaluate attempts to reduce emissions. Moreover, knowing where the largest sources of emissions are helps to determine and prioritize actions to be taken.

However, there is perceived limited control over emissions sources. This seeming inability to affect change is a barrier to organizational emissions reductions, as explained by Wine 1 (Table1): "We found that 80 percent of the footprint is actually outside of us. So it's going to be hard for us to achieve reductions because we consider ourselves so efficient."

In the wine industry, packaging and refrigeration were mentioned as major sources of emissions. Both of these sources are considered outside of the winery's control: packaging is obtained from an external supplier and loss of refrigerant gases is deemed unavoidable given the current technology available. However, there is potential to reduce emissions by influencing the supply chain; both Wine 1 (Table 1) and Wine 3 (Table 1) noted that they were able to achieve significant intensity reductions by pressuring their supplier to reduce glass bottle weights.

Although there are win-win benefits to reducing emissions (for example, reducing the amount of glass per bottle consequently reduces the cost of packaging), the required initial financial and/or personnel-based investments are seen as obstacles to climate change actions.

Certification and audit systems with specified goals of continual improvement add accountability and provide motivation by enforcing a certain level of action. Wine 3 (Table 1) described how their previous experience with both effective and ineffective audit systems affected their climate change strategy and reinforced their decision to adopt certification and continual emission audits:

“Having a one off energy audit didn’t work because there was no follow-up; you ended up with the report and there was no motivation to continually improve. We already knew from other audit systems we have in place based on continual improvement that once you have a certification and you have an independent audit you actually have people that are motivated to do something about it and that becomes part of the organization.”

Actions are enforced all the way down the chain of command.

Offsets

Given the controversy surrounding offsets, transparency and legitimacy are key to organizational emissions offsetting practices. Reforestation offsets are considered the most credible and easiest for the end consumer to understand, as Wine 1 (Table 1) explained: “People know that forestry sequesters CO_2 and it’s a nice easy story to tell. It’s a bit harder to tell people that our land fill in Nelson is capturing methane.”

Co-benefits to the general ecosystem also make reforestation offsets attractive. New Zealand based credits are generally preferred as they are seen to benefit the local community and are often perceived as more legitimate. Sourcing credits locally can also be mutually beneficial for the buyer and the seller: “We knew the farmer from The Sounds that was selling these credits, so it was that relationship; he’d tell our story - we’d tell his story” (Table 1, Wine 1). However, other considerations such as price and availability also factor into the equation.

The three wineries examined had very different relationships with offsetting: Wine 1 has purchased offsets for several years and plans to continue along this route, Wine 2 is currently looking into purchasing offsets, and Wine 3 decided against it.

The perceived variance in legitimacy of the approaches affected their choice of actions. Financial considerations as well as market volatility, and consequently long-term legitimacy concerns were also taken into account.

Wine 2 (Table 1) viewed offsetting as “probably a useful alternative to nothing”, that is to doing nothing. They were deciding between going with an established program and doing it themselves. Balancing financial versus legitimacy considerations was central in their decision making process.

Offsetting, the VCM, and organizational carbon neutrality were all seen as interrelated. As stated by Wine 1 (Table 1), “if there’s no one trying to achieve carbon neutrality – well, you don’t have a market.” The question remains whether organizations will voluntarily choose to become carbon neutral. For Wine 1, they “still see a business case for going down that route” (Table 1, Wine 1).

The Taxi Industry

Taxi companies are among business organizations most linked to urban pollution, greenhouse-gas emissions, and fossil-fuel usage. Is this an inevitable characteristic of the nature of the industry? Can a brown industry become greener (if not green), and can this be done as a side effect of the pursuit of economic advantage? What role does market entrepreneurship from within the industry play in making these improvements? The recent industry shake-up with the hybrid vehicle movement provides an interesting case study to examine these issues. Taxis are now among companies most associated with carbon neutrality in New Zealand due to their highly visible street presence and advertising. Three New Zealand taxi companies were investigated. All three advertise themselves as carbon neutral; one is self-proclaimed carbon neutral while the other two are CarboNZero certified.

Conformity and Radical Differentiation

The taxi industry in New Zealand is a mature industry which had, until 20 years ago, been highly regulated by the Government, leaving a legacy of prescribed actions. There was no need to make an effort to attract customers: "when you're in a regulated industry, you don't need to have a customer focus, that disappears because you've got a captured market" (Table 1, Taxi 3, Y1, R1). The mature and settled nature of the industry resulted in conformity and uniformity.

The industry has a longstanding direct link to fossil fuel use and is considered inherently polluting. The combustion engine was the norm and so even when new technology became available there was hesitance to venture into unchartered territories. As Taxi 2 (Table 1) noted, "at the time, there was no real push for [changing to hybrid technology], so it kind of got pushed to the side." Taxi companies' unique organizational structure with drivers essentially operating their own business makes it particularly challenging to impose new measures.

The greatest barrier for established taxi companies to adopt climate change actions was "overcoming objections from people within the company itself" (Table 1, Taxi 2). Driver buy-in is essential. But, the polluting nature of the industry made it seem incompatible with environmental actions. Climate change actions and hybrid vehicles were initially seen as a fad and mocked. However, industry pressures would later provide a platform for a step change within the industry and pave the way for the hybrid movement.

Green Cabs was the first carbon neutral taxi company in New Zealand. An industry outsider, Green Cabs was a rarity in the stagnant taxi industry. Unconstrained by typical industry logics, the company sought radical differentiation rather than conformity. Not only did Green Cabs establish a hybrid-only fleet, the taxis were painted bright green. Some in the industry saw this as "gimmicky vehicles or whacky paint jobs" (Table 1, Taxi 3, Y2, R1), but this bold new marketing worked, as admitted by their chief competitor.

The company also benefited from good timing, launching in late 2007 when a lot of media attention was being paid to climate change and the New Zealand Government had implemented policies such as the Carbon Neutral Public Service to cut government departments GHG emissions.[6]

Using Green Cabs was an easy and visible way for organizations to show that they were doing something for the environment.

With that said, the taxi industry's tradition of conformity led to innovations being met with resistance. Competitors try to discredit novel actions: "It is a cut-throat industry and my competitors have been trying to do everything they can to shut us down – stop us growing whatever – stop customers using us." (Table 1, Taxi 1)

Although some taxi companies had already gradually and quietly started using hybrid technology, the sudden initial success of Green Cabs legitimized and sped-up the uptake of environmentally friendly actions.

Business Case for Environmental Action

The rise of Green Cabs forced other taxi companies to take notice. Mobilization was necessary to maintain a competitive edge in the changing marketplace. For Taxi 2 (Table 1), becoming carbon neutral certified was "marketing, a business concept" to counter the arrival of the new green company. The business case for moving beyond the comfort of conformity had been established, and whereas previously environmental actions had been mocked within the industry, they became legitimized and accepted as a means of competitive business practice.

[6] See Birchall et al (2013) and Birchall (2014a) for a discussion of the Carbon Neutral Public Service programme.

All three interviewees emphasized the importance of, as well as the struggle with, driver buy-in. Gradual voluntary uptake of the new technology was a way to cultivate allies and not appear too radical. The business case proved the best motivator for driver buy-in.

Investing in a hybrid vehicle was rationalized on an economic basis with the initial higher price more than offset by fuel savings. Taxi 1 (Table 1) explained to potential drivers who worried about affording the hybrid cars needed to join his company that “the petrol savings alone will pay for the vehicle over the life of the car.” This rationale is strengthened year on year as the price of the technology drops and the price of petrol increases.

Customers’ predominantly positive reaction to hybrids has softened the widely held notion that only larger vehicles work successfully as taxis. Attracting customers and gaining a marketing advantage further strengthened the business case.

Shifting perceptions as well as self-interested entrepreneurship provided a platform for the hybrid movement. Positive word-of-mouth from early adopters influenced other drivers to come on board. As hybrids gained more visibility in the industry, they became not just a viable option but a preferred one. Further, since companies already had vehicle replacement policies which specified that vehicles need to be replaced every 6 to 10 years, modification of this policy to restrict the types of new vehicles allowed in the fleet could force a shift away from the standard petrol cars and greatly reduce GHG emissions.

Increased driver buy-in facilitated the introduction of company-wide environmental measures. Nevertheless, the process was often infused with power struggles and tensions between drivers and corporate. For example, Taxi 3 recounted that initially they passed on carbon offsetting costs to drivers to provide a direct incentive to reduce emissions but this lead to negative feedback and resentment; they later softened their approach by indirectly absorbing the costs into general fees which was more readily accepted.

Adaption for survival is a powerful driver of organizational change. Oil prices and consumer choices forced companies to adapt and could in the future incentivize more innovations.

Offsets

Carbon neutrality and environmental claims involve deviating from accepted industry norms and thus are frequently subject to scepticism and scrutiny. All three interviewees mentioned either dealing directly with investigations by the Commerce Commission (Taxi 1 and Taxi 2) or concern about being subject to greenwash enquiries impacting their actions (Taxi 3). For Taxi 2 and Taxi 3, certification was seen as way to validate environmental actions.

The certification provides clear guidelines with prescribed actions and third party verification. The robustness of the process can alleviate credibility concerns.

Though the certification includes emissions’ measurement and reduction, most of the apprehensiveness arises from the emissions’ offsetting portion of carbon neutrality. A main concern is that offsetting is used as a façade to avoid taking personal responsibility.

Another concern is over the credibility of the offsets themselves. Are carbon credits actually benefiting the environment or simply a way to make money? As Taxi 1 (Table 1) noted, “a lot of people think carbon credits are just something which has been dreamed up so that you can have a carbon market and charge people.”

Taxi 2 and Taxi 3 relied on their certification programme to vet and provide assurance that their offsets were credible. They purchased registered third-party verified credits; they believed the rules and verification processes associated with these credits assures a level of quality. Taxi 1, on the other hand, believed that those processes were unnecessary, “an extra series of steps just so that you fit in”. Taxi 1 (Table 1) chose to forego certification and simply plant trees.

Taxi 2 and Taxi 3 indicated a preference for local credits (though cost and availability also factored into their decision), while Taxi 1 invested in projects in developing countries. Taxi 1 held that these projects would more cost effectively help the environment. All three companies supported their position and interests by trying to discredit the other side.

The Carbon Services Industry

The carbon services industry emerged in conjunction with the carbon market. This new industry rapidly evolved and expanded to fill any perceived needs associated with the market. Consultants, certifiers and auditors provide an infrastructure of skills for organizational climate change actions and emissions trading. In the voluntary market in particular, where rules are undefined, these actors occupy a critical position by advising their clients and thus influencing norms and practices. Two carbon neutral certifiers, two consultants, one auditor, and one offset registry were included in this study.

Emergence of a New Field

The creation of a carbon market commoditized environmental protection actions by attributing a tangible commercial value to GHG emissions. Institutional factors for the carbon services industry that developed to support the market result from a blending of existing logics put to a new problem: climate change. This is evidenced by how the service providers describe becoming involved in this nascent field. For example, Consultant 1 owned a wilderness park and had a longstanding interest in nature restoration. The carbon market opened up new financial avenues for reforestation and thus Consultant 1 (Table 1) became involved in providing reforestation offsets and related consulting services: “It was like a revelation that here - latent in the whole thing was a real dollar value…therefore the possibility of doing good works for the environment could actually become a commercial activity.”

Consultant 2 also aligned their environmental and forestry background to the problem of climate change, working as a project developer, educator, and policy specialist. Consultant 2 (Table 1) developed forest conservation projects in New Zealand and the Pacific Islands after finding a need and an opportunity to use the market as an incentivising tool: “I had to figure out how to engage with climate change as a professional. There was no incentive mechanism to reduce [the deforestation] rate at that stage, so I thought, wow, that’s my entry point.”

Likewise, Certifier 1 started from an environmental perspective and then turned it into a commercial opportunity. Initially, a research division was created to work with private landowners to trial a biodiversity project that would also produce carbon credits. In conjunction with offsets creation, a second division, Certifier 1, was launched to work with organizations to measure their carbon footprint and purchase the resulting carbon credits.

Due to customer demand, the measurement and purchase division evolved into a full certification programme. The process became more formalized and rigorous to ensure organizations could credibly market their climate change actions. In contrast, the founders of Registry 1 had no previous experience in the environmental industry or in markets, but they did have extensive business and executive experience. The registry was started for “purely business and commercial reasons” (Table 1, Registry 1). They endeavoured to fill a structural hole found in the emerging carbon market; infrastructure was needed to assure market integrity and give participants confidence in the marketplace.

Auditor 1 similarly assures the integrity of climate change actions and claims. As a major accounting firm, they provide professional services to businesses. The firm’s services evolved to support the changing needs of their clients, in this case creating a sustainability and climate change practice.

Certifier 2 came at climate change from a highly successful entrepreneurial background. Certifier 2 was drawn to start a business in carbon trading because environmental actions associated with the carbon market seemed to be the next high growth industry.

Business Opportunities

Business logics were a central pillar for organizations to enter the carbon services industry. The business case was discussed by interviewees not only in relation to their own activities, but also in relation to gaining buy-in from a spectrum of potential actors in field. Business logics were used to promote services to clients. Similar to the taxi industry where the business case rather than the fear of climate change was presented to gain driver buy-in, carbon service providers focused on the opportunities and liabilities associated with carbon to gain clients.

Changing behaviour is largely dependent on the associated financial implications. Pricing carbon or energy savings into investment decisions (for example whether or not to adopt clean technology) can drive change by altering the dynamics of marginal cost curves. However, policy changes and the resulting uncertainty in the market complicate these decisions. The volatility of the market and subsequent crash of the carbon price had the opposite of the desired market effect: actions were disincentivised, as Auditor 1 (Table 1) noted: “It was quite frustrating at times, you might be working with a client doing something and then it was just like, well, actually I’m just going to wait.”

The business case for taking climate change actions goes beyond strictly immediate financial implications. There is also a belief that organizations demonstrating environmental responsibility have been shown to be more successful than their competitors.

The business case was also made to engage potential offset sellers. Consultant 1 viewed the carbon market as a way for willing landowners or farmers to change their method of earning money: “They would become paid caretakers of the environmental needs of the population.” (Table 1, Consultant 1)

Setting the Rules, Assuring Market Integrity

Ensuring and assuring integrity of the market was mentioned by interviewees as a way to limit liabilities and mitigate risks. As Auditor 1 noted, regulatory markets such as the New Zealand ETS have clear rules that participants must follow; the challenge with voluntary markets is that “the road map isn’t as prescriptive” (Auditor 1). Many of the interviewees talked about ‘carbon cowboys’ or ‘sharks’ taking advantage of the system. The lack of defined rules opens the voluntary market to abuse. Establishing rules helps to give confidence in the market.

However, what constitutes quality and what rules are needed to ensure integrity of the carbon market is hotly debated. Many of the carbon services interviewees were deeply involved in these debates. As Consultant 2 (Table 1) put it, “there is a network of people who are debating these issues sort of like the carbon market mafia.” Networking and participating in working groups and discussions were recurring themes.

The interviewees highlighted a number of critical concepts (e.g. additionality; permanence; double counting of offsets; standards and rules) that were commonly debated. Many of the interviewees had strongly held, often opposing, views on these issues.

Additionality, for example, is widely accepted as a prerequisite for creating carbon credits and is included as a requirement in all major standards. All of the interviewees mentioned the concept and only one questioned its validity. Consultant 1 argued that it penalized people for their initiative; early movers should be able to get carbon finance to maintain their activities.

Two interviewees, Consultant 1 and Energy 1, were directly involved in creating and selling offsets. And although their projects passed additionality tests and their offsets were purchased by reputable organizations, both acknowledged that their activities likely would have occurred without financing from the carbon market. The forest regeneration project by Consultant 1 had slowly begun prior to carbon financing and likely would have continued, albeit at a slower pace. The wind farm projects by Energy 1 (Table 1) were self-admittedly “on the cusp” of the eligibility criteria to gain revenue from carbon credits; similar projects by the company have since gone ahead without that extra revenue stream. Thus, even if additionality is viewed as a requirement, the criteria may not be stringent enough to weed out projects that would have occurred anyway.

Permanence is another contentious issue, particularly in the forestry sector where there could be future logging or forest fires, for example.

Some projects have complex insurance strategies and buffers to manage these risks and assure integrity of the protected carbon stocks. Consultant 2 and Certifier 1 both described using buffer zones where sequestration activities are not sold as offsets but are used as insurance to cover liabilities in the event of damage to the offsets carbon stocks. Consultant 1 (Table 1), on the other hand, believed that despite the best of intentions, no long-term assurances could be made.

Auditor 1, Certifier 1, and Registry 1 expressed more confidence in offsets based on renewable energy projects than forestry projects due to the issues surrounding non-permanence risks. These three organizations are heavily involved in assuring the integrity of the market and have a direct stake in managing associated reputational risks. Auditor 1 (Table 1) noted that they wouldn't want to be "tainted" with bad offsets, while Registry 1 (Table 1) understood that to maintain integrity "you've got to be squeaky clean". These organizations are thus very cautious about what offsets they will accept.

As for the issue of double counting, can there even be a legitimate voluntary market in a country bound by Kyoto compliance? Or, are voluntary reductions already counted in the country's national inventory and thus any claims or credits in a voluntary market would amount to double counting? Interviewees had varied views on how this concern should be addressed. Current laws in New Zealand effectively block the creation of voluntary carbon credits after 2008 when Kyoto came into effect. However, Consultant 1 took the stand that the carbon rights on his property were his to do with as he pleased.

The Government ended up purchasing all Consultant 1's available carbon rights for the next 10 years, likely to avoid any potential double counting. The issue of double counting is not only a concern for offset sellers, but also for offset buyers and organizations making carbon neutral claims. Auditor 1 (Table 1) questioned the credibility of organizational offsetting within an expanding regulatory market.

Certifier 1 whose business is centred on a voluntary programme disagreed and reasoned that voluntary action, even if there is double counting, is better than no action.[7]

However, Certifier 1 did recognize that claiming carbon neutrality by purchasing offsets is contentious. As Registry 1 (Table 1) stated, "carbon neutrality is an overdriven word and it's a bit debatable in any instance. I don't know that there is such a thing as carbon neutral per se". Certifier 1 thus advises their clients to instead use their programme name and state that they are certified to the programme.

Standards and programmes have become the central pins defining the rules and norms in the VCM, and the carbon services industry has had an active role in shaping these standards and programmes. For example, Registry 1 (Table 1) indicated that they list credits for nine internationally-recognized voluntary standards and were actively involved in the development of the Voluntary Carbon Standard (VCS). The Greenhouse Gas Protocol and ISO 14064 for measuring and reporting emissions, and the Gold Standard and the VCS for creating offsets were the most commonly used standards mentioned by the interviewees. Although there is widespread use of standards, the interpretation of the rules can be inconsistent.

Therefore, standards are frequently used by service providers in combination with in-house guidelines. For example, Registry 1 (Table 1) overlays requirements from standards on top of their own general requirements to assure "the singularity and provenance of a credit."

[7] Certifier 1 (Table 1), however, noted that offsetting is only a small part of their programme: "the amount of offsetting that goes through our programme is in the order of 50,000 tonnes a year. So it's very small."

Programmes are often more prescriptive than standards. Service providers, such as certifiers, set rules that their clients must adhere to in a consistent way and remove any room for interpretation.

Over time, these rules have become stricter and more consistent. For example, although Certifier 1 has always required their clients to have an emissions reduction plan, they added rules in 2009 requiring achievement of reductions to stay in the programme. Their clients reacted positively to this change; “across the board, the clients said, unless you’ve got something like that [requiring reductions], you’re not credible” (Table 1, Certifier 1). However, they also cautioned about adding too many rules: “If you keep changing the rules and keep adding more and more and more, you’re not going to have anybody participating. You take the incentive away for behaviour change in the organization” (Table 1, Certifier 1).

There is a fine balance between stringency required to ensure integrity and practicality. Certifier 2 used the same standards as other certifiers but viewed their programme as an option that was “cheaper and less onerous to deal with, more commercially focused, rather than heavy handed” (Table 1, Certifier 2). Yet, Certifier 1, with a more complex bureaucratic process, holds the dominant position in the marketplace. Organizations seem to be responding to the legitimacy that Certifier 1 confers.

4. Conclusions

Overall, the carbon services industry, as well as the carbon market in general, has had its share of both successes and setbacks. The major setback can be summarized as a stagnation of the VCM: buyers and sellers drifting away from the market, as illustrated notably by Energy 1. Communication challenges, low certification recognition, risk of greenwash exposure, policy uncertainty, the global financial crisis, and general disenchantment with the carbon market were listed as some of the causes. But despite these setbacks there were successes, including endeavours which focused on promoting market integrity through infrastructure (e.g. a registry, certification programmes), as exemplified by Registry 1 and Certifier 1. Networking, knowledge sharing, and influencing others to shift behaviour were also identified as successes: “Has the voluntary market driven change? Absolutely – yeah without a doubt, but it’s small and too small still.” (Table 1, Registry 1)

Through critical investigation at the organisational and field levels, this empirical research explores the cognitions, commitments, actions and accountabilities involved in New Zealand’s emerging VCM. Exploration of these institutions provides insight into how and by whom they are being shaped, and what effect they have on participants. Moreover, this research sheds light on the market’s ability to facilitate a low-carbon economy.

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Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of University’s Human Ethics Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Age, ageing and sustainable work: where thus the buck stops?

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Abstract

Ageing is a global trend and one of the greater challenges of the current societies, with strong consequences on general population and particularly on workforce composition. In fact, ageing issues were been stressed on the agenda of European policies over the last years, with the establishment of goals intended to increase the employment rate of 55-64 workers and also increase of the retirement age. Demographic changes have a great impact on the composition of workforce. According to the 5th European Working Conditions Survey workers aged 50 and over represent 25% of employees in EU, which places a new challenge for corporate social responsibility. The most common answer for ageing at work has been the encouragement of ageing workers to remain active and at the same time convince companies to retain these older workers. But this aim cannot be achieved without an adaptive change of working conditions, considering the health and needs of older workers, providing the access to lifelong learning and rethinking benefits, rewards, participation, recognition and careers. Are companies aware of demographic trends and their impacts? Do the companies perceive ageing as a “social concern” or a “management issue”? Are they prepared to face this challenge inside them? In this sense, the purpose of our studies, conducted in Portugal, is to provide a comprehensive approach on age management topic, based on literature review but also on empirical work developed with Human Resources managers, trying to understand how companies evaluate and manage ageing, in the context of corporate social responsibility. Our findings suggest that Human Resources managers are generally concerned with age but they usually see this as an external problem, being mainly a society issue. Age is not being taken as a real challenge for companies while economic recession and youth unemployment are shaping the labor market. While economic recession is transitory, ageing is a structural trend and cannot be answered without a long-term approach based on public policies gathered with management practices. The managers’ short-term vision is a barrier to a strategic development and undermines the sustainability of organizations.

Keywords: Demographic changes, age management, sustainable work, corporate social responsibility

Causal chain concept for sustainability risk controlling in urban water systems

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Abstract

The urban water sector is facing increasing pressures associated with climate change, shifting social and economic patterns and regulatory circumstances. The collaborative project NaCoSi ("Sustainability Controlling for Urban Water Systems – Risk Profiles and Control Instruments") developed a risk management instrument that focuses on a sustainable development of urban water service providers. It helps urban water service providers and decision-makers to improve their sustainable performance by managing short and long-term risks. In order to understand and encounter complex and dynamic risk causes in urban water systems, cause-based risks were identified and systemized using the causal chain concept. In urban water systems, a single hazardous cause can have various effects and simultaneously can affect various sustainability objectives. On the other side, a single sustainability objective can be affected by several hazardous events, which are described by indicator-based thresholds. The aim was to make the complexity of multidimensional, interrelated sustainability risks manageable in order to create a consistent database. For this purpose, a systemized risk database was created with the help of literature and expert knowledge. The complex networks of cause-effect relationships were decomposed into unbranched linear exposure pathways, which are managed as records in the risk database. Based on this database, different instruments for risk assessment, monitoring and trend analysis were developed. The developed instruments are based on the causal chain concept and were tested by 12 practice partners as well as reviewed and adapted by the projects research partners. The causal chain concept for sustainability risk systematization in urban water systems is an ideal approach to reduce complexity and to create a database for the development of instruments, like risk assessment for different purposes and monitoring or trend analysis. Indicator-based thresholds as a central element of the developed instruments were used to make sustainability comprehensible and measureable.

Keywords: causal chain concept, risk management, cause effect relationships, sustainability controlling, urban water management

1. Introduction

The United Nations General Assembly recognised the access to water and sanitation as a human right (UN Resolution 64/292, 2010). At the same time, the disposability of water, which can be sustainably used, is decreasing in many regions of the world. Therefore, a sustainable handling with fresh water and waste water is more relevant than ever. To ensure access to water and sanitation for all is part of the 2030 Agenda for Sustainable Development with the sustainable development goal 6 (SDG 6) (UN Resolution 70/1, 2015). Urban water systems are heavily depending on a strategic orientation towards sustainability, as they not only effect society and ecosystems similarly, but also consist of large and long lasting sociotechnical systems with a high degree of path dependency. However, these strategic targets must be repeatedly aligned to challenging framing conditions, because urban water systems are facing increasing risks, resulting for example from climate change, institutional change and shifting demographic and economic patterns (UNEP, 2012). Failure of climate change mitigation and water crises are globally ranked as the most significant long-term risks (WEF, 2016). The complexity and dynamics of the different changes threaten the economic, ecological and social performance of urban water systems in the short and even more in the long-term. As changes and measures are often slow processes, which need long-time periods, the adaptation of infrastructure systems towards changing framing condition has to be initiated as early as possible.

In order to meet the challenges of urban water service provisions, several management instruments are already available. Designed as specified management instruments, they cope with their field of application, but do not focus on threats regarding companies' sustainability objectives. At the moment neither quality management, environmental management, technical security management, benchmarking nor risk management is capable of systematically identifying and assessing cross-sectional short and long-term risks (Beck et al., 2015). In addition, for urban water systems no methodological frameworks exist for multidimensional risk evaluation.

The aim of the collaborative project "Sustainability Controlling for Urban Water Systems" (NaCoSi), which is funded by the German Federal Ministry of Research and Education, was to develop and test a risk based sustainability controlling. This management approach allows water service providers and decision-makers to identify and evaluate sustainability risks.

This paper introduces the approach of the NaCoSi controlling. It includes the definition of sustainability objectives and presents the risk analysis, the indicator based monitoring, trend analysis as well as scenario based simulation games. The paper focuses on a causal chain concept for sustainability risk systematization and discusses the methodology of making sustainability comprehensible and measureable with the help of indicator-based thresholds.

2. Approach of sustainability controlling

Overview

As Lundie and Ashbolt state, "sustainability is not a state to be arrived at but a broad evaluative framework for understanding and justifying social practice" (Lundie, et al., 2008). Sustainable water management is therefore not about achieving a certain state but rather the process of influencing the behaviour of decision-makers and stakeholders (Pearson et al., 2009). There are several approaches for sustainable urban water management, which intend to reach sustainable conditions by fulfilling sustainability criteria (Foxon et al., 2002) or measure achievements by indicators and thresholds (Bossel, 1999; Rahdari and Anvary Rostamy, 2015; Marques et al., 2015). The NaCoSi sustainability controlling adopts a differently oriented approach: Risks that endanger sustainability objectives –sustainability risks– should be managed and minimized in the course of risk management (Benz, 2014) thus allowing a proactively response to changing conditions. By continuous application of this approach a long-term transformation towards sustainable urban water management can be promoted. The NaCoSi sustainability controlling approach is based on a standard risk management system (ISO 31000:2009) and consists of different interacting steps, which in turn include several methods, **Figure 1**.

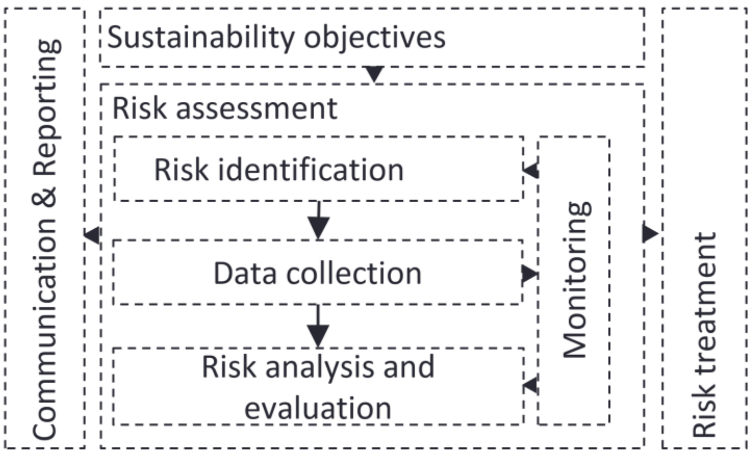

Figure 1: NaCoSi sustainability controlling approach (Eller et al., in press)

Sustainability objectives

The starting point is a system of sustainability objectives adjusted to water service providers (**Figure 2**). These were developed in cooperation with partners from technical, economic and socio-ecological research facilities and practice partners from the German water sector, e.g. water service providers. The objectives serve for the operationalization of sustainability in the water sector and ensure a general understanding of all features concerning sustainability (Eller et al, 2014). The systematization of the sustainability objectives was orientated towards the five-pillar model of the DVGW (German Technical and Scientific Association for Gas and Water) and the DWA (German Association for Water, Wastewater and Waste) (DVGW W 1100, 2008). In addition, the long-term perspective together with targets regarding intergenerational justice, were emphasized for the understanding of sustainability in water management. The developed sustainability objectives have an open and adaptable structure and it is easy to add or to change different goals respectively, in order to adjust them to other requirements of different stakeholders, like water authorities.

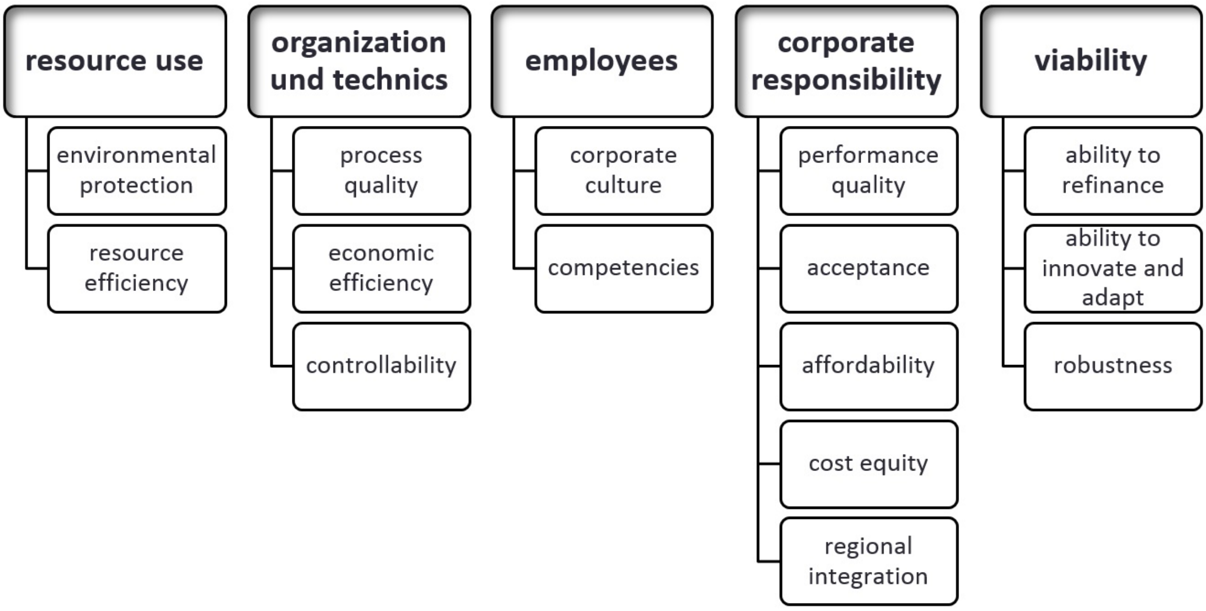

Figure 2: Sustainability objectives (Eller et al., 2014)

The objective category –resource use– deals with the responsibility towards the environment. This includes firstly the mandatory tasks of urban water management to protect the environment and secondly, more far-reaching aims at efficient resource utilization. –Organisation and technics– includes sustainability objectives of the company's internal organisational structures as well as cost efficiency and technical implementation of the task fulfilment. The objective category –employees– is concerned with the corporate culture and the competencies of the employees. Urban water systems are part of public services. Therefore companies bear responsibilities for providing adequate and affordable services towards citizens and promote social and economic developments in the region. The corresponding objectives are subsumed under the objective category –corporate responsibility–. –Viability– summarizes sustainability objectives, which emphasize the long-term perspective. The cost recovery in the long-term and the ability to adapt to predictable changes or unforeseen developments are part of this objective category (Eller et al., 2014).

Risk identification

A specific method for risk identification was developed, which allows the diverse risk causes and risk consequences to be systematically captured in order to make them accessible for a subsequent risk analysis. Therefore, it is possible to initially regard single, isolated risks and afterwards to picture and analyse complex risk networks (Geyler et al., 2015). Instead of trying to capture complex networks on the whole, unbranched, linear causal chains are collected, which can be managed as records in a risk database. A straight-line modular system is applied to model relationships between risk causes and respective affected sustainability objectives. Thus, each causal chain describes an isolated sustainability risk and consists of determined consecutive elements. In **Figure 3** the systematization is shown. The –risk source– triggers the cause of a sustainability risk and thus is causally prior to the risk's –cause–. It provides additional information about the origin and character of the risk and thereby helps to specify the –cause category–. As a cause may be gradually traced back infinitely, the cause of a sustainability risk is defined as the last event of a sequence of causal events that directly draws an impact on the water system. The –consequence–, which is defined as an observable effect of a related cause, is associated to a certain –system–, –subsystem– and –process– in the water system. The –sustainability hazard– specifies why and how exactly the corresponding sustainability objective is affected. It is characterized by an –indicator–, which has a yellow and red threshold. The –yellow threshold– describes a noticeable indicator value, while the –red threshold– describes a critical state. The indicators make the sustainability hazard measureable and serve for a risk assessment. As the last element of each causal chain, the affected –sustainability objective–, as described above, is addressed. Finally, the endangered –objective category– is assigned. This systematization of the causal chain concept enables to identify vulnerable processes, major risk sources and endangered objectives. The causal chains are managed in a risk database, which is open-ended and can be expanded with future risks.

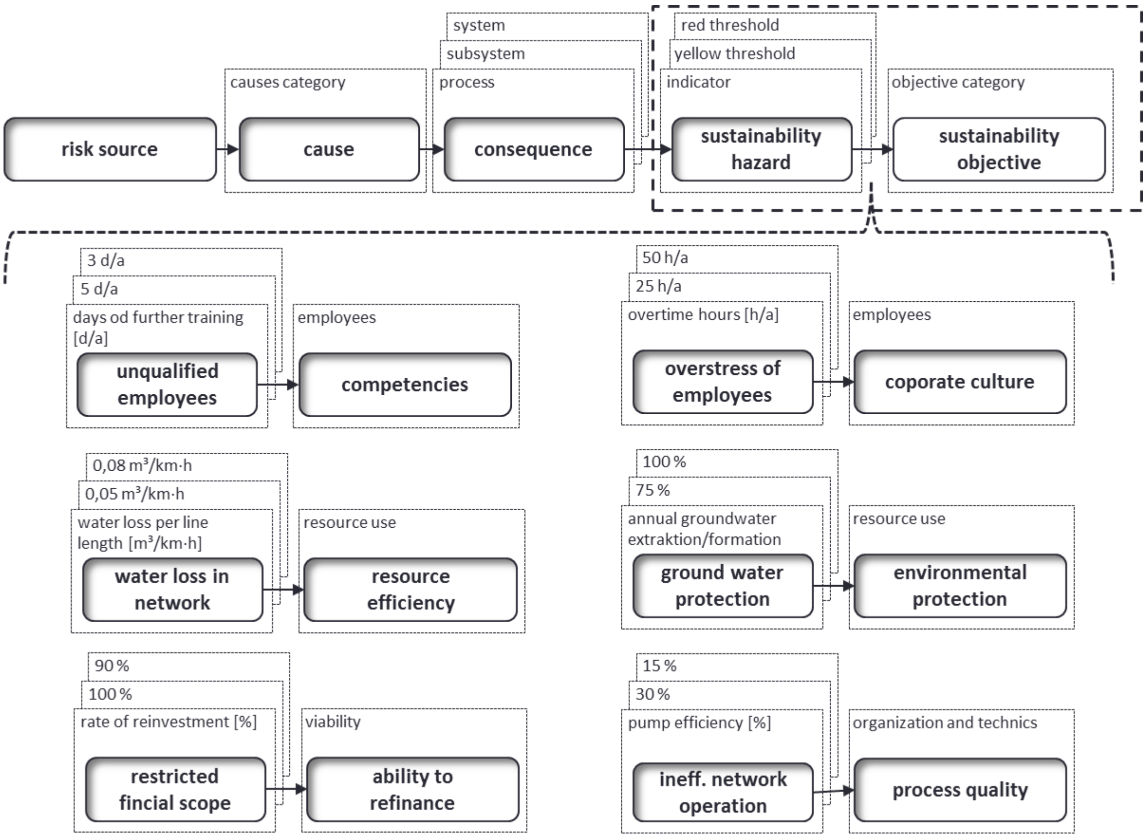

Figure 3: Causal chain concept with examples for indicators, sustainability hazards and objectives

More precisely, the indicators and thresholds describe the endangerment of sustainability through objective deviation. To make the holistic and long-term nature of sustainability comprehensible and measureable, newly designed indicators besides from the already existing were developed and applied. The challenge of finding suitable indicators to describe sustainability hazards is one of the main assignments to be solved. Therefore, a precise and clear-cut definition of sustainability objectives for the application group was needed. With an allocation of consequences to defined sustainability objectives, different sustainability hazards were derived. Different examples for sustainability hazards, which can be measured through their indicators and thresholds, are shown in **Figure 3**, together with their affected sustainability objectives.

Risk analysis and evaluation

Within the –data collection– (**Figure 1**), user specific data are recorded with the help of a questionnaire. Every single causal chain describes a potential risk, which is characterized by the extent of loss and the probability of occurrence. These are conditional probabilities an depend on the selected period, the specific cause and the level of the threshold. With the help of this information, a detailed questionnaire regarding indicators, the extent of loss and the probability of occurrence for every causal chain was derived. The systematization of the causal chains enables users to filter the database for certain processes or subjects and to keep the effort for the data collection as low as possible.

In –the risk analysis and evaluation– (**Figure 1**), the identified risks are visually ranked by risk profiles, which depict the risk situation at a glance as the risks are summarized for each sustainability category and plotted as radar charts. Risk matrices, which are widely used as a risk screening tool, give detailed information about the extent of loss and the possibility of occurrence for every single risk (ISO 30010:2009). Thresholds are aligned to indicators (monitoring) and with the help of indicator time series, a trend analysis is conducted. The results from both instruments were used to examine consistency in order to validate the risk level of every causal chain and to subsequently evaluate them. The results of the risk assessment are summarized in sustainability reports, as successful risk assessment is dependent on effective communication and consultation with stakeholders (**Figure 1**, communication and reporting). Based on these reports, future worst case scenarios are developed. Workshops regarding different risk scenarios are organized. In these workshops simulation games with different stakeholder characters are conducted and simulated by the participants. As a result of these workshops, strategies are developed to avoid or exit the different future worst case scenarios. As an important outcome of the workshops a catalogue of measures for short and long term risks was developed (risk treatment).

3. Results of testing the approach with practice partners

The developed approach for sustainability controlling was tested by twelve practice partners within two successive test runs. In the first run, the basic method was tested, such as the approach to measure sustainability hazards through indicator-based thresholds. Furthermore the completeness of the database and the way of data collection regarding causal chains was tested. After the first test run, the interface between data collection, processing and analysis was harmonized. The data collection was divided into a basic and a company specific part to reduce the effort for the participating companies. Within the second test run, the optimized approach was retested and validated.

In response to the data provided, the participating partners received company specific sustainability reports summarising their major risks, their most threatened sustainability objectives and the respective vulnerable processes. Based on the sustainability reports, workshops were organised to reflect the results and to perform scenario based simulation games, in order to derive a catalogue of measures. At the same time, group discussions with practice partners helped to understand the various influences of framing conditions on the exceedance of thresholds.

The test runs and the workshops confirm the operability of the sustainability controlling. The causal chain concept and the developed thresholds were accepted as being fruitful to make sustainability risks easily comprehensible and measureable. At the same time, crucial aspects of the concept were revealed. The causal chain database must cover the risky developments exhaustively. The standards to quantify risks and the thresholds should be broadly applicable and especially thresholds that define critical deviations from sustainability objectives must be effective and accepted. As setting thresholds adequately is very important, the following section will compare different sources from which they can be derived.

4. Discussion – ways of deriving thresholds

In this section, the relevance and challenge of setting thresholds for risk systematization and valuation is discussed. Further, different reference sources for deriving thresholds are compared.

Defining thresholds (see **Figure 3** for some examples) that display critical deviations from sustainability objectives, is a crucial part of sustainability controlling, as it is an important input for risk analysis and monitoring. Risk analysis combines the probability of a threshold to be exceeded in a certain period in the future with the damage that is caused when a certain sustainability objective is not pursued by a company. The monitoring instrument produces trend analysis with the help of indicator time series.

Both instruments apply thresholds for estimating the probability of failing a company's sustainability objective. Setting thresholds too low (too close to the sustainability objectives) will lead to an overestimation of the probability of occurrence. Setting them too high (too far from sustainability objectives) will reduce the estimated probability of occurrence, implying a sustainable development even if this is not the case. There are more consequences, when setting the thresholds incorrectly. As the outcomes of the sustainability risk assessment will be communicated either within the company, between the company and municipal stakeholders or between companies, thresholds create an anchor point for communication. Setting an adequate anchor point leads to the right starting point for communicating and discussing sustainability risks.

Finally, risk analysis comprises not only the probability of occurrence of exceeding the thresholds, but also the damage done to the company when thresholds are surpassed and sustainability objectives are failed. Hence, damage estimation will depend on thresholds as well. Thresholds, set too low, will imply lower damages and the error of misjudging a threshold regarding risk estimation is counterbalanced. (A threshold, set too low, will lead to an overestimation of the occurrence probability and similarly to an underestimation of the damage done to the company). Although the counterbalance effect seems to reduce the problems of misjudging thresholds somehow, a perfect counterbalance seems to be incidental and cannot be taken for granted.

For the derivation of thresholds, four main sources can be differentiated. First, for broadly known and already existing indicators the prioritized sources to find suitable thresholds are regulations, technical instructions and guidelines. Second, benchmarking results of the water sector can be exploited. Third, experts can be asked to provide thresholds. Finally, the companies can set the thresholds themselves. However, all sources have their advantages and disadvantages. The scope of exploiting regulations and guidelines for deriving threshold is limited to those objectives that are related to environmental or health aspects. In Germany, there are further technical guidelines indicating the state of technology. They can be used to describe process quality. However, technical guidelines can be outdated or unrealistic and are not necessarily an applicable source for thresholds.

Benchmarking results can be used to derive thresholds by comparing the performance of participating companies. The advantage is that thresholds are linked to real performance figures and support cross-sectoral communication regarding sustainability. However, framing conditions of companies can be extremely heterogenic, calling for individualized thresholds. Thus it is difficult to find the right peer group for deriving thresholds, the more so as the peer group may change regarding different sustainability objectives. Benchmarking results may be further biased when governance failures hamper sustainable development of the whole sector. Due to discussions regarding the governance of German water sector (Gawel and Betdke, 2015), the bias of the respective performance figures of the German water sector cannot be excluded unerringly.

Using expert knowledge may be useful to overcome some of the problems mentioned above or may be used to fill gaps in empirical information. However, there is always the risk of misjudgment of experts. Finally, companies can set thresholds by themselves. This allows the adoption of thresholds to individual framing conditions. However, an incentive remains for choosing thresholds strategically, as companies can exaggerate or hide their sustainability risks this way.

For the results that are presented in this paper, thresholds have been derived by using these sources. When testing the tool with the practice partners, the thresholds were set using guidelines/regulations, benchmarking results and expert knowledge. After producing preliminary risk results, these results together with the thresholds applied were discussed with the practice partners. Then, specific framing conditions can be acknowledged for exceeding certain thresholds.

5. Conclusions

The NaCoSi sustainability controlling offers a risk based approach towards the urban water sector, by which short and long-term risks or cross-sectional risks can not only be included into strategic management decision, but also can be used for communication with customers, citizens and stakeholders. A risk assessment approach was developed, which allows risk identification, data collection, risk analysis and evaluation as well as monitoring of those risks.

The instruments are based on a data base, which comprises potential risks. In order to do so, a causal chain concept was developed. It links possible causes with consequences, which are systemized by processes and endanger sustainability objectives. Applying the database to a specific company with the help of risk analysis and evaluation, the company can spot the main risks and the threatened sustainability objectives as well as the main causes and the vulnerable processes.

To operationalize this concept, changes in system elements, processes and deviations from sustainability objectives must be described by indicators. Furthermore, indicator-based thresholds regarding critical deviations from objectives must be derived. The exceedance of these indicator-based thresholds, which signal companies when they leave a sustainable orientation, is the reason for the development of risk measures, which are supposed to reduce the probability of occurrence for exceeding thresholds and the simultaneously the damage to a company.

Thus, setting thresholds adequately is one of the most crucial steps of the sustainability controlling. As it has been shown, no single source exists that can be instantly and reliably exploited to generate thresholds. Neither can thresholds be set by a company alone, nor can thresholds be drawn from one external source alone, such as regulations, benchmarking or from experts. Experience from testing the NaCoSi sustainability approach has shown that companies ask for predefined thresholds to get external inputs on the one hand. On the other hand, companies question thresholds in order to adopt them to a specific framing condition.

A first set of thresholds has been developed by research and practice partners. However, this is just the starting point for future research endeavors. As sustainability controlling is a communication approach between companies, customers, citizens and stakeholders. The process of improving thresholds will additionally foster communication regarding sustainability risks even further.

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The role of sustainability and frugal innovation in BOP ecosystems

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Abstract

There is a growing interest in the Bottom of the Pyramid (BOP) markets as new options for frugal innovations. Frugal innovation is widely discussed, but can be seen as an inclusive and flexible approach that reduces costs and complexity within the production processes by maximizing value. The approach is often related to minimize financial and natural resources at the same time. BOP markets can not only be developed by multinationals but also by alternative business models involving entrepreneurs and local companies in the value creation process, e.g. as service providers, suppliers or owners. BOP 2.0 focus on co-creating value rather than selling to the poor. Therefore, it is a crucial concept for facing the roles of entrepreneurs, networks, business models and sustainability in frugal innovation in developing countries. Moreover, they can revitalize innovation in industrialized countries as well since frugal innovation involves new technologies or new business models. Introducing new ideas successfully to the market as innovations and new technologies entrepreneurs play a pivotal role as they create value by generating new businesses and social activities. The diffusion of new ideas and technologies are complex. The emergence of innovation are challenging and often interwoven processes as there are several technologies, actors and political conditions given and involved. This goes in line with the current understanding of innovation ecosystems as a meshwork of interrelated institutions and organizations including actors from the whole value chain, thus, production as well as use sides, by concentrating on value creation through innovation. As the relations between frugal innovation, the roles of corporations, networks, business models and sustainability is mainly unexplored in literature, this study focuses on the research questions: How do different types of corporations or networks, business models and sustainability relate with each other in the context of frugal innovation? What is their impact on the BOP markets? Using a multiple case study design, from June 2014 until October 2015 a total of 59 frugal products and services were investigated concerning their business model, corporate embedment, and sustainability orientation as well as BOP ecosystems' characteristics. The sample of 59 cases analyzing frugal innovations, products and services was based on an exploratory multiple case study design. In order to analyze the cases different classifications were used. SPSS was used for assessing the inter-observer consistency and inter rater reliability. Cronbach's alpha was used for sustainability whereas the sustainability archetypes were measured by Cohen's kappa. Finding relations between the respective classifications contingency analysis was applied. Findings show that entrepreneurs and local companies offering frugal product and services manage to combine the business model elements in an insightful manner and create economic, social and environmental value. Furthermore, we found that market entry and sustainability strategies are different for entrepreneurs, NGOs and multinationals. However, all play equally a role in developing sustainable BOP markets. According to our analysis there are basic difference concerning the revenue models.

Increasing competitiveness in global markets: the mediating role of eco-innovation

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Abstract

Climate change urges major changes in companies' operations, and affects consumers' lifestyles, motivating both companies and consumers to work and live in a more sustainable manner and to promote products and services that are more environmentally friendly than the existing alternatives. Eco-innovations (i.e., products, production processes and organizational changes that throughout their lifecycle result in a more efficient use of resources, reduction of pollution, and are generally less environmentally harmful than the existing alternatives) are thus an answer to salient environmental issues. The main aim of our study is to explore the mediating effect of eco-innovation on the relationship between internationalization and firm performance. The effect of internationalization on firm performance has been extensively studied. In this paper, we posit that the direct effect of internationalization on firm performance is further mediated, causally, by the level of eco-innovation implementation. More and more companies enter foreign markets in search of opportunities and increased competitiveness. They internationalize either to ensure the company's survival (selling outside the domestic market, because the domestic market is limited and thus the products or services have shorter lifecycles), or to accelerate their growth. At the same time, companies try to pursue sustainability, by adoption or development of eco-innovations. Reasons why companies decide to embrace sustainability and invest in eco-innovation are many, and may stem from the desire to build or improve their reputation, to gain cost savings, to respond to market demand, to effectively fight fierce competition, to do things right or simply to comply with regulatory requirements. Eco-innovations by definition combine environmental and economic dimensions. From an economic point of view, they lead to economic growth and represent a source of competitive advantage (they represent a strategy how to cope with competition and gain competitive advantage over their competitors). From the environmental point of view, eco-innovations result in decreased adverse effects on the environment. Therefore, eco-innovations result in a win-win situation, where both company and environment benefit. As aforementioned, we are interested in whether eco-innovation mediates the relationship between internationalization and firm performance, and thus results in better firm performance. In order to explore these relationships, we develop a conceptual model. The proposed model is empirically tested on a sample of 151 Slovenian internationalized companies, employing structural equation modeling. Results indicate that adoption of eco-innovation mediates the relationship between internationalization and firm performance. Internationalization exerts a positive and significant direct effect on firm performance, and the relationship gets stronger when we add eco-innovation as a mediator. Therefore, the results of this study offer strong evidence of complementary mediation of the relationship between internationalization and firm performance, by the mediator variable eco-innovation. Eco-innovation adoption significantly contributes to better/improved firm performance, and therefore, enhances and strengthens the effect of internationalization on firm performance. To practitioner, our findings emphasize the role of eco-innovation, and speak to whether or not eco-innovations should be adopted and integrated in companies in order to improve firm performance.

Keywords: eco-innovation, sustainability, firm performance, internationalization

Is sustainability a competitive advantage for small businesses? An empirical analysis of the possible mediators in social-financial performance relationship

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Abstract

The contribution of a single firm to the overall sustainability context is largely dependent on its perceptions about the advantages related to its sustainability strategies and consequent Corporate Social Responsibility (CSR) practices. The relationship between CSR and firm performance has been debated since the Seventies (Bragdon and Marlin, 1972; Moskowitz, 1972). In the next decades some relevant reviews were made to sum up the different findings of these studies: Margolis and Walsh (2001), and Orlitzky et al. (2003) used respectively "vote-counting" and meta-analysis techniques, while more recent reviews used methodologies dedicated to consider not only the sign of the relationship, but also a weighted significance in terms of sample size (Lu et al. 2014). Major limitations of previous studies were related to the large use of ready-made ratings like KLD that includes only large US companies in the analysis; some also argue that the different empirical findings which leaves the Corporate Social Performance (CSP)-Corporate Financial Performance (CFP) relationship undefined are also biased by the lack of adequate investigations on the real path of influence; this means that possible mediator or moderator factors have not been fully investigated yet (Cantele et al. 2015). Our research is aimed at defining a model of CSP-CFP relationship in which CSR practices are supposed to impact on financial performance via some strategic drivers or antecedents of firm success, such as reputation, customer satisfaction, organisational commitment and competitive advantage. The model measures the sustainability practices of SMEs and shows their impacts on different areas of firm performance; it includes the social dimension of sustainability (relationships with human resources, supplier, customers and community), the environmental dimension (management of environmental impacts), and the economic dimension by considering the financial performance and its antecedents. The analysis is based on the results of a survey on the perceived benefits of CSR among Italian manufacturing SMEs; we collected 348 complete questionnaires and run a Structural Equation Modelling (SEM) in which we included four constructs dedicated to CSR, defined after a review of CSR scales used in similar research (Agan et al. 2013; Bagur-Femenias et al. 2013; Gadenne et al. 2009; Lindgreen 2009; Perrini et al. 2007), a construct dedicated to perceived financial performance (Hamman, 2009; Saeidi et al. 2015) and constructs measuring the possible mediators in the CSP-CFP relationship: corporate reputation (Fombrun and Shanley, 1990; Schwaiger, 2004), customer satisfaction (Galbreath and Shum, 2012), organisational commitment (Jaworski and Kohli, 1993; Maignan and Ferrell, 1999; 2001) and competitive advantage (Chang, 2011; Chen et al., 2006). All items in these constructs used a 5-point Likert scale (from 0: "strongly disagree" to 5: "strongly agree"). The Cronbach's alpha value for all constructs exceeds 0.80, indicating acceptable reliability (Hair et al., 2006). The results demonstrate that the data are unidimensional. The study also tested the influence of four classical control variables: industrial sector, respondent's organizational role, firm size (employees), and firm size (revenues). None of these factors proved significant. The study used IBM AMOS for the validation and reliability of the model. As Barret (2007) and Markus (2012) suggest, a sample size above 200 cases is a minimum goal for SEM analysis. Therefore, the sample (348 valid questionnaires) in this study is acceptable. The results are the following: Chi-square/df = 1.752, ρ = 0.000, RMSA = 0.056, P-Close = 0.03, CFI = 0.956, TLI = 0.911, and NFI = 0.942. These results indicate an adequate model fit. The study used the Sobel test (Hair et al., 2006) to analyse the multiple mediation models, by using bootstrapping (5000 times) to test the indirect and total effect of the independent variables. The remaining effect (or direct effect) emerges by subtracting the indirect effect from the total effect. Starting from

this model, it was possible to find that CSR positively impact on corporate reputation, customer satisfaction and organisational commitment, which, in turn, positively impact on competitive advantage (total mediation effect); competitive advantage was also found to positively contribute to financial performance; so differently from previous research (Saeidi et al., 2015) we found that competitive advantage is a second-stage mediator of the relationship between reputation, customer satisfaction, organisational commitment and financial performance. The contribution of our study also lies in having tested the CSP-CFP relationship in an under-explored context, that of manufacturing SMEs in a European country (Italy). Further research could deepen this findings by investigating other samples of SMEs in different industries, or by better considering the role of time in the relationship, but also the bi-directional influence which encompassed when financial performance is the antecedent of sustainability/CSR practices.

Keywords: Corporate social responsibility (CSR), Sustainability, Corporate Financial Performance (CFP), Competitive Advantage, Small and Medium Enterprises (SMEs)

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Breaking the silence: a case study of open strategy in the clothing retail sector

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Abstract

An underlying assumption in strategy research and the corporate world is that business strategy should be kept secret and exclusive. A recent stream of research challenges this conception, as they argue that companies are becoming increasingly open with their strategies (where openness is defined in terms of transparency of strategies during and after the formulation of them and inclusion in the strategy making). However, few studies have looked empirically at how the process behind opening strategy evolves over time. This is problematic, since traditional strategic research falls short in explaining why and how a company opens up their strategies and few companies have insights to the process and the potential benefits of opening up. In the clothing industry, one of the best kept secrets is where and how the goods are produced. However, a public discussion on sweatshops, poor working conditions and negative environmental impact in the industry, has put pressure on companies to become increasingly open to the public. This study discusses and explains the process behind opening the business strategy, which traditionally has been considered a business secret of the firm. Through a longitudinal field study (2012-2016) of Nudie Jeans Co's attempt to "become the most transparent company in the world", this study shows how a company wants to break the silence on poor working conditions from an industry point of view, by becoming increasingly open with where and how they produce their goods. The study contributes to the research on open strategy with insights on the process behind opening up, how transparency and inclusion interact over time, and suggests a framework for understanding and explaining the various outcomes in terms of openness. Furthermore, the article discusses the link between open strategy, transparency and sustainability.

Keywords: Open strategy, transparency, sustainability, clothing retail industry, case study

Adapting to climate change: Becoming a resilient organisation.

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Abstract

This conceptual paper seeks to understand organization adaptation to climate change. It examines the concept of resilience as applied to the organization and suggests that while our understanding of the natural environment has embraced a process or system perspective our understanding of organization adaptation to climate change and development of a resilient organization remains predicated on a substantive ontology. Here the organization is seen as a 'thing' independent of context; change is captured by change in the qualities of the attributes of the organization; adaptive capacity is seen as a critical property that moderates exposure and sensitivity to climate change; and adaptability the capacity of decision-makers to mange these attributes. The paper argues while this approach makes knowledge actionable it limits our ability to advance our understanding of resilience and achieving sustainable outcomes. It promotes business-as-usual, framing the uncertainty of climate change within the existing corporate lexicon of risk. The future is given a presence and uncertainty can be translated into probabilities and financially qualified giving rise to managing risk and identifying opportunities in a constructed probable world. However calculated and linear risk excludes the irregular uncertain aspects of climate change, shortens decision time frames and turns time into another variable to be controlled, such as time to return to stability. Adaptation is simply a single snapshot in time and an organization well adapted to the current situation may quickly find the accompanying pace and uncertainty of environmental and technological change and wide variations of the social impacts, likely to make that adaptation, no matter how quick and flexible, already obsolete. The future doesn't just unfold, organizations also shape the future as they adapt and respond to climate change. They need the capacity to recognize and realize opportunities, not only in exploiting their immediate benefits but also exploring them as openings to new opportunities, or risk sacrificing adaptability in the future. I suggest our understanding is advanced through a process ontology, where 'things' are reification of processes, and the resilient organization unfolds through ongoing interaction between multiple levels across the organization and context, through a process of simultaneous emergence, construction, reconfiguration and decomposition. The paper examines the underlying mechanisms that drive this process. Structured changes in organizational governance and developing diverse networks of internal and external communities of practice facilitate recognizing and reconfiguring resources and create boundary-spanning situations. Through these situations opportunities are co-created so that the organization is perpetually poised to pursue innovation and therefore able to respond at the forefront of change in the environment, in the process of 'becoming' a resilient organization.

Keywords: Resilience, process methods, adaptation, innovation, value

How to develop a sustainable strategy in a chemical company - CUF case study

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Abstract

Over the years, sustainability has become an essential topic when talking about successful business, namely in the chemical industry. As a consequence of the global sustainability awareness CUF, a chemical company with 150 years old, also embraced this very important subject. Nowadays, CUF believes that the sustainable development of business is defined by a healthy balance between economic success, environmental protection and social responsibility. CUF is therefore committed to use natural resources in the most efficient and beneficial way for the environment, provide value to its stakeholders and simultaneously promote a better quality of life for present and future generations. In 2013, CUF decided to implement the sustainability department under the CEO commitment to this subject and with central management by the Executive Committee, both key elements for bringing sustainability at all levels and functions of the company. The sustainability department was embedded in the Strategic, Planning, and Innovation Division, and thus this topic became part of the company's strategy, allowing its development in the core business. The implementation of the sustainability area at CUF has been a gradual and weighted process, which included a number of key-moments, such as the study of CUF's materiality, which considers the potential environmental, social and economic impacts of the company's business. This study was made in a participative way, involving all company directors, managers, coordinators and technicians, with the result being the identification of CUF eight priority areas: Technology and Innovation, Logistics, Resources and Energy, Environment, Water, Product and Safety, Employees and Community. With these areas in mind, CUF's managers were challenged to elaborate specific action plans for their departments, with knowledge sharing about sustainable business development being central for achieving this objective. The monitoring of CUF's sustainability performance in a persistent and continuous way is also crucial to achieve this goal and therefore tools were specifically developed or improved to this purpose, as for example the Sustainability Report, which analyses the commitment and effort dedicated to sustainability projects and practices. 2014 CUF's Sustainability Report, was developed and published according to GRI 4.0, with the aim of communicating to stakeholders the company's economic, environmental and social performance. As the work on sustainability should not be restricted solely and exclusively to the presented initiatives, it is CUF's objective to show greater ambition and go further on the theme of sustainability. To accomplish this, is part of CUF's future plans to present specific sustainability challenges to technical departments, to pursue the sustainability related ISO certifications, to perform materiality and sustainability strategy periodic revision - which is known as a best practice in corporate sustainability management - amongst other. These are some of the topics CUF intends to share in the 22nd Annual International Sustainable Development Research Society Conference.

Assessing the role of alternative schemes for the implementation of environmental management systems

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Abstract

The pressures placed upon organisations to control the impacts of their activities on the environment and society have been driving the adoption of more sustainable practices. To facilitate the implementation of corporate environmental management strategies a wide range of approaches may be implemented. This is the case of Environmental Management Systems (EMS), which stand out as one of the most popular tools to manage environmental aspects and improve organisational environmental performance. Within this context, ISO 14001 and the Eco management and Audit Scheme (EMAS) arise as the most commonly used frameworks for EMS implementation. However, some obstacles have been reported by several authors in the implementation of these EMS models, such as specific EMS requirements (e.g., difficulties in the implementation of environmental management programs), internal conditions (e.g., the size of the organisation) and the external organisational context (e.g., recognition of the organisation's efforts by stakeholders). In response to these obstacles, several EMS certification schemes have been created and are available to organisations, although their role and effectiveness have been scarcely studied. Hence, the goal of this paper is to investigate the contribution of these alternative schemes to the implementation of corporate environmental management strategies and practices. More specifically, we aim to provide insights on governance structures, advantages, limitations, effectiveness and achievements obtained with the adoption of alternative EMS schemes. For this purpose, a set of 20 schemes reviewed by the European Commission was selected for our analysis and cross-comparison of alternative EMS models. Most schemes have been developed between 1995 and 2005 and are applied in Central and Northern Europe. A questionnaire was sent by e-mail to the organisations responsible for the administration of each scheme, collecting information on the following topics: general characteristics, strategies deployed to facilitate EMS implementation, governance structure, and perceptions on the effectiveness of the scheme. A telephone follow-up was performed to increase the questionnaire response rate, which allowed collecting responses from 50% of the schemes. Most of the alternative schemes were developed and managed by private organisations, however the organisations involved are mainly from the business sector, non-governmental organisations and consultancy firms. The "flexibility to adapt to different business models and organisational characteristics", as well as "the provision of dedicated supporting materials, tools and personnel" are perceived as the main advantages of the schemes, which is aligned with the obstacles commonly referred in the literature to EMS implementation when following ISO 14001 and EMAS. With respect to limitations of alternative schemes, some of these overlap with those of the incumbent schemes (e.g. financial constraints to implement programs of measures). Other limitations, however, are particular to these schemes and mostly related with their lower levels of dissemination (e.g., lack of external recognition). In conclusion, our study shows that alternative schemes are perceived by their responsible organisations as highly effective and valuable tools to promote continuous improvement of environmental performance. They play a complementary role to widely adopted schemes by simplifying EMS requirements and promoting networked approaches, thus enlarging the portfolio of instruments promoting corporate sustainability management.

Keywords: Environmental Management Systems; Alternative Certification Schemes; ISO 14001;

Eco management and Audit Scheme.

Ethical decision making in upcoming managers - Tendencies, moderators and mediator

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Abstract

The paradigm of Sustainable Development is one that best represents the dependence organizations have today of its stakeholders and external environment. Aware of this, some United Nations initiatives like the Global Compact have focused part of its targets in motivating companies to take a leading role as strategic agents of change, due to its great impact on the environmental, economic and social systems. However, an organizational culture established on this paradigm will always be dependent on the pre-existence of an ethical and socially responsible organizational culture. This in turn is dependent on an effective training of managers, aware and able to ethically cope with the impacts and accountability of the organizations they manage and make decisions considering the multitude of expectations placed on them. Several specific initiatives, which are offshoots of the aforementioned plans, have also declared the importance of promoting an education for sustainability, specifically directed to upcoming managers. Demonstrating that Higher Education Institutions also have the responsibility to train professionals able to deal with and decide about, complex and contingent issues in the field of Sustainable Development. An important part of business schools worldwide already includes Business Ethics and Corporate Social Responsibility in their undergraduate management courses and recognize the need to further enhance the relevance of these issues in the curricula. Accordingly, in Portugal, a significant part of undergraduate management programmes already have a discipline dedicated to these issues, although the integration of the remaining curriculum around these issues remains nearly non-existent. Calling into question, how responsive are the upcoming managers towards Corporate Social Responsibility and how ethical is their decision making process. The study of ethical decision-making in management, as a research field, has been addressing individual (such as age and gender) and situational (such as organizational culture and job context) moderators which influence it. Thus we present a study on the impact of this crumbled teaching of these subjects on the decision-making process of the upcoming managers, now finishing their management degrees. Using data collected from questionnaires, we present several trends in the responsiveness of students towards Corporate Social Responsibility, in their business philosophy and ethical decision making. We also studied the mediating effect of the cognitive process of moral disengagement in the relationship between individual traits in business philosophy and ethical intensity in decision making. It is concluded that these students, although sensitive to the different dimensions of Corporate Social Responsibility and types of stakeholders, can't easily recognize the moral burden of an ethical dilemma. In addition, their business philosophy shows relevant features of Machiavellianism and ethical relativism, usually associated with unethical decisions. It is also demonstrated that age and gender act as moderators in ethical decisions and that moral disengagement process plays a mediating role in the relationship between some individual moderators and unethical decisions. Finally, evidence is presented about the irrelevance of the current model of Business Ethics and Corporate Social Responsibility teaching, in student's sensitivity to Corporate Social Responsibility, business philosophy and ethical decisions.

Keywords: higher education, Corporate Social Responsibility, Business Ethics, decision making, moral disengagement

1. Introduction

Companies are one of the most important stakeholders in the Sustainable Development (SD) challenge. Due to their great impact on the environmental, economic and social systems, some United Nations (UN) initiatives have focused part of their targets in summoning companies to take a leading role in this global effort. However, this commitment requires that companies acknowledge their responsibilities to society far above the legal frontier, as well as the power extent of their actions. As the UN Global Compact mission puts it: "Business as a force for good". A Business Education which can provide the necessary tools to help future managers in dealing with complex problems created by SD, in an interdependent and accountable system, is therefore crucial. Many Higher Education Institutions (HEI) are among the early enforcers of the SD project, in a political and strategic level, through the subscription of several initiatives like the Principles for Responsible Management Education (United Nations, 2007). But, when it comes to practice, in management education, the curricula are usually focused on teaching students that all elements are secondary when compared to profit or assets valuation and that all other stakeholders beyond shareholders and investors are of secondary importance (Wu, Huang, Kuo, & Wu, 2010). A curriculum which can help to empower managers with tools to deal with SD, must be necessarily integrated around Business Ethics (BE) and Corporate Social Responsibility (CSR). The problem is that the concepts of BE and CSR are disconnected from short-term profit maximization strategies (Gioia,2002) and require an approach based on a new paradigm of the firm (Down, 2006) transformative (Sipos, Battisti & Grimm, 2008) and focused on what's right. Although many of these HEI already included CSR and BE in their undergraduate management courses (Matten & Moon, 2004; Bowden & Smythe, 2008), through a dedicated course, there's still no proof that they are enabling students to develop a set of skills which inhibit them to deal with these challenges. Namely, a more critically-reflected, mature and holistic understanding of their professional role, of business activity and of the interdependence between it and the natural environment (Brinkmann & Sims, 2001). The questions arise then: are undergraduate management courses helping the students to have a better understanding of CSR and manage in every one of its dimensions? Are management students able to identify moral issues? What moderates their ethical decision making and mediates the ethical load put in it? Do dedicated courses of BE and CSR foster learning outcomes like the ones we presented here?

2. Methods

A sample of 191 questionnaires was collected from undergraduate management students, who were enrolled in the last year of their courses. The online survey was distributed in 22 HEI, randomly selected from the universe of 55 undergraduate study programmes. The first part of the questionnaire is dedicated to the student's sensitivity to CSR. Recognizing the need to assess the influence of personal moderators over the perception of CSR (Rupp, Ganapathi, Aguilera, & Williams, 2006) we used the Turker (2009) questionnaire. Although there are other praiseworthy tools specifically designed to gather perceptions of students in relation to CSR (Sobczak, Debucquet, & Havard, 2006; Wong et al, 2010; Panwar, Hansen, & Anderson, 2010) none of the proposals presented itself so aligned with the objectives of this work, as the Turker (2009) questionnaire. It is composed of eighteen phrases that result from the condensation of fifty-five statements, through a selection process for statistical significance. One of those eighteen statements condensed by Turker (2009) was, however, split in two (41a and 41b) resulting in nineteen final statements which were presented to the students. We then asked them to indicate their degree of agreement with every statement on a 5-point Likert scale. The second part of the questionnaire is dedicated to the student's business philosophy.

In order to understand some of its common traits among students, the ATBEQ questionnaire (Neumann, 1987) was used. Created by Neumann (1987) the ATBEQ was further used by several authors (Moore & Radloff, 1996; Bageac et al., 2011; Nejati, Amran & Shahbudin, 2011; Goksoy & Alayoglu, 2013) in different countries, but never in Portugal. In the ATBEQ, the students qualify in a 5-point Likert scale their level of agreement with each of thirty statements thus identifying its business philosophy traits of five distinct types: Machiavellianism, Moral Objectivism, Legalism, Ethical Relativism and Social Darwinism. The third part of the questionnaire deals with moral disengagement. To measure it we use the scale that results from an exploratory factor analysis performed by Detert, Treviño and Sweitzer (Detert et al., 2008) to the Moral Disengagement Scale of Bandura, Barbaranelli, Caprara and Pastorelli (1996) and that specifically applies to management students. This section of the questionnaire consists of twenty-four statements, covering the eight mechanisms through which one can ignore one's self-regulatory mechanisms which govern transgressive conduct. In each of these statements, the student must again use a Likert scale of five points to show their level of agreement with it. In the last part of the questionnaire the students are placed in various everyday ethical dilemmas mixed with ethically neutral (control) statements, which permits one to answer questions about the moral intensity of their judgments. The questionnaire consists of a group of thirteen questions, five of which are serve as control, in which the student qualifies in a Likert scale, how likely it would be for her/him to behave in the manner described. As the questionnaire on moral disengagement, these issues are part of the questionnaire created and used by Detert et al. (2008).

An Exploratory Factor Analysis (EFA) conducted on the CSR sensibility questionnaire enabled the identification of four factors. The same procedure was used on the ATBEQ questionnaire, with similar results, allowing the isolation of five axes which were also studied and related with the rest of the decision making process. The questionnaire on moral disengagement was also analysed through an EFA and seven factors were identified. After the splitting of one of the factors, the whole set overlapped, in terms of grouped variables, with the latent variables associated with each of the eight mechanisms in the questionnaire. To assess the questionnaire's reliability, we used Cronbach's Alpha on factors and latent variables identified. Polychoric and Spearman correlations were then calculated to determine how each of the latent variables and factors correlate. Considering the normality of the variables in hand, parametric and non-parametric tests were used to verify the differences between sub-groups of students, in the ethical charge present in their answers to the dilemmas. Finally, a mediating test based on bootstrapping, was used to verify the mediator effect of moral disengagement over the relationship between some of the student's individual moderators and ethical decision making.

3. Results

The EFA to the questionnaire results identified four factors in sensitivity to CSR: competitiveness, activist momentum, species survival and imperative of legality. The four factors presented explain 94,96% of the total variance, with a very high sample adequacy (Kaiser-Meyer-Olkin test = 0,86) rejecting the null hypothesis of Bartlett's sphericity test ($p<0,01$).

The EFA in the ATBEQ results identified five factors that are assumed here as axes of opposing philosophical positions. We thus have identified five axes: collectivism-selfishness, moral-amoral, means-ends, duties-virtue and liberal-conservative. The five presented factors explain 86,47% of the total variance, with an average sample adequacy (Kaiser-Meyer-Olkin test = 0,716) rejecting the Bartlett's sphericity test null hypothesis ($p<0,01$).

The EFA on the questionnaire about moral disengagement resulted in the identification of seven factors, which match with the moral disengagement mechanisms originally identified as latent variables by the authors. The seven factors presented explain 98,77% of the total variance, with a high sample adequacy (Test Kaiser-Meyer-Olkin = 0,815) rejecting the null hypothesis of Bartlett's sphericity test ($p<0,01$). Given the overlap of the factors with latent variables, we only used the original set of variables, suppressed those who showed no relevant loadings AFE.

The results of the calculated Cronbach alphas for the latent variables and factors vary in general between acceptable and good levels, which grants reliability to the collected data. An ANOVA was conducted on the ethical decision variables, which showed significant effect of the issue's ethical charge (Wilks λ = 0.581, $F(1,190)$ = 137,067, p <0,01, η^2=0, 419). Therefore, offering sufficient evidence to reject the null hypothesis that the answers were to measure types of identical decision. In general, students have a high sensitivity (Likert scale mean=4,2) to all dimensions of CSR (see Table 1).

As expected, being commonly accepted as mandatory rules, company's legal responsibilities are regarded as the most consensual. Sensibility to philanthropic responsibilities is less prevalent among students (Likert scale mean = 4,11) which is consistent with the fact that there's a lower sensitivity to the secondary stakeholders (x = 4,15) when compared with primary stakeholders (Likert scale mean = 4,24). Students have a higher sensibility to no-social stakeholders (x=4,26) when compared to the social ones (x = 4, 20). After analysing the statements with greater positive impact on this difference, it appears that these items corresponded to statements about future generations, which may be related to the growing public debate on environmental issues.

From the analysis of the boxplots shown in Figure 1, one can observe that attending a CSR and BE course can have a positive effect on the student's sensibility to CSR, both in its different dimensions, and in relation to different stakeholders. When observed in the light of the factors identified in the EFA, this variation seems to be related with a greater propensity for activism on the part of students attending these dedicated courses. Nonetheless, in what concerns every dimension of sensibility to CSR, the difference between students who enrolled in these courses and students who did not, isn't statistically significant (Table 2).

Table 1 – Student's sensitivity to CSR (dimensions and factors)

	N	Minimum	Maximum	Mean	Std. Deviation
CSR dimensions					
Primary stakeholders	191	2,80	5,00	4,2362	,46166
Secundary stakeholders	191	2,75	5,00	4,1479	,53746
Non-social stakeholders	191	2,40	5,00	4,2639	,50836
Social stakeholders	191	2,86	5,00	4,2012	,46631
Ethical responsibility	191	2,50	5,00	4,2468	,49289
Philantropic responsibility	191	2,00	5,00	4,1094	,55038
Legal responsibility	191	2,75	5,00	4,3220	,50300
Influencing factors					
competitiveness	191	1,88	5,00	4,2919	,52821
activism	191	2,20	5,00	4,0042	,61523
species survival	191	2,50	5,00	4,3482	,52301
legality	191	2,33	5,00	4,2987	,57862
valid N (listwise)	191				

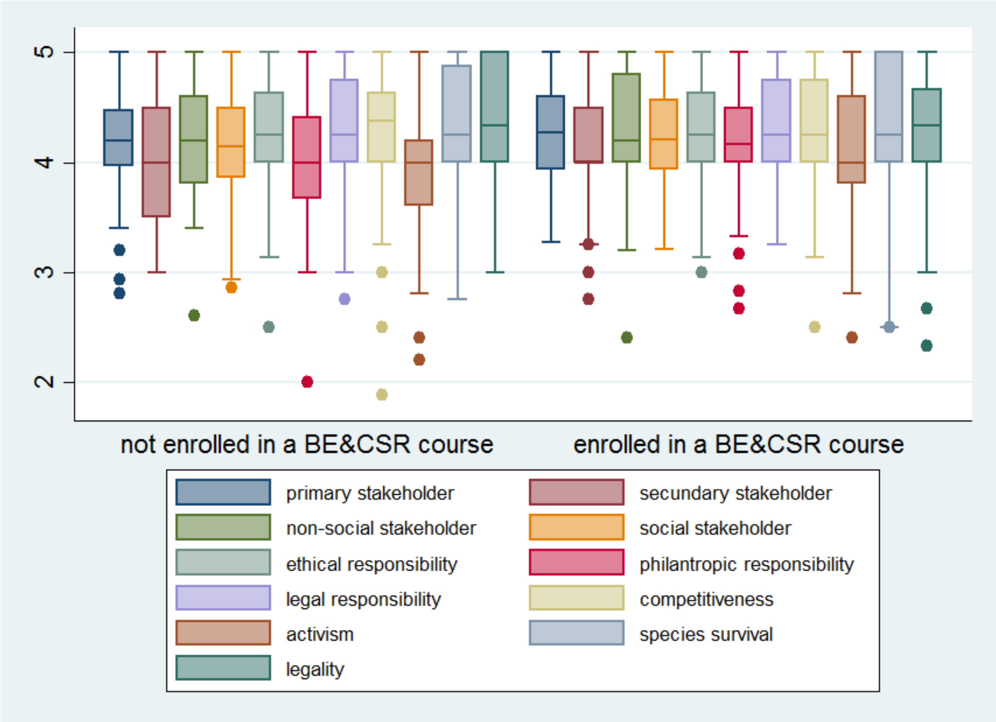

Figure 4 - Student's sensibility in CSR, due to have attended or not, a dedicated BE and CSR course.

Neither are the factors that influence that sensibility, for the same grouping (A student's enrolment in a dedicated course of BE&CSR doesn't seem to affect its business philosophy (see Figure 2). Still, some minor changes are observed, namely a stronger disagreement with Machiavellian practices (see Table 5). This slight shift is consistent with a reduction of the first (selfishness) and fourth (virtue over duties) factors in students who attended these courses (see Table 6).

Table 3). Students have a very balanced philosophical position towards Business Ethics (see Table 4). Of all the ethical dimensions analysed, they recognized Social Darwinism as the less ethical perspective, whereas the marketplace mustn't solely be a competition zone in which the most suitable companies eliminate the weakest. For them, the right thing to do, is more easily understood by a morally objectivist stance with a well-defined and stable ethical matrix as a rulebook. The second most prevalent philosophical position is Ethical Relativism, which being more based on social interests, it is also more dependent on the context in which companies operate.

Table 2 - Differences in sensibility to CSR dimensions, in function of their enrolment or not, in a dedicated BE and CSR course

	Primary stakehold.	Secondary stakehold.	Non-social stakehold.	Social stakehold.	Ethical responsib.	Philanthrop. responsib.	Legal responsib.
Mann-Whitney U	4262,000	4004,000	3957,500	4223,500	4266,500	4455,500	3852,500
Wilcoxon W	7832,000	7574,000	7527,500	7793,500	7836,500	10233,500	7422,500
Z	-,613	-1,315	-1,428	-,715	-,603	-,103	-1,700
(p) value	,540	,188	,153	,475	,547	,918	,089

A student's enrolment in a dedicated course of BE&CSR doesn't seem to affect its business philosophy (see Figure 2). Still, some minor changes are observed, namely a stronger disagreement with Machiavellian practices (see Table 5). This slight shift is consistent with a reduction of the first (selfishness) and fourth (virtue over duties) factors in students who attended these courses (see Table 6).

Table 3 - Differences in factors influencing student's CSR sensibility, in function of their enrolment or not, in a dedicated BE and CSR course

	competitiveness	activism	species survival	Legality
Mann-Whitney U	4492,500	3794,500	4084,000	4368,000
Wilcoxon W	8062,500	7364,500	7654,000	10146,000
Z	-,004	-1,859	-1,108	-,339
(p) value	,997	,063	,268	,735

Ethical considerations in relation to the fulfilment of the law primacy (legalism) also diminish. This is consistent with the fact that the teaching of these subjects isn't normally used to strengthen or defend the need for compliance with legislation. Students who attended these courses show a greater homogeneity towards the Ethical Relativist and Social Darwinian approaches. Still, all of these differences between groups aren't statistically significant ($0,145 < p < 0,943$) which leads us to conclude that attending or not a dedicated course on BE and CSR makes no difference in any of the latent variables and factors identified in the EFA.

Table 4 – Statistical description of the factors and traits in student's business philosophy

	N	Minimum	Maximum	Mean	Std. Deviation
Philosophical traits (1-5)					
machiavelism	191	1,20	4,20	2,4356	,50616
social darwinism	191	1,29	3,71	2,2282	,41759
ethical relativism	191	1,00	4,33	2,6090	,65500
moral objetivism	191	1,50	4,00	2,8024	,51543
Legalism	191	1	5	2,45	,944
Influencing Factors (1-5)					
collectivism-selfishness	191	1,00	3,67	1,4136	,49732
moral-amoral	191	1,29	4,29	2,5280	,51512
means-ends	191	1,29	4,57	2,6948	,59468
duties-virtues	191	1,63	4,50	2,8207	,44044
liberal-conservative	191	1,00	4,25	2,3796	,60526
valid N (listwise)	191				

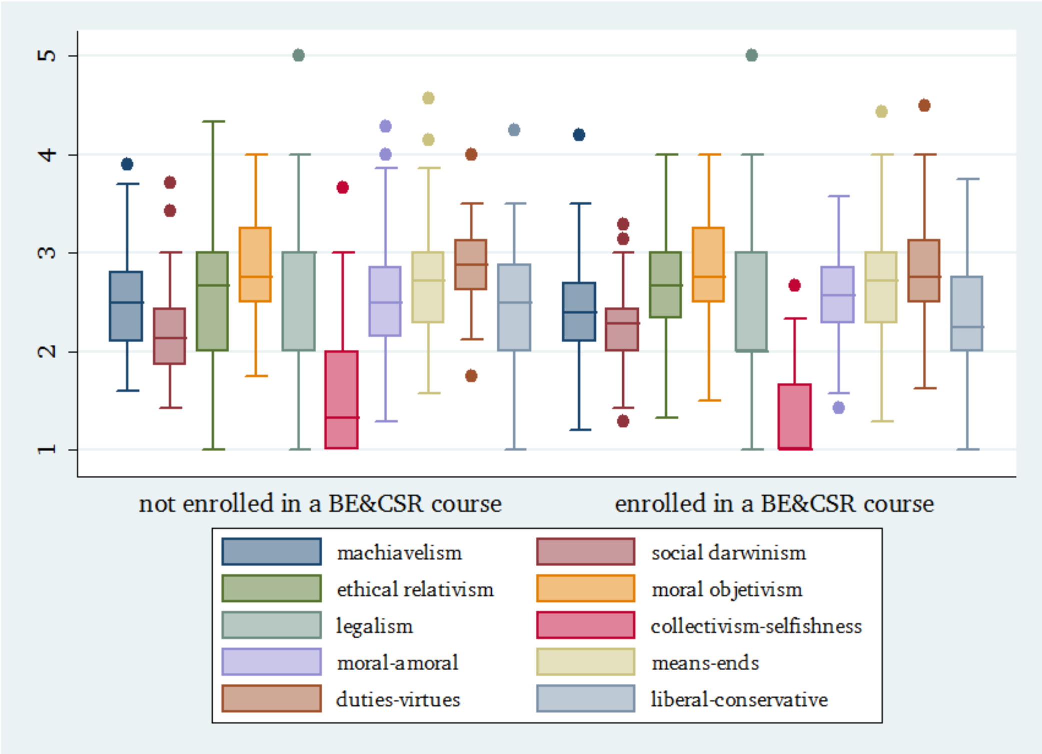

Figure 5 - Traits and factors in student's business philosophy, due to have attended or not, a dedicated BE and CSR course.

Students show minimum levels (Likert means between 1,51 and 1,89) of the majority of moral disengagement mechanisms (see Table 7). However, three of the mechanisms show significant levels: moral justification (Likert mean=2,81), diffusion of responsibility (Likert mean=3,02) and displacement of responsibility although this less relevant (Likert mean=1,97). These are three mechanisms operating in cognitive reconstruction of own behaviour. In the case of moral justification students rationalize the harmful behaviour as socially accepted and represents it as a good deed. In the case of diffusion of responsibility, the student feels less responsible for a nefarious behaviour, the greater the number of participants or decision makers is, with whom he can share responsibility.

Table 5 - Differences in student's business philosophy traits, in function of their enrolment or not, in a dedicated BE and CSR course

	Machiavelism	social darwinism	ethical relativism	moral objetivism	legalism
Mann-Whitney U	4089,000	4208,000	4477,000	4413,500	3893,500
Wilcoxon W	9867,000	7778,000	10255,000	7983,500	9671,500
Z	-1,070	-,759	-,045	-,215	-1,671
Not enrolled in course (mean rank)	100,82	92,60	96,20	95,04	103,15
Enrolled in course (mean rank)	92,21	98,67	95,84	96,75	90,39
Asymp. Sig. (2-tailed)	,284	,448	,964	,830	,095

To a lesser extent, some students rationalize harmful decisions that decide to take, through the displacement mechanism of accountability that allows the individual to act immorally if someone takes responsibility for their actions, usually in a hierarchical perspective.

Table 6 - Differences in factors influencing business philosophy in students, in function of their enrolment or not, in a dedicated BE and CSR course

	collectivism -selfishness	moral-amoral	means-ends	duties-virtues	liberal-conservative
Mann-Whitney U	4129,000	4284,500	4467,000	3943,500	4087,000
Wilcoxon W	9907,000	7854,500	10245,000	9721,500	9865,000
Z	-1,030	-,555	-,071	-1,458	-1,082
Not enrolled in course (mean rank)	100,35	93,51	96,32	102,55	100,85
Enrolled in course (mean rank)	92,59	97,96	95,75	90,86	92,20
Asymp. Sig. (2-tailed)	,303	,579	,943	,145	,279

The impact of enrolling in a Business Ethics and CSR course, over moral disengagement, seems to be virtually nil and not observable (see Figure 6), with a small negative dislocation in the moral justification and displacement of responsibility mechanisms. These variations are however not statistically significant (see Table 8). Although not statistically significant (p=0,764 in Table 9) there seems to be a slightly higher propensity to unethical decisions, among the students who haven't enrolled in these exclusive courses (Figure 4). The students who attended a unique course, also appear to identify slightly better, the absence of ethical charge in the dilemmas, although this difference between the two student's groups, isn't also statistically significant (p=0,142).

Table 7 - Statistical description of the student's use of moral disengagement mechanisms

	N	Minimum	Maximum	Mean	Std. Deviation
moral justification	191	1,00	4,67	2,8081	,79659
euphemistic labelling	191	1,00	3,50	1,5052	,53061
palliative comparison	191	1,00	4,67	1,5966	,68506
displacement of responsibility	191	1,00	4,50	1,9686	,74272
diffusion of responsibility	191	1,00	5,00	3,0193	,93679
distortion of consequences	191	1,00	4,00	1,6091	,56095
attribution of blame	191	1,00	4,67	1,8933	,67023
dehumanization	191	1,00	4,33	1,8183	,83596
Valid N (listwise)	191				

On a broader analysis of polychoric and Spearman's correlations between latent variables and factors in CSR sensitivity, business philosophies, moral disengagement and decision making, we found that all of them are all positive, albeit at different amplitudes. All correlations between sensitivity to the different stakeholders and various levels of social responsibility, show significant negative correlations and more importantly, statistically significant, with moral disengagement (p <0,01) and unethical decision (p <0,01 or p <0,05). Only the correlation between competitiveness and the unethical decision is not statistically significant (p> 0,05). Negative correlations suggest that greater sensitivity to these issues implies a level of moral disengagement lower and higher ethical burden in decision making. Correlations between the variables which measure sensitivity to CSR and decisions without an ethical charge (control statements) are always lower and rarely statistically significant. The previously mentioned factors, which resulted from the EFA, have consistent correlations with these philosophical profiles which strengthens our results.

Table 8 - Differences in student's moral disengagement mechanisms, in function of their enrolment or not, in a dedicated BE and CSR course

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
moral justification	3914,5	9692,5	-1,54	0,124
euphemistic labeling	4114,5	9892,5	-1,058	0,29
palliative comparison	4269	10047	-0,617	0,537
displacement of responsibility	4165	9943	-0,892	0,373
diffusion of responsibility	4476	8046	-0,048	0,962
distortion of consequences	4474	8044	-0,054	0,957
attribution of blame	3897	9675	-1,597	0,11
dehumanization	3994	9772	-1,348	0,178

The most selfish philosophies have positive correlations with moral disengagement. This is the case of Machiavellianism (polychoric = 0,38 and Spearman's rho = 0,35, p <0, 01), Social Darwinism (polychoric = 0,39 and Spearman's rho = 0,37, p <0,01) and the Ethical Relativism (polychoric = 0,3 and Spearman's rho = 0,32, p <0,01). Legalism, as one would expect in an ethically neutral philosophy, has a correlation with moral disengagement, close to zero (polychoric = 0,03 and Spearman's rho = 0,01) and not statistically significant. Business philosophies which have a higher correlation with unethical decision making, are Machiavellianism (polychoric=0,31, Spearman's rho=0,27, p<0,01) and Social Darwinism (polychoric=0,35, Spearman's rho=0,32,p<0,01). As it was also expected, moral disengagement is highly correlated with unethical decision making (polychoric=0,42, Spearman's rho=0,41, p<0,01). Six of the eight moral disengagement mechanisms present statistically significant correlations (p <0,01) with the ethical charge in the decision. These correlations are positive which implies that greater use of these mechanisms is correlated with an unethical decision. Overall, moral disengagement presents a statistically significant positive correlation (polychoric=0,42 and Spearman's rho= 0,40, p<0,01) with unethical decisions. One can observe that the Machiavellian traits have a high correlation with a feeling of amorality in business and the overlap of the ends on the means to achieve them. Darwinists traits seem to be influenced by feelings of selfishness or egotism and an equally amoral view of the market. Social Darwinism, remind yourself, it suggests the struggle for survival of organizations and this struggle for self-interest overrides any morality design. The Ethical Relativism is moderately correlated with the justification of means to the ends and with an ethic more focused on the manager's honesty, fairness and trust.

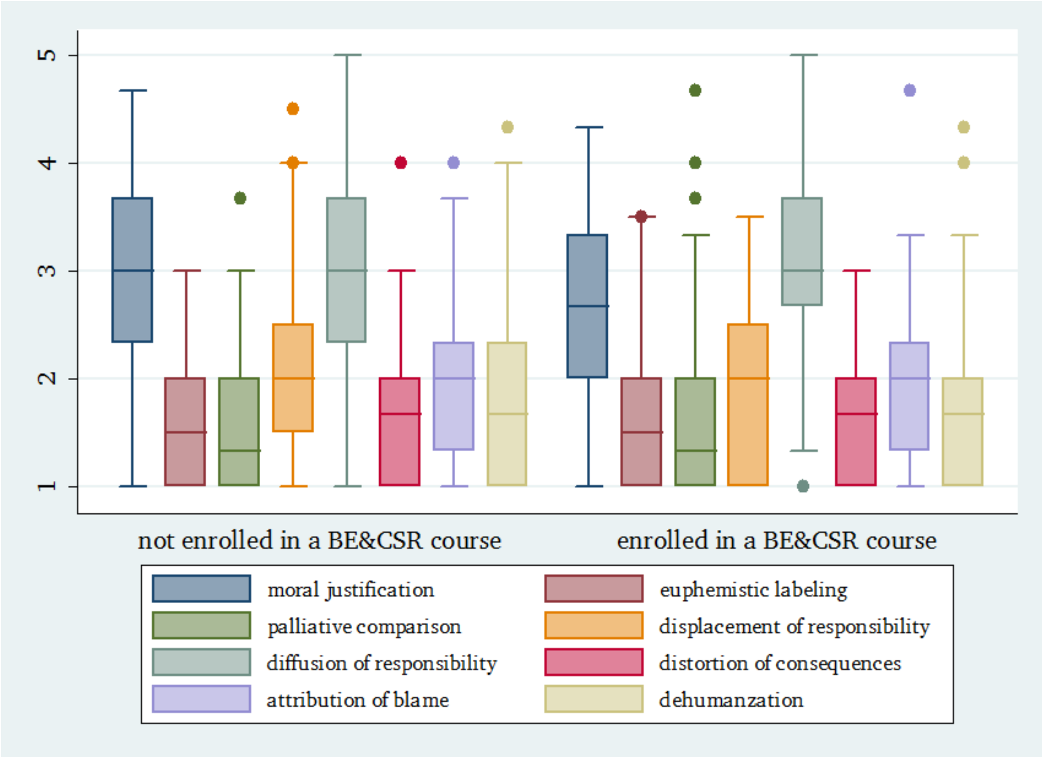

Figure 6 - Student's use of moral disengagement mechanisms, due to have attended or not, a dedicated BE and CSR course.

This moderate correlation is also consistent with the idea that to an ethical relativist, there are indeed moral standards that apply to the business world, but which are specific to it. Both Moral Objectivism as Legalism emerge strongly related to a conservative trend of strict compliance with duties and a clear definition of them. This is a correlation confirming a strict view of the moral objectivist over an emotions-free business world. The fact that students attended a dedicated course of BE and CSR have little impacts on these philosophical tendencies, none of them being statistically significant.

Table 9 - Differences in both types of decision, between undergraduates who enrolled in a BE and CSR dedicated course and students who hadn't

	unethical decision	Ethically neutral decision (control)
Mann-Whitney U	4380,500	3939,000
Wilcoxon W	10158,500	7509,000
Z	-,300	-1,469
(p) value	,764	,142

From the bootstrapped mediation analysis using the macro PROCESS for SPSS (Hayes, 2013), results that moral disengagement has shown a mediating effect on the previously mentioned relationships between Machiavellian and Social Darwinist traits and unethical decision making. In these two situations, the direct effect of the independent variable on the dependent is statistically significant (respectively p=0,016 and p=0,002) and the effect of the mediator is never zero and is always positive. It is therefore concluded that a greater presence of these two characteristics in the mix of values and beliefs that is the student's business philosophy, imply a less ethical decision and part of this effect is assignable to the mechanism of moral disengagement. Through the execution of non-parametric tests for independent samples and ANOVA's, several ethical decision moderators were identified, age and gender being the most important. A Kruskal-Wallis H test showed that there was a statistically significant difference in unethical decision making between the different age groups (X^2=7.858, p=0.02) with a mean rank unethical decision score of 103.89 for the age<25 group, 96.44 for the with ages between 25-35, and 76.24 for the group of students older than 35 years.

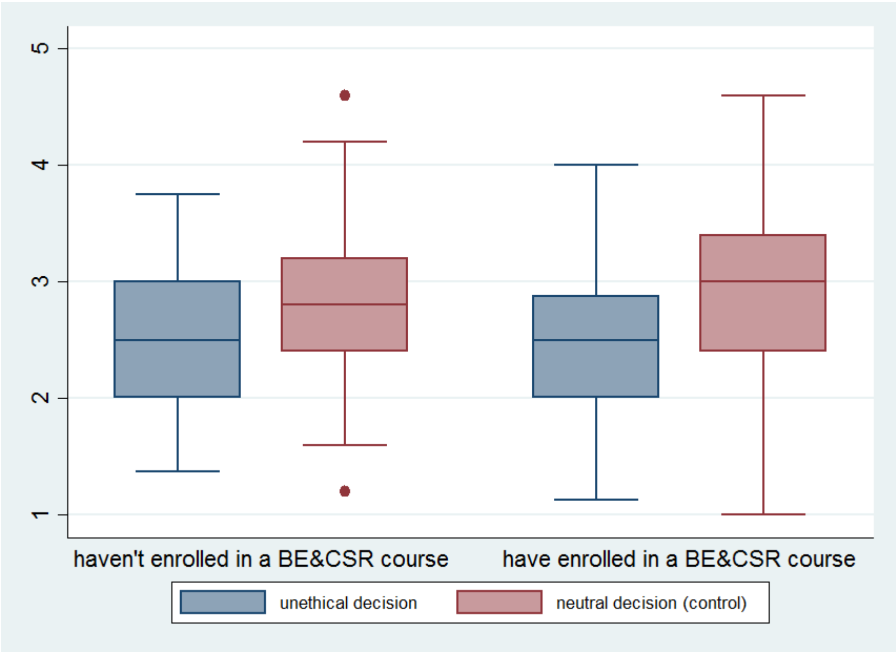

Figure 7 - Decision making in management undergraduates, in function of their enrolling or not in a dedicated BE&CSR course

Using a Mann-Whitney U test, it can also be concluded that unethical decisions in males (mean rank score of 106.91) were statistically significantly (U = 3492, p = 0.043) higher than among females (mean rank score of 89.86). A two-way ANOVA was conducted that examined the mixed effect of gender and age group on unethical decisions, but a statistically significant interaction wasn't found (F (2, 185) = 0.052, p = 0.949). The HEIs is also a moderator in the decision making process. Using a Mann-Whitney U test, it can also be concluded that unethical decisions in students from public HEIs (mean rank score of 105.15) were statistically significantly (U = 3717, p = .029) higher than among those from private HEIs (mean rank score of 87.67).

4. Discussion

When comparing CSR sensibility of these students with the results obtained by Correa (2013) using the same questionnaire (Turker, 2009) one can suggest that their sensitivities are sorted in the same way, although more intense, when compared to those of an ordinary citizen. This increased sensitivity to CSR, together with the absence of a statistically significant relationship between it and the attendance of BE and CSR dedicated courses, is a very relevant non-result that should be discussed. Taking into account that Portuguese management study programmes show minimal levels of CSR and BE integration in their curricula (Vilar & Simão, 2016) it can, in theory, mean that students develop a greater sensitivity through processes of acculturation and socialization. If that's true, then sensitivity to CSR cannot be seen as an evolutionary process, always increasing where the student will be more sensitive as time passes. But rather as an expression of political and philosophical profile less prone to detectable changes in the short and medium term, and more chaotic in its development. It is thus even more important to study the business philosophy of the students as well as the factors which influence it. We propose five factors, in the form of axes, which may influence a student's business philosophy: collectivist / selfish motivation; moral / amoral marketplace conception; guidance towards means / ends; ethical imperative of duty / virtue; and liberal / conservative ethical normative that the organizations are subject to.

From the obtained results, stands out the relevance of the trend towards collectivist motives and a more conservative view of the rules, as perfectly aligned with high uncertainty avoidance and low individualism characteristic of the Portuguese national context (Hofstede et al., 2010). The students present an objectivist trend that is compatible with a prescriptive view of business ethics. It is as if the students hoped they were told what is right and is not right to do. This idea is reinforced and not contradicted by the second most recurrent philosophy in this study, ethical relativism. For these future managers, if it is written in a code of conduct, then it probably is the right thing to do. From the comparison with other studies that also used the ATBEQ questionnaire, it is possible to identify some differences in business philosophy of Portuguese management students.

Regarding the results obtained and compiled by Moore (1996), a smaller agreement of the Portuguese students with Darwinists statements is visible when compared with their fellow Americans, Israelis, South Africans and Australians. The most common traits in the business philosophy of Portuguese students, moral objectivism and ethical relativism, are however in line with those identified in other nationalities. The biggest positive differences occur is in Machiavelist traits and legalistic, where Portuguese students have better results than their American counterparts, South African and Australian. In another work where ATBEQ was used, the differences were studied between the business philosophy of American students and Japanese (Shields, Comegys, Lupton, & Takei, 2013) and concluded that there weren't significant differences between genders. Our study found the opposite evidence, since it was possible to demonstrate that men have more pronounced Machiavellian traits which in turn are correlated to high fashion with an amoral view of the manager profession and with an orientation for the purpose at the expense of the means used. The conjunction of these two pieces of evidence allows us to suggest that maybe Portugal, despite being a culturally egalitarian country, is a country where the gender imbalance in executive positions within the company is motivated by the greater availability of men managers to meet amoral and focused strategic plans exclusively the immediate prosperity of the organization.

Age, gender and the subsystem of the HEI where the student belongs, have some influence on the ethical charge in the decision and a reduced impact on other moderators. Older students tend to decide more ethically. This result suggests the contribution of different factors, again not necessarily linked to education and more related to the life and professional experience of students. The older students who were studied probably have been subjected to experiences through their life, that today act as moderators of their decisions. The same relationship with age was found by other authors studying different types of individuals: as professionals (Brady & Wheeler, 1996; Kim and Chun, 2003), researchers (Kelley Ferrell, & Skinner, 1990), consumers (Brady & Wheeler, 1996) and, most relevant to this paper, as management students (Brown, Sautter, Littvay, Sautter, & Bearnaise, 2010; Ruegger & King, 1992 ; Stevens, Harris, & Williamson, 1993). As an individual ages his amount of social interactions and cultural experience increase. But that fact alone does not guarantee that these interactions and experiences would have a mostly positive effect on ethical considerations. It is suggested here, the possibility of this change being positively correlated with age, in a similar physiological dimension to the existential stage of moral development, as it exists in the normal phase of moral development (Gibbs, 2013, p. 96). Borkowsky (1998) considers that it's the maturity of the individual that causes this change in the ethical charge. In our study, gender was also identified as an ethical decision making moderator. Other researchers had shown that women decide more ethically in professional environments (Ameen, Guffey, & McMillan, 1996; Chan, Jamilah, & Rusinah, 2012; Fleischman & Valentine, 2003), usually because they are more sensitive and less tolerant of pernicious attitudes. The same trend was detected specifically in studies on management students (Cohen et al., 2001; Glover et al., 1997; Okleshen & Hoyt, 1996). As age, the evidence of gender while moderator of the ethical charge in the decision making process, come from samples in diverse cultures. Being transversally, the evidence weakens the use of occupational socialization theories, different in every culture, to justify it. Mason (1996), for example, found this difference only in women with an occupation related to management, but not in female management students. McCabe, Ingram and Dato-on (2006), who also studied management students suggest a generating mechanism of these gender differences, which requires a clarification between the concepts of sex and gender. Understanding sex as a physiognomic feature and gender as a socio-psychological complex construct, it prevents the second to be considered as a dichotomous variable. Their decomposition mechanisms and factors allows to identify two more present characteristics in females that these researchers have proven to be the mechanisms that generate the observed difference in the ethical burden of the decision: the sense of egalitarianism and expressive behaviours (such as to care, be emotional and affectionate).

It was found a very significant relationship between Machiavellianism traits and negative ethical burden in decision making. This is, however, not new to the social sciences. Since 1970 that several studies address this relationship with unethical decision making (Christie & Geis, 1970; Flynn, Reichard, & Slane, 1987; Jones & Kavanagh, 1996). These traits are mostly used in the decision-making process, to avoid penalties other than to obtain rewards (Flynn et al., 1987). Considering that managers are mostly confronted with decisions related to the negative impacts of business activity, this evidence is particularly alarming in the context of BE and CSR. A manager with this profile is more likely to incur in pose practices, deception and misinformation as in the case of greenwashing (Laufer, 2003).

The moral disengagement rates found in these students are low in absolute terms. However, it is important to note that the moral disengagement scale was initially created to predict and assess aggressive and transgressive behaviours (Bandura et al., 1996). Low values, but not minimum, are therefore relevant to this study, since it's not the propensity of some people to justify acts of war or torture (Aquino, Reed, Thau, & Freeman, 2007) that it's being studied, but the propensity to take part as moral agents of organizational decisions. Considering this, two of the behavioural cognitive reconstruction mechanisms have thus values rather higher than the rest: moral justification and the diffusion of responsibility. This result is slightly different from the obtained by Detert, Treviño and Sweitzer (2008) who have found minimal levels of moral disengagement among students who also attended a degree in Management.

The moral justification mechanism is especially relevant for organizations that see in CSR just a beautification and marketing tool, as seems to be the case for many companies in Portugal. If these organizations have on their staff, managers available to create a purely laudatory speech, relatively diffuse and difficult to confirm, framed in those who seem to be the common moral values of the community, then the hope of moving to a new development paradigm is null. The concept of moral justification is not, however, absolutely linear and can often be confused with self-defence concepts, protection of a greater good, acting in the interest of the common good, etc. It is, therefore, necessary to clarify that, rather than helping students to rationalize their moral justifications (which may even be legitimate), we need to help them understand when we are in the presence of an unfounded and Machiavellian moral "excuse" even if both concepts aren't always easy to distinguish.

The diffusion of responsibility mechanism is a topic widely studied in the field of human and economic psychology and is closely linked to group decision making. Students who show a greater susceptibility to this mechanism, may eventually come to take greater risks in their decisions and feel less responsibility for them, depending on the number of people involved. Considering that young managers are often recruited as interns by large corporations for their first job in crowded departments where they compete directly with peers for a limited number of admissions, this evidence is particularly alarming. After all, the practice of lying is more prevalent through the diffusion of responsibility among homogenous groups of employees (Conrads, Irlenbusch, Rilke, & Walkowitz, 2013). Future managers can thus take a decision, despite understanding the negative impact of it, overlapping their sense of belonging to the group and / or the possibility of career advancement, to the relevance of that impact. This is not, however, critical to the training of the decision group but rather to the need to train the inhibition of this mechanism in the classroom.

The diffusion of responsibility has also the potential to be a parasitic organism especially in bureaucratic and administratively complex contexts. It was also demonstrated in our study that moral disengagement is positively related to unethical decision making. This is a relationship already proven by Detert, Treviño and Sweitzer (2008) and Moore et al. (2012) have demonstrated that the propensity for moral disengagement allows to predict unethical behaviour in the workplace. Egels-Zanden (2015) suggested that the negative impacts of moral disengagement in management can spread through the entire value chain of an organization, including to its suppliers, through selective audit of these in quality assurance systems. All dimensions of sensitivity to CSR have a negative correlation with moral disengagement and a positive correlation with the ethical charge in decisions about ethical dilemmas. This means that students with greater sensitivity to these agents and subjects take more ethical decisions and are less susceptible to disengage from the cognitive mechanisms of self-censorship. Conversely, all philosophical traits studied with the exception of legalism, have a positive correlation with moral disengagement and a negative correlation with the ethical burden placed on the decision.

Among the personal motivations that contribute to a more ethical decision are demonstrably activism, the survival instinct and the desire for legal compliance. Understandably, the instincts of economic competitiveness don't have a noticeable effect on the ethical charge of the decision. Moral disengagement has a mediating effect over the relationship between Machiavellian traits, Social Darwinists and Ethical Relativistic, and the unethical decision. To enrol in a dedicated course of BE and CSR hasn't showed any statistically significant moderator effect over ethical decision making, or any of its moderators. It is possible to discuss that this lack of impact may be due to a complex set of factors, which may include: the absence of experiential methods in teaching, the choice of a prescriptive and deontological ethics approach in teaching, not based on a notion of common good and a paradigm of sustainable development, the personality traits of students and the mixture of expectations and fears inherent in the socio-economic Portuguese context. The fact that these dedicated courses have a null impact on sensitivity to CSR, business philosophy and ethical considerations in decision making shows that the Portuguese Higher Education is not helping to create managers with a sustainable consciousness. This lack of interest may help to perpetuate and disseminate harmful practices within companies, such as organizational corruption and bullying. Detected Machiavellian traits and Ethical Relativism, should they be encouraged, could turn some of these students in callous and cold-blooded managers. This danger is increased by the defective ethical sensitivity of students and some of its moderators, including mechanisms of moral disengagement.

5. Conclusions

Sustainable development demands managers to look at their organizations as complex, interdependent and accountable parts of a much greater system that needs to be much more co-operative to remain viable. To make Business Ethics and Corporate Social Responsibility a vital part of a business plan, managers must be empowered with tools which will enable them to rationalize problems in a SD framework and deal with ethical issues in their decisions. We found that although undergraduate business students in Portugal, have a high sensibility towards many of the CSR dimensions and stakeholders, still they're not very proficient in identifying the moral intensity of an issue. Also, Portuguese management undergraduates show strong Moral Relativistic and weak Social Darwinist traits, which may be a consequence of an underdeveloped labour market and a certain aversion to risk. We showed that although a higher sensibility to CSR correlates with more ethical decisions, traits like Machiavellianism, selfishness and a consequentialist orientation towards goals correlate with the opposite: unethical decisions. While CSR sensibility is teachable, philosophical traits aren't usually easily permeable to external influence which makes them a cornerstone for ethical decision making. Other moderators, where no change can be forced, seem to also influence the ethical considerations in a decision: age and gender.

We also showed that moral disengagement is a mediator for unethical decisions and that Portuguese undergraduates are especially prone to two of its mechanisms: moral justification and diffusion of responsibility. Finally, we found that dedicated courses on BE and CSR, in their current form, have no impact in any of these sensibilities or ethical decision moderators and mediator, neither they have any relevant impact in the student's decision process itself. In a time where sustainable development is already the current paradigm for all the natural sciences, the responsible for management education need to choose and accept the consequences for the side they take in this battle.

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Open Innovation for Sustainable Innovation and its Influence on Performance

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Abstract

Considering sustainability aspects in corporate innovation can lead to competitive advantages but at the same time increases complexity and requires extensive know-how and additional competencies. Thus, pursuing an open innovation approach can be seen as one strategy leading to innovations in the context of considering triple bottom line principles. In line with this, open innovation for sustainable innovation has to be understood as an outside-in process where external knowledge is gathered to support the internal development of sustainable innovations. However, so far only limited research has been carried out in this field and due to the fact that the concept of eco, green and sustainable innovation has not been clearly defined yet, the adaptation of the relevant concepts and their further combination with the open innovation approach is still in its infancy. Open innovation and sustainable innovation still appear to be two relatively distinct fields in research though, and also have not been applied extensively in firms too. In this context, the aim of this research was to investigate the application of open innovation for sustainable innovation in a cross-industry sample in Austria (n=85). We did so by conducting a quantitative empirical research study. This study has been executed between September 2014 and April 2015. Two questionnaires were sent to CEOs and innovation/R&D managers separately, which allowed a limitation of the potential common source bias to be imposed. In order to proof to which extent the existence of open innovation for executing sustainable innovations has an influence on the company's economic innovation performance (EIP) and sustainability economic performance (SIP) a benchmarking analysis was applied. Benchmarking is commonly used to identify success factors. In order to identify the benchmark group, we calculated the top 20%-quantile of the performance metric and, thereby, identified the benchmark firms. The same procedure was replicated for the bottom 20%-quantile to identify a low-performer comparison group. In addition, the Pearson correlations between all investigated variables and performance measures were calculated based on the entire sample. The correlation coefficient and its significance provided further information about the relationship existing between each management practice and firm performance. The main finding is that there is a positive correlation between EIP and SIP, which means that profitability and sustainability are not in conflict with each other. Moreover, our findings imply that a) customers are (still) the most important cooperation partners in terms of EIP and SIP; b) intermediaries play a crucial role for achieving sustainability-related goals; c) cooperation with universities specifically fosters EIP; d) cooperation with NGOs facilitates EIP and SIP; e) awareness for sustainability increases both EIP and SIP; and f) a formal innovation strategy, comprising economic as well as sustainability goals, is one additional success factor. To conclude, open innovation for sustainable innovation has a positive influence on performance whereby companies that are outstanding in terms of their EIP are also likely to be outstanding with regard to the SIP.

Corporate Sustainability and CSR: The Indian Context

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Abstract

Please insert your abstract text here as a single paragraph. Text alignment is formatted as justified. 21st century is the century of sustainability. The Sustainable Development Goals (SDG), officially known as 'Transforming our world: the 2030 Agenda for Sustainable Development', are set of aspirations of nations with 17 goals having 169 targets. Nations alone cannot achieve these goals. Therefore, not only the communities, municipalities, districts, states or nations but even the corporates need to be sustainable. Corporates, some of them having greater budgets than quite a few nations, need to actively share responsibility in achieving these sustainable development goals. The concept of corporate sustainability, thus, came into being. Corporate Sustainability is in broad sense, the corporate response through strategies and practices that address the key issues for the world's sustainable development. Global Reporting Initiative, formally inaugurated as a UNEP collaborating organization, issued the initial Guidelines for sustainability reporting, which steadily improved, the latest being the fourth generation of Guidelines (G4). Issued in May, 2013, it offers Reporting Principles, Standard Disclosures and an Implementation Manual. Most of the corporates, world over, are presently providing their Sustainability Report under G4 guidelines. Some pessimists, however, believe this voluntary economic, environmental, and social reporting as mere glossy pages and a Greenwash. Of late, the realm of legal requirements relating to sustainability and CSR has emerged. The Danish Parliament was the first to bring a legislation making it compulsory for their large enterprises to report their corporate CSR investment policies. They legislated that such investments should be included in their annual financial reports from the year 2010. This was followed by recent developments in the European Union and India. In fact, India was the first country to legislate CSR reporting and spending in 2013 itself through amending its Companies Act, according to which a company must establish a CSR Committee comprised of at least three members of the board of directors. No doubt, corporate social responsibility ("CSR") reports have proliferated; most of them were not outcome of legal requirement but a reaction to public or internal pressure. In India, while sustainability report is voluntary, CSR report is a legal requirement. While meeting this legal requirement, Indian companies are trying to make it a business case. This paper contributes to the ongoing theoretical development of corporate sustainability and corporate social responsibility. After discussing how the concept of corporate sustainability and corporate social responsibility have evolved, the author's delve into the only legislation on CSR in the world that India has enacted and the implementation of this legal provision and impact thereof.

Keywords: Global Reporting Initiative, Sustainable Development, Corporate Social Responsibility, Business Case

The strategic potential of a Portuguese corporate sustainability index (ISE): resilience and vulnerabilities of BCSD-Portugal associated companies towards global risks

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Abstract

The last decade show a large proliferation of corporate indexes for measuring sustainability performance. Indexes became popular as they allow a systematic comparative ranking in sustainability performance, setting benchmarks and expanding the visibility of well-ranked companies. Over the years such reporting has been strongly influenced by the Global Reporting Initiative thematic indicators, however missing an assessment process as well as a lack of a strategic view over the results provided. In Portugal, in 2008 a Corporate Sustainability Index (ISE – Indice de Sustentabilidade Empresarial) was created by Instituto Superior Técnico, in partnership with the Business Council for Sustainable Development (BCSD) Portugal. The ISE purpose has been to establish the metrics for comparative evaluation of corporate sustainability performance of the associated companies of BCSD-Portugal. ISE architecture (top, descriptive and singular indicators), has 4 years of application to more than 40 companies/year. It was designed as an instrument of the Corporate Sustainability Observatory (OSE). A key component of the process to inform both OSE and ISE is SMOSE, a monitoring system. The OSE and ISE have the purpose of communicating the performance of BCSD member companies, to enable a comparison of how these companies perform in relation to other Portuguese companies, and to develop a benchmarking system to position the ISE sample companies at national and international levels. The overall objective is to validate results and contribute to improve performances. This paper aims to show ISE contribution for corporate sustainable management, outlining the operational side, and the interdependencies between ISE, OSE and SMOSE, and why ISE is distinct from other indexes based on four aspects: i) sustainability integration beyond the dimensions proposed by the triple bottom line; ii) the uses of a reduce number of top themes to reflect the competitive factors of companies sustainable development (i.e. 5 top indicators - Energy and Climate Change; Biodiversity and Ecosystem Services; Sustainable Production and Consumption; Strategic Leadership; Human Capital); iii) identical importance to each top theme; and iv) qualitative and quantitative inter-related criteria. A second aspect is the strategic potential of ISE, by exploring a qualitative and quantitative analysis of the ISE 2014 companies results in relation to the global risks 2015 areas - Economic; Environmental; Geopolitical; Societal; Technological - according to the World Economic Forum, in order to identify overall resilience and vulnerabilities of corporations as well as company's individual behaviour when analysing specific questions of ISE 2014. This revealed to be a valuable contribution for strategic management reflections on companies sustainable development. Key conclusions point to the increased level of comfort of ISE participative companies in relation to the physical side of sustainability, and the discomfort with the non-physical side (e.g. leadership). Furthermore, ISE 2014 indicates that companies deliver a sustainability performance above national average, although some present a surprisingly resilience in some aspects, and others a high vulnerability to aspects that are core to their business - indicating the need for a qualitative and deeper analysis to integrate corporations indexes results strategically.

Keywords: sustainability, sustainability indexes, corporative resilience, corporative vulnerabilities, strategic management

Reactive or proactive approach towards sustainability? A conceptual framework based on sustainable business models to increase stakeholders' sustainable value capture

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Abstract

Indications towards the need for development and implementation of solutions for more sustainable development are not recent. However, the world is still struggling to tackle these challenges, and sustainability is not an optional agenda, but rather it is an obligatory and necessary issue for the various actors in society. This is also valid for organizations, which are expected to assume a more proactive and entrepreneurial posture towards tackling sustainable development challenges. In this sense, sustainable business model approach can support organizations to be more sustainable, serving as instrument to help companies describe, analyze, manage and communicate their sustainable value proposition, creation, delivery and capture mechanism. In particular, this research focuses on value capture dynamics, aiming to explore how companies can increase their contribution to sustainable development by fostering sustainable value capture of their stakeholders. Thus, we bring a literature review to discuss the mechanism of two approaches: the reactive and proactive approach. The first logic is about satisfying stakeholders' needs and wants, reacting to their demands. A more reactive approach to stakeholders' expectations is supported by motivations derived from marketing, corporate social responsibility, international standards, sustainability reporting, labelling, etc. However, these demands are not always aligned with sustainability, creating tensions between stakeholder satisfaction and corporate sustainability. In this sense, a proactive approach to foster sustainable value capture can complement the reactive approach by delivering value beyond stakeholders' expectations. In this case, companies use their capabilities to identify opportunities to create and deliver sustainable value that stakeholders were not expecting or demanding, but that are positive in terms of sustainability. The proactive approach on managing stakeholders finds its justification on questioning companies about their institutional role in society, demanding sustainability innovation in companies' business models and challenging companies to seek for business opportunities with an entrepreneurial attitude to help solving sustainable development challenges. By combining both approaches, organizations have the opportunity to increase sustainable value capture by its stakeholders, acting on their institutional responsibility as actors in the societal system. Thus, future researches are invited to contribute to further theoretical and empirical discussions to explore the potentials of fostering sustainable value capture.

A Cascade System for Sustainability Management in Enterprises

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Abstract

The concept of sustainable development is often considered by industrial enterprises as vague and hardly operational. Moreover, the word "sustainability" in relation to industrial activities has been so heavily overused, with too many different meanings applied to it. To make it operational, sustainable industrial development may be considered as a process of continuous improvement of environmental, economic and social performance in industry. Such approach allows specialists to identify particular process performance parameters that could be controlled and managed. Integration of sustainability management into the overall business planning is very important aspect to be tackled because efficiency of management systems largely depends on connections between the management systems and strategic/ financial decision making. Enterprises often lack explicit information about their activities, particularly reliable quantitative information on technological processes and various sustainability aspects. Moreover, the existing data information is seldom systemised in a suitable form for effective decision making. The main research goal was to develop the concept and the structure of the sustainability management system, based on the analysis results, authors' and other researcher's experience. The research method was based on the performance analysis of more than 100 resources efficient and cleaner production innovations implemented in Lithuanian industrial companies in the period 1995-2014. Despite the fact that implementation results have showed good economic and environmental benefits, it was revealed that resource efficient and cleaner production, eco-design, and sustainability reporting are seldom sufficiently integrated in management system, without mentioning corporate social responsibility. To ensure effective decision making aimed at improvement of sustainability performance, a cascade sustainability performance management system based on three hierarchical levels (process, activity and strategic decision making) was elaborated and recommended for use in enterprises because it ensures involvement of decision makers at all sustainability levels and enables collection of information needed for effective decision making at different managerial and operational levels. The cascade model presents the key elements of environmental management system and other sustainable industrial development tools in a sequence of integration. The material presented in this paper is based on the authors' theoretical and practical experience gained from a number of national and international projects which focused sustainability performance improvement and were implemented jointly by industrial enterprises.

Keywords: Resource efficient and cleaner production, Continuous improvement, Cascade environmental management, Performance indicators, Sustainability

1. Introduction

Sustainable development at an organizational level is usually described to use a triple bottom line that divides performance into economic, environmental and social dimensions (Topfer, 2000; Elkington, 1997). Hence, sustainable industrial development may be defined as a strategy for adopting activities to meet the needs of enterprises and other stakeholders today, while protecting, sustaining and enhancing the human and natural resources that will be needed in the future. Moreover, the word "sustainability" in relation to industrial activities has been so heavily overused, with so many different meanings applied to it, that it has become quite meaningless (Aras and Crowther, 2009).

To ensure contribution of industry to the process of sustainable development, there is a need to explain in operational terms what the concept of sustainable development means to industry and, more specifically, to an industrial enterprise. To make it operational, sustainable industrial development may be considered as a process of continuous improvement of environmental, economic and social performance in industry. Such a process approach allows industrial specialists to identify particular process performance parameters that could be controlled and managed. In this context, sustainability performance can be interpreted as a result of management of sustainability aspects in enterprises. Thus, sustainability management can be defined as “a profit-driven corporate response to environmental and social issues that are caused through the organization’s activities” (Salzmann et al., 2005).

One of the key approaches to increase sustainability performance of enterprises is cleaner production and environmental management system. However, cleaner production is (in general) diffusing comparatively slowly despite good results achieved (Bonila et al., 2010). It could be also stressed that management systems are often implemented with a “certificate-oriented” approach whose efficiency in terms of sustainability performance improvement is low (Iraldo et al., 2009). Even if management systems are implemented with a “performance-oriented” approach, enterprises might not be able to realize their full potential for performance improvement. One of the reasons is lack of motivation to maintain the system after certification (Pedersen and Nielsen, 2000).

It should be also stressed that one of the difficulties in measuring the company’s level of sustainability is to determine which directions of change are leading towards sustainability (Krajnc and Glavic, 2004). “When properly done, a sustainability analysis of a system of interest, which can either be products, or processes, or corporations, or even ecosystems, should include indicators used to quantitatively represent the system from the viewpoint of environmental, economic, and societal impacts, in accordance with the basic principles of sustainability“ (Sikdar et al., 2012).

There are several internationally acknowledged sustainability/ environmental performance evaluation/ reporting initiatives and methodologies. The first comprehensive list of environmental performance indicators was developed and recommended by the German Environment Ministry (BMU) and Federal Environmental Agency (UBA) in 1997. Soon after that, in 1999, international standard ISO 14031 for environmental performance evaluation was introduced by the International Standard Organization followed by sector-specific initiatives, for example, a sustainability performance evaluation initiative of the Britain’s Institution of Chemical Engineers (Sikdar, 2003). Eco-Efficiency Assessment was developed by the World Business Council for Sustainable Development in 2000. Global Reporting Initiative (GRI, 2015) is intended to assist enterprises to assess performance and to improve communication with stakeholders (Bass and Dalal-Clayton, 2012). For selection of initial environmental indicators, the specific indicator systems for particular industrial branches could also be used (Pohjola, 2005; Enroth, 2006; Viluksela, 2009).

One of the main strengths of the above mentioned methodologies in the context of sustainability performance management is a possibility to use benchmarking, because a standard format is used for reporting of sustainability performance. At the same time, a significant shortcoming of existing sustainability performance evaluation systems is their focus on external reporting and underestimation of the internal information needs for decision-making, i.e. for increased management efficiency and for actual performance improvement. Furthermore, a concern is sometimes expressed that sustainability reports published by enterprises are only “green-wash” intended to improve the company‘s public image. For example, a review of the frameworks of business sustainability indicators has shown that they present simple lists of indicators with little or no guidance as to how to apply them over time to become more sustainable (Veleva and Ellenbecker, 2001).

These shortcomings can be partly explained by the fact that one of the main driving forces for sustainability performance evaluation is often a pressure on an industrial enterprise from external stakeholders to publish sustainability performance information. It could also be related to establishment of “socially responsible” investment funds and investment rating systems, e.g.

"Dow Jones Sustainability Index" (Ballou et al., 2006). It could be stressed that efficiency and the value added of the performance evaluation system for an enterprise depends mainly on the strength of internal motivating factors and ability of enterprises to apply sustainability performance indicators properly. They are to be focused more on the information needs for decision making at an enterprise level (Staniškis and Arbačiauskas, 2009). Generally, main drivers for enterprises to act in sustainable ways are market place demands, changes in business procurement, government legislation and regulation, the rise of socially responsible investment, competitors' actions and the changing expectations of employees (Epstein, 2008; Pryce, 2002).

Enterprise's system consists of operations and processes, management and strategy, organisational systems, procurement and marketing, assessment and communication (Lozano, 2012). Taking into account that there is no particular standard for sustainability management, researchers and practitioners try to fill this gap.

The objective of this article is twofold: (i) to present a structural model for integration of sustainable industrial development tools; and (ii) to present hierarchical procedure for sustainability management and to provide recommendations related to the selection of performance indicators.

The structural model presents the key elements of environmental management system and other sustainable industrial development tools in a sequence of integration. Distinctive features of the proposed model are integration of sustainability aspects and criteria at operational level, and shift of conventional management system to sustainability management system as. Hierarchical procedure for sustainability management covers process, activity and strategic decision making with legal and other requirements as well as a new scientific knowledge and stakeholder expectations constituting the system input information. Decision makers at different hierarchical levels are provided with the feedback information based on the indicators of enterprise's sustainability performance.

The material presented in this paper is based on the analysis of relevant literature and on practical experience of the authors gained from a number of national and international projects focused on improvement of environment/ sustainability performance and implemented jointly by industrial enterprises and the Institute of Environmental Engineering (APINI), Kaunas University of Technology (KTU).

2. Methods

Sustainable industrial development tools generally address different elements of an enterprise system: operations and processes, management, communication, etc. At the same time, these tools contribute to different dimensions of sustainability (environmental, economic and social). Lozano (2012) proposed a framework for selection of tools (Corporate Integration of Voluntary Initiatives for Sustainability (CIVIS) framework). Main criteria include full coverage of the enterprise's elements and all dimensions of sustainability (including the time dimension).

Analysis of different approaches/ tools suggests that application of the following approaches/ tools covering all key elements of an enterprise system (production, products, management, and communication with internal and external stakeholders) could be used to ensure sustainability performance improvement in enterprises:

- Resource efficient and cleaner production approach (RECP) to improve production processes. This approach is based on rational use of energy and natural resources and minimization of pollution/ waste at the source where it is generated. Resource efficient and cleaner production assessment can be used as a tool.
- Eco-design approach to improve product characteristics. Checklists and eco-indicator 99 are perhaps the most suitable tools for SME's to implement this approach.
- Integrated management systems to keep continually applied and incorporated into enterprise system above mentioned approaches and to improve management practices. The basis of management systems is development of a cycle for continuous performance improvement.

- Sustainability reporting based on sustainability performance evaluation to improve communication with internal and external stakeholders.

Nowadays, most of the companies integrate their management systems. However, cleaner production, eco-design and sustainability reporting is seldom sufficiently integrated in management systems, despite the fact that efficiency of these tools depends largely on their integration level in the overall strategy of enterprises and everyday activities.

Experience of the authors suggests that one of the ways to increase motivation of maintaining management system and ensuring its efficiency is systematic/ integrated use of cleaner production and other sustainable industrial development tools listed above. Sustainable industrial development measures may be integrated using a classical “plan – do – check – act” management cycle used in management system standards. Systematic and integrated application of these measures may enable an increase in their efficiency and may lead to cost savings associated with more efficient use of human and natural resources, improved product characteristics, more effective operational procedures, reduced waste generation and harmful emissions to the environment, etc.

Integration of different environmental and other management tools is not particularly novel but practical models for enterprises to meet sustainable development requirements are lacking. In a given case, environmental management system is taken as a basis for integration of sustainable industrial measures (Fig. 1). The structural model presents the key elements of environmental management system and other sustainable industrial development tools in a sequence of integration. The level of improvement of environmental performance depends largely on the planning phase, when the potential for performance improvement is systematically analysed and preventive measures are developed. To identify preventive performance improvement options, cleaner production methodology could be used, when a set of alternatives is developed for each significant aspect. Environmental, technical and economic feasibility analysis leads to development of action programmes for implementation. In the given case, both process and product improvement options are considered. A set of sustainability performance indicators has also to be developed in a planning stage to ensure effective decision making.

Distinctive features of the proposed model are integration of sustainability aspects and criteria at operational level, and shift of conventional management system to sustainable management system, but still social dimension is missing.

One possible link between sustainability modelling and control engineering could be so called cascade closed-loop management system. The system theory views this management as a hierarchy of successively higher-order systems in which the control of the smaller, more immediate events employing less energy in the lower-order systems brings about larger, more distant, events involving more energy in the outer higher-order system loops. Although the processes of the inner loops must be of lower magnitude and of higher frequency than those in the outer loops, management of the inner loops is more possible and, by influencing the rates of change of the higher-order loops, provides a wider range of choice in influencing the behaviour of the outer loops. Thus the output from the inner loops proceeds to the outer loops as a hierarchy of management is ascended. The inner loops are susceptible to short-range planning in order to bring about longer-term changes in the outer loops, but is also clear that such management usually involves complex and flexible inner loops restrains which are required to produce more simple long-term changes in the outer loops.

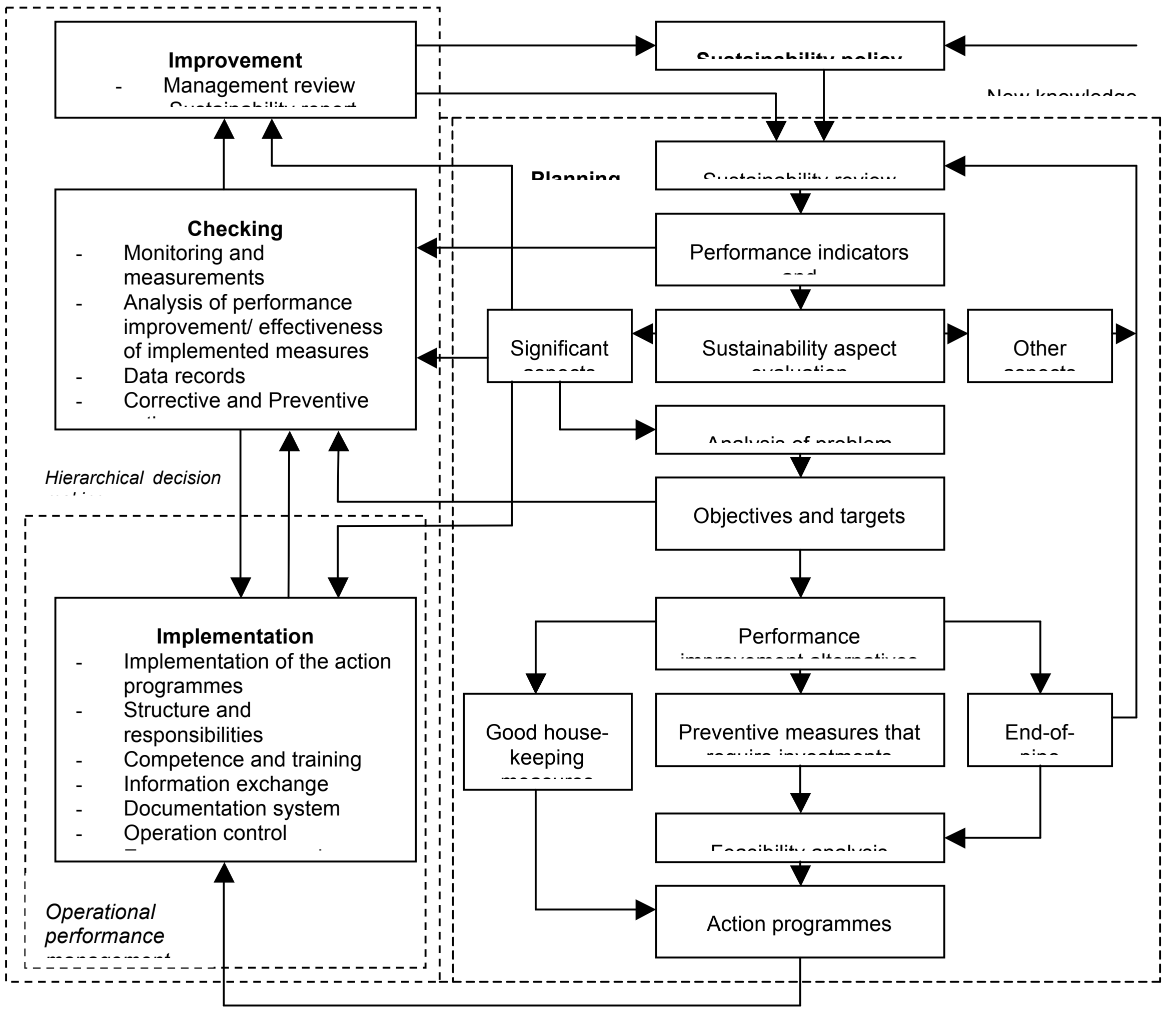

Figure 1. Structural model for integration of key tools of sustainable industrial development into classical management system.

To ensure effective and systematic application of the key tools of sustainable industrial development and to support their integration, enterprises are recommended to use cascade system for sustainability management (see Fig. 2). Such a system may help to increase effectiveness of the decision making process and to facilitate reorientation of a problem solving approach from reactive to proactive/ preventive including social dimension.

The proposed system of sustainability performance management is based on a hierarchical approach to decision making. The system covers process, activity and strategic decision making with legal and other requirements as well as a new scientific knowledge (stakeholder expectations and scientific knowledge) constituting the system input information. The control system also relies on feed-back information from several process stages. Decision makers at different hierarchical levels are also provided with the feedback information based on sustainability performance indicators of the enterprise. Such approach enables to increase participation of employees in problem solving at different levels of enterprises. Process indicators (level I) provide information to the enterprise personnel on the process efficiency and help identify both the deviations from technological specifications and the measures for improving the process efficiency. In the context of management systems, process indicators facilitate operational control.

Activity performance indicators (level II) are used at process, product, department and enterprise levels and present the “digested” information obtained from a detailed analysis of processes, products and services. These indicators are particularly useful for decision making in terms of identifying the priority areas for sustainability performance improvement and generating particular improvement measures. It is very important to monitor performance indicators to make the right decisions on time.

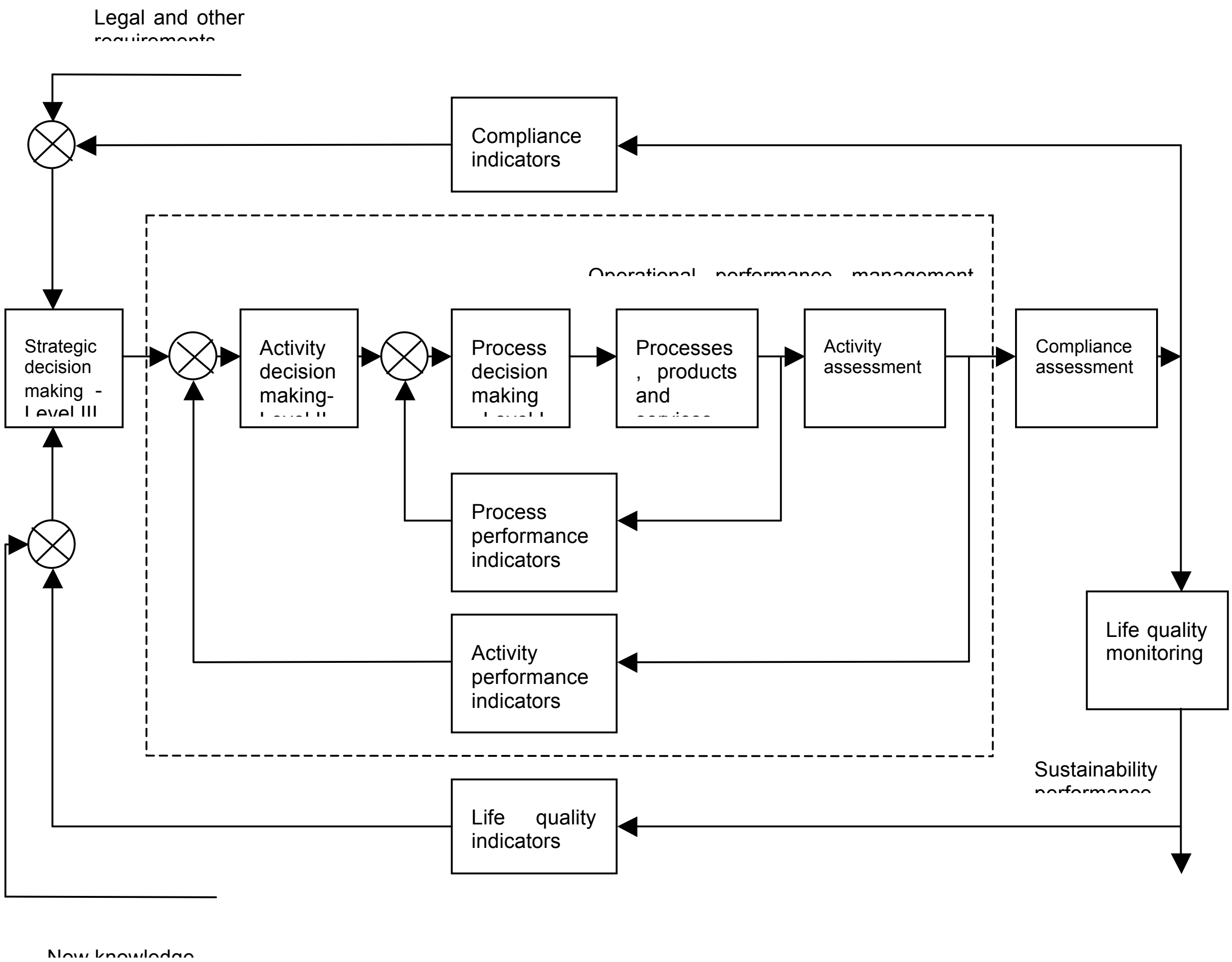

Figure 2. Cascade system for sustainability management at an enterprise level.

Compliance and life quality indicators are used in the level III. Compliance indicators cover the following areas: legal compliance, compliance with the other requirements as defined in the management system standards (e.g. requirements specified in the contracts with other organizations), and achievement of objectives and targets specified in the management system documentation or other documents. The information contained in life quality indicators is a result of monitoring or statistical activities performed by the enterprise or other organisations. These indicators cover the natural environment, the work environment, social and economic spheres. Such indicators may reflect air quality in the vicinity, biodiversity in nearby water bodies, quality of the work environment and other health & safety issues, an employment rate in the local community, etc. Life quality indicators may be used in identification of strategic directions to the enterprise's efforts to reduce an environmental impact and, more generally, to improve sustainability performance.

Generally, an indicator provides useful information about the system; it can be used to describe the state of the system, to detect its changes and to show the cause and result relationships

(Mille, 2001). Indicators may be quantifiable (quantitative) and non-quantifiable (qualitative). The best approach is the combination of both methods (Diakaki et al., 2006). It terms of the expression, there are four types of quantifiable indicators: absolute indicators, relative indicators, aggregate indicators and indexed indicators. Aggregate and indexed indicators integrate the data into particular categories or into one number presenting the level of performance. Such indicators may be useful in the overall assessment of the enterprise's performance, but they lack detailed information and it limits their practical use in terms of improvement opportunity identification for performance optimization. In this respect, the use of absolute and relative indicators is recommended. Nevertheless, indexed and aggregated indicators can be useful in sustainability reporting. Finally, performance indicators can be expressed in natural and monetary units.

Taking into account the nature of decision making (e.g. strategy development, innovation generation), performance indicators can be defined at enterprise, department or process levels. Moreover, to ensure legal compliance and adequate response to negative changes in the environment in relation to enterprise's activities, a set of compliance and environmental condition indicators has to be selected. In addition to traditional sustainability indicators, such as economic, environmental and social ones, communication indicators may be considered, too. However, it should be stressed that although the number and nature of the indicators chosen s may differ from the system type to system type, the alternatives to be compared must use the same set of indicators (Sikdar et al., 2012).

The question for cascade management system usually is of what types of indicators should preferably be used for particular purpose (level of decision making). For example, absolute process indicators (technological parameters) are best suited for process decision making as they enable efficient process control. Relative compliance and life quality indicators are effective in strategic decision making but are not useful for decision making at process level. Generally, indicators at higher hierarchical levels (from process to quality of life indicators) are more useful in strategic decision making. In development of a set of sustainability performance indicators, application of a hierarchical approach that corresponds to the level of the enterprise‘s ambition in its performance evaluation may be useful as it helps industrialist to keep a clear and relevant structure/ composition of the performance evaluation system. The enterprise can start from the evaluation of compliance/ resource use efficiency and with a gradual development of experience it continues with a more sophisticated performance evaluation. The following hierarchy that has five levels in relation to the basic principles of sustainability may be used: (i) facility compliance/ performance (e.g. a number of notices of violations); (ii) facility material use and performance(e.g. heavy metal emissions to water in tons per year); (iii) facility effects (e.g. carbon dioxide emissions from energy use in million tons); (iv) supply chain and product life-cycle (e.g. post-consumer recycled material used); and (v) sustainable systems (e.g. percent of the total energy used from renewable sources harvested in a sustainable way) (Veleva et al., 2003). A particularly important aspect in selecting sustainability performance indicators is a product life cycle approach. Frequently, enterprises limit their performance analyses to the production and other internal processes, sales and general economic indicators. Finally, to develop an operational system to bring value to the enterprise, the key requirements for sustainability performance indicators should be fulfilled. The requirements for good indicator are following: target orientation, comparability, measurability (access to data), meaningfulness (scientific reliability or analytical soundness), integrity (capability to relate to other indicators), continuity, clarity, efficiency. For each indicator should be defined key attributes like unit of measurement, type of measurement (absolute or adjusted), period of measurement and boundaries (Veleva and Ellenbecker, 2001). In practice, enterprises seek to have a manageable number of indicators, that are clear and easy to measure/ monitor, that provide possibility to compare with best practices.

The internationally acknowledged sustainability performance evaluation systems, e.g. Global Reporting Initiative, should be preferably used as reference materials. This will help any enterprise develop a functional and effective performance evaluation system that fully reflects its values and needs. This recommendation may be supported by the findings of other researchers (Keeble et al., 2003; Searcy et al., 2005).

3. Results and discussion

To ensure the progress of sustainable industrial development, enterprises have to address the sustainability aspects related to production processes, management practices, products, and communication with internal and external stakeholders by applying cleaner production, product oriented tools (e.g. eco-design), integrated management systems and sustainability reporting based on sustainability performance evaluation.

In Lithuania business development service provider's role was fulfilled by KTU Institute of Environmental Engineering and the role of financing institution – by Nordic Environment Financing corporation (NEFCO). RECP assessment is one of the basic grounds for RECP investment project development according to the methodology presented above, which covers:

- RECP pre-assessment (RECP audit preparation; division of processes into unit operations; construction of process flow diagrams linking the unit operations);
- material balance (determination of process inputs and outputs; derivation of a material balance (gathering the input and output information, deriving a preliminary material balance, evaluating and refining the material balance);
- synthesis (identification of RECP innovations; environmental, technical and economic evaluation; design of RECP action plan);
- the company's "economic health" analysis;
- the development of a RECP investment project.

For each RECP investment project, a supervision and monitoring plan is prepared as part of the loan application. The company has to provide APINI experts with a possibility to inspect goods, sites, factories, installations and construction sites included in the investment project, any related documentation, and to supervise the implementation of the project.

Financial and physical performance indicators are specified in the loan agreements. Environmental performance indicators (EPIs) monitor the company's effectiveness and efficiency of resource management. This applies mainly to physical resources (materials, etc.).

For each project, the realised savings are verified and compared with the expected savings. A standardised reporting format is provided, with a focus on savings in energy use, water use, use of chemicals, etc. The environmental effects of each project are verified. This verification should document the reduction in emissions and wastes and the reduction in inputs (water, energy, chemicals, etc.). The mentioned standardised format ensures the management of all RECP innovation data in a special database at APINI. The data in the database are continuously updated.

In conventional cost accounting, the aggregation of environmental and non-environmental costs in overhead accounts results in their being "hidden" from the management. There is substantial evidence, based on experience of Lithuanian industrial companies that the management tends to underestimate the extent and growth of such costs. By identifying, assessing and allocating environmental costs, environmental accounting allows the management to identify opportunities for costs savings. For example, it can be said that more than 29% of environment-related measures in the Lithuanian companies that had developed RECP investment projects were re-estimated using the APINI-NEFCO approach, allowing to reallocate the investments and to get significant environmental and economic benefits (Staniškis, 2012).

The main reason for the differences between the calculated and the real results is the increase/decrease of production volumes. Also, it should be stressed that continuously increasing prices of natural resources and raw materials help to keep or even exceed the expected theoretically calculated savings. Therefore, the success of RECP in Lithuania can be measured by environmental and economic benefits. Below, the real data from the APINI RECP data base are presented (see Table 1.):

Table 1. Results from implemented RECP innovations.

Number of companies	126
Number of implemented RECP innovations	211
Environmental results (yearly):	
El. energy consumption reduced	27 584 000 kWh
Heat energy consumption reduced	60 518 000 kWh
Waste amount reduced	86 700 t
Chemicals consumption reduced	850 t
Air emission reduced	79 500 t
Drinking water consumption reduced	297 500 m3
Diesel consumption reduced	387 000 l
Environmental results (yearly):	
Natural gas consumption reduced	5 883 000 m3
Fuel consumption reduced	656 800 t
Wastewater amount reduced	622 500 m3
Industrial water consumption reduced	468 900 m3
Economic profit:	
Total investment in RECP innovations	16 529 000 EUR
Yearly savings from RECP innovations	9 605 000 EUR

Key conclusions and future trends include: Cleaner production is a more and more important part of the planning, design, operation and management in all industrial sectors. To assess and evaluate progress towards more sustainable systems, it is essential that proper monitoring and management of the environmental and social impacts is done on a regular basis and that results are used to help focusing societal attention on ways to make further improvements towards sustainable societal lifestyles (Klemeš et.al., 2012).

It is clear that all RECP innovations presented in Table 1 demonstrates economic and environmental results, but the social dimension of sustainability is missing. For several heat energy production based on alternative fuel units the cascade management system was introduced (see Fig. 3). This illustrates the cascade of emissions into atmosphere producing an air quality which is monitored not only emissions at the stack, as it was in RECP case, but the air quality in the atmosphere and in terms of public health, each of which produces a negative feedback loop designed to improve life quality. The system consists of three loops, where time constant/inertia of the first loop T1 is lower than of the second loop T2 and time constant/inertia of the second loop T2 is lower than of the third loop T3 (T1<T2<T3).

The cascade management system was used in few heat production companies which have switched from fossil to alternative fuel and where resource efficient and cleaner production management system was installed (see Fig.1, Table 1). The economic and environmental benefit in most cases was the same, but social effect was evident (less sick leaves, higher trust and satisfaction of employees, better image in the region, etc.), i.e. better quality of live. Different investigations has showed that both the improvement in the services that are provided as well as the way they are exercised from environmental and social perspectives influence one‘s perception of quality of life (Bayulken and Huisingh, 2015).

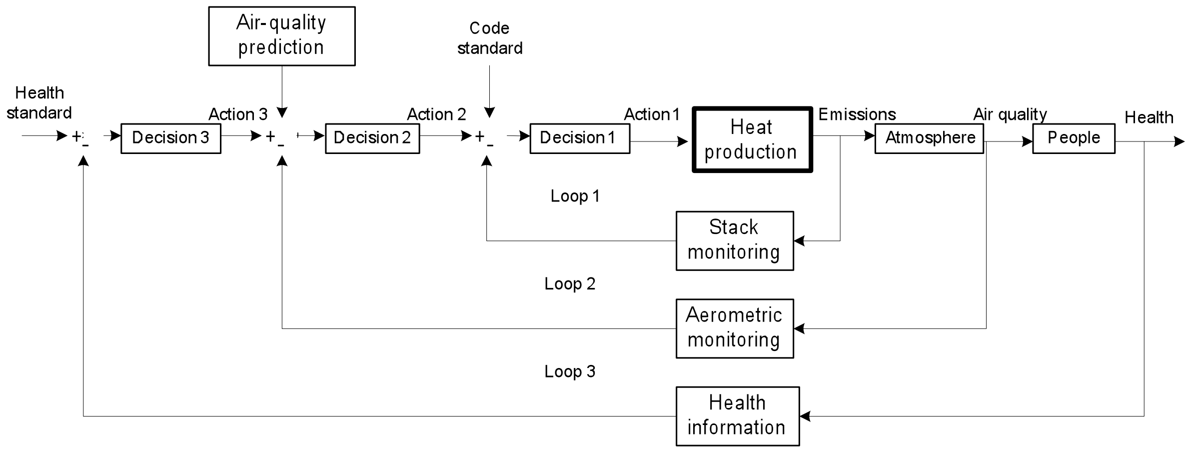

Figure 3. Cascade management system for heat production unit sustainability.

But still it is generally accepted that preventive approaches, e.g. resource efficient and cleaner production methodology, in some cases make it possible to eliminate the need for pollution control (end-of–pipe) technologies or to reduce the capacity of the pollution control equipment. This may lead to significant financial savings in addition to a reduced impact on the environment, possibly, to improved work conditions and improved product quality. However, decision-makers are often "too quick" in finding solutions to particular problems. Real causes of a problem are seldom analysed because the solution often seems to be "obvious", e.g. when a new legal requirement for the emission of a particular pollutant is introduced, decision makers are tempted to go along the easiest, but not the most efficient and economically viable way – to look for pollution control technology that would enable them to capture pollution. Additional data collection and analysis could help identify more alternatives for material substitution, production process modification or better control of the process as a result of additional training of employees. Moreover, enterprises often underestimate the performance improvement potential lying in good house-keeping measures that are easy to implement and frequently do not require financial resources.

Experience shows that management systems are often implemented using a "certificate-oriented" approach and their efficiency in terms of sustainability performance improvement is rather vague. Moreover, a lot of enterprises still rely on the end-of-pipe approach when dealing with environmental issues. Integration of sustainability performance management into the overall business planning and integrated application of sustainable industrial development tools discussed in this article leads to environmental, economic and social benefits. One of the side-effects observed is a positive change of employee thinking and improvement of the work culture. Moreover, integrated application of sustainable industrial development tools ensures continuous improvement of sustainability performance. There are investigation results suggesting that the combination of socio-economic and biophysical indicators is essential to provide a better understanding of the limits of economic growth and while ensuring sustainable societal well-being (Frugoli et al., 2015).

The proposed cascade management system requires features relative simplicity and takes life quality including social dimension perspective into account.

4. Conclusions

1. To be operational from a perspective of industrial enterprises, sustainable industrial development may be considered as a process of continuous improvement of environmental, economic and social performance in industry. A number of tools are available to industrial enterprises to be applied, but the best results are achieved by applying the key tools in an integrated way, because particular sustainable industrial

development tools are mutually supportive, e.g. environmental management systems are more effective when based on resource efficient and cleaner production and this methodology is applied more systematically when environmental management system is in place. Our experience has showed that a classical management cycle used in all ISO management system standards is the best for such integration and ensures significant economic and environmental benefits.

2. To ensure effective decision making aimed at improvement of sustainability performance, a sustainability performance management system based on three hierarchical levels (process, activity and strategic decision making) is recommended for use in enterprises, because it ensures involvement of decision makers at different levels and enables collection of information needed for effective decision making at different managerial and operational levels.
3. To ensure effective information flows for decision making, appropriate performance indicators should be selected. No standard set of performance indicators could be prescribed to an enterprise. To make sustainability performance evaluation meaningful in terms of the better enterprise management, enterprises have to develop their own sets of indicators that reflect their profile and needs. Standard performance evaluation systems could be used as a reference.
4. To satisfy the needs of decision making in enterprises aimed at continuous improvement of sustainability performance, four categories of performance indicators should be used: (i) process performance indicators, (ii) operational performance indicators, (iii) compliance indicators, and (iv) life quality indicators. Relative indicators are particularly useful in decision-making as they enable specialists to observe the changes of particular values (e.g. pollution) in relation to a common denominator (e.g. raw material or production unit). Aggregated indicators may also prove to be valuable in assessing sustainability of an enterprise.

It is to be hoped that the application of systems theory to sustainability management will encourage planners to give increasing attention to the structural character of the management system which enables to include in the performance index all the dimensions of sustainable development.

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Drivers which encourage the sustainable practices in the Manufacturing industries: a comparison between Europe and Asia

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Abstract

Firms are suffering great pressures to address sustainability issues, especially those who had a bad environmental reputation. Between them, high performance manufacturing companies highlighted since their production process are recognized for being highly polluted. In this context, they are trying to make many efforts through the implementation of practices to improve their environmental reputation. Several efforts have been done in order to identify what the drivers of these practices are: Top Management Support, Customers, Employees, Regulation and Industry; and finally, Cost. Notwithstanding, there is not much research that quantifies them. Being able to identify the practices that are enforcing the sustainability efforts in manufacturing plants is extremely relevant because otherwise the efforts would not the expected effect. Additionally, Institutional Theory provides the theoretical framework to consider that these drivers could have different importance depending on the culture of the country in which they operate. Consequently, the aim of this piece of research is to know if the kind of drivers (top management support, customers, employees, regulation and cost) that encourage more the sustainable practices into the High Manufacturing Companies differ across the groups of countries considered. The sample is composed of the answers given to a questionnaire by the managers of the companies implied in the IV Round of International Project of High Performance Manufacturing. Until the moment, we have evidence from 112 companies from Europe and 76 from Asia. To carry out our research, the Partial Least Squared (PLS) technique has been used due to their benefits considering the items, the characteristics of the samples and the objectives proposed. The results presented allow concluding that the drivers which more encourage the sustainable practices are not the same in European and Asian companies. While the drivers focused on the regulation are those which have a higher impact on the sustainable practices of the European High Performance Manufacturing companies, drivers related to the employees are those which affect more to the environmentally-friendly actions carried out by the Asian companies. Managers should consider the drivers which have a greater influence on their Environmental Practices depending on their national culture.

Keywords: Sustainability, Drivers, Institutional Theory.

The representation of ISO 26000 elements in German water supply companies

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Abstract

Water-supply and distribution companies (WSCs) are dealing with one of the most crucial resources and operating in a monopolistic landscape. WSCs are closely interlocked with the agricultural, pharmaceutical and energy sector as well as private households, and second, are facing rising and changing water pollution. Ethical business leadership calls for an explicit integration of sustainability, social or environmental requirements in the core entrepreneurial activities and corporate governance. To act social responsibly does not only mean to fulfil the legislative expectations, but also to be active beyond compliance. ISO 26000 defines corporate social responsibility (CSR) and how it can be implemented into the companies. CSR focuses on the entrepreneurial impacts on society. How is CSR practiced by the German water companies? Therefore, 110 German WSCs and their CSR aspects, like ISO 26000 elements and sustainability management tools, were analysed on the basis of content analysis and by means of correlation analysis. In the sense of data triangulation, additional interviews and surveys with ten of the companies (selected by chance) were conducted to understand the CSR engagement more deeply and comprehensively as well as match the data. Therefore, the level of implementation of the respective tools as well as their CSR understanding was surveyed. The research showed that the ISO 26000 elements, a sustainable energy use and sustainable management systems are just marginally communicated in this sample. Many WSCs do not make CSR credible to public. Yet, there are valuable examples for good CSR practice, like cross compliance, own renewable power generation, BOP partnerships and extra filtrations. In the water industry CSR is mainly implemented by risk or cost strategies, and there is a high variety of cost/risk optimisation up to opportunity optimisation. Some WSCs even engage in their core areas in CSR issues, but do not communicate; others communicate inconsistent, and even other WSCs provide little CSR impact in well prepared and excessive wordings. All in all, although CSR is not well and comprehensively presented there is several good practice of CSR engagement in the whole value chain. Further research is necessary to understand better why CSR representation differs so greatly from public and direct communication.

Corporate sustainability integration by coalescing organisational culture, structure and learning applying a retrospective analysis

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Abstract

Corporate leaders have become more aware of their responsibility for the impact business activities generate. The scope of this responsibility has been evolved from eliminating negative effects of business activities towards a broader view of how companies contribute to the sustainable development of society. Companies that have been able to understand what this responsibility means and successfully integrate Corporate Sustainability into their business activities outperform equivalent companies over the long term. Therefore, the integration of the Corporate Sustainability into business activities results in the creation of value for businesses and society alike. An extensive amount of Corporate Sustainability approaches is available to support this integration. Despite the attention of research on these approaches, there is still the need to improve the understanding of the Corporate Sustainability integration process. To contribute to this understanding this article presents a holistic framework combining the physical and social determinants of an organisation with the three dimensions of Corporate Sustainability (i.e. issue, time and place). The framework proposes the coalescence an analysis of the organisational culture, structure and learning related to the integration of Corporate Sustainability. Additionally, it proposes a retrospective view in this analysis connecting the present situation of CS integration to developments of the past. By combining these analyses, the Corporate Sustainability integration process can be understood on a high aggregated level with the possibility to focus on the lower level of the specific evidential integration items. To validate the framework, this article presents the outcomes of the application of the framework in several case studies.

Corporate Social Responsibility as a Form of Awareness and Corporate Accountability to Society and Environment in Achieving Sustainable Development in Indonesia

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Abstract

Issues pertaining to the environment have lately attracted the world's attention in relation to sustainable development. It ensues because most developing countries in the world put more emphasis on the economic aspects of their national development without considering its impact to the environment. Hence when running its business activities, a company has a very important role in protecting the environment to achieve sustainable development. In every economic activity carried out by a company, its goal is to garner profit for their owners or shareholders. In subsequent developments, it is only fair that the profit gained were not owned only by shareholders but also shared with the people who have close relationship with the company. This view raises a new idea or perspective known as the Corporate Social Responsibility. CSR is “the commitment of business to contribute to sustainable economic development working with employees and their representatives, the local community and society at large to improve quality of life, in ways that are both good for business and good for development”. In Indonesia, Corporate Social Responsibility is recognized as a company's commitment to build a better quality of life shared between the company and the related parties, especially the neighboring people and the environment where it is located. It is conducted on a continual basis and in an integrated manner with the company’s activities. Several legislations, in which there are passages containing the concept of CSR, have been issued, they include: Law No. 19 Year 2003 on State-Owned Enterprises, Law No. 25 Year 2007 on Investment, Law No. 40 Year 2007 on Limited Liability Companies Law No. 4 Year 2009 on Mineral and Coal, and also Law No. 32 of 2009 on the Protection and Environmental Management. In practice, differences in the perception or understanding on what is meant by the Corporate Socal Responsibility remain among the government, business actors (companies) and the public, e.g., to what extent is the awareness and responsibility of the company in the implementation of CSR? Hence, the crucial question in this research is: “How to regulate and implement the Corporate Social Responsibility in Indonesia within the framework of sustainable development”. The research method used is a normative juridical, using secondary data (literature) as the predominant data. The data obtained were analyzed qualitatively by way of interpreting the law in a systematic legal manner and legal analogy. The collected data, both primary data obtained from field studies as well as secondary data, were analyzed qualitatively with the abstract-theoretical approach. The results of the analysis are presented in a descriptive form. The conclusions are: First, the CSR arrangements in the Indonesian law have already included compulsory aspects of economic, social and environmental, especially for companies engaged in natural resources or related to natural resources. Secondly, the implementation of CSR activities in Indonesia is still the initiative of the company or the government, and the general public has not fully understand their CSR rights.

Keywords: company, corporate social responsibility, environment, awareness, sustainable development.

1. Introduction

Issues pertaining to the environment have lately attracted the world's attention in relation to sustainable development. It ensues because most developing countries in the world put more emphasis on the economic aspects of their national development without considering its impact to the environment. These circumstances resulted in environmental degradation.

Environmental degradation is generally defined as the diminution of the environment in quantity and its deterioration in quality. A certain level of environmental degradation is an inevitable consequence of human activity. Since little attention has been paid to the role of the environment -- either as a resource base or as a “sink” to receive the residues of production and consumption activities -- any exploitation of nonrenewable resources inevitably results in their partial or total depletion, as well as in the degradation of the landscape and the generation of waste (Theodore Panayotou, 1993 : x,3,4).

The problem of environmental degradation occurs when economic development becomes an underlying goal in the national development of a country. To attract investments natural resource management is given more emphasis as the objective in order to increase economic growth. To entice investors into the country, various facilities and amenities are provided, such as the provision of land, tax relief and various regulatory in support of its activities without regard to aspects of environmental vulnerability and limits, the welfare of workers and the local community, and also the befallen environmental damage where the business activity is placed.

It is inevitable that business activity and economic development of a country go hand in hand, because the economic progress of a country will be strongly influenced by the development of its business, whereas business development and economic growth characterizes a developing and progressing country. Companies play an important role in the business world, and economic development is inseparable from the role of a company. Accordingly, the company's role is very important in protecting the environment in the context of sustainable development when running its business activities.

With respect to a company, the primary purpose of the establishment of a company in conducting their business activities is generating profit in order to achieve welfare for the founders / owners (shareholders). Thenceforth, new belief and awareness emerge in the subsequent development among entrepreneurs, as business players, that in addition to having economical responsibility they have social responsibility as well. What is meant by social responsibility is the conviction and awareness that the profit the company earned does not belong only to the owners of the company (shareholders) but the surrounding community and the people who have relationships and linkages with the company such as employees, agents or distributors of the company (stakeholders) should also be able to enjoy the benefits. The role of stakeholders is enormous because their support allows the company to develop and grow and ultimately gain profit. At that point the company's social responsibility is understood as a charitable contribution and voluntarily donated to the surrounding community. Such consideration is the basic concept of Corporate Social Responsibility (CSR).

World Bank defines CSR as “the commitment of business to contribute to sustainable economic development working with employees and their representatives, the local community and society at large to improve quality of life, in ways that are both good for business and good for development”.(Busyra Azheri, 2011 : 20-21) :

CSR is initially understood to having economical responsibility as well as social responsibility, and is regarded as a corporate philanthropy to the community with voluntary nature, evolves even further. In subsequent developments, around 1970 to the 1980s, the idea of a more compassionate company emerges; specifically the entrepreneur is not concerned only with economic problems but also confronts social problems and environmental problems simultaneously. A shift towards a more progressive concenpt in the responsibility of companies begins at this time, namely the corporate responsibility does not only cater to the purely economic interests (profit) for company owners (shareholders) but also to social or community-related interests (stakeholders) as well as to sustainable development. Business people have already understood the limitations of the earth’s carrying capacity, hence how the exploitation of natural resources should be done will also be considered in carrying out the activities and interests of the company. Acknowledging the principles of conformity, harmony and balance, the exploitation of natural resources must be done prudently in order that development may be accomplished in a sustainable manner.

In those days the company's presence in the community is required to assume responsibility by promoting wider social value as a form of community development agenda. Companies are expected to contribute in raising the quality of life, not just producing and supplying goods and services to the community, but it also cares about the environment. The demand for environmental awareness is given greater emphasis to companies whose business activities exploit natural resources or associated with natural resources causing direct or indirect pollution, and the exploitation of the environment. Through community development, many companies are shifting the concept of philanthropy toward more productive approach. The company's concern to the community, which is the social responsibility, originally perceived as charity now shifts toward community empowerment, such as: establishing cooperation with small businesses, providing education and skills training, management assistance or opening of market access (Nor Hadi, 2011: 52-59).

Around 1990 the concept of "The Triple Bottom Line" advocated by John Elkingtons made a major breakthrough in the development of the concept of CSR (Yusuf Wibisono, 2007: 22-36). The concept classifies CSR on three aspects, and is better known as the Triple Bottom Line (3BL). These three aspects comprise welfare or economic prosperity, social justice, and improving the quality of the environment (environmental quality). Furthermore, for a company to have a competitive edge and to survive, whilst concurrently implementing the concept of sustainable development, it must heed the three elements P, namely: Profit, People and Planet (3P). The company should not be compelled to only seek profit (Profit), but must make a positive contribution to society (People), and should actively participate in protecting the environment (Planet). The concept of the triple bottom line is a continuation of the concept of community development linking the dimensions of objective and responsibility.

Profit is a responsibility that must be attained by a company. Improving the well-being of the shareholders, increased welfare for employees, and increasing contribution to the community through taxes, all of which can be achieved if it is supported by the company's ability to generate profit. In addition, expanding the business and increasing production capacity will require financial resources acquired from profit.

People is a society (community) where a company is located. Since surrounding communities are parties that influence and are influenced by the existence of the company, the community has a strong interdependence in creating added-value for the company. It is almost impossible for a company capable of conducting its business activities without the support of the people residing around the company. Therefore, it is important for companies to approach the local community with corporate social responsibility strategies.

Planet is a natural environment, where the company is established. The natural environment has a significant impact on the existence of a company, because it is a place where companies sustain. Environmental degradation and exploitation without limits will put the company and the community in peril.

In general, the company's activities in improving the welfare, indicated by economic assessment and income, do not go hand in hand with the worsening state of environmental resources. Rapid economic development results in the environmental destruction. Such circumstances led to the inability of people to live sustainably in an effort to improve the economy and at the same time preserve the environment.

The concept of sustainable development was first discussed in the Summit Conference in Stockholm in 1972. The following discussion occurred with the convening of the World Summit in Rio de Janeiro, Brazil in 1992, also known as the Earth Summit. This meeting was held to formulate the sustainable economic development and sustainable environment. It gave rise to conflicting dichotomy, namely the rescue of the natural environment on the one hand with the improvement of the economy on the other. Both of these issues in practice turned out to be less achievable by business players in conducting their business activities, and consequently followed up with a meeting in Johannesburg, South Africa in 2002, commonly known as the World Summit on Sustainable Development (WSSD).

Johannesburg meeting was motivated by the development of an increasingly globalized business world that leads to liberalism, and its political influence transgressed the political boundary of the countries in the world.Against the backdrop of the business world status at the time, the meeting lead to a common vision among the countries in attendance. A universal ruling for the welfare of mankind was adopted, namely the recommended concept of social sustainability that accompanied the previous two aspects: economic and environment sustainability.

The inclusion of social sustainability into policy instruments, which is to be complied by all countries in the implementation of its development to improve people’s living standards, will allow the expected objectives of each country be aligned with each other. These three aspects become a benchmark for companies in implementing social responsibility (Corporate Social Responsibility).

Hereinafter, the summit reconvened in Rio de Janeiro, Brazil in 2012, named the United Nations Conference on Sustainable Development (UNCSD), also called as Rio +20 Summit. UNCSD endorse the document ‘The Future We Want’ that become directives for the implementation of sustainable development at the global, regional and national levels. The document contains the views of the future agreement to be expected by the world (common vision), and strengthening the commitment to sustainable development (renewing political commitment) (Koesnadi Hardjasoemantri, 2006: 7-37). This document strengthens the implementation of the Rio Declaration of 1992 and the Johannesburg Plan of Implementation of 2002.

There are three key issues in the ‘Future We Want’ document for the implementation of sustainable development, namely:

1). Green Economy in the Context of Sustainable Development and Poverty Eradication

2). Institutional Framework for Sustainable Development

3). Framework for Action and Means of Implementation

The action framework includes the preparation of Sustainable Goals which include "the three pillars of sustainable development", namely: economic, social and environmental.

Administering these three concepts is, in reality, difficult to do. They even tend to overlap and contradict each other. The implementation of economic and environmental policy may often depend on the social policies of a particular group, causing disharmony in carrying out the policy. In cases like this, cooperation among fellow stakeholders is required.

The business world considers that a company may accept only the responsibility resting on a single bottom line, i.e. the value of the company is reflected only in the company's financial condition. In the subsequent development, however, a company must also consider the social and environmental aspects (triple bottom line). In maintaining the survival of their business, companies no longer carry out merely economic activities to create profits, they also bear the responsibility towards society and environment (A.B. Susanto, 2007: viii). The effort of improving the welfare of life, indicated with high-level of economic activities and earnings, nevertheless, does not go concurrently with the worsening state of environmental resources. Such circumstances led to the inability of people to live sustainably in an effort to improve the economy and at the same time preserve the environment.

In Indonesia, Corporate Social Responsibility (CSR) is recognized as a company's commitment to build a better quality of life shared between the company and the related parties, especially the neighboring people and the environment where it is located. It is conducted on a continual basis and in an integrated manner with the company’s activities. As for Sustainable Development, it is defined as the process of development (land, cities, businesses, communities, etc.) to meet the needs of the present without compromising the fulfillment of future generations (Nurdizal M. Rachman, 2011: 11).

The concept of CSR and the concept of Sustainable Development advanced in the international world certainly had an impact on the existence of CSR in Indonesia, and it definitely puts an impact on the formation of laws. Some of the legislation in which there are articles that contain the concept of CSR has been conceived by the government, the problem is how to regulate and to implement it in Indonesia.

In practice, there are still a lot of work yet to be done not only by the government but also by all stakeholders, because several obstacles exist that impede the implementation of Corporate Social Responsibility. Differences in perception or understanding exist between the government, businesses (companies) and the public on what is meant by the Corporate Socal Responsibility. A consensus is also needed to resolve the controversy: to what extent the company's span of responsibility in the implementation of Corporate Socal Responsibility, particularly in terms of company responsibility whose business is related to natural resources and the environment so that development can be sustained.

Problem Identification

The primary problems of this research are:
1) How to regulate the Corporate Social Responsibility in Indonesia within the framework of sustainable development?
2) The extent to which the implementation of Corporate Social Responsibility with regard to the awareness and responsibility of the company?

Research Objectives

This research aims to:
1) formulate the regulation of Corporate Social Responsibility in Indonesia within the framework of sustainable development.
2) formulate the implementation of Corporate Social Responsibility with regard to company awareness and responsibility.

2. Methods

In this study, the research method used is a normative juridical, using secondary data (literature) as the predominant data (Ronny Hanityo Sumitro, 1985: 9-10). The data obtained were then analyzed qualitatively by way of interpreting the law in a systematic legal manner and legal analogy (Soerjono Soekanto, 2006: 13-14). Using normative legal research methods, the legal research is done by searching, reviewing, and researching secondary data (literature) related to the subject matter of the research, namely the various legislations and policies on Corporate Social Responsibility and Sustainable Development.

The collected data, both primary data obtained from field studies as well as secondary data as the result of literature study, were analyzed qualitatively with the abstract-theoretical approach. The results of the analysis are then presented in a descriptive form, which describes the data as accurately as possible on the regulation and implementation of Corporate Social Responsibility in Indonesia as a form of corporate awareness and corporate responsibility towards society (M. Aslam Sumhudi, 1986: 45-46).

3. Results and Discussion

3.1. The setting of Corporate Social Responsibility in Indonesia within the framework of sustainable development

The objective of establishing the state of Indonesia is prospering all Indonesian citizens and the entire homeland of Indonesia as stated in the Preamble of the Constitution of 1945 (UUD 45). Therefore, a foundation or legal basis is established which is the ground rule of the economy in Indonesia, as stipulated in Article 33 of UUD 45 Amendment 4, which reads as follows:

(1) The economy is structured as a joint effort based on the principle of consanguinity

(2) Production branches, which are paramount for the State and dictating the welfare of many, are controlled by the State

(3) The earth and water and natural resources contained in it are controlled by the State, and utilized to the utmost for the people's welfare.

(4) The national economy shall be organized based on economic democracy with the principles of togetherness, efficiency, justice, sustainability and environmental awareness, self-reliant, and maintaining harmony, advancement and national economic unity.

In conclusion, the essence of Article 33 is that all business actors, both cooperatives, private enterprises and state-owned enterprises have equal opportunity in running its operation, and with the principles of efficiency, justice, sustainability and environmental awareness, self-reliance, along with maintaining harmony, progress and unity of the national economy with a goal to upgrade the welfare of the people of Indonesia. The business actors or entrepreneurs are entities that play an important role in the development, especially the economic development of a country.

Indonesian government's concern for the environment begins with the inclusion of the concept of sustainable development in the Outlines of State Policy (Garis-Garis Besar Haluan Negara : GBHN) in 1973, a follow up of the Stockholm Declaration ratified in 1972. Although it has been included in the GBHN, concern for environmentally sustainable development, particularly in the development related to natural resources, not enough attention was given. Indonesia is still focused on the development aimed at economic growth.

Subsequently in 1992 as one of the participants of the United Nations Conference on Environment and Development (UNCED), better known as the Earth Summit, Indonesia has received a number of non-binding agreements and has adopted them as the Agenda 21 Indonesia, which in essence is a comprehensive guidelines for the implementation of development and veritably incorporate environmental considerations into all of its activities (Office of the Minister of the Environment, 1996: iv).

Twenty years later, a resolution, known as The Future We Want was reached by member states. Among the key themes agreed on were on poverty eradication, energy, water and sanitation, health, and human settlement. Paragraph 246 of The Future We Want outcome document forms the link between The Rio +20 agreement and The Millenium Development Goals : We recognize that the development of goals could also be useful for pursuing focused and coherent action on sustainable development. The goals should address and incorporate in a balanced way all three dimension of sustainable development (environment, economic,and society) and their interlinkages. (http://en.wikipedia.org/wiki/Sustainable Development Goals).

The MDGs were supposed to be achieved by 2015. A further process was needed to agree and develop development goals from 2015-2030. On 25 September 2015, the 193 countries of the UN General Assembly adopted the 2030 Development Agenda titled Transforming Our World : the 2030 Agenda for Sustainable Development. The Agenda adopted 17 Sustainable Development Goals, that is :

Poverty – End poverty in all its forms everywhere

Food – End hunger, achieve foof security and improved nutrition

Health – Ensure healthy lives and promote well – being for all at all ages.

Education – Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Women – Achieve gender equality and empower all women and girls.

Water – Ensure availability and sustainable management of water and sanitation for all.

Energy – Ensure access to affordable, reliable, sustainable and clean energy for all.

Economy – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Infrastructure - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Inequality - Reduce inequality within and among countries

Habitation - Make cities and human settlement inclusive, safe, resilient and sustainable.

Consumption – Ensure sustainable consumption and production patterns.

Climate – Take urgent action to combat climate change and its impacts.

Marine-ecosystems – Conserve and sustainably use the ocean, seas and marine resources for sustainable development.

Ecosystems – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forest, combat desertification, and halt and reverse land degradation and hal biodiversity loss.

Institution - Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institution at all levels.

Sustainability - Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Indonesia inaugurated President Joko Widodo and Vice President Jusuf Kalla on October 20, 2014 to lead this nation. During his administration, President Joko Widodo carries Nawacita as national development agenda. As a high priority development agenda, Nawacita was then interpreted into the National Medium Term Development Plan (RPJMN) 2015-2019 launched on January 8, 2015. RPJMN document consists of three parts, namely the National Development Agenda, Sector Development Agenda, and Regional Development Agenda. Nawacita is explicitly described in RPJMN, chapter six of the first part (UNDP, ConvFinal-Id.pdf).

Nawacita is nine priority agenda towards Indonesia being politically sovereign, self-reliant in the economic field and with cultural identity. The nine programs are (http: //www.selasar):

1. Create a safe state and security for all citizens

Build a clean governance, effective, democratic, and trustworthy

Build Indonesia from the fringes by strenghening localities and villages within the framework of a union state

Reject being a weak state by reforming the system and enforcing corruption-free law, dignified and trustworthy

Improve the quality and welfare of Indonesian society, and education

Achieve economic self-reliance by propelling the strategic sectors of the domestic economy

Improve people's productivity and competitiveness in international market

Revolutionize people's character through a realignment policy of the national-based curriculum

Reinforce diversity and strengthen social restoration through diversity policy.

Nearly one year later, on 25 September 2015 at the UN Headquarters, the Sustainable Development Goals (SDGs) was adopted by the leaders of UN member-states as the new global development agenda for the period 2016-2013. Responding to the agreement of the UN member-states stipulated in "Transforming Our World: The 2030 Agenda for Sustainable Goals" dated August 2, 2015, the ratification of 17 SDGs becomes a new milestone in the international community's commitment to the global development agenda to forward the achievement of the Millennium Development Goals (MDGs). Since Indonesia has adopted the SDGs, they certainly need to be translated and integrated into national and regional development agenda. The convergence between Nawacita with RPJMN and SDGs is discernible. Global objectives have largely been reflected in the national agenda with very inclusive approach, and adopted for the formulation of post-2015 development agenda. Important steps need to be taken to design participatory mechanisms for civil society, the private sector, philanthropic organizations in garnering support for the SDGs and national development priorities (UNDP, ConvFinal-Id.pdf).

Partnership is one of the manifestations of implementing CSR by a company. CSR change a company that was oriented only to profit (profit oriented) to one with social responsibility.

CSR is at the core of business ethics, whereas a company does not only have economical and legal obligations to shareholders, it also has obligations to other interested parties (stakeholders). (R. Erni Ernawan, 2007, p. 110).Companies are not only responsible to shareholders but also to employees, suppliers, distributors, the public and government, because all of them had a role in the development and progress of the company.

Considering CSR is an important aspect of company activities, the Indonesian government as regulator incorporates CSR components to some regulations and laws, in order to amend the earlier existing legislation or to make up a new law.

Numerous regulations are made by the Indonesian government to accommodate the implementation of CSR. Considering the urgency and social dynamics, locally and globally, lawmakers decided to reinstate CSR initially as a moral responsibility to legal responsibility by inserting them as numerous clauses in the legislation (Busyra Azheri, 2011: 133).They include: Law No. 19 Year 2003 on State-Owned Enterprises, Law No. 25 Year 2007 on Investment, Law No. 40 Year 2007 on Limited Liability Companies Law No. 4 Year 2009 on Mineral and Coal, and also Law No. 32 of 2009 on the Protection and Environmental Management.

The CSR settings in those regulations can be observed as follows:

3.1.1. CSR setting in Law No. 19 2003 2003 on the State-Owned Enterprises (SOE Act)

SOE Act provides the legal basis for the implementation of CSR in SOEs in Article 88, which reads:

(1) SOE can set aside part of net income for the purposes of fostering small businesse/ cooperatives and community advancement around the SOE

(2) Further provisions regarding allowance and use of income referredto in paragraph (1) shall be regulated by a decision of the Minister

CSR stipulated in the SOE Act is a form of company's concern to the community in the form of corporate social responsibility.

Furthermore, the Ministerial Regulation of State Enterprises No. PER-05/MBU /2007 on SOE Partnership Program with Small Business and Community Development Program (CSR) confirmed that the Partnership as part of CSR for SOEs is no longer voluntary but becomes a mandatory activity.

Although it is mandatory, the implementation of CSR activities by SOE can only be done if it has gained profit. If SOE does not gain profit the compulsory nature of it becomes void.

The partnership program, in practice, takes place in the form of collaboration between SOEs and Micro, Small and Medium Enterprises (SMEs) and cooperatives in the form of aid such as marketing, capital or human resources.

3.1.2. CSR setting in Law No. 25 Year 2007 regarding Investment

A general explanation of Investment Law states that "corporate social responsibility is a responsibility that is inherent in any capital investment companies to keep creating harmonious, balanced relationships and in accordance with the environment, values, norms, and local culture".

Investment Law related to CSR, which is essentially regulating, is scattered in various chapters,

a. Article 3 (1) explains the investment principles contained in this law, such as:
    1) The principle of sustainable, namely the principle that a planned development process through investments is advancing to ensure the welfare and progress in all aspects of life, both for the present and for the future
    2) The principle of environmentally prudent, the investments made by promoting the local potential without excluding the inflow of foreign capital in order to ensure economic growth.
b. Article 15 stipulates that every investor is obliged to exercise the principles of good corporate governance, and implement corporate social responsibility.
c. Article 16 of the Investment Law states that each investor shall be liable:
    1) To bear and resolve any liability and damages if investors stop or leave or abandon unilaterally its business activities in accordance with the provisions of the legislation
    2) Preserving the environment
d. Article 17 of the Investment Law states that "every investor engaged in business related to nonrenewable natural resources are required to allocate some funds for site restoration efforts that meet environmental standards. Its implementation is regulated in accordance with the provisions of the legislation".
e. Article 34 of the Investment Act set penalties for enterprises or individuals who do not carry out their CSR obligations, in the form of administrative sanctions and other sanctions in accordance with the provisions of the prevailing legislation.

Some CSR provisions stipulated in the Investment Law indicates that CSR has been confirmed as a mandatory within the meaning of liability for any investor. They who do not implement CSR in their business activities as stipulated in the Investment Law will be penalized. (Busyra Azheri, Corporate Social Responsibility, 145).

3.1.3. The CSR setting in Law No. 40 Year 2007 on Limited Liability Company.

CSR activities are ventures commonly performed by many companies in general, since the company is responsible not only to stakeholders but also to the shareholders.

Limited Liability Company Act enforced on 20 July 2007 gave a different understanding of CSR from the one in Investment Law. According to the Limited Liability Company Act, social responsibility and environmental responsibility are two separate entities of CSR.

Article 1 (3) of Limited Liability Company Act states: "Social and environmental responsibility is a commitment by the company to participate in sustainable economic development by improving the quality of life and environment which will be beneficial both for the company itself, the local community and society in general".

To achieve sustainable economic development, social and environmental responsibility are necessary to ensure the enrichment of the quality of life and the quality of the environment that are rewarding to the company itself, the local community and society at large. Social and environmental responsibility aim to support the construction of a harmonious and balanced relationship between the company and the local community, in conformity with the environment, values, norms and native culture (M. Yahya Harahap, 2009: 297).

The arrangements of Social and Environmental Responsibility hereinafter contained in Article 74 which consists of four paragraphs and reads as follows:

(1) The Company conducting its business activities in the field and / or related to the natural resources is required to implement the Social and Environmental Responsibility

(2) Social and Environmental Responsibility as referred to in paragraph (1) is an obligation of the company as an expense of the company to be budgeted and accounted for, and to be carried out with due regard to decency and appropriateness

(3) The Company not implementing the obligations referred to in paragraph (1) will be penalized in accordance with the provisions of the legislation.

(4) Further provisions on social and environmental responsibility are regulated by the government.

The rule of law contained in the Limited Liability Company Act states that the company's business activities in its field and / or related to the natural resources is required to implement social and environmental responsibility. Such provisions have legal consequences if they are not met by a company. Namely, if a company does not fulfill its social and environmental responsibilities, it will be penalized in accordance with the provisions of the legislation.

With the enactment of the Limited Liability Company Act, the CSR activities previously carried out voluntarily now become compulsory (mandatory), especially for companies engaged in the field of natural resources.

In practice, CSR activities undertaken by companies engaged in the field of natural resources have determined the amount of the funds in advance. These funds are usually submitted to local governments where they operate. The fund was initially to be used as expenses for environmental restoration activities to recover after enduring effects of pollution from the company's activities. Funds provided by the company as expenditures for CSR activities are incorporated into the company's budget. This means that the funds alloted for implementing CSR will be borne and passed on to consumers, because the amount is inserted into the product components offered by the company as the purchased price of the product. Therefore, the CSR funds are no longer derived from portion of the companies' profits.

The obligation to carry out CSR by companies engaged in the field of natural resources, such as mining, oil or plantations, was motivated by the notion that every activity pertaining to natural resources will cause damage the environment, and efforts are essential to restore the degraded natural conditions. CSR is needed to restore the damaged environment caused by the company's activities to its original state through activities such as reforestation, reclamation or invigorating the environment damaged by quarries.

3.1.4. Law No. 4 Year 2009 on Mineral and Coal Mining (Mining Law)

Explanation of the Mining Law mentioned that the exploitation of mineral and coal must be capable of providing economic and social benefits, accelerating the development of the region and encouraging economic activity of the community / small and medium businesses as well as supporting the sustainable development. Therefore any mining activities should be carried out with due regard to environmental principles, transparency and public participation.

Each mining management of mineral and coal should be guided by four principles as detailed in Article 2 of the Mining Law, namely:

a. Benefits, fairness, and balance,
b. Protecting the national interest
c. Participation, transparency, and accountability,
d. Sustainable and environmentally friendly.

The setting in the Mining Law does not only give priority to economic benefits in the mining management of mineral and coal, but gives also consideration to social and environmental aspects. This demonstrates that the principles underlying the operation of mines in Indonesia as stated in the Mining Law has accomodated the basic principles of CSR.

In the mining sector, the Indonesian government has issued numerous Mining Rights to irresponsible mining entrepreneurs with poor management skills causing environmental degradation. Therefore, the Law No. 4 of 2009 on Mineral and Coal Mining (Mining Law) replacing

Law No. 11 of 1967 on the Basic Provisions of Mining, specifies that mining management objectives as stated in Article 3 of the Mining Law are as follows:

a. Ensure the effective implementation and control of mining business activities effective, efficient, productiveness, and competitive,
b. Ensure the benefits of mineral and coal mining in a sustainable and environmentally friendly manner,
c. Ensure the availability of mineral and coal as raw materials and / or as a source of energy for domestic needs,
d. Support the growth and development of the national competitive capabilities in the at the national, regional, and international levels,
e. Increase the revenue of local communities, regions, and national, as well as create jobs for the utmost welfare of the people, and
f. Ensure legal certainty in the implementation of the mineral and coal mining business activities.

Moreover, Article 108 of the Mining Law regulate matters relating to the development and empowerment, and mentioned that:

(1) Holders of Mining Business License (IUP) and Special Mining Business License (IUPK) shall draw up program of development and community empowerment.
(2) Preparation of plans and programs referred to in paragraph (1) is to be consulted to the government, local government, and community.

CSR in Mining Law has already covered business activities aimed at improving the economy of shareholders, even the social and environmental responsibility as well as the awareness to the community outside of the company has already been included.

Principles and objectives set out in the Mining Law are guidelines that must be held by business actors that manage mining as a form of their accountability and obligations towards stakeholders. This is the manifestation of CSR in the management of mineral and coal mining in Indonesia.

The application of CSR principles should be considered in the utilization of mineral resources and coal in Indonesia as an effort to maintain a balance of existence and sufficiency of natural resources as capital growth (resource based economy) and at the same time a supporting system of life (life support system) (Busyra Azheri, 2011: 276).

3.1.5. Law No. 32 of 2009 on the Protection and Environmental Management

Law on Environmental Protection and Management which established in 2009 enacted on the premise that:

a. A pleasant and healthy environment is a fundamental right of every citizen of Indonesia.
b. National economic development as mandated by UUD 45 is to be accomplished by the principles of sustainable development and environmentally responsible.

This law should be enforced due to various reasons, namely:

a. The environmental quality is declining, and has threatened the chance of survival of humans and other living creatures
b. Severe global warming is causing climate change and exacerbating environmental degradation,
c. The spirit of regional autonomy in the governance of the Republic of Indonesia has brought changes in the relationship between the central and local governments, including in the field of environmental protection and management.

The Law on Environmental Protection and Management regulates business activities that affect the environment. Each planned activity expected to have a significant impact on the environment shall be equipped with the Environmental Impact Assessment (AMDAL). Article 1 (11) of Law on Environmental Protection and Management states:

"Environmental impact assessment, hereinafter referred to as theAmdal, is the study of the significant impact of a business and / or planned activities on the environment necessary for the decision making process in functioning a business and / or activity".

Preparation of Amdal should consider various aspects, such as physical, chemical, biological, socio-economic, socio-cultural and public health. A planned activity can be declared environmentally unfit, if based on the study of Amdal, the resulting negative impacts cannot be mitigated by the available technology. Likewise, if the effort required in mitigating the negative impact is costlier than the expected positive impact to be brougth about, the planned activity is declared environmentally unfit. Therefore, the Amdal must be prepared based on the activity of the business actors at the pre-exploitation, exploitation and post-exploitation stages.

For activities that do not cause significant impacts on the environment, compliance to the Environmental Management Effort (UKL) and Environmental Monitoring Effort (UPL) is sufficient. In Article 1(12) of Law on Environmental Protection and Management, it is stated that the Environmental Management Effort (UKL) and Environmental Monitoring Effort (UPL) are the management and monitoring process of business and / or activities that do not cause significant impact on the environment necessary for the decision making process in functioning a business and / or activities.

Some of the laws issued by the Indonesian government exemplifying the inclusion of CSR provisions in them, and has also been discussed earlier, indicate a shift from voluntary to compulsory (mandatory), although the compulsory nature has several categories, namely:

1. It is mandatory for any company that engages in or related to natural resources.

It is mandatory for any SOE, if it earned profit, and the expenses for CSR were part of the profits gained.

These mandatory provisions are imposed for the purposes of protecting the environment from pollution, i.e., the company will always observe the principles of sustainable development in each of its activity.

3.2. Implementation of Corporate Social Responsibility regarding corporate concern and responsibility.

Pursuant to Article 33 paragraph (4) of UUD 45, which is the constitution of Indonesia, it asserts that: "The national economy shall be organized based on economic democracy with the principles of togetherness, efficiency, justice, sustainability and environmental awareness, self-reliance and maintaining harmony, advancement and unity of the national economy".

It is evident that any economic development activities in Indonesia must be environmentally sustainable, not only for the present but also heed to the future.

Until recently, economist were taught that natural capital was not treated as a conventional form of capital and thus its depreciation and maintenance requirement were not included in economic calculation. Natural capital, in essence, were free goods provided by nature in unlimited quantities. Today, we have become keenly aware that nothing is given away for free; everything is sold. This simple statement is an important paradigm shift that is taking place in economics; the transition from an economy based on a perception of infinite resources to one based on an understanding of environmental limits (Theodore Panayotou, 1993 : x).

The company's activities, particularly those engaged in natural resources that are required to implement CSR in doing their business, should be based on three aspects of the so-called Triple Bottom Line (3BL), which includes welfare or economic prosperity (economic prosperity), improving the quality of the environment (enviromental quality), and social justice (social justice). A company aspiring to apply the concept of sustainable development must adhere to the "Triple P", i.e: Profit, Planet and People.

When 3BL is associated with Triple P, it can be concluded that Profit represents economic aspects, Planet represents environmental aspects, and People represents social aspects.

CSR is a concept that companies have a responsibility to all stakeholders in connection therewith, thus they are not only responsible to the shareholder, but also responsible to employees, customers, communities around the corporate area, as well as the environment in all aspects of company operations including economic, social and environmental. Therefore, CSR is closely linked to sustainable development. In running its operations, the Company is not allowed to make its decision based only on priority in terms of profit alone or from the economic aspect alone, but should also consider the social and environmental impacts arising from the company's decision. Therefore, CSR can be regarded as the company's contribution to sustainable development objectives by way of impact management (minimizing negative impacts and maximizing positive impacts) to all stakeholders of the company.

The company's concern to the community and the surrounding environment will attract public attention; hence it will generate positive impact on the company’s image and will indirectly bring a reputable name and ultimately benefit the company. Actions of companies without any concern to employees, or corporate activities that pollute the environment, or make products that are harmful to consumers will have a negative impact on the company. All of these misconducts will not be easily forgotten by the public.

CSR is not just a form of charity or philanthropy of a company, but it also requires a firm in its decision-making to seriously consider the consequences affecting all of the company's stakeholders.

Classical opinion says that the only social responsibility of a company is to bring maximum benefits to itself. Economically speaking, that is indeed the objective of establishing a company; but socially and morally speaking, question will arise whether it is truly a success for the company.

The notion developed in most of the companies believes that the involvement in various social activities has traditionally been regarded as the most urgent manifestation in the implementation of CSR. There was even a notion stating that the involvement in social activities of the company is the only company's CSR activities. The company is expected to do business not only for the sake of profit, but also contemplate on virtue, progress, and prosperity, and being involved in various social engagement in addressing social and economic inequality. These social activities may be exemplified in various forms including the construction of houses of worship, build public facilities and infrastructure, reforestation, scholarships, free training, etc.

As previously discussed, the convergence between Nawacita with RPJMN and SDGs is indicated in which the global objectives have largely been reflected in the national development agenda. Important steps need to be taken in designing participatory mechanisms for civil society, the private sector, philanthropic organizations to rally support for SDGs and national development priorities.

The Indonesian government recently is intensely asking business people to implement CSR in the form of water supply and sanitation for the community. Below is a table detailing the implementation of CSR that represent the economic, social and environmental activities (Hardinsyah and Muhammad Iqbal, 2006: p. 6):

Table 1

Activities of Corporate Social Responsibility

No.	Aspect	Action
1.	Social	education, training, health, housing, social welfare, sports, youth, women, religion, culture, etc.
2.	Economic	entrepreneurship, business groups or Micro, Small and Medium Enterprises (SMEs), agriculture, employment, economic infrastructure and other productive enterprises.
3.	Environment	reforestation, land reclamation, water management, nature

		conservation, ecotourism, environmental sanitation, pollution control, the production and use of energy efficiently.

At grassroots level, for example, the introduction of CSR has been conducted amid the counseling process of drafting the village regulations on civic spatial management in the village of Tarumajaya, Kertasari subdistrict, Bandung, Indonesia, in January 2015. On the discussion of CSR, in general, the village people are familiar with CSR but many are not aware how to implement it, whether it is purely as an initiative of the company or the public can ask for it. Moreover, is it voluntary as a form of the company's empathy or the public can demand as a form of corporate responsibility.

A company in running its operations must implement good corporate governance (GCG) consisting of four principles, among others: accountability and responsibility. The principle of accountability asserts that the management framework of the enterprise should ensure the strategic guidelines of a company, effective control of the board of management, accountability to the company and shareholders, whereas the principle of responsibility is more directed to matters relating to the fulfillment of social obligations of a company as part of the social life structure (Busyra Azheri, 2011: 194-195). In GCG, CSR refers to the compliance of the principle of responsibility but in a broader sense it must satisfy the principle of accountability.

4. Conclusions

Based on the research that has been done, the conclusions are:

1). The CSR arrangements in the Indonesian law have already included compulsory aspects of economic, social and environmental, especially for companies engaged in natural resources or related to natural resources.

2). The implementation of CSR activities in Indonesia is still the initiative of the company or the government, and the general public has not fully understand their CSR rights.

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Individual dynamic capabilities and business sustainability perception: a gender approach

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Abstract

Dynamic capabilities are considered relevant competencies in the fields of strategic management. The nature of dynamic capabilities (CD) was proposed as a framework for analyzing the sources of wealth creation in rapidly changing environments. However, there are few authors who analyze dynamic individual skill requirements for the manager of a business to ensure business sustainability. These authors define dynamic capabilities as individual competencies and skills available to the manager (sensing, seizing, transforming), which could influence strategic decisions and have the ability to adapt quickly to changing environments and affect business sustainability. Some of the future lines of research propose to analyze the impact of dynamic capabilities on performance or the competitive advantages of companies, taking into account performance measures linked to environment and the subjective conditions of managers and their role and their management in the process of dynamic capabilities. This study aims to shed light on the research mentioned above. The aim is to analyze whether there is a direct relationship between individual dynamic capabilities of the manager of the company and their perception of business sustainability. In addition, it analyzes whether there are significant gender differences. In order to contrast this hypothesis, we decided to study the development and distribution of a questionnaire, which was answered by 339 managers. These managers were asked about these important aspects of individual dynamic capabilities, environmental commitment and social commitment. The expected results are intended to show that there is a direct and positive relationship between individual capabilities and environmental and social commitment. If segmented by gender, there are significant differences in the environmental and social commitment between men and women. Women have greater environmental and social commitment than men. In conclusion, this study helps to break down barriers for women in senior management positions and aims to step in expanding knowledge of the theory of business management from a gender perspective.

Keywords: Individual dynamic capabilities, business sustainability perception, innovation management, gender and dynamic capabilities, business theory.

1. Introduction

In the current economic environment, consumers reward more socially and environmentally responsible companies (Laparra and Perez 2011; Schaltegger and Wagner 2011) . This forces companies to adapt to these new requirements of the environment (Smallbone et al 2012; Chofreh et al 2014). Since they are the lead managers who must adapt to the new environment, they should have new capabilities (Augier and Teece 2009; Teece 2012; Alonso- Almeida et al. 2015a).

Literature developed so far on dynamic capabilities focuses on investigating how companies develop dynamic skills that allow them to obtain long-term sustainability and competitive advantages. Thus , studies have focused on the nature of these capabilities (Teece et al 1997 , 2010 , Augier et al.2008) , results (Helfat 1997 , Zott 2003) , the processes required to carry them out (Eisenhardt and Martin, 2000 , Adner and Helfat 2003 , Zahra et al 2006 , Zollo and Winter 2002) , the environments that are recurrent (Eisenhardt and Martin 2000 , Aragon - Correa and Sharma, 2003, Helfat and Winter, 2011) its relationship to innovation and entrepreneurship (Teece 2007 , Augier and Teece 2009 , Pitelis and Teece 2010, Salazar and Pelaez, 2011, Teece 2012 , Al- Aali and Teece 2014 , Lanza and Passarelli 2014) .

However, the literature on individual dynamic capabilities is scarce and there is little experimental research yet. Teece (2012) stresses the importance of the role of a manager for the transformation of the company in changing environments. In these cases, dynamic capabilities become competences of an individual (manager) that are defined as sensing (identification and evaluation of opportunities), seizing (carry out the identified opportunity to create value) and transforming (continued innovation). Wilden et al (2013); Lanza et al. (2014) and Leigh et al (2014) identify these same powers as manager capabilities to ensure business success and sustainability.

Carattoli (2013) proposes research focused on the relationship between dynamic capabilities and other constructs; especially those that are relevant to make sustainable links to certain environmental company measures and its relationship with the environment (Adner and Helfat, 2003; Augier and Teece, 2009; Schaltegger and Wagner 2011; Wilden et al 2013; Lanza and Passarelli 2014).

The sustainability of a company refers to the transformation of business models oriented towards purely economic objectives where, besides economic sustainability, another model incorporates environmental and socially aware criteria into the overall strategy (Larson, 2000 Kyrö, 2001; Strothotte and Wüstenhagen, 2005; Cohen and Winn, 2007; Cohen et al, 2008; Van Passel et al., 2009; De Grosbois, 2012, Alonso-Almeida and Bremser, 2014, Setó-Pamies, 2015).

According to Schaltegger and Wagner (2011) and Tata and Prasad (2014), the introduction of social goals and environmentally responsible managers facilitates sustainable development over the long term for companies, with positive effects on customers and society in a coordinated manner. Individual dynamic capabilities facilitate this process by allowing the combination of resources to create value and thus contribute to sustainable development (Augnier and Teece 2008, Teece 2012).

Individual dynamic capabilities are a new field of research. Today, there is no evidence from studies on the impacts in a company, where the effect of the dynamic capabilities of a manager committed to social and environmental commitment is analyzed from a gender perspective. The literature so far has studied leadership or how to manage an enterprise-considering women as "engine change" (Cohen and Huffman, 2007) - or the perception of women and their impacts on the social and environmental aspects in the company. There is consensus in previous literature to attribute to men a dominant leadership style in the company characterized by authoritarian, with power and status eagerness and oriented towards economic performance (Godoy and Mladinic, 2009). In contrast, women are attributed to transformational leadership based on social values, interpersonal relations, welfare for others and empathy (Rudman and Glirk, 2001; Bird and Brush 2002; Eagly and Carli, 2003, Eagly et al. 2007; Aygün et al. 2008, Alimo-Metcalfe, 2010).

The literature review on social and environmental commitment from a gender perspective argues that women have greater social commitment than men, because of their concern for the welfare of society (Tata and Prasad 2014) and its commitment to ethical values themselves (Smith et al 2001; Galbreath 2006). Men, on the other hand, have a greater environmental commitment arising from their economic orientation to shorter term results (Hindle et al. 2009; Kronsell et al 2014; Santos et al 2016). In the same vein, Bernardi and Threadgill (2010) suggest that there is a relationship between the number of women who make up the top management team with the greatest social commitment of the company because women incorporate greater commitment to donations , society and outside recognition of the work of employees.

Since previous literature suggests that both how to manage and leadership, as well as social and environmental commitment of men and women are different, it is assumed that the individual dynamic capabilities of men and women affect their social and environmental commitment also differ in gender. Therefore the following assumptions are made:

H1: There are significant differences produced by the gender of the manager on the impact of individual dynamic capabilities on its social commitment.

H2: There are significant differences produced by the gender of the manager on the impact of individual dynamic capabilities on its environmental commitment.

2. Methods

In order to contrast the above hypotheses we analyzed a sample of 339 managers who completed a Masters in Business Administration (MBA) in Spanish universities during the academic years 2013-2014 and 2014-2015. Individuals in the sample have an average age of 40 years allowing more than 50% of respondents have a work experience between 5 and 10 years. In addition, in view of their current employment about 67% of women and 75% of men have taken part in their last job of the management team. A very high percentage of respondents (95%) for both men and women have a university education, which corresponds to the training managers usually have in business. As for the sex distribution of approximately 36% women and 64% men, this bias in the sample is consistent with an unequal distribution of access to management positions between men and women, an aspect of great importance and suggestive of various ethical and sociological nature considerations, which have already been highlighted previously in the literature (eg Alonso-Almeida et al, 2015a;. National Statistics Institute in Spain, 2016).

The sample may have limitations. The first could be that MBA students cannot be completely representative of the adult population. However, this sample study used presents MBA students who are actually going to occupy leadership positions in companies in the future. They must have new skills and social and environmental commitment. A second limitation is the geographical area in which the sample was made advising the realization of new empirical research to enable the reaffirmation of these conclusions.

These managers completed a survey with different items that were trying to assess the different capabilities required of a business manager and social commitment to the environment and presenting each candidate. The survey was designed based on prior academic literature in the field of dynamic capabilities (Tang et al 2012; Wilden at al 2013; Buil et al 2016; Kucel et al 2016) and social and environmental commitment (Alonso- Almeida et al. 2015b). The answers to questions are set according to a Likert scale with values from 1 to 7, where a 7 represents the highest degree of identification with this question and 1 represents the lowest.

Mean values for the questions from the questionnaire show values above 4 for a Likert scale of 1 to 7, in all cases. With regard to both social and environmental commitment of respondents mean values are higher in all cases to 4 although there is some difference with somewhat higher results for social commitment compared to environmental commitment values. The statistical study was divided into two distinct parts: the first part consisting of a factor analysis and a second part where the goodness of model through structural equation modeling is tested.

In the first part of the statistical study, the aim of the exploratory factor analysis (EFA) is to determine, from the variables that make up the questionnaire, the different dimensions that made the model to be tested. As the literature points out (Loiacono et al, 2002), they removed from the model those variables, with changes lower than 0.5 resulting in a grouping of variables in three dimensions: individual dynamic capabilities (IDC), social commitment (SOC COM) and environmental commitment (ENV COM). Having defined the composition of dimensions, each was subjected to a confirmatory factor analysis (CFA) to validate each construct. The result of this analysis eliminated various factors not to exceed the threshold load of 0.7 required by the literature, being reduced to 12 and 3-dimensional factors that make up the model. These dimensions were subjected to analysis of Cronbach Alpha excelling in all cases the value of

0.7 required (Carmines and Zeller, 1979). As the second to the last stage of this first part, analysis consistency, reliability, and validity convergent size was performed, being in all cases greater than 0.6 composite reliability (Bagozzi and Yi, 1988), the extracted average variance (AVE) greater than 0.5 and convergent validity confirmed in accordance with the provisions of Fornell and Larcker (1981). Finally, once defined and tested dimensions proceeded to a final analysis of discriminant validity, demonstrating in all cases each construct was more related to their own dimensions with the dimensions of other constructs.

In the second part of the statistical study, using the EQS 6.1 software and using the robust structural equation modeling, the boom of the proposed model was tested , leaving clear the suitability of this , via the main statistical observation . According to the literature, Schermelleh - Engel et al. (2003) established that it is sufficient to have 3 statisticians in its recommendation to test the boom and explanatory power of the models defined values according to this methodology. In the model we are dealing with, these minimum requirements are exceeded, confirming the robustness and explanatory power of the model.

Table 1. Standardized values by sub-sample.

		CDI → SOCCOM	CDI → ENV COM
MEN	β	0.263	0.211
	Statistic1	7.854**	6.365**
WOMEN	β	0.289	0.242
	Statistic1	8.119**	6.012**

[1] Robust method.

*** Statistically significant at the 0.05 level.*

To detect possible differences between men and women and using the same EQS software, a multi-group analysis is conducted. This analysis compares the multiple-group model with a nested model in which the relationships between all of the dimensions are constrained to be equal across groups. Using the chi-squared distribution p-value, calculated from the difference between the chi-square of the two models and the degrees of freedom, we are able to determine whether there are different behaviours according to the subsample.

These results indicate that there are differences between men and women. In summary, the multiple-group analysis shows that different results are obtained from the separate samples and the two types of people display different behaviors in terms of social and environmental commitment. The results in table 1 show that there are differences in the relationship between CDI and SOCCOM and also in the relationship between CDI and ENVCOM for men and women. Next, the same multi-group study is conducted to determine in detail where the differences are most pronounced by analyzing each relationship across dimensions. The results are shown in table 2.

Table 2. Invariance test for all relationships.

	CDI → SOCCOM	CDI → ENV COM
Δx2	4.148	3.055

Δd.f.	1	1
p-value	0.029**	0.024**

*** Statistically significant at the 0.05 level*

3. Results and Discussion

The first hypothesis (H1) produced significant differences by gender of the manager on the impact of individual dynamic capabilities on its social commitment. The results of structural equation modeling show that there are significant differences in the social commitment of the manager by gender. Women display more social commitment to a variable value of 8,119 against 7,854 of men. Some reasons why social commitment is greater in women than in men is due to their own characteristics as a woman: warmth, nurturing, interpersonally sensitive, concern with others' welfare (Eagly et al 2003), his concern for the welfare of society (Karam and Jamali 2013, Tata and Prasad 2014) or the commitment to ethical values themselves (Galbreath, 2006). In addition, networking relationships established with partners and cultural values and beliefs of women increase their social commitment to the men (Santos et al. 2016). This research reinforces the findings of previous concerns that social commitment is higher in women than in men, and suggests the need to incorporate more women in the top management team in order to ensure the sustainability of the company (Khan and Vieito, 2013; Kogut et al 2014).

The second hypothesis (H2) suggests the existence of significant gender differences produced by the manager on the impact of individual dynamic capabilities on its environmental commitment. The results of structural equation modeling show that there are significant differences in environmental commitment between men and women. Men have a greater environmental commitment than women (variable value 6,365 to 6,012 men against women). The extensive previous literature states that men have a greater environmental commitment derived from its focus on economic performance in the shorter term (Hindle et al. 2009; Kronsell et al 2014; Santos et al 2016). However, as a new study, and contrary to previous literature, this paper establishes that environmental commitment is also higher in women than in men. Some reasons suggested are that women have greater environmental awareness because they perceive the risks to health and the environment (Park et al. 2012), are sensitive to the effects of climate change (Ciocirlan and Pettersson 2012) and women are more concerned to attitudes to the environment (Diamantopoulos et al., 2003).

5. Conclusions

The results provide a number of conclusions relevant to the business environment, the education sector and academia. The present study shows the existence of a significant relationship between individual skills and more dynamic social and environmental commitment that helps the company to be more sustainable in the long term. It is noted that this relationship is more significant in women than in men. For this reason, companies are recommended to enhance the role of women in top management teams in order to ensure the inclusion of social and environmental measures to promote the sustainability of the company, protecting the environment and improving the welfare of society.

For education, this study highlights the need to incorporate into educational programs and learning processes of future business managers programs for the development of individual dynamic skills. The addition of these dynamic skills surpasses training on updating business plans for workers so as to include the development thereof, and the incorporation of these dynamic skills in the daily management in the company at all levels of decision and for all male and female employees. The positive effects of incorporating these skills not only cultivate higher economic growth but also the development of a business that is more adaptable to change and rapidly productive. In addition it involves incorporating aspects of social and environmental considerations in determining business objectives, which is increasingly in demand in today's society.

Finally, for academia, various lines of future research can further progress the study of gender differences in the relationship between individual dynamic capabilities and social and environmental commitment, as well as their relationship with agents coming are targeted and as measures derived from and seek new implications for the company resulting from gender differences, such as market orientation of these.

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Registrations decreasing and new possible incentives: investigating EMAS Regulation applying a Structural Equation Modelling approach

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Abstract

The Environmental Management Systems (EMSs) are a voluntary tool through which companies can demonstrate their proactive approach towards environmental protection. A survey of the literature shows that EMSs are effective in order to contribute to a circular economy, setting high environmental performances. The most widespread EMSs are realized in compliance with the ISO 14001 standard and the EMAS (Eco Management and Audit Scheme) European Regulation. In the last five years, the number of European organizations with an EMAS registration significantly dropped. This negative trend occurred also in Italy, where in 2012 for the first time drops out from EMAS exceeded the new registrations, starting a negative trend. In order to investigate this recent phenomenon, we conducted a survey targeted to all Italian organizations that dropped out of EMAS between 2010 and 2015. This article deepens the analysis already presented in a previous work, applying a Structural Equation Modelling (SEM) approach. We conducted the investigation in collaboration with ISPRA (Italian Superior Institute for Environmental Protection and Research), the Italian Competent Body for EMAS. Examining the ISPRA dataset, 397 organizations that did not renew the certification during the period were identified. We realized data collection between October and December 2015, obtaining 99 responses with a 25% response rate, that we evaluate as a good result, considering that the interviewed organizations were not anymore certified, and often they do not have a responsible in charge of the EMS. The survey has been conducted through a questionnaire mainly composed of two sections. The main goal of the first part was to identify the reasons why organizations dropped out of EMAS; the second section aims at identify policies and support tools that would be most effective in order to encourage new registrations in the future. We performed an explorative data analysis (EDA) on the results of the survey in order to find trivial relations among the aspects that determine the non-renewal decision and expectations to renew the registration. Starting from the EDA results, we build a Structural Equation Modelling (SEM) dealing with latent variables to summarize the information. In section one, starting from 44 potential motivations to drop out of the registration, we set eight latent factors. In section two, we set two latent factors from the ten variables representing actions that could motivate organization to re-implement EMAS. The aim of this model-based approach is to find the relationships among not directly observed variables represented by the latent variables on the SEM. Thus, the primary goal of the research is to identify latent relationships between reasons to drop out of the scheme and most favorable measures to encourage organization to come back to EMAS. Results aim at figure out how European and Members States authorities may realize actions to give new impulse to disseminate EMAS among European companies.

The sustainability of the Italian water sector: an empirical analysis by DEA

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Abstract

Climate change and the hydrological variability are natural driving forces that, when combined with the pressures from economic growth and major population change, make the sustainable development of our water resources a challenge. The combination of these factors commonly results in increased water use, competition and pollution in addition to highly inefficient water supply practices. These results can be traced back to the fact that most decisions in water resources management, at almost all levels, remain principally driven by short-term economic and political considerations that lack the long-term vision needed to implement sustainable development practices. In this pattern the state of the Italian water services - fragmented management and high deficiencies in the collection and treatment of wastewater, and even present and future problems in water supply in some areas of the country – explains the rationale of the radical reform introduced by Law 36/1994 for hydro services. Based on the necessity to industrialize the sector and, at the same time, on the impossibility of avoiding a natural monopoly, the law imposes at least the exploitation of all possible economies of scale and scope, aiming at reaching a competition for the market as a surrogate of the impossible competition in the market. Moreover it is necessary to ensure as soon as possible in Italy a national coherent governance of water resources, able to adopt a regulatory framework with a unified integrated management of water resources. Good governance of water is not only a fundamental pillar of sustainable use of natural resources, but also the key element for the social welfare and economic growth. In this paper a set of Italian water utility companies is utilized in order to estimate the sustainable efficiency of the whole Italian water sector. In particular the present evaluation has been carried out using the mathematical/linear programming of Data Envelopment Analysis (DEA). DEA is a well-established mature multi-criteria analytic technique for evaluating the efficiency of systems that exhibit similar operational characteristics with several inputs and outputs. Such technique is able to not only assess the efficiency of each one of the different units of the system relative to the other ones, but also suggest corrective policies and measures which could make the inefficient units efficient. This approach can be useful for policy makers to direct decisions towards a more sustainable and efficient water sector.

Keywords: water resources, company, sustainability.

Rethinking Models of Evaluation: Sustainability as the Goal of International Cultural Organisations

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Abstract

The purpose and conduct of organisational evaluation is variously defined and understood. With the shift to the 'new managerialism' and the steady advance of audit culture in the public sector, evaluation models have proliferated but they are often narrowed to crude measures of impact and performance. They subject people to unhelpful, top-down forms of appraisal and accountability in the interests of transparency and economic efficiency with little respect afforded to the multiple perspectives and divergent goals of the actors involved. There is often a lack of clarity about what is being evaluated and from whose perspective. This paper traces the development of the Cultural Value Model (CVM). It was developed as part of UK-wide research programme aimed at rethinking how we assess the value of cultural activities. The primary objective of the CVM is to provide an analytical and methodological framework for re-conceiving models of evaluation. In particular, it shifts the frame of analysis away from impact to value. Our project aimed to deliver a robust, evidence-based understanding of the changing cultural value of the British Council (BC) and BBC World Service (BBCWS). These publically funded international organisations are an integral part of the UK's diplomatic infrastructure and subject to stringent accountability measures to satisfy diverse stakeholders. They are experiencing rapid and convulsive change in response to financial, technological and geopolitical forces and their purpose and value is being questioned. In the paper we argue that the CVM, in fostering a more engaged, participatory approach to performance evaluation challenged and even subverted existing practices but with mixed results. In the case of the BC, it generated a high degree of interest and engagement to the extent that it is currently being adopted and integrated into organisational practices. In contrast, the BBCWS were more resistant to innovation believing that their audience ratings and internal reviews suffice. The flexible adaptability of the CVM presents an opportunity for other organisations to move from away from top-down performance and impact assessment towards a more inclusive, reflective and sustainable model of value. However we need to get a better understanding the organisational constraints that obstruct innovation if more participatory models of learning, monitoring and evaluation are to intervene in social and organisational processes and achieve sustainable models of good practice.

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1. Introduction

Evaluation can be understood as the 'systematic application of social research procedures in assessing the conceptualization and design, implementation, and utility of social intervention programmes' (Rossi & Freeman, 1985 page 19). It is a rapidly evolving field (Green & McClintock, 1991) with a dizzying array of innovation in the application of new methods, techniques and approaches constantly emerging (Hites et al., 2013; Miller & Fredericks, 2006; Mills, Crone, James, & Johnston, 2012). With the advance of neo-liberal forms of governance, and associated forms of 'new managerialism' and audit culture, accountability and transparency have moved centre stage in public sector organisations (Deem, 1998; Shore, 2008). New technologies of governance require new methods of accountability. But methods are not neutral tools. Methods are performative. They shape and in turn are shaped by social and organisational factors (Gillespie, 2013). Impact evaluation is but the latest manifestation of neo-liberal forms of governance and has become a pervasive activity in organisational culture but its rationale and benefit are questionable (Epstein & Klerman, 2012). How is it possible to attribute impact to an identifiable and measurable cause? How relevant are non-measurable variables? Can evaluation indicators be established for the important qualitative aspects of organisational, social, cultural life (Bell & Morse, 2008, 2011)?

The current interest in the development of evaluation structures which focus on participatory methods and on complex cultural phenomena comes out a growing dissatisfaction with neo-liberal forms of accountability and impact measurement (Coll-Serrano, Carrasco-Arroyo, Blasco-Blasco, & Vila-Lladosa, 2012; Daigneault, Jacob, & Tremblay, 2012). When it comes to international cultural organisations Like the BC and BBCWS, measuring the impact of cultural activities poses very particular challenges, especially if seeking to monetise culture and attribute an economic value or a return on investment (Skuse, Gillespie and Powers, 2012; Gillespie, 2011). The Cultural Value project funded by the AHRC sought to rebalance a prevalent focus on measuring the instrumental value of culture with a greater attention to the intrinsic value of cultural activities. (Gillespie and Bell et al., 2014).

2. Methods

Culture, as Raymond Williams pointed out in Keywords, is one of the most complicated words in the English language (1976: 87). Add to it the term value, which is almost equally polyvalent, and we are faced with a considerable analytical and methodological challenge. Our project aimed at understanding the changing cultural value of the BBC World Service (WS) and the British Council (BC) at a critical moment in their history. These key national-to-global institutions have been the voice and face of Britain overseas for some eight decades, connecting overseas publics to the UK and in so doing bringing a range of economic, political and cultural benefits to Britain. Our main argument is that cultural value – the communicative, connective and creative benefits that these organisations generate in interaction with their audiences and users – is the catalyst of all other forms of value. However, it is not recognised as such because economic and other instrumental forms of value dominate current thinking and models of assessment. Our Cultural Value Model (CVM) redresses this imbalance and provokes new ways of thinking about and doing assessment.

Until recently, WS and BC were funded by Grant-in-Aid by the Foreign and Commonwealth Office (FCO) as two key cultural components of the UK's diplomatic infrastructure. Since April 2014 the BBCWS has been funded by the licence fee payer as part of the BBC's Global News Division. The BC now only gets only 25% of its funding from the FCO. Such shifts in funding and governance, combined with the impact of new communications technologies and new configurations of global publics, mean that these organisations are at a critical time of change. Their value is being questioned from a number of directions. How can the use of public money to benefit overseas publics be justified at a time of domestic austerity? Economic returns and accountability, concepts of culture and ethos, the very concept of public service itself, are issues at the centre of public debate about how we understand and value these organisations (Gillespie and Bell et al 2014).

BC and BBCWS are very well known and respected abroad. But 'at home' in the UK, awareness of their activities is negligible. Little academic research has been done into the cultural value they generate and channel, although this project was able to build upon seven year's prior research into WS at The Open University (Gillespie and Webb 2012). Our project connected in a dynamic way two key components of cultural value set out by the AHRC's remit to develop a deeper: i) 'understanding cultural value in an international setting', and (ii) 'foster reflective individuals and engaged citizens'. It was an ambitious project in aiming not just to deliver a new academic understanding of the ways in which BC and WS in their interactions with users and audiences generate cultural value abroad and at home, but a practical product to help these and other organisations conceive and assess cultural value.

This paper is centrally concerned with describing the development of the Cultural Value Model or CVM. In the following sections we will describe what the research team understood by the term Cultural Value (CV). We discuss why it emerged as important to understand CV in measurable terms in organisations that are tasked with providing cultural relations activities and international news. We show how the measurement of value (in both quantitative and qualitative terms) can contribute to a wider discussion concerning the assessment of organisations of all kinds in terms of their performance and impact. We demonstrate how the assessment of 'value' as distinct from performance and impact, provides a different vantage point and from which to analyse contemporary organisations and professional practices. Building on this we will describe the development of the CVM and demonstrate how it was applied within projects at the BC and BBCWS. Finally, we will discuss how our findings contribute to the discussion about the assessment of organisations more generally.

We use the term 'cultural value' to encompass the multi-dimensional nature of the benefits that BC and WS bring to citizens overseas and in the UK via their interactions and activities. Cultural value has many components but at the heart of the matter are the creative, communicative and connective benefits that these organisations bring to audiences and funders, as well as to the organisations themselves and other stakeholders (Negus and Pickering 2004).

Why is measurement of value important and how does this question link to wider questions about measurement of performance and impact in organisations? Over the last forty years business and management science has moved from metrics gathering to performance measurement to impact analysis and increasingly to value appraisal. As Holden has argued, the value of culture is difficult if not impossible to measure by statistics alone (Holden, 2004) and the importance of value over more established assessments such as performance has been noted (Ong & Chen, 2014). What others have suggested and we have argued is that value is not readily definable or quantifiable. Value is judged differently according to the perspectives of specific people, groups or organisations in which hierarchies of value are established. But when it comes to cultural value it is often assumed that universal and objective standards should and must prevail. The task of CVM assessment is to take these apparently opposing positions into account. The CVM can support contradiction and paradox and in so doing avoids the pitfalls of either subjectivist or objectivist accounts of cultural value by bringing them into dialogue.

If value is a concept of growing importance in the assessment of organisations and their performance then the measurement of value must be key to this assessment.

The point and use of a CVM is to provide stakeholders within and their partners outside an organisation with an approach to assessment of the value of the work they are engaged with. If they do not get an 'added-value' from the CVM then there can be little defence for investing in it in the first place. Users are at the heart of both these organisations. It is their very raison d'etre so our model also places assessment by audiences and users at the heart of the model. In line with the contemporary concern with empirical and participatory assessment, the CVM emerging from this research represents a shift in intention on a number of scales:

- A shift from the monitoring of others to the understanding of ourselves
- From assessment of performance and impact to assessment of value
- From unrealistic and painful striving for continual excellence to managing sustainable balance

These are all major objectives of the CVM described in this paper.

In order to develop our model and to reflect multiple perspectives of 'value' in each organisational context, we needed an ethnographic understanding of the culture of each organisation (Gillespie and Webb, 2012). Such an understanding included not only an analysis of their histories and relationship to government but also how they imagine and engage their users and audience and how they measured their success or failure – the methods used to evaluate their practice and how diverse data sets were put to use for different purposes (Gillespie, 2013). It also include an analysis of the changing face of organisational work under the impact of new technologies, the manner and delivery of projects, team and personal reflections on management styles and organisational change. We wanted to gain a broad sense of the working practices of each organisation. A rounded assessment of these elements formed the basis for subsequent modelling.

In October and November 2013 we ran workshops for staff and stakeholders in the BC and BBCWS. The workshops were organised making use of an approach called Imagine (Bell, 2011; Coudert & Larid, 2011; Kalopedis & Plan, 2007; Maher & Plan, 2006) which is specifically designed to help groups, by use of simple diagrams called Rich Pictures, to come to agreement about issues and concerns which are of common interest to all group members. The Imagine methodology is also a basis for criteria assessment making use of a diagrammatic form of composite indicators called an amoeba although at the outset this was not expected to be the foundation of the CVM. Rather, Imagine was applied purely as a means to surface values of importance to the cultures of each organisation.

The first Imagine workshop on the 29th October 2013 involved the BBCWS.

The 31 participants when divided into five groups were asked to set out issues that were of importance to them and tasks which they felt needed to be addressed by their organisation. The list of concerns is set out in Appendix 1.

Following the workshop presentations by the groups the researchers assessed the list for repeated, high frequency and high importance issues emerging from the day (i.e. those which were most often mentioned and those which raised a high degree of group interest during plenary sessions). For the BBCWS the issues were as follows:

- Ensuring Legacy
- Managing Global reach
- Remaining Relevant to audiences
- Building bridges of International Understanding
- Balancing continuity and change

The second Imagine workshop on the 5th November 2013 involved the BC. The 34 participants when divided into six groups were again asked to set out issues of importance and tasks that needed to be addressed.

As with the BBCWS workshop, the researchers drew out a short list of high frequency and high importance factors. These were as follows:

- Managing Legacy
- Coping with Scale – from local to global
- Widening participation via Digital development
- Maintaining/ensuring Trust – partnership and commercial tensions
- Challenging the commodification of culture
- BC ambition to be thought leaders not just conduits of UK culture
- Measuring impact
- Promoting Innovation
- Encouraging Flexibility

Any model representing the value of the organisations would need to be responsive to the issues raised by the two groups. For our purposes the lists developed at the two Imagine Workshops would form the basis of the collectively highly regarded human activity and this was seen as being discreet components, indicative of the cultural value of the organisations.

3. Results

Having gained insights on the current practices and activities of the BBCWS and BC our concern was to find a means to model these assessments and represent them as components of CV that related closely to the goals and targets that they ae trying to achieve. The model brought into dialogue the components of value identified in the Imagine workshop and our prior historical and ethnographic knowledge and experiences of the two organisations. In line with our research objectives we wanted to develop a robust analytical and methodological framework in order to understand CV in the BBCWS and BC had been imagined and demonstrated in the organisations. We wanted to do this based on the workshops, a number of highly focused digital projects and on the long-term familiarity of the members of the research team with the two organisations.

The development of the CVM can be explained in terms of five distinct Parts – each one often iterated following practice, demonstration and review by stakeholders in the BBCWS and BC. The five Parts are described next.

As already noted, the workshop model applied for the BC and BBCWS was an adapted version of the Imagine methodology. Imagine is at one level a means to help groups assess matters of common importance (see for example Eisle, 2003). It is also a means to develop a diagrammatic, non-aggregated composite indicator known as an amoeba (originating with the work of Ten Brink, Hosper, & Collin, 1991). The essential and non-reducible requirements for the development of an amoeba diagram are:

- Segments of discrete interest such as the differentiation of internal and external environments for an organisation (e.g. Management, Production, Market, Wider world)
- Vectors (hereafter known as Components or Component spokes in the diagram) which can be used to assesse each segment (e.g. Management might be assessed in terms of a series of values including: leadership, policy effectiveness, empathy, drive, enthusiasm, etc.)
- A qualitative or quantitative indicator to assess each Component
- A known Band of Equilibrium (BoE) or ‘balanced’ value for each Component (this is explained in more detail shortly).
- A measurement process which provides dots on each Component spoke and which, when linked produces the ‘amoeba’ shape.

If these five elements are in place then an amoeba diagram can be constructed – such as that which is shown in Figure 1 below.

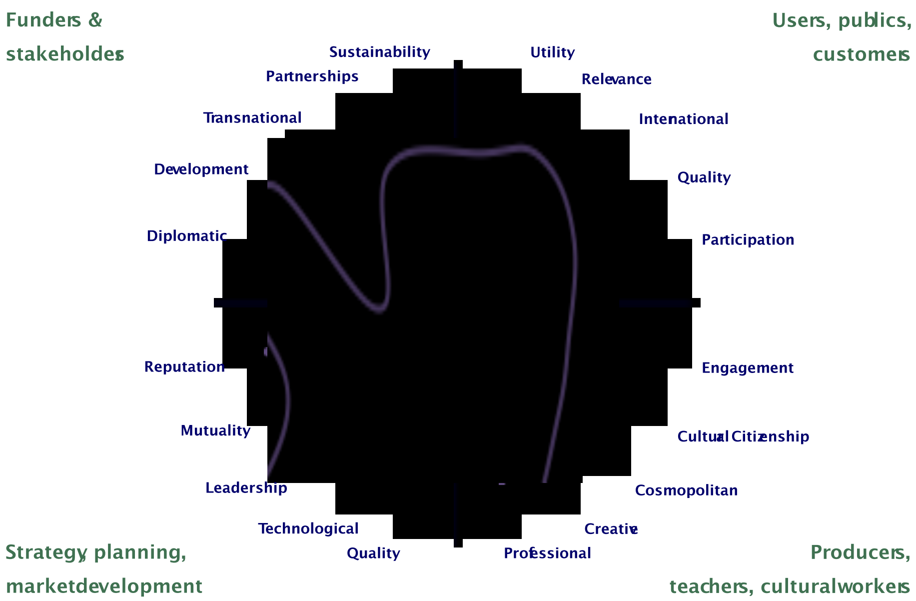

Figure 1. Amoeba diagram

In this amoeba diagram there are four segments of discrete interest: Funders and stakeholders; Users, public, customers; Producers, teachers, cultural workers and Strategy, planning, market development. Each segment has a number of Components – such as: utility, relevance, international, quality and participation in the segment for Users in the top right hand corner. Each Component has been measured and a score included. The score or worth of each Component is indicated by the 'dot' on each Component spoke. The Components all share a band of equilibrium (or BoE) which is shown by the shaded ring. If a point on a component is measured to be within the ring then the component is said to be in equilibrium – it is sustainable. If the point is within the inner circle of the ring (e.g. cultural citizenship in the Producer, teachers, cultural workers Segment) then the Component is said to be unsustainable by deficit. If the dot on a Component is outside the outer ring of the BoE (e.g. Relevance in the Users, publics, customers Segment), then the Component is unsustainable by excess. When the various points are joined up the distinctive amoeba shape is produced.

The main presentational power of the amoeba is in its nature as a non-aggregated diagrammatic composite indicator. What do we mean by this? When dealing with systemic qualities (e.g. welfare or happiness or development or sustainability) single indicators will not adequately assess the complexity of the context. In such circumstances one response is to combine single indicators or even indexes of indicators in a composite.

The search for a systemic and multi-dimensional portrayal of a complex reality results in indicators being combined in composites and as such present arrays of linked but conceptually segregated domains. A composite indicator should, if it is doing its job really well reveal in one indicator or even number the results of the array ("the answer is 42!"). If this is going to work well then the composite is theoretically underpinned by a conceptual structure which allows different indicators to be included, in some manner amalgamated and provided with a weighted value in the combining. The composite should in some way represent in a comparative manner the qualities and values of the item being studied.

Because of the nature of the combining of a variety of values in one overall 'score' composites are all technical in character. They are seen as having wide ranging value and cover a spread of domains, for example from the Shannon-Weiner Index (Simon Bell & Morse, 2008 pages 24 - 26) for measuring biodiversity (comparing number of species in sample and number of individuals in each species in sample) to the Human Development Index (for a critical review see Tonn, 2007) (containing three indexes of health, education and living standards). Clearly the contrast between these two is vast but it demonstrates the wide-ranging appeal and apparent value of the composite (evident in fields as diverse as economy, social analysis, environment, technology and agriculture).

The power of the composite is its capacity to abbreviate and span. This is also the key weakness. The technical engineering of the final number will always require a considerable number of assumptions to be made regarding the weighting of components, the relative value of factors and the exclusion of some items. All such issues are invisible to the external observer or non-technical person. For this reason a composite is in danger of misuse (e.g. inaccurate data for the requisite components), misapplication (e.g. application to non-relevant contexts) or erroneous conclusion (e.g. the misreading of the indicator for the context in question).

One way around the single figure composite is to amalgamate various indicators, still in their atomic form within a schema or diagram. This allows an overall, visual and readily assessable analysis of a diversity of indicators whilst at the same time maintaining independence for each and avoiding anonymity of factors. The amoeba diagram is one such device. In the amoeba the various components are retained and not 'lost' in a composite value, they are visible in the diagram and the composite, the overall 'indicator' is expressed in the shape of the amoeba. In much the same way that composite indicators of a more conventional form can be compared and valued (for example GDP or Gross Domestic Product indicators are regularly compared and contrasted both historically for nation states and between nation states, league tables emerge and relative worth is graded) amoeba diagrams can also be assessed and valued. As well as the potential for diagrams between organisations or projects to be compared to each other, a 'good' amoeba would be represented by a shape where all the components points are located within the BoE ... in this case the amoeba tends to the shape of a circle within the BoE ring. Any amoeba shape that is not like this can be seen as being more or less unsustainable. The knowledge of the message of the amoeba composite is instant, visual and conclusive.

The selection of the amoeba as the basis for the CVM was arrived at during a research team meeting in late 2013. At this meeting one member of the Team provided a schema that showed the organisational structure of the BBCWS as a systems map. The map, when considered at a higher level of abstraction was seen to correspond to four cardinal points: the External and Internal elements of the BBCWS; strategic and audience facing components. The four cardinal points when superimposed on the map provided four segments and this in turn led to the opportunity for an amoeba structuring process.

The organisational structure is shown in Figure 2 and the overlay of the segments is shown in Figure 3.

In Figure 3 the four segments are shown to correspond to significant and distinct elements of the BBCWS system and environment. A similar modelling exercise was undertaken for the BC and a comparable structure emerged (although different in terms of the detail of the Components and Segments).

With the establishment of the background or 'Field Map' for an amoeba diagram, the research team could seek to continue to adapt and apply the Imagine approach in order to develop the CVM. The next step in this process was the agreement on the Components which would provide the essential value measurement for the diagram

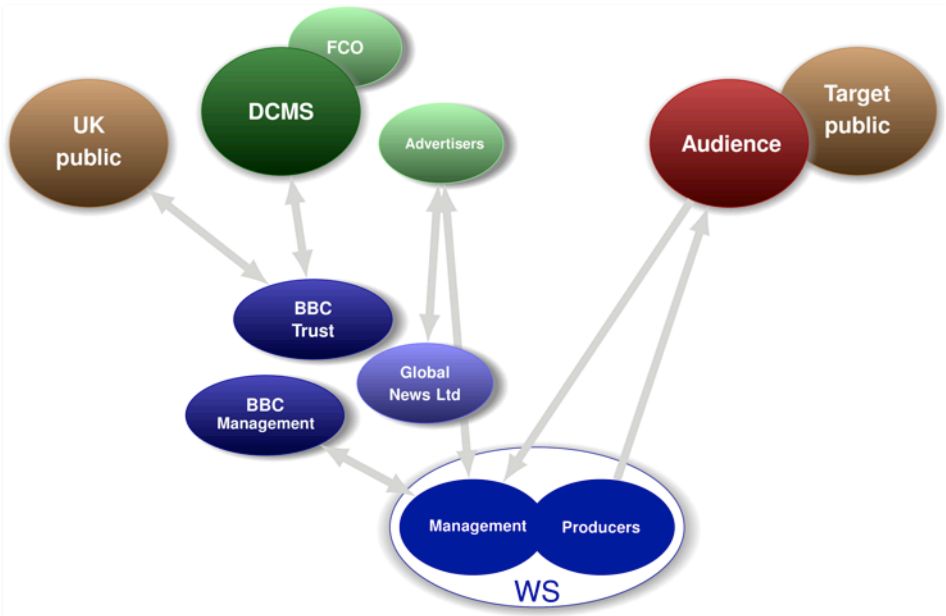

Figure 2. BBCWS organisational structure: systems map

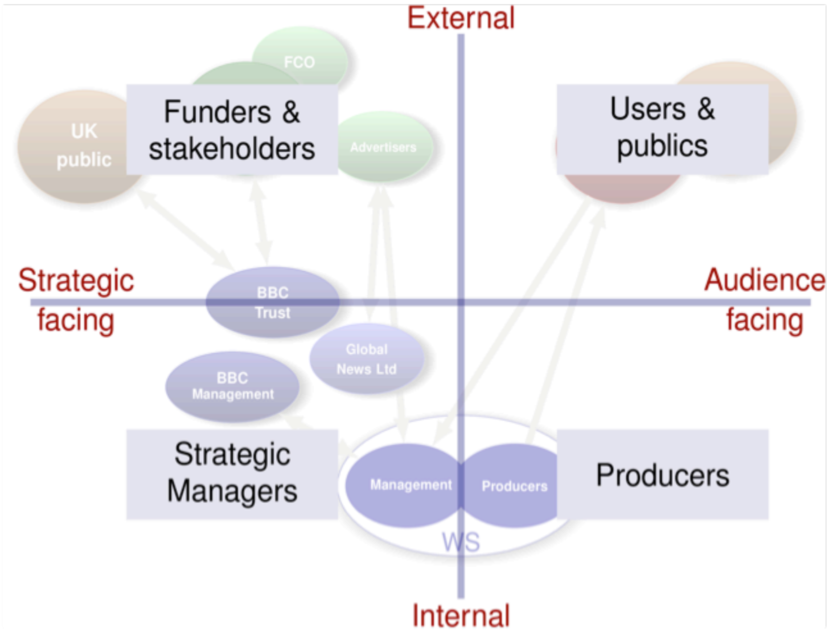

Figure 3. BBCWS segments – the 'Field Map' of the CVM

As noted in earlier sections of this paper, the Components provide the spokes for the CVM and represent the segregated sense of value of the members of the BBCWS and the BC. Value in our definition is not readily derived from literature or cultural theory; rather it emerges from the practical conceptualisation of the members of the organisation and the immediate stakeholders. Earlier we described the preliminary workshops which we ran in October and November of 2013 and from which a number of Tasks and Issues emerged as being of specific relevance as segregated and discrete hints towards a sense of the value of each organisation. We wanted to develop up to five value components for each Segment of the CVM. Why five? In order to make a valid and comparable assessment of the changing value of the BBCWS and the BC we wanted to chose a small but manageable set of Components which would allow the two organisations to assess significant and discrete elements but not at the same time be overwhelmed by a plethora of Components in the amoeba composite. We made the judgement (based on the use track record of the Imagine methodology) that around five Components per Segment and therefore around 20 components per four Segment CVM would provide the necessary level of granularity and detail to the modelling exercise without at the same time overwhelming the CVM user with unnecessary detail and confusing complexity for the interpretation of the diagram. The numbers; five Components per Segment and four Segments per CVM were not to be seen as fixed or absolute, rather they would provide a guideline for CVM developers. Arguments could always be made for more or less Segments and, similarly more or less Components.

Although the Workshops with BBCWS and BC in October and November 2013 would provide a good basis for the development of Components, this was not to be the single or even most important basis for Component development.

The Components need to be meaningful to the BBCWS and BC – they really need to emerge from what we might call the 'value story' or 'value narrative' which the members of these organisations and their near stakeholders tell each other. Applying an approach which we call Value Analytics – which places multi-perspectival value analysis using participatory methods at the heart of all evaluation activities - we constructed the initial set of Components for both the BBCWS and BC from three sources:

1. The Tasks and Issues emerging from the initial workshops.
2. The observed and understood expressions of value as emerging from the various case studies which we were undertaking with the two organisations. These case studies were of the history of the two organisations and also of five digital projects (British Council: Learn English MENA Facebook, South Asia Season; BBC World Service: 100 Women, Olympics 2012 and Syria). These projects would form the basis for our various versions of the CVM.
3. The long-term understanding of the two organisations represented in the knowledge of the various members of the Research Team.

Further, the developing sense of the meaning and worth of each Component was tested at various seminars and workshops held with members of the two organisations at events in February, March, April and May of 2014. For these events it was understood that each Component would require a detailed description.

It should be emphasised at this point that the development of the Component spokes for the CVM and the assessment of their current value within each project was a constant and iterative process. As members of the Research Team and, more importantly, members and stakeholders of the BBCWS and BC learned about the CVM and provided their insight into the values of the various Components so these Components and their related assessment changed. At a higher level, as the development of the specific versions of the CVM was adapted to each project so the number and types of Segment also changed over time. This iterative development process is an important feature of the CVM and the Value Analytics which is instrumental in its development. A Component is rarely 'fixed' in the same manner as, for example the elements of a conventional composite indictor could be said to be fixed. A key concept behind the CVM and established in Value Analytics is that value is dictated by the balance of views of those engaged with or serviced by the organisation – the main stakeholders. This balance can be said to be fixed (in a relative fashion) when the stakeholders who comprise the group of those engaged or serviced by the organisation have settled on the Component balance which they feel is representative of the Cultural Value of the organisation or project.

In our research our research team were leading in the development of the CVM and necessarily led in the development of the Components as headlines, glossary narratives and relative value within the specific context. As the CVM developed and as more members of the stakeholder group for the various BBCWS and BC projects were engaged in the development of the Components in workshops and seminars, so these elements of the CVM changed and developed. For example, with the 100 Women project the initial sketch of the various Components in the amoeba diagram is shown in Figure 4. A few weeks later, taking more views into account and considering the perspective of these stakeholders a computer-generated version emerged and this is shown in Figure 5.

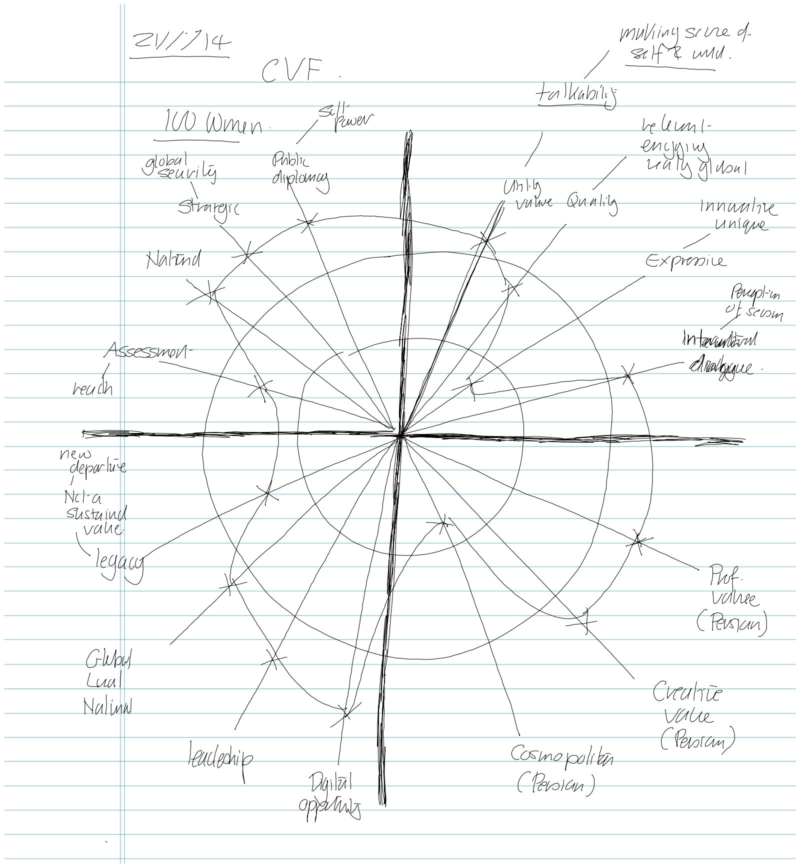

Figure 4. 100 Women

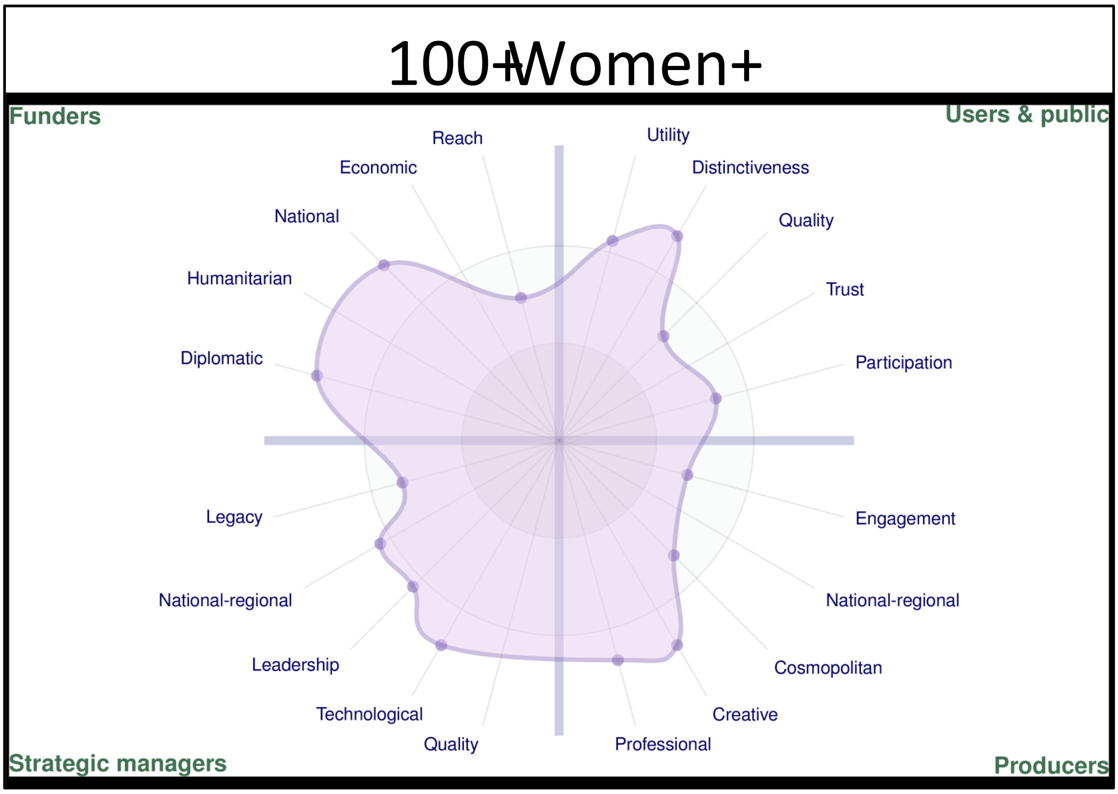

Figure 5. 100 Women – a little later

The differences between the two diagrams are many and critical. In a sense the CVM is a constant work in progress – developing and adapting as the stakeholder community behind it develops and adapts. In a deeper sense the CVM is stable and representative. It is stable in that our experience indicates that around 70% of the Components remain constant between any two given presentations (and it should be kept in mind that all indicators change – even such fundamental indicators as unemployment assessment and GDP). It is representative in that it can be seen to accommodate the values of stakeholders and be expressive of the elements of the project or organisation which concerns them.

Most fundamentally, what does Figure 5 say, what does it add to the 100 women projects self-assessment? Without going into too much detail four main themes emerge:

1. The amoeba demonstrates a tendency to exceed – this excess is shown by the number of dots on Components outside the outer circle which we call the Band of Equilibrium (more on this later). 9 of the Components are exceeding the Band and although that shows excellent work it also marks a potential lack of sustainability for future, similar projects.
2. Only 8 of the Components are in or near the Band. This means that the minority of Components are in balance.
3. The model is a model of excess performance with no Components under-performing (within the Band).
4. Excess is particularly evident in the Funders and Strategic managers Segments but less evident in the users and public and producers Segments. This may be fine but does this suggest that the self-assessment of value indicates a focus on meeting the exaggerated aspirations of funders? Could this ultimately mean a dropping off of focus on audiences?

These are provocative observations which we would argue are suggested in the interpretation of the amoeba.

We will say more about the interpretative and evaluative use of the CVM later in the paper.

Key to the development of an amoeba is the Band of Equilibrium – BoE. The BoE is one of the main innovations in the Imagine use of amoeba diagrams and represents a major development for the CVM.

The concept supporting the BoE is that any value, indicator or metric will have a range of possible scores – represented on the amoeba diagram as a point on a Component spoke. In developing the amoeba the stakeholders are asked not just to nominate and agree a range of Components but also to agree two critical scores – the lower and upper range of a sustainable score.

For example, if we were dealing with a Component which reflected audience participation in a given broadcast. The stakeholder group may agree that they will know, within an error range of one or two thousand, roughly how many people will individually engage with the interactive social media which supports the broadcast. The stakeholders may feel that the total engagement could be as much as 40,000 (given room for error as previously suggested). The stakeholders are then asked to suggest a lower and upper band score which would be 'sustainable'. This is a tricky term and one which requires some discussion in its own right. Sustainability is famously hard to define and lends itself to vague and occasionally patronizing or even melodramatic description (e.g. 'the best we can do', 'your responsibility to yourself' and 'the world we hand to our kids'). A sustainable return on an indicator tends to mean that the indicator is in a form of balance and that this return can be relied upon to be repeatable again and again. It may not be 'ideal' or 'excellent' but it is good enough and, if repeatable, very much fit for purpose. In our example here the stakeholder team may say that if the possible range of social media interactions is 0 – 40,000 then the BoE might be represented by return in the range of 25,000 (the lower limit) to 30,000 (the upper limit). Measured returns in this range would conform to the Band.

Our point is, and this is a point emphasised by previous use of the BoE in numerous projects, each Component when provided with a BoE allows the stakeholder team to gain a sense of the individual worth of each Component and a sense of if this worth is fit for purpose or is in some way in deficit or excess of a sustainable return. When twenty or so such Components and related BoE scores are assembled, the final diagram representing not just the current valuations of each Component but the relative worth of each Component valuation set against the BoE provides a very rich assessment of the overall project/ organisation or what ever form of agency is being assessed. However, the BoE is not always so quantifiably produced as suggested in the example provided here relating to social media hits. Often a Component will be of a qualitative nature (e.g. Esteem, or Reputation or Creativity) and valuation of such a Component in a specific context by the relevant stakeholders needs to be achieved by means of a narrative and an agreed positioning. For example, here are the valuations of three Components taken from the Project managers segment of the British Council South Asia Season project.

Engagement: (low/medium)

Contact across the season with audiences low but with target contacts high

Professional: (high)

Project workers were exposed to (unprecedented) wide range of people and countries, learned a great deal and built good professional networks. There was evidence of good teamwork across the organisation and sectors – draws on different aspects of BC – satisfying priorities for integration as set out in the Global Operating model

Cosmopolitan: (medium to high)

Staff played bridging role between places, cultures and languages but UK and global SA diasporas were not effectively mobilised – limited diversity – tended to involve well-known UK diaspora figures in arts and literary scene so arguably didn't manage to open up range and nature of people interacting

In this example the Engagement Component was scored as low to medium (probably just in the lower range of the BoE) because the targeted contacts were engaged but the wider audience was not so involved. The Professional Component was rated as high (probably above the upper limit of the BoE) because the project delivered professional benefits beyond those expected and, therefore, probably beyond those which could be reasonably expected to emerge in future. Finally, the Cosmopolitan Component was rated as medium to high (probably within the upper limit of the BoE) because the project was only partially successful in engaging plural and multicultural audiences.

As with the Components, so with the BoE – the nature of the band and its valuation will be expected to change with the change in the stakeholder group who agree it. Over time it would be expected that the BoE would shift and develop. If it is seen as being too easy to achieve then the worth of the lower limit of the BoE may be raised. If the Component is seen to be redundant or irrelevant, then it and its BoE will be exchanged for a new, more relevant Component.

The main theme is that the BoE allows a group of stakeholders to make self-assessment of sustainable value and to make this across a range of Components which in sum represent the snapshot of the Cultural Value of the project or organisation at that time.

4.Discussion

The nature of the CVM as presented at our final event for the British Council on the 20th May 2014 has shown some innovation on the basic Imagine / amoeba model.

Firstly and invisible to the reader of the diagrams, the structure of the CVM has adapted and changed as stakeholders have been engaged and the Research Team has improved its grasp of the changing nature of the CVM. Segments have been questioned and their titles simplified, Components have been adjusted and even removed, valuations of the BoE have been repeated and adjusted as the understanding of the meaning of the worth of each Component has changed. Also, the change from amoeba to constellation is more than a change in label and aesthetic. The sense of a constellation lends a new insight to the overall diagram. The implicit meaning of an amoeba is a blob, a changeable and, shape-wise, meaningless shape. A constellation on the other hand has implicit and explicit meaning in the shape. As: ‘a recognizable pattern that is traditionally named after its apparent form or identified with a mythological figure’ (Google dictionary) a constellation suggests meaning in the shape. The shape can appear cruciform or ellipse, circular or crescent. The shape will imply a meaning derived from the nature of the Components which are highlighted by the shape. The shape may provide a nudge to a behavior change (e.g. “I am uncomfortable with the irregularity of the shape”, “I really thought we would represent as a fuller circle”, “This crescent shape is really surprising”).

Two examples of the revised and updated CVM are shown in Figures 6 and 7.

In Figure 6 the British Council South Asia Season project is shown now as a Constellation Diagram appears slightly cruciform is outline with 13 of the 20 Components in or near the BoE (now shown as a Milky Way). Although there are some clear under and over performing Components, much of the diagram shows as in equilibrium.

The Figure 7 constellation of the MENA project shows further adaptation. In reflection the project team agreed that three segments were more accurate as describing the project context – rather than four. The 15 Components are spread equally among the three Segments and the shape of the constellation, as with Figure 6 is cruciform. In this case the under performing Components are more clearly below the BoE (e.g. Prestige and Citizenship) but 10 of the 15 Components are in or near the BoE and this does not suggest a project in crisis but clearly the five significantly ‘out’ Component valuations need to be reviewed in order to see if there are implications for this and /or other projects.

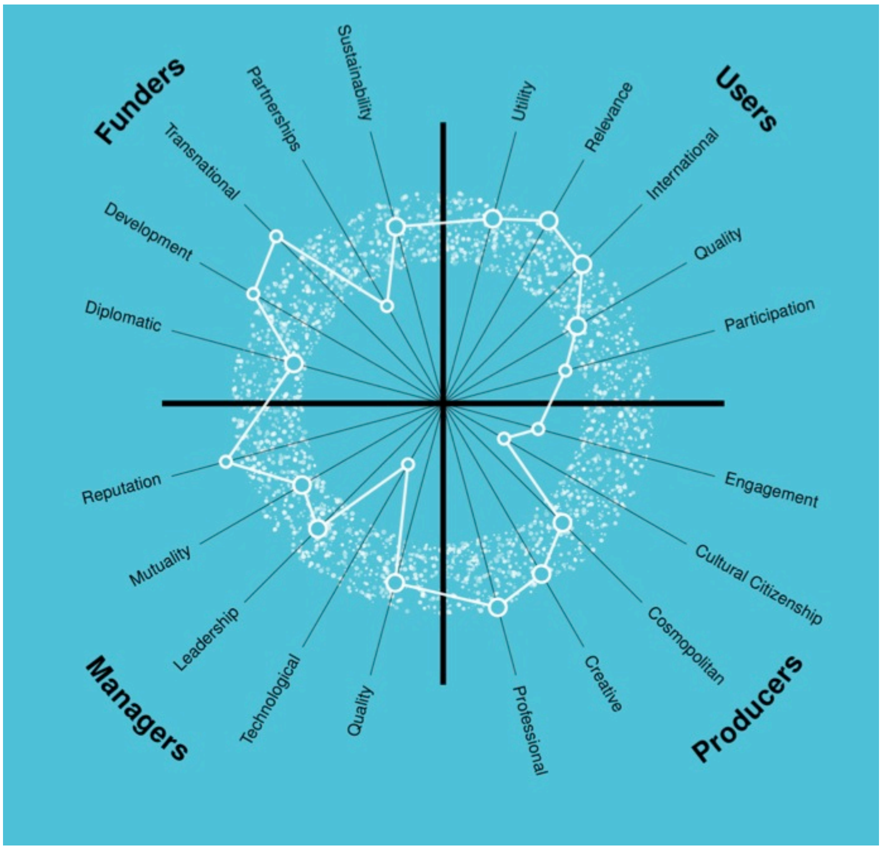

Figure 6. Constellation CVM South Asia Season

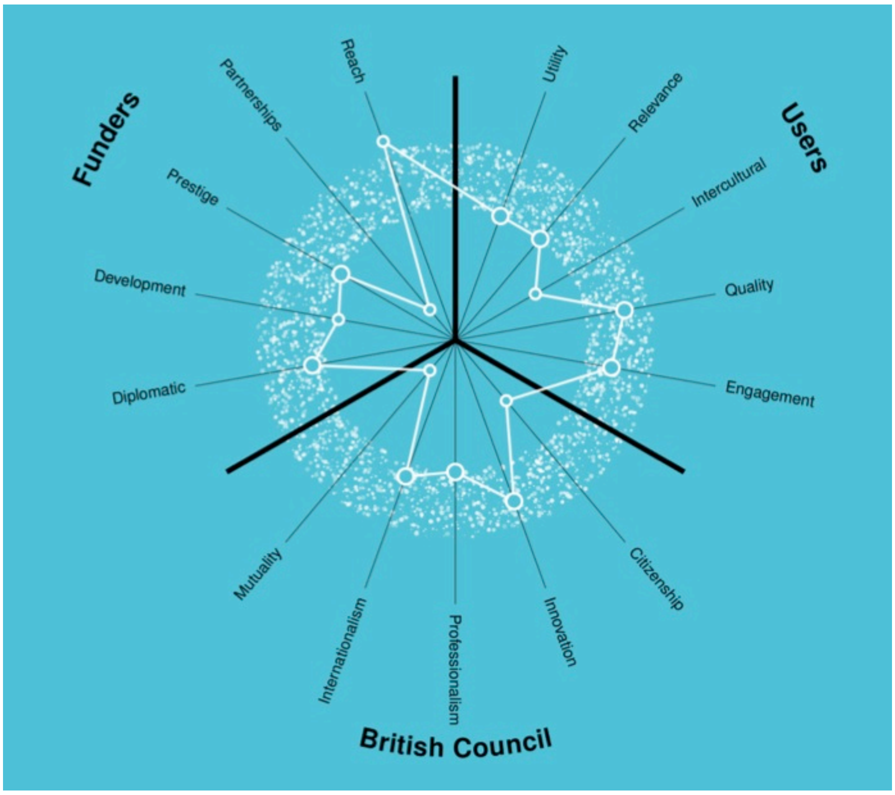

Figure 7. Constellation CVM MENA

5. Conclusion

In this paper we have set out the development path and some of the outcomes of the use of the CVM. We believe that the following implications emerge:

Firstly, at the time of writing, response to the CVM by BBCWS and BC stakeholders have been mixed but the Constellation diagram appears to provide an at times contentious but stimulating overview of project work. This was the intended response. If the Constellation does not stimulate discussion and interest then its existence is called into question as a provocative intimation of value.

Secondly, there has been some quite encouraging interest in the interpretation of the meaning of the Constellation in both organisations but particularly the BC. This is reflected in the BC's use of the CVM in the assessment of subsequent major global festivals, cultural programmes and interventions including: The UK-Iran Season of Culture, Shakespeare Lives in 2016, The South Asia Digital Libraries Revolution Programme. The BBCWS proved to be more resistant. This is mainly because they have a large audience research department that in their view suffices for purposes of evaluation for editorial and accountability (to the FCO) reasons. It gives them regular measurements - from audience ratings to page views to retweets to Facebook analytics (Gillespie et al 2010). Despite this, producers tend to pay most attention to numerical measures and although qualitative data is gathered, producers actually don't pay very much attention to it.

Thirdly, the BoE has proved difficult to achieve but has produced some encouraging responses. To consider an assessment of value set against a sustainable position remains a comparatively novel approach to the BBCWS and BC project teams. There is a generalised challenge here around the concept of a visual interpretation acting as a spur to deeper conjecture. The BoE is a potent visual means to explore variations from accepted or assumed levels of sustainability. Prior to this however, groups and teams need to engage with familiarisation of the concept. Without some prior understanding of the summative nature of the visual the group conceptual movement from assessing the BoE to understanding its various messages can be messy and defensive.

Fourthly, the Constellations are 'snapshots' by specific stakeholders at specific times. Comparison of the snapshots is limited at the time of writing but the project team would be interested to develop a series of snapshots of one or several similar projects in order to achieve a longitudinal analysis or Constellation Moview of value change.

Fifthly, the CVM represents an additional assessment task for teams in the BBCWS and BC. There are already well-established performance and impact assessment procedures in each organisation and to adopt CVM requires both faith in the value of the additional work and time to undertake it.

In conclusion, the CVM can be seen as part of a more generalised interest in the use of diagrams and visualisation techniques in evaluation and a movement away from the tyranny of basic metrics. We see this as representative of a maturing of evaluation impact culture and a move towards a more systemic and sustainability orientated conception of organisational value.

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Sustainable Human Resource Management: state-of-the-art and future research

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Abstract

Sustainable human resources management (HRM) considers sustainability as a business model for the organizational survival accomplished by the development of the triple bottom line concept: social equity, economic and environmental performance. This literature review identified a predominance of exploratory studies, some difficulties in conceptualization, as well as, the different terminologies that link sustainability and HRM: Sustainable HRM, Sustainable Work System, HR Sustainability, Sustainable Management of HR and Sustainable Leadership. This study aims to analyse the state-of-the-art human resources management and to identify key elements, trends and research gaps. A systematic literature review was carried out using Scopus database, covering the period from 2001 to 2015, which resulted in a corpus of 87 scientific articles. Data analysis occurred through content analysis tools and statistical processing of the abstracts by the Alceste software, version 2015. The results showed four categories which comprise 80% of the elementary units of the corpus analysed. The first comprised studies on sustainable leadership, based on individual and group power and embedded in its principles, processes, practices and organizational values. The second demonstrated the relationship between HRM, environmental sustainability and organizational performance. Such approach reflects the alignment of HR practices (recruitment, selection, performance appraisal, training and rewards) with environmental objectives of the organization and the strategic dimensions of HRM. The third category considered the tensions and paradoxes between HRM practices and sustainability. On the one hand, HRM should focus on cost reduction and corporate profitability (in the short-term); on the other, their actions should provide long-term sustainability of organizational performance. The last category dealt with the link between HRM and the social dimension of sustainability, especially with regard to organizational social responsibility and the company's relationship with its stakeholders. In conclusion, this paper aims to contribute to the ongoing discussion on the topic of sustainable HRM by analysing the state of the art and future directions of HR studies.

Keywords: Sustainable HRM, Sustainability, Social Responsibility, Sustainable Leadership

1. Introduction

This paper examines the significance of the concept of sustainable human resource management (HRM) for organizational performance. The intersection between sustainability and human resources management is based on two assumptions: the role of human resource management in promoting organizational sustainability (Cohen et al., 2012; Ehnert et al., 2013; Guerci and Pedrini, 2014) and the sustainability of human resources management processes (Mariappanadar, 2003; Ehnert, 2009b; Cohen et al., 2012).

Existing researches have different goals and are based on different assumptions about the role of HRM in sustainability.

The first part highlights the role human resource management in supporting business sustainability (Cleveland et al., 2015) adopting practices that could influence individuals and groups in developing attitudes and behaviours consistent with a sustainable approach (Avery, 2005; Avery and Bergsteiner, 2010; Cohen et al., 2012; Parkes and Borland, 2012). In the second part, sustainability principles could be incorporated into human resources management practices, and provide professionals with long-term physical, social and economic well-being (Taylor et al., 2012).

On the other hand, it is possible to distinguish some integration between the two perspectives for human resource management benefits from sustainability and assists in its implementation (Guerci and Pedrini, 2014). Mohrman and Shani (2011) support such interpretation. According to them, organizational sustainability depends on the workforce understanding the company's new objectives and mission. In addition, human resource management practices are a vital sign so professionals will believe in the organization's commitment to sustainability.

The relationship between sustainability and human resource management is an innovative approach in the field of management studies. Being a fairly new perspective (Dao et al., 2011; Ehnert and Harry, 2012; Mak et al., 2014), sustainable human resources management still requires deepening of its concepts and practices, in order to reduce inconsistencies found in the literature (De Prins et al., 2014). Furthermore, researches on the subject are still evolving (Ehnert and Harry, 2012) and comprise predominantly conceptual and exploratory studies (Ehnert et al., 2016).

Considering this theoretical background, this paper examines the assumptions underlining the different ways concepts of sustainable human resource management have been used in organization studies, by assessing state-of-the-art human resources management and its identify key elements, trends and research gaps. The following literature review shows a predominance of exploratory studies and some difficulties in conceptualization, as well as, different terminologies to link sustainability and HRM: Sustainable HRM, Sustainable Work System, HR Sustainability, Sustainable Management of HR and Sustainable Leadership.

Sustainability is a major principle for human resources management and it unfolds into two elements (Sotome and Takahashi, 2014): the contributions of sustainable management of human resources applied to financial performance and organizational goals considering employees' satisfaction, commitment and well-being; the sustainable nature of the process enables the maximization of corporate results and a decrease in damage to stakeholders (employees, communities and government, among others).

The sustainable management of human resources started to be discussed in the late nineties in Germany, Switzerland and Australia. Research by Müller-Christ and Remer (1999), Zaugg et al. (2001), Gollan (2000) e Wilkinson et al. (2001) were decisive in the area. Those authors highlighted the importance of sustainability for the management of human resources based on previous studies on environmental management, human relations and corporate sustainability (Ehnert and Harry, 2012).

Currently, research on sustainability applied to the management of human resources is developed by different disciplines and research areas. Such studies focus on corporate sustainability, corporate social responsibility and sustainable work systems, which propose a different perspective respect traditional concepts and practices of strategic management of human resources in the business environment. The sustainable management of human resources has multiple levels of analysis (effects on individuals, process management, organization and society), dimensions (economic, ecological, social and human) and different time perspectives (short and long term) (to be considered Ehnert et al., 2013).

Given the theme's conceptual multiplicity and contemporaneity, the literature is still diverse and fragmented (Ehnert et al., 2013; Kramar, 2014). Moreover, definition of the term "sustainable management of human resources" is imprecise and the implications of the process of organizational results present different approaches (Kramar, 2014). The theoretical multiplicity of the concept of sustainability influences such context (Table 1).

Table 1. Definitions of Sustainable Human Resources Management (SHRM) identified in literature review.

Authors	Definitions
Müller-Christ	Sustainable management of human resources related to the actions the

and Remer (1999)	organization should implement in order to have lasting access to qualified human resources.
Gollan (2000, p. 60)	"Capacity of organizations to create value in their organizations thereby having the ability and capacity to regenerate value and renew wealth through the application human resource policies and practices. This will entail investment in human knowledge through continuous learning, and the application and development of such knowledge through employee participation and involvement"
Zaugg et al. (2001, p. 1)	"Sustainable human resource management can only be implemented if it is based on individual responsibility of employees and is future-oriented. It is defined by methodological and instrumental approaches whose objectives are long-term-oriented, socially responsible and economically efficient recruiting, training, retaining and disemployment of employees. Increasing employability, guaranteeing a harmonious work-life-balance and enhancing individual responsibility take on an important role in the concept of sustainable human resource management."
Mariappanadar (2003, p. 910)	"Sustainable HR strategy can be defined as the management of human resources to meet the optimal needs of the company and community of the present without compromising the ability to meet the needs of the future."
Thom and Zaugg (2004)	Long-term conceptual approaches, such as social responsibility and economic viability recruitment actions, selection, development, maintenance or reduction of the workforce.
Gollan (2005, p. 25)	"Capacity of organisations to create and regenerate value through the sustained application of participative policies and practices."
Ehnert (2009b, p. 74)	"Sustainable HRM is the pattern of planned or emerging human resource strategies and practices intended to enable organisational goal achievement while simultaneously reproducing the HR base over a long-lasting calendar time and controlling for self-induced side and feedback effects of HR systems on the HR base and thus on the company itself."
Freitas et al. (2011, p. 226)	"Sustainable human resource management is regarding to achieving organizational sustainability through the development of human resources policies, strategies and practices that support the economic, social and environmental dimensions, at the same time."
Cohen et al. (2012, p. 3)	"Sustainable HRM is the utilization of HR tools to help embed a sustainability strategy in the organization and the creation of an HRM system that contributes to the sustainable performance of the firm. Sustainable HRM creates the skills, motivation, values and trust to achieve a triple bottom line and at the same time ensures the long-term health and sustainability of both the organization's internal and external stakeholders, with policies that reflect equity, development and well-being and help support environmentally friendly practices."
Wagner (2013, p. 443)	"Sustainability-oriented sustainable) human resource (HR) management as a management of human resources (HRs) that meets the current needs of a firm and society at large without compromising their ability to meet any future needs."
Kramar (2014, p. 1084)	"Sustainable HRM could be defined as the pattern of planned or emerging HR strategies and practices intended to enable the achievement of financial, social and ecological goals while simultaneously reproducing the HR base over a long term. It seeks to

	minimise the negative impacts on the natural environment and on people and communities and acknowledges the critical enabling role of CEOs, middle and line managers, HRM professionals and employees in providing messages which are distinctive, consistent and reflect consensus among decision-makers."
Ehnert et al. (2016, p. 90)	"Sustainable HRM can be defined as the adoption of HRM strategies and practices that enable the achievement of financial, social and ecological goals, with an impact inside and outside of the organization and over a long-term time horizon while controlling for unintended side effects and negative feedback."

According to the above definitions and approaches described by Jabbour and Santos (2008), human resource management is an integral part of organizational sustainability. It presents the following characteristics:

a) the potential of human resources management to apply sustainability principles in an organizational context;
b) organizational sustainability and modern human resource management require actions that go beyond economic performance aiming at long-term results;
c) the current paradigm of human resource management is the promotion of organizational sustainability;
d) modern human resources management needs to be effective, in order to meet the needs of the organization's stakeholders.

The debate on sustainability in a corporate and human resources management context relates to practices and business strategies that have a significant impact on natural and social resources, as well as on the different environments within the organization; those will, in turn, influence management conditions and the future context of business transactions (Ehnert, Harry, 2012). In this sense and considering that organizations seek business sustainability, management practices should focus on creating strategic value based on three elements: people, environment and profitability (Dao et al., 2011).

Studies on Sustainable HRM can be analyzed in a timeline perspective (Ehnert and Harry, 2012). First definitions of Sustainable HRM focussed on sustainable work systems considering their economic, social and environmental dimensions. A second wave of studies included studies linked systematically sustainability and human resources management, including researches on the externalities of human resource strategies and the impacts of downsizing, for example. The last wave includes interdisciplinary studies that emphasize a broader understanding of the role of HRM towards a social debate of sustainability.

From now on, the present paper will be structured as follows: section 2 will describe the methodology of the systematic literature review and the software used for data analysis (lemmatization process); section 3 will present the results on the lemmatized corpus and discuss its findings. The conclusion will reveal the insights obtained.

2. Methods

The different conceptions of sustainable human resources management are reflected in the various nomenclatures currently being used. Despite the diversity of terminologies, they all recognize, implicitly or explicitly, the human and social perspectives of organizations and the impact that human resources have on the success and survival of companies (Kramar, 2014).

In order to analyse the studies that link sustainability and human resources management, the authors carried out a systematic literature review that aimed at identifying its main theoretical aspects and highlighting the main characteristics of the publications. The review enabled the researchers to identify gaps in the studies analysed.

A preliminary review defined search terms in the following fields: title, abstract or keywords (Table 2). The authors chose the Scopus database as it is widely used in academic researches. The search criterion included articles published in scientific journals of social sciences and humanities.

Table 2. Main terms for data collection.

Terminology	References
Sustainable HRM	Freitas et al. (2011) Ehnert and Harry (2012) Zink (2013) Osranek and Zink (2013) De Prins et al. (2014) Kramar (2014) Mariappanadar and Kramar (2014) Mazur (2014) Ehnert et al. (2016)
Sustainable Work System	Docherty et al. (2008) Jackson (2012) Kira and Lifvergren (2013) Zink (2013) Zink (2014)
HR Sustainability	Gollan (2000) Wilkinson et al. (2001)
Sustainable Management of HRs	Ehnert (2006)
Sustainable Leadership	Avery and Bergsteiner (2011) Kantabutra and Avery (2011)
Sustainable Organisation	Jabbour and Santos (2008)

A total of 195 publications were found. After reading the abstracts and, when necessary, the article contents, 87 studies were selected.

Afterwards abstracts of selected studies were organized into specific files, in order to carry out an analysis of their content via the 2015 edition of Alceste software (Lexical Analysis of a Contextual Text Segments Set). This version allows a researcher to analyse interviews, literary works, articles, essays and other texts, in order to quantify and extract their most significant structures, i.e. their elementary context units (ECUs) (Illia et al. , 2014).

Alceste's method is known as Hierarchical Decreasing Classification (HDC). The corpus to be analyzed is successively split in chunks; the researcher then observes the distribution of the most significant words within every segment extracting the most representative words from the text. The software uses chi-square test to verify the association of context units into classes (Vallbé et al., 2005).

One important advantage of using Alceste is that human bias is controlled, as human coding is guided by an explanatory report: the researcher analyzes quotations only once these have been identified as being either representative or not of a specific co-use of words. In other words, the researcher analyses quotations based on reports of how the language in each quotation is contrary or similar to the language used in other quotations (Illia et. al., 2014).

The above stage produced a corpus of 87 elementary context units (ECUs) that when processed, yielded 528 elementary context units (ECUs). This process allowed the identification of four categories that comprised 80% of all elementary context units (ECUs) of the analyzed corpus.

3. Results and Discussion

Initially, the 87 articles were classified according to the year of publication (Figure 1). Throughout this stage, the authors found that 44% of the articles were published between 2014 and 2015. The trend line also shows the growing interest and the innovativeness of the sustainable management of human resources concept (Zink, 2013; Ehnert et al., 2016).

A total of 14% articles were published in the Journal of Cleaner Production (15 articles) and the International Journal of Human Resource Management (14 articles); 20% of the researches was carried out in the United States, 18% in Australia and 11% in Great Britain; nine studies were authored by Sooksan Kantabutra, eight by Charbel José Chiappetta Jabbour; Sugumar Mariappanadar and Gayle C. Avery had 5 articles each.

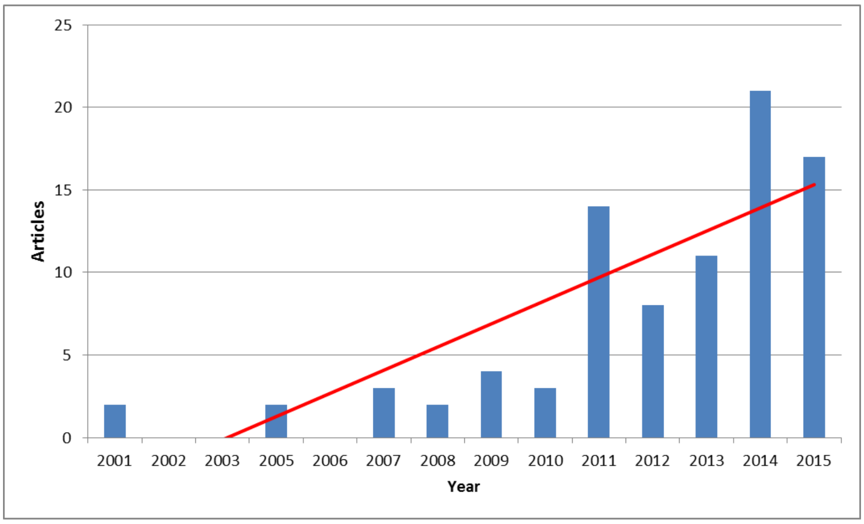
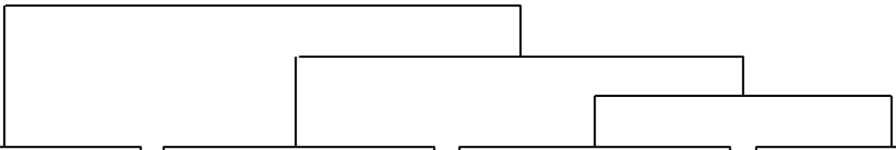


Figure 1. Articles per year of publication.

The preliminary analysis of articles shows a significant proportion of theoretical studies (40 articles), as expected for an emergent subject (Ehnert et al., 2016). Considering the remaining 47 articles (empirical), there is a balance in the qualitative and quantitative approaches: 23 (48.93 %) are quantitative and 24 (51.06 %), qualitative.

The keywords, abstracts and title of the articles were analyzed by the software Alceste, version 2015. The software considered keywords, titles and abstracts as Elemental Context Units (ECU), which are text segments composed of roots and their variations. A set of all ECUs constituted the research corpus, from which outputs were generated.

Within this corpus, Alceste classified 422 ECU (80.20%) out of the 528 that were created and created four stable categories. The classes and the main words in each class are presented in a dendrogram (distance tree) generated by that software (Figure 2). From this classification, the axes and the classes were named. The chi-square values (χ^2) associated with each word represents its semantic importance within the class.



Class 1 (10%)		Class 2 (24%)		Class 3 (34%)		Class 4 (32%)	
Leadership for Sustainability		**Environmental Dimension**		**Economic Dimension (Tensions & Paradoxes)**		**Social Dimension**	
ECU	χ^2	ECU	χ^2	ECU	χ^2	ECU	χ^2
Avery	147	environme+	46	hrm	45	corporate	54
leadershi+	91	dat+	35	we	40	value	31
six	81	employe+	33	paradox +	32	social	31
adopt	81	performan+	30	explore+	25	responsib+	30
Bergstein	81	associati+	29	human+	24	branding	18
principle	76	manufactu+	25	issue	21	concern	17
Innovatio+	65	survey	20	resource+	20	firm	16
Rhineland	63	important+	20	chain	19	many	16
long_term	58	initiativ+	20	scholars+	19	its	15
grid	54	implement+	20	tension+	17	tool	15
adopting	54	japanese	18	natur+	16	importanc +	15
observati +	54	training+	18	then	15	demonstra+	15
thailand	53	productiv+	18	green	15	volunteer+	15
were	51	employmen+	17	article+	15	originali +	14
staff	48	positivel+	17	supply	14	stakehold+	14
published	45	sample+	15	this	12	bmw	13
conglomer+	45	quantitat+	15	argue	12		
Axis 1-Leadership for Sustainability		**Axis 2 – Tiple Bottom Line Concept**					

Figure 2. Classes and axes dendrogram - Alceste software.

The distance tree represents visually a descending hierarchical classification and guided the researcher's analysis since the interpretation needs to take into consideration that classes of discourse are very different (beginning of tree) or somehow overlapping (end of tree) in their use of language (Illia et al., 2014).

Each category identified are focussed in selective ways and provides slightly different ways of understanding and accessing sustainable human resource management (Figure 3).The most meaningful category (43% of the variance explained) is category 1, which represents 10.00% of the ECU. It is entitled "Leadership for Sustainability", because it refers to works by Avery (2005) and Avery and Bergsteiner (2010). Avery's model (2005) is based on six core elements of sustainable leadership: adopting a long-term perspective, investing in people, creating a strong organizational culture, support for innovation, environmental and social responsibility and ethical behaviour.

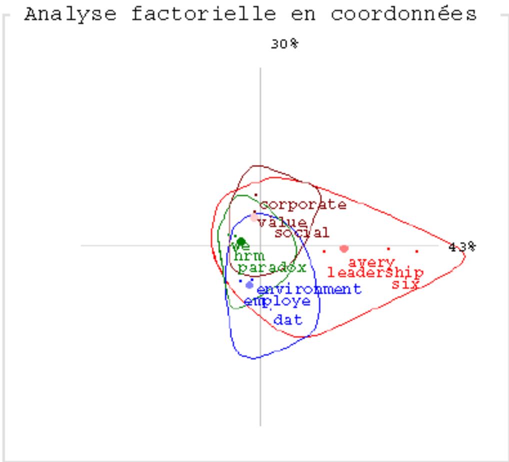


Figure 3. Factorial analyses with classes - Alceste software.

The Leadership for Sustainability incorporates several sustainable practices related to the organization's employees. Some authors (Kantabutra, 2014; Suriyankietkaew and Avery, 2014) support the incorporation of sustainable leadership in the field of human resource management.

In this context, sustainable management of human resources is an integral part of sustainable leadership, given that it encompasses other organizational factors (environmental responsibility, retention and knowledge sharing processes, decision making, ethical behaviour, long-term projections, among others) (Avery and Bergsteiner, 2011; Kantabutra and Avery, 2011). Managers are indeed an important element for the implementation of sustainable management of human resources: they must consider people as an essential element in the organization. In this sense, the selection, development and leadership succession processes are important practices (Hoeppe, 2013).

Therefore, it is possible to identify some factors related to human resources management that may affect the company's sustainability (Daily and Huang, 2001):

a) top management support: to communicate policies, plans and other important information to employees; to enable cultural changes necessary for its implementation; to reward team members according to the achievement of results and improvement interventions; and to monitor environmental management system;
b) Training: it promotes awareness and implementation of environmental management system. In addition, it prepares the workforce to develop new environmental and corrective actions;
c) participation and empowerment: it favours communication, control, emergency preparedness and employees' effort regarding non-conformity adjustments and implementation of preventive actions;
d) teamwork: its implementation contributes to communication and coordination between departments, as well as it enables knowledge sharing and it helps to avoid the duplication of activities between the teams;
e) rewards: it encourages and motivates employees to implement and maintain practices related to the environmental management system.

The second category is called "Environmental Dimension" and it represents 24.00% of the ECUs. It includes studies on the role of human resource management in promoting the environmental sustainability of organizations. This perspective is dealt with in studies by McCann and Holt (2010), Merriman and Sen (2012), Longoni et al. (2014), Benn et al. (2015), Jabbour (2015), Rae et al. (2015) e O'Donohue and Torugsa (2016).

The majority of studies on environmental and sustainable management of human resources have an empirical and, in many cases, quantitative design. Consequently, some terms (data, survey, results, search, evidence, limitation, empirical fact and findings) were grouped in this category. Even though studies in this area are already assessing the influence of human resource management process on environmental sustainability in an organizational context, some authors highlight further research opportunities in the area (Jackson and Seo, 2010; Wagner, 2011).

The possibility of human resources management supporting environmental sustainability practices originated in the context of industrial growth and the improving in living conditions in different countries. Such growth was constructed, in most cases, on environmental degradation (Daily and Huang, 2001).

According to Wagner (2015), in the past, organizations were not concerned about environmental preservation, mainly due to poor or lack of regulations. The creation of new and stricter rules increased business costs. Given this context, companies developed immediatist solutions, with little involvement of human resources management once it was not clear how the area could effectively contribute to environmental management actions (Wagner, 2015).

Analysis of the results allowed the authors to identify a third category that relates to the "tensions and paradoxes" permeating sustainable human resources management. Its terms emerge from studies that address the existing dualities in the objectives of the process: Ehnert (2009a), Aust et al. (2015) e Peters and Lam (2015).

According to Ehnert (2009b), the dilemmas of corporate sustainability are: financial growth and social and environmental sustainability; short-term and long-term vision; importance of shareholders as compared to other stakeholders; and ethical dilemmas.

Therefore, dualities and dilemmas are constant elements in the life of a human resources professional: on one hand, human resource management needs to promote the efficiency of processes, reduce costs and increase business profitability in the short term; on the other, it needs to invest in the development of human capacity and provide sustainability for the organization in the long term (Kramar, 2014).

In this context, tensions arise from the duality between productivity goals (linked to the economic dimension of sustainability) and human well-being (Zink, 2013). Moreover, from the perspective of human resource management, such paradox highlights the tensions between the performance targets set for the workforce and their personal objectives, inserting, in this context, the organizational goals (Aust et al., 2015).

This duality is also highlighted by Wilkinson et al. (2001). According to those authors duality emerges when the question is how employers can balance the interests of stakeholders and, at the same time, preserve a sustainable work environment for employees. They believe the organization should focus simultaneously on the results of sustainable human resources, aiming at profitability and the company's survival, and meet the needs and aspirations of employees in relation to work. Aust et al. (2015) point out, however, that such issues are challenges to the establishment of policies and human resources management practices.

Category 2 encompasses studies that link human resources management to environmental sustainability; category 3 incorporated terms related to environmental issues considering that it is a subdivision of category 2. In addition, environmental issues can be seen as an organizational paradox: companies need, simultaneously, to explore and preserve the environment. Guercino and Carollo (2016) by focusing on the environmental dimension of sustainability, consider that successful managers have the ability to accept the tensions arising from organizational paradoxes and lead the process with harmony without focusing on only one of the contradictory poles.

Finally, category 4 referred to as "social dimension" included the perspective of corporate social responsibility emphasized by Aggerholm et al. (2011) e Yang et al. (2013), for example.

Corporate social responsibility can be considered a subfield of organizational sustainability (Marrewijk, 2003; Weber, 2008). Therefore, companies should focus on economic sustainability in the long run and avoid the implementation, in the short term, of actions harmful to society or the environment (Yang et al., 2013).

One of the objectives of corporate social responsibility is to voluntarily integrate social, environmental and economic strategies established by the organization (Sanchez-Hernandez and Gallardo-Vázquez, 2013). Therefore, the principles of corporate social responsibility are embedded in sustainability and some studies consider such concepts as synonyms (De Prins et al., 2014).

Boxall (2014) points out that human resources management enables the promotion of social welfare, considering that individuals and organizations can work together, in a reciprocal and sustainable manner, seeking long-term benefits. Yang et al. (2013) corroborate this view and highlight practices that promote corporate social responsibility:

a) to provide suitable working conditions through the analysis of jobs, fair wages, and occupational health, law compliance and development and implementation of codes of ethics and conduct;
b) to assist in incorporating corporate social responsibility into organizational culture, supporting volunteer work, community services and social and environmental projects;
c) to optimize opportunities for training and development and to incorporate indicators of corporate social responsibility in performance evaluation;
d) to assist in the disclosure of principles and actions of corporate social responsibility, providing transparency to the process.

Based on the above practices, human resources management appears as a significant element to the implementation and incorporation of values of corporate social responsibility to organizational practices (Sharma et al., 2010).

5. Conclusions

In conclusion, beyond the triple bottom line concept, leadership plays a very important role in sustainable human resources management. A formal and clear leadership definition is, in fact, the most important element for the implementation of sustainability principles in human resources management. As the number of studies increases, we could expect some convergence among this issue.

The analyses of these studies allowed the authors to recognize the resistance in the simultaneous exploration of sustainability and its relationship with human resources management. Parallel researches focussing on the concept of “HRM Green” (Green Human Resources Management) and surveying the relationship between human resources management and the environmental dimension of sustainability have been identified.

In addition, human resources management practices should focus on the needs of workers and their families and go beyond the mere fulfilment of legal regulations. This would include training and development opportunities, career management, democracy in the workplace and employees’ participation. It should also focus on social responsibility initiatives, observing the interests of internal and external participants and striving for short term efficiency and long-term sustainability.

The principles of business sustainability gained prominence in recent years given the impossibility of developing a sustainable society without the effective participation of corporations. Thus, the following questions arise: How companies can contribute, effectively, to the challenges posed by sustainability? In which contexts can a business be considered truly sustainable?

The present study expects to make theoretical and practical contributions to HRM studies. Firstly, it analyzed the dimensions of sustainable human resources management, obtaining an integrative perspective. Secondly, it provided a panoramic assessment of available researches, allowing the authors to identify gaps of knowledge and, consequently, new topics to be investigated. Finally, it can offer to companies and stakeholders a perspective beyond the triple bottom line concept: the inclusion of the sustainable leadership for human resources management.

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Product-service systems for sustainable fashion-evidence from Sweden

Herman Stal

Abstract

Currently the fashion industry is dominated by a value creation logic referred to as “fast fashion” (Cachon and Swinney, 2011; Kant Hvass, 2014; Niinimäki and Hassi, 2011). This particular logic thrives upon a specific version of planned obsolescence, where trend and production cycles are continuously shortened, and thereby boosting production and consumption volumes (Christopher et al., 2004). Needless to say, this increased production of fast fashion-clothes is unsustainable e.g., due to water and chemical use, CO2-emissions and unfair working conditions (Allwood et al., 2008). Clothes are often worn only at a few occasions and thereby also stress ecosystems when discarded as waste. Due to these problems with fast fashion, there is a need for business model innovation within the industry to implement alternative ways of creating value (Armstrong et al., 2015). Here product-service-systems, (PSSs)(Goedkoop et al., 1999; Tukker, 2004), are suggested as viable options because added services can either directly address negative impacts, for instance through maintenance and end-of-life services (Bocken et al., 2014), or because renting rather than selling clothes calls for lasting, rather than obsolete, products, to create value for firms (Armstrong et al., 2015). The aim of this paper is to explore the potential for PSSs to act as an alternative to fast fashion. In particular the study seeks to understand how such models are being implemented among fashion companies, and thereby reflect upon the possibilities of changing dominant value creation logics through such changes. The study consists of case studies of Swedish fashion companies implementing different types of product-service-systems, such as clothes rentals or repair services. The cases were chosen to represent different types of models, and where studied through qualitative methods, as is common when research seeks to understand processes in their context (Eisenhardt and Graebner, 2007). The findings show that the most common approach among Swedish fashion companies has been to implement take-back systems where consumers can hand worn clothes, and sometimes other textiles, back to the store. Such systems may “move” discarded clothes up the waste hierarchy as they enable recycling of fabrics rather than energy recovery. However they appear not effective in terms of changing the value creation logic within the focal firms, mainly because the responsibility for running the systems is often outsourced. This makes it difficult for the internal functions of the firms to learn from handling the waste. Such learning is necessary to improve design practices, making clothes more amendable to recycling or reuse. However, product-oriented services that sustain product life, such as offering free repair, could be effective to limit consumption of new products. Lastly, efforts at implementing new rentals models face particular difficulties, much in line with what the PSS-literature suggests (Tukker, 2015). However, framing such efforts as part of strategy work, searching for new business models to avert the threat against fashion companies by digitalization, could be a viable option to sustain the internal support for these PSSs.

Keywords: Sustainable consumption, sustainable fashion, product-services systems, recycling, fast fashion

Focusing executive education on corporate perceptions of priorities and skills in sustainability

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Abstract

The term sustainability is used in this study as a multidimensional and integrated concept in three dimensions: Economic, Environmental and Social, in reference to the triple bottom line of "profit", "planet" and "people" (Elkington, 1999). Focusing the debate on both priorities and skill needs on sustainability matters, this study aimed at identifying issues that are worth further exploring in the context of corporate sustainability from a corporate perspective. Thus, the study specifically takes stock of priorities identified by managers in Portuguese organizations, as well as its perception of skills needs. Methodologically, the research pursued a survey strategy with an exploratory purpose aiming at closing the gap between the real world view on sustainability and the focus of executive education. This means aligning the perceptions of the managers in terms of the priorities and skill needs in the corporate world with what is offered by the executive education. The construction of the questionnaire in the dimensions of sustainability followed the international reporting framework G4 of the Global Reporting Initiative (GRI), as it was considered to be the most comprehensive framework in this area. Questionnaires were applied to a convenience sample, based on existing institutional databases. The questionnaire was online in Qualtrics platform from mid-September to mid-October 2015. The final sample consisted of 149 respondents. In summary, although this is an exploratory study, it can be concluded inter alia that: 1) when analyzed globally, the highest priority goes for the economic dimension, followed by the social and, lastly, the environmental ones; 2) There tends to be an alignment between the priorities identified and the skills needs, although perceptions of need for skills reveal higher average (with few exceptions); 3) The evaluation of suppliers appears, in various dimensions, consistently near the bottom in terms of priorities and skills needs. Since this is a first approach, the analysis of the results raise several issues requiring greater depth in future studies. For instance, an illustration of a future avenue of research raised by this study is the need for further research on the motives behind the lack of priority given to the evaluation of suppliers in its different dimensions. The issue of sustainability in the supply chain, and more precisely traceability has been explored in the literature (e.g. Pagell and Wu, 2009). Traceability refers to the identification and tracking of the supplies from the origin into its final stage, i.e. an end to end view that crosses over the independent businesses boundaries by focusing on significant overall business processes. Indeed, many companies are now focusing on their supply chains looking for Economic, Environmental and Social impacts. Thus, it looks relevant to further investigate the drivers of this phenomenon and to extract the consequences of this finding to the executive education in order to adjust both practices and syllabuses as the main outcome.

Keywords: corporate sustainability; sustainable supply chain; supply chain traceability; executive education

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A Behavioral Perspective on the Sustainability Oriented Theory of the Firm

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Abstract

A promising theoretical contribution in the field of corporate sustainability is the recently proposed Sustainability Oriented Theory of the Firm (SOTF) (Lozano et al.2015). In this paper, we consider the normative foundation of the SOTF and argue it should be infused with a more behavioral perspective. In particular, we consider the perceived trade-offs and conflicts occurring in practice when firms have to prioritize different needs in a sustainability context. This paper aims to shed light on how such a behavioral perspective can provide more accurate explanations of why and when firms move form resisting to implementing sustainable operations. The scientific contribution is to develop the SOTF further by integrating fundamental insights from the area of organizational behavior. Following the approach of SOTF's authors we argue that knowledge development should be grounded in established theories of firms and their behavior. For our purpose, we apply the seminal work by Richard M. Cyert and James G. March - A Behavioral Theory of the Firm (BTF). A conceptual analysis using the BTF pictures firms as myopic systems that are seeking to reduce external uncertainty and that are rather insensitive to complex, global analyses of environmental and social problems in the wider, global supply chain. Firms will try to avoid direct trade-offs between sustainability related goals and other, profit related goals. Adoption of sustainable practices is possible as long as performance on other, active objectives does not fall below set aspiration levels. At the same time will firms continue to exhibit unsustainable behavior as long as key performance variables reach or exceed current aspiration levels. The set of active objectives is the result of ongoing bargaining processes between coalitions of stakeholders, each pursuing their goal. The conceptual analysis reveals similarities, tensions and gaps between the SOTF and the BTF. Further developing these insights can make a substantial contribution to the field of corporate sustainability because the area currently lacks descriptive and explanatory theories on firm behavior. Further empirical research is needed on validating and further testing our BTF-inspired conceptualization of sustainability-oriented behavior by firms. Such research should pay particular attention to the concept of coalitions and how engagement with stakeholders affects organizational learning.

Keywords: Corporate sustainability, Sustainability Oriented Theory of the Firm, Behavioral Theory of the Firm, Conceptual analysis, Theory development

1. Introduction

The Sustainability Oriented Theory of the Firm (SOTF) by (Lozano et al.2015) is based on several principles on how a firm should make decisions in order to integrate environmental and social issues in their operations. The role of the theory is to establish norms and values that can be applied in change management for sustainability. Indeed, this is an imperative contribution to the area of corporate sustainability because it facilitates transformation of firm behavior towards a more sustainable society. The theory is formulated as follows:

"The firm is a profit generating entity in a state of constant evolution. This entity is a system comprised of resources and networks of relationships with stakeholders. The firm's employees are responsible to represent the firm, manage its resources, and empower its stakeholders so

that the firm complies with laws, maintains its 'licence-to-operate', increases its competitive advantage, and better contributes to foster the evolution of more sustainable societies by holistically addressing the economic, environmental, social, and time dimensions." (p.440)

A core element of the theory concerns the responsibility of the employees to holistically address multiple objectives. Logically, this is premised upon a certain level of individual capabilities, e.g. cognitive skills, along with enabling decision-making structures based on collective agreements, such as legal frameworks and organizational resources. In other words, we argue that the employees' responsibility to act must be seen in relation to the degrees of freedom given by the social conditions at hand. Consequently, there is reason to ask if organizations and their individuals have a real possibility to behave in accordance with norms of the SOTF.

There are several reasons to question the realism of the SOTF and its implications. Most importantly, the need to combine social, ecological and economic values along with long-term thinking give rise to fundamental tensions for the organization and its members (Hahn et al., 2015, Slawinski and Bansal, 2015, Van der Byl and Slawinski, 2015). In fact, fundamental insights from the area of behavioral decision making indicate the members of the organization have limited ability to grasp the complexity of such situations because of limited time, resources and cognitive abilities, i.e. bounded rationality (Simon, 1965, March and Simon, 1958).

A premise of this paper is that the SOTF must take into account fundamental mechanisms linked to organizational decision making because its current state represents a knowledge gap in terms of making the theory useful in an organizational setting. For this reason we argue that the seminal work of Cyert and March (1963/1992)– *A Behavioral Theory of the Firm* (BTF) represents a major potential for conceptual insights which can be used to develop the SOTF further.

Section 2 explains our research approach by rationalizing the methodological choices. Here we also introduce the main features of the BTF. In section 3 we conduct a conceptual analysis by explicating implications for sustainability-oriented behavior through the application of the BTF. These insights are discussed in relation to the SOTF in section 4 before we present some conclusions on theory development in section 5.

2. Methods

The purpose of this paper is to develop the SOTF further in order to increase both applicability and utility of the theory. Consequently, we adopt the same methodological approach as Lozano et al. (2015) by conducting an interpretive meta-analysis in the context of the four dimensions of sustainability, i.e. economic, environmental social, and the time dimension. We end this section by arguing why the BTF represent a substantial contribution to the SOTF.

2.1 The Sustainability Oriented Theory of the Firm (SOTF)

The SOTF is at an epistemological and ontological level grounded in an interpretive position because Lozano et al. (2015) draw on the philosophy of hermeneutics (Gadamer, 1975, Dilthey,

1972) and holism (Dreyfus, 1980). This choice resonates well with discourses in the sustainability area in general where multi-disciplinary research, multiple interpretations, and a holistic system perspective are advocated norms (see e.g. Ostrom, 2009, Griggs et al., 2013).

Lozano et al. (2015) aim to apply the most used theories of the firm in a meta-analysis. They present an overview of in total nine specific theories. Table 1 show this overview in addition to the core references linked to each theoretical perspectives. Number of citations in Google Scholar is included as a proxy for usage and quality.

Table 10 Theories of the firm and their popularity

Name of the theory	**Core reference**	**Citations on Google Scholar as of March 2016**
Artificial Entity	Machen (1911)	300
Aggregate theory	Machen (1911)	300
Real Entity	Machen (1911)	300
Contractual/Agency	Coase (1937)	32000
Evolutionary	Nelson and Sidney (1982)	1700
Resource-based View	Penrose (1959/1995)	24000
Stockholder	Friedman (1970/2007)	10900
Social Contract	Rousseau (1762)	200
Stakeholder	Freeman (1984/2010)	20100
Behavioral *(Not included in the original SOTF)*	*Cyert and March (1963/1992)*	*22000*

The BTF is represented by the seminal work of Cyert and March (1963/1992) and it has received more than 22000 citations on Google Scholar. It obviously falls within the scope of theories of the firm and focuses on real life behavior and decision making. The theory's popularity is a strong argument for inclusion, especially when comparing with other theoretical perspectives already included in the SOTF.

2.2 The Behavioral Theory of the Firm (BTF)

The BTF was first published in 1963 and according James March, as written in the preface to the second edition, was completed a year before that. The main motivation for writing the book was the authors' conviction that prevailing theories, in particular those stemming from economics, could not adequately describe and explain how business firms "actually" make decisions. Detailed empirical observations of actual decision-making processes were – and still are – difficult to reconcile with normative theories of the firm. The BTF is essentially about trying to develop a comprehensive theory that provides a rationale for why firms make decisions in the way they do.

During the past 50+ years that have passed since it was first published, the BTF has had an enormous impact on the management and organizational literature (e.g. Scott and Davis, 2015, Gavetti et al., 2012, Mitchell et al., 1997). Several of the concepts developed in the BTF, for example *standard operating procedures* and *organizational slack*, have become familiar concepts in contemporary books and articles on organizations and management. Indeed, Gavetti et al. (2012) argue that: *"[The BTF's] central concepts have become foundational to any theoretical and empirical work focused on organizational phenomena."* (p.1). It is surprising then that, in the light of its broad impact, its use as a theoretical perspective for the study of corporate sustainability has been modest[8]. One reason for this may be that there are very few direct references to sustainability in the book. On page 124 in the second edition, 'good business ethics' is mentioned as an example of general standard operating procedures that apply to entire sectors and industries, but otherwise, there no explicit mentioning of corporate sustainability.

Still, what was driving us towards the BTF was the idea that if the BTF was considered one of the most influential works in the field of behavioral organizational theory, it should also have something to say about how firms deal with questions of corporate sustainability. The apparent lack of a direct discussion in the book of corporate sustainability turned out to be deceiving. Upon a closer look, and as we shall elaborate on in the next section, each component of the BTF could rather easily be related to questions of corporate sustainability. In fact, we shall argue that the BTF essentially is a theory of sustainability as it provides a comprehensive and powerful model of how firms deal with their environment, both on the short term and on the longer term. Firms both persist and adapt to pressures from the environment. They pursue multiple, conflicting goals simultaneously and survive by what Cyert and March call "short run adaptive reactions". These reactions may be short run and aimed at maintaining the status quo, but due to their adaptive nature, they will on the longer run change the firm and keep it sufficiently aligned with (changes in) global economical, environmental and social demands and conditions, yet without the firm necessarily planning this consciously.

In their book, Cyert and March first address three fundamental aspects of organizational decision-making: (1) organizational goals, (2) organizational expectations and (3) organizational choice. Based on extensive treatments of these three topics, they construct the "final" representation of their theory consisting of four relational concepts: (1) quasi-resolution of conflict, (2) uncertainty avoidance (3) problemistic search and (4) organizational learning. Together, the four concepts constitute the BTF. In the next section, we shall first discuss and analyse the three fundamental aspects in more detail and derive implications for sustainability oriented behavior. We then systematically link the implications found with the key elements in the SOTF.

3. Results

Chapters 3, 4 and 5 of Cyert and March (1963/1992) respectively address *organizational goals, expectations and choice*. In the following subsections we present the results of a detailed analysis of each chapter with a view to derive implications for sustainability oriented behavior. The implications are subsequently discussed in relation to the key principles of the SOTF as described on page 11 in Lozano et al. (2015):

[8] The area of sustainable supply chains has shown a growing interest in the BTF, see Kirchoff et al. (2016) and Wu & Pagell (2011).

1. The firm has to generate *profits* (P)
2. The firm and its system (including key functions) are *constantly evolving* (CE)
3. The firm is comprised of products, activities, structures and *relations to stakeholders* (S)
4. The firm has interrelated tangible, intangible and human *resources* (R)
5. The firm influences, and is influenced, through a network of relations and by different stakeholders which can provide or withdraw the firm's "*license to operate*" (LtO)
6. The firm is controlled by managers who are responsible for making sure that the firm operates within the *law* (L)
7. The firm's employees represent the firm externally and are responsible for *balancing* profit related objectives with responsibilities in relation to all stakeholders (B)
8. The firm's employees are also responsible for developing the firm's resources and integrating them *holistically* throughout the firm's system over time in order to create a competitive advantage (H)
9. Both the firm and its employees can be prosecuted for *breaching* sustainability related *laws* (BL)
10. The firm and its agents should recognize that the firm, its competitors, customers, governments and the world as a whole, are *constantly evolving* (CEa)

Based on these 10 principles, Lozano et al. (2015) formulated their SOTF, as shown in the introduction of this paper. In our discussion of the results of the analysis of the BTF we shall refer to the SOTF principles by using the acronyms used above.

3.1 Organizational goals from a corporate sustainability perspective

A key element of the BTF is Cyert and March's conceptualization of organizational goals. First, firms pursue multiple goals, of which only some are related to profits and costs. More in general, what constitutes the active set of goals for a firm is the result of an ongoing bargaining process between stakeholders related to the firm. Secondly, goals are essentially treated as constraints, rather than criteria for maximization. Ultimately, the core task of the firm is to find decision alternatives that meet the constraints. Table 2 below shows the results of our analysis of chapter 3 in the BTF.

Table 11 Organizational goals and sustainability-oriented behavior

Key elements from BTF on organizational goals	Implications for sustainability-oriented behavior
Within the firm, there is only superficial agreement on very general goals; underneath, there is considerable disagreement about more explicit goals; the firm pursues multiple goals simultaneously.	At a strategic level, pursuing "sustainability" may have limited impact; one should assume disagreement about the relevance and meaning of sustainability at lower levels in the organization.
The active set of multiple goals in the organization results from bargaining between coalitions of active members of the organization. So-called side payments are	The firm will adopt sustainability related goals – and matching policy commitments – if these are considered important by a powerful enough stakeholder.

given in the form of policy commitments.	
Organizational precedents act as a stabilizing force such that the active set of goals does not change quickly.	Sustainability related goals will neither quickly emerge nor quickly disappear.
Sequential goal attention – firms ignore many conditions that outsiders regard as contradictions. The firm pursues multiple goals simultaneously, attending to each goal separately.	Firms exhibit both sustainable behavior in some areas and unsustainable behavior in other areas. Conflict between sustainability and other goals is partly solved by addressing them sequentially.
Organizational slack allows a firm to absorb and "stock" excess resources in times where goals are easily met or exceeded and to maintain or meet goals in more unfavorable times. It provides stability, i.e. reduces the need to change dramatically and quickly, and dampens variability.	In times or markets where the firm easily meets or exceeds external sustainability goals, goodwill is built up and upward adjustment of internal sustainability goals will be tempered. The goodwill built up permits the firm to deal with other, much more demanding times and/or markets without changing internal sustainability aspirations.
A set of minimal requirements from the firm's external environment determines which set of coalition members becomes viable. An attention-focus mechanism selects which particular demands and problems are actively attended to by the coalition members. The set of active demands and problems changes over time.	Stakeholders striving for sustainability will not become member of a viable coalition unless the external environment imposes a certain sustainability related performance, which requires a contribution from these stakeholders. Attention to demands and problems related to sustainability is not necessarily continuous and may disappear altogether during certain periods.
Procedures and mechanisms for the evaluation of demands in terms of the resources required to fulfill them and their consistency must be compatible with assumptions of bounded rationality and hence, typically only incremental changes are considered.	The courses of action considered for achieving sustainability related goals will usually be derived from existing practices and solutions.

Starting with principle P, the BTF both supports the SOTF and deviates from it. The BTF clearly recognizes the importance of profit as an organizational goal. However, the BTF assumes the existence of multiple goals, not only profit. These goals function as constraints and must all be met.

A similar conclusion can be drawn regarding principles CE and CEa. The BTF supports the claim that the firm and its environment (both local and global) are dynamic and evolving systems. In particular, the BTF suggests that the active set of goals may change as a result of negotiations between stakeholders and, hence, that the status of sustainability related goals may vary accordingly. On the other hand, however, the BTF also stresses the relative stability and persistent nature of the firm. Changes are not considered as long as the aspiration levels for the multiple goals are achieved. Organizational precedents and slack further act as mechanisms that slow down the speed of change.

Regarding principle R, the BTF could enrich the SOTF by more precisely explaining how resources are interrelated. The BTF does not directly address material resources much but immaterial and especially human resources are central elements. Again, the concept of organizational slack seems important: as long as economic resources, which may be both material and immaterial, are sufficiently available, latent conflicts of interest and conflicting objectives among actors (human resources), for example regarding more sustainable practices, will remain relatively unproblematic. As resources become scarcer, the hidden interrelationships will appear more clearly. Resources may also be related to the importance of organizational precedents as discussed in the BTF: the existing material resources, for example in terms of production equipment, transportation infrastructure, as well as immaterial resources, for example in terms of the knowledge acquired by the firm's personnel, will act as stabilizing forces in relation to the current organizational goals. Investments made in certain training, infrastructure, equipment and so on, will encourage the firm to maintain goals that exploit these investments. Sustainability related goals are likely to reflect the influence of available resources.

Principles LtO, L and BL can be directly related to the way the BTF models the firm as a system having to keep multiple variables above minimum aspiration levels. The "licence to operate" stipulates these aspiration levels. Legal requirements (BL) also function exactly as suggested by the BTF; they represent minimum requirements to be met by the firm.

Principles B and H evoke some interesting questions from the perspective of the BTF and lead us to suggest some slight but distinct adaptations of the SOTF. First, the BTF specifically uses the term coalitions of stakeholders, which will typically include the firm's employees but also its management. It seems likely that management just as much act as the firm's ambassadors as the employees – if not more so. Furthermore, from a BTF perspective, it is more likely that the employees themselves operate as a constellation of several coalitions rather than one homogeneous group. When it comes to balancing the "profit generating objective with the responsibilities to all stakeholders" (p. 11), the BTF suggests that such a balancing process will be simplified by avoiding direct trade-off's and attending multiple and conflicting goals sequentially rather than simultaneously. In a similar vein, it is somewhat difficult to reconcile the notion in the SOTF of "holistically integrating resources" (p.11) with the BTF's emphasis on reducing the complexity the firm is facing by decomposing it in smaller parts and loosening the interrelationships between them.

3.2 Organizational expectations from a corporate sustainability perspective

The next key element in the BTF is referred to by Cyert and March as organizational expectations. It deals with assumptions about how firms search for information as an input to their decision-making. The results of our analysis are summarized in table 3.

Table 12 Organizational expectations and sustainability-oriented behavior

Key elements from BTF on organizational expectations	**Implications for sustainability-oriented behavior**
The amount, scope and intensity of search is dependent on the amount of organizational slack. When slack is large, search is less extensive and performed in a more fragmented manner: the interdependence of decisions is recognized to a lesser extent.	If sustainability related slack is large, local solutions that only just meet the set constraints will be accepted. The more slack, the less comprehensive the analysis of sustainability related problems – and how it relates to other problems and goals – will be.
Computations – if any – of possible consequences is rudimentary. Trying to develop a single measure for evaluating alternatives is considered awkward. Marginal advantages of different alternatives are only compared roughly.	The expected sustainability related consequences of alternatives are established by simple methods resulting in approximations rather than precise assessments. Typically, firms do not attempt to integrate the results in a common performance scale. Pairwise comparison of alternatives in terms of sustainability related performance is limited.
Firms search for alternatives and, conversely, alternatives also search for firms.	Sustainable solutions are not necessarily developed or sought after by the firm, but also emerge from the firm's environment.
Firms tend to use easily verifiable data about actual effects rather than more complex predictions and forecasts.	Firms will prefer simple systems that can measure some aspect of actual sustainable performance (feedback) rather than more advanced models for predicting future performance.

Again, principles CE and Cea can be related to the BTF. In times of much organizational slack, the BTF suggests that firms drastically reduce their search effort. Any solution, however imperfect, that meets the minimum requirements will be accepted. The importance of the notion, as expressed in CEa, that the firm, its customers, its competitors, governments and the world at large are constantly evolving, may depend on a firm's slack. High levels of slack could allow the firm to – at least for some time – continue to use inferior solutions and practices, despite the environment evolving.

The principle of LtO can be related to the BTF's notion of firms searching for alternatives and vice versa. The LtO principles states that the firm influences and is influenced through a network of relations and different stakeholders.

Similar to our discussion in 3.1, we find that principles B and H are difficult to reconcile with the BTF. As shown in table 3, the BTF suggests that firms seldom manage to integrate the results of evaluating an alternative on multiple criteria on a common scale. This implies that true holistic analyses are unlikely.

3.3 Organizational choice from a corporate sustainability perspective

The third key element in the BTF concerns organizational choice and, in particular, how standard operating procedures and learning shape choice. The results of our analysis are summarized in table 4 below.

Table 13 Organizational choice and sustainability-oriented behavior

Key elements from BTF on organizational choice	**Implications for sustainability-oriented behavior**
Decisions are strongly guided by standard operating procedures and decision rules. Rules that have been successful in the past are likely to be repeated and maintained as long as the active goals of the coalition are achieved. The procedures and rules favor alternatives that have been tried before by the firm or by other firms known to the firm.	If unsustainable practices have been "successful" in the past, within in the firm itself or in other firms known to the firm, it is more likely that the firm will choose or continue with this practice in the near future. Also, sustainable solutions that have proved successful before, are more likely to be tried again than other (sustainable) solutions.
Operating procedures and rules are important vehicles for passing on the results of organizational learning. Current rules embody the "best practice" that has resulted from successful previous experience, while the next level procedures and rules facilitate learning when the solutions suggested by lower level rules start to become ineffective. Rules for prescribing solutions, rules for searching for new solutions as well as the aspiration levels set for the active goals are subject to evaluation and adjustment based on the rules' effectiveness and the ease with which ambition levels are met or exceeded.	A firm's current practice, no matter how sustainable or unsustainable, is the result of an ongoing learning process, characterized by the principle that whatever practice seems to work for now is the default choice for the future as well. When, unavoidably, at some point, this practice becomes ineffective, the experience serves to adjust the rules about what works and what does not work and where to look for new solutions. A change towards more sustainable practices requires existing rules to become ineffective first. Aspiration levels for sustainability related goals are adjusted upwards or downwards depending on how easily they are achieved and how easily alternative solutions are found.
Firms apply simple, short term feedback based models to forecast competitors' behavior and market demand. Optimization of costs is not assumed. The firm operates with a simple estimate of how cost vary with the firm's output.	Forecasts of competitors' production of sustainable products and market demand for sustainable products are based on simple, linear models. Optimality in terms of sustainable performance is not assumed.
If the alternative suggested by a standard operating procedure fails to meet the active goals, a new alternative must be developed. First, however, a re-examination of the current is carried out to see if it can be accepted anyway by reconsidering assumptions about the alternative's scores in relation to the active goals (constraints). If	If existing or conventional alternatives initially seem to violate active sustainability related goals (constraints), the firm will try to re-examine the way these alternatives are or can be used in an attempt to make them acceptable.

under sufficient pressure, the firm may find ways of making the alternative meet the active constraints, and gain a better, more holistic understanding of how an alternative is related to different goals.	
If, even after re-examination, an alternative still violates the active set of goals (constraints), pressure will emerge to relax the constraints. Ultimately, a new alternative will be developed, by modifying the existing one.	If re-examination of the conventional alternative in order to meet the active sustainability goals is unsuccessful, pressure to relax these goals will emerge. Ultimately, a new, more sustainable alternative must be developed, typically by trying to modify the existing one.
Firms adapt primarily in response to short-run feedback and by executing standard operating procedures. These procedures are typically stable over longer periods of time and their change is subject to the application of more general procedures.	The firm does not globally “optimize” the long term situation for itself, society or the world. The unfavorable and wider consequences of unsustainable behavior are not a priori considered on a global scale by the firm. Only first when lower level procedures in the firm repeatedly fail, e.g. due to increasingly more demanding goals or problems, higher level procedures are activated leading to changes in the lower level rules.
Three basic principles drive choice behaviour in the firm: (1) avoiding as much as possible uncertainty by developing procedures that reduce the variety in the firm’s environment (2) persisting in applying these procedures as long as the outcomes meet the set of active goals and (3) keeping procedures simple and allowing individual judgment in applying them.	Firms will try to reduce external uncertainty related to sustainability issues, for example by developing or promoting standards and influencing the processes, that lead to sustainability related laws and regulations.

As in sections 3.1 and 3.2, most of the key principles of the SOTF can be related directly to the BTF. In particular, in the context of organizational choice, we emphasize the apparent tension between the principles CE and CEa on the one hand and the key role that standard operating procedures play in the BTF. The firm will not necessarily evolve or change in the same pace as the environment. As long as the standard operating procedures result in the firm meeting the aspiration levels, the procedures will not change. After repeated failure to reach an aspiration level, a higher level procedure will trigger the search for a procedure that can replace the original, malfunctioning one. The success or failure experienced in these searches constitutes an important part of the firm’s learning and adaptive capability. It is interesting to note that the aspect of learning is not explicitly mentioned or a part of any of the key principles of the SOTF. From a BTF perspective, mechanisms for learning and adaptation are crucial for understanding a firm’s sustainability oriented behaviour.

In a similar vein, we mention the BTF’s focus on uncertainty reduction and applying simple, feedback based models for forecasting events and behaviour in the firm’s environment.

Reducing external uncertainty by negotiating with external stakeholders fits well with principles S, L and LtO in the sense that they acknowledge the existence and influence of bargaining processes with stakeholders. The BTF's clear emphasis on the use of short-term feedback based models, fits well with the SOTF's view of the environment and world constantly evolving. In such a world, comprehensive and long term forecasting and global optimization models seem less appropriate. Still, the SOTF does not contain clear assumptions about human decision-makers' ability to process information and make decisions based on comprehensive, complex models. We interpret the SOTF's focus on the environment and world as constantly evolving systems as a reason to encourage firms to adapt themselves accordingly and approach sustainability as a global problem, requiring holistic solutions. The BTF, however, argues that firms to a large extent (must) do the opposite.

4. Discussion

It is important to note that the two theories contain fundamentally different purposes. The SOTF is a normative theory anchored in business ethics where the goal is to establish norms and values that can drive change for corporate sustainability. The BTF on the other hand is a descriptive theory with a purpose to explain how and why firms behave according to certain patterns. Our key argument is that in order to change the world for the better (normative perspective), one must understand underlying mechanisms of the situation at hand (descriptive perspective). Thus, in the following discussion, we shall focus on three questions:

1. Which elements of the SOTF are clearly supported by the BTF?
2. Which discrepancies seem to exist between the BTF and SOTF?
3. How can the BTF further add to the SOTF by providing elements not covered by SOTF?

The basis for the discussion will the SOTF as formulated by Lozano et al. (2015, p.440), which is given in the introduction of this paper.

4.1 Supported elements of the SOTF and the BTF

The SOTF states that the firm comprises of resources and networks of stakeholders. On a general level this is supported by the concepts of organizational slack and coalitions. One of the main insights from the BTF is that negotiations between stakeholders are always ongoing and create dynamics in relation to what are considered objectives to be achieved by the firm. This supports the idea of a firm as a system exposed to constant evolution and change as stated by the SOTF. Finally, claiming that the firm is a profit-generating entity is not a contradiction with the BTF since firms will adopt multiple goals on the basis of negotiations between active coalitions of stakeholders. Therefore, given that the owners of the firm take part in such a coalition, profit will be an active goal.

4.2 Discrepancies between the SOTF and the BTF

In its underlying principles the SOTF mentions both employees and management as key stakeholders of the firm. Moreover, several responsibilities are given the the employees, such as representing the firm and to empower its stakeholders. This normative placement of responsibility can be challenged in different ways. The BTF argues that employees will take part in several internal coalitions within the organization. The coalitions influence goals and firm practices through negotiations, and thus all the coalition members take part in the process. As an example, one could picture that employee representatives sit together with the management in a joint meeting where important decisions are made. In other words, from a BTF perspective, it becomes problematic to consider employees as one homogenous group.

Another important aspect of the SOTF is to holistically address economic, environmental, social and time dimensions. According to the BTF, such dimensions will be represented by different coalition members in the organization through negotiations. This creates inherent tensions between underlying needs and values. In the BTF these tensions are resolved by attending to different dimensions separately and by defining minimum aspiration levels, rather than jointly optimizing the overall firm performance. As long as performance in one dimension, e.g. social values, does not fall below a minimum level, no action will be taken. This points to the fact that firms have multiple goals that act as constraints and minimum requirements. Finally, practices related to sustainability will vary across time because of varying levels of organizational slack, organizational learning and changing aspiration levels.

4.3 New elements added by the BTF to the SOTF

As mentioned in the beginning of this discussion, the SOTF is a normative theory based on set of principles anchored in business ethics. These principles cannot be criticized on the basis of factual statements because they are deduced from ideal values. However, their implications for decision-making processes can be scrutinized. Surely, in those cases where the principles have contradictory implications or highly unrealistic prescriptions, there must be room for modifications. We argue that BTF can contribute with important insights in this regard.

The clearest contradiction between the SOTF and the BTF concerns the principle of holistically addressing multiple needs and values. Since the organization is not an acting unit on its own with cognitive capabilities (the error of reification), it is the individuals of the firm who act and make decisions. The BTF show that they operate in sub-groups (coalitions) which also includes external stakeholders such as suppliers and regulators. The core argument is that the coalitions represents different values and their disagreements are never resolved completely. This implies inherent tensions, which result in varying attention to goals and underlying values in a dynamic manner. As an example, a firm can adopt an environmentally-friendly strategy in its product development at a certain point time because a strong stakeholder such as government bodies or customer groups. However, these investments and efforts will change when the firm has reached a certain aspiration level. Then the focus can be shifted to other pressing matters such as governance practices and labor conditions of the employees.

The SOTF in its current form states that employees of the firm are responsible for the development of sustainable practices. As discussed in 4.2, employees cannot be regarded as a homogenous group with similar behavior. Individuals and intra-firm groups will participate in coalitions based on their preferences at a given point in time. Such coalitions can also exist between internal employees and external stakeholders. The normative implications of this behavioral insight is that responsibility must be placed in a more precise and consistent manner. Moreover, this must take place as a requirement from the organizational environment, for example through legal regulation. Given the legal structure of today's business system, it is logical to assume that the Board of Directors is the responsible unit in the firm. Consequently, they must also draw the boundaries for stakeholder engagement. The Board should for example make explicit decisions on how to resolve the tensions linked to the four sustainability dimensions (economic, environmental, social and time).

5.Conclusions

We recognize the need for a normative theory in the area of corporate sustainability, but we argue that the SOTF should be modified in order to resonate with core insights into how organizations actually make decisions and the underlying causalities. In order to propose theories and models for increased sustainability in business practice it is imperative to understand fundamental mechanisms of organizational behavior.

By drawing on our analysis in section 3 and the discussion in section 3 we propose a modified version of the SOTF (*changes are indicated by **bold** letters*):

*"The firm is a profit generating entity in a state of constant evolution. This entity is a system comprised of resources and networks of relationships with stakeholders. The firm's **directors** are responsible to represent the firm, manage its resources, **and prioritize among stakeholders' needs** so that the firm complies with laws, maintains its 'licence-to-operate', increases its competitive advantage, and better contributes to foster the evolution of more sustainable societies **by acknowledging and resolving the inherent tensions of holistically** addressing economic, environmental, social, and time dimensions."*

Our proposition resonates with emerging literature in the area of corporate sustainability. Several authors has advocated the importance of inherent tensions linked to differing values, time perspectives and levels of analysis (Dahlmann, 2016, Van der Byl and Slawinski, 2015, Hahn et al., 2015). Furthermore, from a practitioner perspective one can argue that firms will need to allocate scarce resources and thus must prioritize between stakeholder needs. Such decisions are ultimately the responsibility of the firm's directors (Eccles and Krzus, 2015).

The area of corporate sustainability seems to be in overweight in normative perspectives that typically supports the notion of acknowledging the needs of all stakeholders rather than shareholders only. There is, however, a gap in understanding how such an ethical principle can be implemented in a business context. Thus, further empirical research is needed on how prioritization mechanisms occur when firms experience diverging stakeholder demands. This can be related to the concepts of the BTF, and especially on how engagement within and between coalitions of stakeholders affects organizational learning.

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The corporate triptych: the relationship between strategy, carbon performance and financial performance

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Abstract

The interlinkages between corporate environmental and financial performance have been a popular subject among scientists for several years now. Similar scholarly attention has been given to the question whether environmental strategies translate into actual environmental benefits. However, only few studies have looked at the three aspects simultaneously. This study aims at filling this gap by taking the example of corporate responses to climate change. Because of their large carbon footprint and important role in climate change mitigation, companies form the global automotive, steel and cement industries have been chosen as object of investigation. The research objective of the present paper is to gain a deeper understanding of the relationship between corporate climate change strategies (CCCS), carbon performance and financial performance of respective companies. The study employs a sample of 45 leading companies. The analysis of companies relies on secondary data sourced from voluntarily disclosed information from the years 2008 and 2013, such as corporate sustainability reports, annual reports, corporate websites and data from the Carbon Disclosure Project (CDP). The empirical investigation of the proposed paper follows a three-step approach. In a first step, the acquired data is analyzed by using a content analysis based on an assessment instrument for CCCS; similar to those used in previous studies in the scientific field. In this regard, the degree of strategy implementation is evaluated by a 5-point Likert scale in order to reveal the characteristics of CCCS on a company level. Secondly, the acquired corporate data is used to conduct a carbon performance assessment based on four indicators: (1) carbon intensity; (2) carbon dependency; (3) carbon exposure; and (4) carbon risk. Financial performance indicators, such as return on equity (ROE) complements the data set. Lastly, structural equation modelling serves to examine the interlinkages between strategy, carbon performance and financial performance. Empirical evidence is provided for the positive effect of emission reduction pressure on organizational capabilities and activities related to corporate competitiveness. Surprisingly, the results indicate no relationship between carbon reduction activities and long-term improvements in carbon performance. Nonetheless, advancements in carbon performance are found to be positively associated with economic benefits.

Keywords: climate change, strategic management, carbon performance, financial performance, automotive industry

Corporate social responsibility in the Congo Basin forestry sector

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Abstract

Tropical forests are extraordinary reserves of carbon and biodiversity. In few decades, they have become one of the main international challenges regarding climate change and ecology conservation. The tropical forests of the Congo Basin are the second largest in the world and play a crucial role in regulating Earth's climatic systems. Despite being resource rich, the countries of the Congo Basin are still underdeveloped, with problems such as poverty, corruption, repressive regimes, weak institutional and legislative frameworks, armed conflicts and serious health problems. The forestry sector has an important role in global sustainable development, due to its raw material basis and the current rapid globalization trend and structural change. It operates under intense public scrutiny, especially in underdeveloped countries, due to a growing environmental and social awareness. This has put pressure in forestry companies to manage often conflicting stakeholder interests and to rethink their business strategies. Emerging ethical markets pose themselves as opportunities for forestry enterprises, which might benefit from social responsibility initiatives by increasing efficiencies, communicating with stakeholders and improving their legitimacy, while effectively contributing to the social, environmental and economic development of the context where they operate. However, corporate social responsibility still remains a concept originating from industrialised countries, and if underdeveloped contexts and the specificities of the forest sector and of the country where the firm operates are often not taken into account, and there is the risk it may do more harm than good. In this paper, a survey of existing studies is performed to assess the current reality of corporate social responsibility practices in the Congo Basin forestry sector. Evolution in corporate responsibility in the forest industry is analysed. It was concluded literature focuses on the largest forestry companies, resulting in an information asymmetry in terms of geography and company size. The Congo Basin forestry sector remains largely understudied. An appeal is made for debate and further research about the use of corporate social responsibility practices in the forestry sector of underdeveloped countries, more specifically in the African tropics.

Keywords: Corporate Social Responsibility, Congo Basin, Forestry

1. Introduction

1.1. Overview

The forestry sector is based on the exploitation of raw materials, and therefore its role in the sustainable development of the planet is unquestionable. Forests directly capture carbon from the atmosphere, helping fight global warming and contribute for biodiversity stability. Besides, it is often related with the social life of local populations. The forestry sector has a strong impact in many regions, under the three perspectives of Corporate Social Responsibility (CSR): environmental, social and economic. Furthermore, this sector includes several multinational companies of large dimensions, with a tendency for expansion and globalization (Toppinen and Korhonen-Kurki, 2013). As a smaller number of companies concentrate most of the market share, the global forestry sector faces pressure from society regarding transparency and accountability. CSR is thus becoming more important, especially in such an environmentally sensitive industry, with increasing demands from its stakeholders (Panwar and Hansen, 2008). Many companies of the sector justify their existence by disclosing their social and environmental performance (Mikkilä and Toppinen, 2008). Forestry, in particular, carries several meanings to humanity, such as cultural, religious, economic or environmental, being very exposed and vulnerable to public criticism (de Wasseige *et al.*, 2015). Therefore, the forestry sector has moved towards placing increasing importance in the environmental, economic and social sustainability aspects of CSR. Large companies are adjusting their social performance strategies to their geographic profiles (Toppinen *et al.*, 2012). Local legitimacy is critical, since the perception of the concept of CSR varies according to the context in which the company exists (Han and Hansen, 2012). CSR constitutes an investment to demonstrate commitment to sustainability and assure legitimacy, either for ethical reasons or to achieve strategic and economic objectives (Jenkins, 2005). In underdeveloped regions of the globe, especially in the tropics, important for global climate regulation and suffering from deep socioeconomic problems, CSR in this sector is still largely understudied (Kolk and Lenfant, 2013).

This study analyses CSR implementation in the forest sector in the African tropics, namely in the countries of the Congo Basin: Gabon, Cameroon, Central African Republic, Equatorial Guinea, Republic of Congo and Democratic Republic of Congo. In section 1.2, the importance of the humid tropical forests of the Congo Basin is highlighted. The forest sector business environment and the social realities of the countries of the region are explored are explored in 1.3. Section 2 summarises the study methodology. Section 3 starts by giving a brief introduction to CSR (3.1), followed by a discussion about CSR implementation in the Congo Basin forestry sector and its implications (3.2). In section 4 the main conclusions of the study are presented.

1.2. The Importance of Central African Forests

Tropical forests are extraordinary reserves of carbon and biodiversity. They have become a major international challenge regarding climate change and ecology conservation. The Congo Basin (CB) is the second largest tropical forest of the world after Amazonia. It is relatively well conserved and has a fundamental role in regulating the global climatic systems (de Wasseige *et al.*, 2015).

Forests capture and store carbon, produce wood and provide ecosystem services such as non-timber products, erosion and siltation control, besides water quality and local climate regulation (WWF, 2016). The dense and humid Central African forests provide subsistence to around 60 million people, in an area exceeding 1.700.000 km^2. These forests also provide social and cultural functions, essential for the local indigenous populations (Nasi *et al.*, 2011; de Wasseige *et al.*, 2014). Besides the contributions to the livelihoods of the community, CB forests contribute considerably to the regional economies.

Up to now, CB forests have remained relatively well preserved due to reduced demographic pressures, rural exodus, difficult access, poor transportation and communication infrastructure, and a poor business environment (Megevand *et al.*, 2013). However, this situation might change, since local governments predict economic emergence in the near future (de Wasseige *et al.*, 2015).

Currently, small scale agriculture and informal timber harvesting activities are the main causes of deforestation and forest degradation in CB, but new large-scale agricultural projects on the pipeline will gain relevance soon (Defourny *et al.*, 2011). Only 40% of present timber concessions are under a sustainable forest management (SFM) plan (de Wasseige *et al.*, 2015). Yet, the whole forest is subject to illegal timber extraction, which cause more degradation and deforestation than legal timber exploitation.

The future impact of climate change will depend on the extension of human activities, but certainly will affect agricultural production and amplify current problems such as food insecurity and access to drinking water, healthcare and education (IPCC, 2014). The CB tropical forests are considered a common good of mankind and thus their management and conservation has been targeted by several multilateral agreements (UNFCCC, 2014). The role of protecting forests and fighting climate change is taken by three types of political initiatives in Central Africa: adoption of SFM techniques; forest governance improvement; and implementation of the REDD+ program, which highlights carbon capture and reduction of forestry-related emissions, considering the services forest may provide to communities such as livelihood and biodiversity (de Wasseige *et al.*, 2015). However, weak forest governance and economic policies have hindered the effective implementation of environmental policies (Martius, 2015). Conflicting expectations from different groups end up delaying effective poverty reduction and sustainable development, and these challenges become costly to the CB nations (Somorin *et al.*, 2012). These countries must collaborate to protect these ecosystems, essential to the communities' livelihoods, national development and regional economic growth. Some progress has been observed, but there is still little coordination (Kengoum and Tiani, 2013).

1.3. The Forestry Sector in the Congo Basin

Forestry profiles in CB are as follows: DRC has abundant forest resources but an underdeveloped forestry sector; RC, Gabon and Southeast Cameroon have significant forest resources and an active timber sector; CAR, EG and South Cameroon have scarce forest resources and a small but active forestry sector (Ruiz-Pérez *et al.*, 2005).

In the CB, only states are competent to issue forestry titles or concessions, since non-urban regions are public property (Karsenty, 2006). However, populations use forestry resources informally, for their livelihoods, outside any legal framework. Forests in the region are divided into common forests and forest titles or concessions.

Common forests have no restrictions to local users about hunting, fishing, collecting non-timber forestry products or agriculture. Shifting cultivation fulfils local nutritional and wage requirements (Finegan and Nasi, 2004). Arguably, this activity may be the main drive of deforestation (Nasi *et al.*, 2012).

CB forests can legally be industrial timber concessions or protected areas (Nasi *et al.*, 2012). Forest management models focus on one product or service in each unit. Strict conservation is enforced in protected areas, but these are still under pressure of armed factions and/or migratory flows of displaced people. A growing number of concessions are under a management plan, which aim to optimise timber extraction while preserving other goods and services for the long-term sustainability of profits. However, most concessions still favour immediate profit over long-term sustainability. Forest management plans are efficient at analysing forest structure, regeneration possibilities and sustainable extraction cycles, assuring long-term profits. However, full-scale implementation of reduced impact timber extraction is not yet achieved.

Growing pressure from uncontrolled forestry over vast areas has resulted in forest degradation and local opportunity reduction (Ndoye and Tieguhong, 2004). Although most trees have other values beyond timber, mixed-use forestry is difficult because communities and timber companies spatially overlap, and have different interests and negotiation capacities (Nasi *et al.*, 2012). Besides, there is insufficient institutional support to communities, inadequate policies and poor enforcement of property rights and forestry legislation.

Smaller concessions find it harder to comply with increasingly strict international standards, driven by high environmental sensitivity of export markets such as Europe (Ruiz-Pérez *et al.*, 2006). Specific initiatives targeting smaller concessions are being implemented, but are threatened by illegal markets.

CB concessions affect regional wild life. Companies have been building roads to and within concessions, making it easier to access remote forests and new markets. Previously only a subsistence activity, illegal poaching is becoming a commercial activity by taking advantage of these accesses (Poulsen *et al.*, 2009).

Concessions provide better infrastructure than urban centres (Nasi *et al.*, 2008) and pay higher wages, stimulating local economic growth and attracting workers, their families and traders to previously scarcely inhabited areas (Nasi *et al.*, 2012). This increases demand for food, increasing agricultural and illegal poaching activities (Poulsen *et al.*, 2009), given that firms are incapable of providing cheap substitutes for bushmeat. After a certain local population threshold, pressure over some species becomes unsustainable (Clark *et al.*, 2009). Distribution of mammal populations within the concession is more affected by poaching and road construction than by direct timber extraction (e.g. van der Hoeven *et al*., 2010).

Adoption of large-scale multiple forest management methods could combine forest protection with productive activities. CSR initiatives could assure part of the profits of timber extraction could be used for conservation and social development while benefiting the firm by e.g. improving the sector's image, valuing products through certification.

2. Methods

This work uses literature review to present a collection of the findings of existing research about the state-of-the-art of CSR strategies and practices in the global and African forestry sector. The existing research about CSR and the African Tropics forestry sector is summarized and analysed, and the current situation is assessed. For the literature review, the time frame selected was starting in the middle of the twentieth century, since the first concerns about the extended responsibilities of companies were introduced by Abrams (1951), until the present. This study period is as complete as possible and is considered adequate for the purpose of assessing the state-of-the-art of research and practices of CSR in the forest industry in the African Tropics. Key details from the papers reviewed and research findings of the forestry industry were selected and summarized to construct a picture of the reality studied.

3. Results and Discussion

3.1. Corporate Social Responsibility

Corporate Social Responsibility (CSR) is one of the most important concepts of literature and it indicates the positive impacts of companies on their stakeholders. CSR concerns the economic, legal, ethical and philanthropic duties of the firm towards its investors, employees, consumers, communities and the environment (Blowfield and Murray, 2008). Business-case arguments defending CSR helps companies reduce costs, achieve competitive advantage, build reputation and legitimacy and develop of positive synergies (Kurucz *et al*., 2008).

Adopting CSR initiatives is not enough: making information about such activities available is also important (Holder-Webb *et al*., 2009). Two of the most popular CSR disclosure theories in literature are legitimacy theory and stakeholder theory.

Legitimacy theory assumes there is a social contract between an organization and society (Deegan and Unerman, 2011). Companies need to legitimize their activities and legitimacy benefits the companies (Toukabri *et al*., 2014). In order to continue operating, corporations must behave within the limits of what society deems responsible (O'Donovan, 2002). Reporting of CSR activities helps create the perception of a positive relationship between social and financial performance, thus legitimizing the firm's operations to shareholders and investors (Bayoud *et al*., 2012).

Stakeholder theory states that companies are accountable to everyone that can be affected by or affect the achievement of the firm's objectives (Freeman, 1984), such as shareholders, employees, costumers, governments and communities (Graves *et al*., 2001). Stakeholder theory prescribes how the companies should engage with society and manage the interests of different stakeholder groups (Deegan, 2013).

However, there is no legal obligation for companies to serve society's wellbeing and governments end up dealing with their externalities. Assuming companies act based on moral principles results may give them impunity (Regan, 1998). Therefore, CSR should not be evaluated by economic criteria nor should environmental ethics be formulated by management rationales serving corporate interests (Snell, 2000). Besides, CSR disclosures may be shaped by corporate interests to discursively legitimize power over society (Banerjee, 2008).

3.2. Corporate Social Responsibility in the Congo Basin Forestry Sector

Societal expectations over enterprises differ across regions and sectors. Among the environmentally sensitive sectors, forestry sector has a crucial role in global sustainable development, due to its raw material basis and recent globalization trends (Li and Toppinen, 2011). Timber is extracted from trees, which have a special significance to humans and should be protected. A growing environmental and social awareness has placed the forestry sector under intense public scrutiny, pressuring companies to manage often conflicting different stakeholder interests and to rethink their business strategies.

Economic growth has been understood as a prerequisite for development, but there are other non-economic dimensions of development essential to proper functioning of the market economy and human development, such as human capital, public institutions, civil society and government (Rosling *et al*., 2006). Africa is a continent swarmed by socio-economic problems, and social development is still very far behind. The lack of confidence in African governments makes it difficult to establish partnerships with them towards social development programs (Kolk and Lenfant, 2013). For instance, Cameroon is rich in natural resources but has high levels of corruption which hinder economic development.

Societies conceptualise CSR according to the socioeconomic context and societal expectations tend to evolve as nations develop socially and economically (Panwar and Hansen, 2008). Legislative contexts also differ: in some countries, laws shape societal perceptions; in others, perceptions shape laws. These characteristics lead many forestry multinational enterprises (MNE) to move their operations to locations with less strict environmental and social laws such as CB nations.

Forest and environmental certification assure sustainable timber extraction, but CSR could and should go further (Panwar and Hansen, 2008). In CB forestry sector, priority should be given to wealth distribution, human rights and environmental protection and organizations should take proactive attitudes in issues such as poverty reduction, fighting climate change and promoting SFM (Vidal and Kozak, 2008). Similarly, more companies of the CB forest sector are pressured to adopt responsible citizen postures and to actively improve local social, environmental and economic conditions.

CSR perception may be guided by regulations or defined as social duty, with focus depending on local characteristics. Because perception of CSR depends on context, CSR programs and standards should be defined at the regional level (Han and Hansen, 2012). The forest sector contribution to the CB economy and its environmental consequences have a large impact at the local level, but its reputation's impact is global.

However, CSR initiatives overlooking the specific characteristics of CB may be detrimental (Jenkins, 2005). For instance, social investment activities made by MNEs may cause a socially undesired power shift from the state to corporations (e.g. Idemudia, 2011). Consequently, African governments become irretrievably dependent of these companies, which assume responsibility in areas such as health or education. The result is a weakening of the state's legitimacy and credibility. It becomes a vicious cycle, where communities grow expectations from MNEs, which in its turn feel more pressure to achieve legitimacy in these areas, while the governments lose their incentives to care for their citizens. Companies should be aware of this risk associated with CSR implementation. Engaging in partnerships involving African governments might be part of the solution to the problem.

Even though there are certainly success cases of CSR in developing countries (Baskin, 2006), CSR's capacity to effectively contribute to development and solve urgent socioeconomic problems common to developing nations remains unclear (Dobers and Halme, 2009). CSR should innovate to adapt to the challenges and opportunities specific to the CB forestry sector, considering its potential to stimulate development, mitigate poverty, create income generating mechanisms and support local self-sufficiency (Merino and Valor, 2011).

Even well-intended CSR programs may be perceived as rhetoric if local context is not properly considered (Panwar and Hansen, 2007). Due to the different relationships between societal expectations and legislation, important local issues may be excluded from CSR of foreign forestry companies operating or based in CB, which has a lower level of socioeconomic development. For instance, while CSR definitions in developed countries might exclude poverty, it is imperative to consider it for CB. Especially when MNEs move their operations to developing countries such as CB nations, communities and the poor are often not considered as stakeholders (Barkemeyer, 2009). However, exposure to bad publicity by the media and NGOs concerning social and environmental malpractices may raise their importance as stakeholders, due to the power of socially and environmentally aware consumers and investors of developed countries (Toppinen and Korkhonen-Kurki, 2013). MNEs should be willing to go beyond what is legally required and actively work to solve such problems.

The CB forestry CSR agenda may be concealed by political and ideological reasons (Dobers and Halme, 2009). The theories, concepts and ideas behind CSR originated from countries with market economies with strong institutional settings (Jamali and Mirshak, 2007). Besides, CSR is mostly adopted by large western MNEs. Most of the global sustainability problems existing nowadays were caused by consumerism and industrialization in developed countries. Thus, in the CB countries, characterized by weak law enforcement, inconsistent bureaucracy, corruption, weak institutional settings and property rights insecurity, CSR must have a different role (Kuznetsov *et al.*, 2009) and focus on other economic and legal factors (Idemudia, 2011). Besides, philanthropy alone will not change local governments' behaviours towards society.

Western-oriented CSR models are not adequate to describe the complexities and dynamics of corporate citizenship in Africa, where problems like conflicts, legal contradictions, job creation, environmental protection, short-term profitability, AIDS, repressive regimes, governance transparency, economic empowerment and social investments are still far from being effectively tackled (Visser *et al.*, 2006). Ethical, legal, economic and philanthropic responsibilities should be adopted by corporations in order to improve living conditions in underdeveloped African countries.

Studies about CSR in forestry sector are becoming more common, although they focus on restricted aspects of a region or particularity of the sector. Although in developing countries social aspects and environmental practices receive more attention, there is much less information available about the actual performance. Furthermore, most of the studies focus on large companies, ignoring small and medium enterprises, despite larger companies having the resources to more easily implement CSR initiatives.

Forestry companies believe participating in environmental performance collaborations may generate financial benefits by improving relationships with stakeholders, obtaining performance data and reducing government regulation (Dyke *et al.*, 2005). Besides, socially responsible forestry companies may gain investors' preference, allowing for long-term economic success (Halme and Niskanen, 2001). Forestry companies seem to have adopted CSR activities based on profit-maximization justifications, with less emphasis on society and stakeholder impacts (Li and Toppinen, 2011). Enterprises of the forestry sector perceive CSR as investments to demonstrate their commitment towards sustainability and assure their legitimacy, either for ethical reasons or for achieving strategic and economic objectives.

CSR and sustainability disclosure is overall poor, as forestry companies tend to publish selective information, e.g. about social and economic indicators, gaseous emissions, liquid waste and energy and water consumption (Li and Toppinen, 2011). However, most avoid disclosing information related with CSR activities beyond legal requirements, i.e. companies are not willing to do more for society than they strictly have to. Furthermore, most of the companies reporting CSR are based in developed countries.

The notion of sustainable development has been adopted, in literature, as part of CSR. There are several definitions of sustainable development, many poorly constructed, which leads to companies being able to ignore social aspects to dictate their own terms, according to their own interests. Most companies uncritically accept the current economic definitions and adopt a definition of sustainable development based on the concept of weak sustainability, i.e. recognising the existence of environmental problems, but not considering them fundamental for the continuity of human progress (Laine, 2005).

In a region with such a great importance for global ecological sustainability as the CB tropical forests, firms should recognise that economic growth has been the cause for most social and ecological problems, and that continuous growth will deter humanity from reaching economic, environmental and social sustainable development. Besides, uncritically accepting the current market system is problematic, because markets are incapable of reflecting the real costs of the forestry companies' activities, such as the cost of reforestation of a slow-growth tropical forest (Hawken, 1995).

One possible way to collectively adopt a proper definition of sustainable development would be to adopt a universal CSR reporting standard for the forest sector, which could also serve as guidelines for elaborating reports and facilitate comparison between different firms. Some standards already exist, although not forestry-specific, but they have been criticised for being too much oriented for large companies and giving little attention to consumers and NGOs (Brown *et al.*, 2009). Their contributions for solving conflicts between companies and society have been negligible (Toppinen and Korhonen-Kurki, 2013) and they have been criticised for lack of detail, difficulty of interpretation (Levy *et al.*, 2010) and questionable auditing (Brown *et al.*, 2009).

Commerce of forest resources affects the interaction of many communities, with strong connections to forest, with nature (Barkemeyer *et al.*, 2009). CSR practices should consider local stakeholder feedback instead of importing standards from other contexts, especially in raw material extraction sectors such as the CB forestry sector (e.g. Mikkilä, 2005). For that reason, some argue CSR standards should not be universal and should consider the specificities of the forest sector and of each CB country (e.g. Panwar and Hansen, 2008).

A deep ideological debate is needed in order to fully benefit from CSR's potential to eradicate poverty in the CB region (Merino and Valor, 2011). Enterprises and intergovernmental institutions assume poverty may be reduced through economic growth and private sector reinforcement. However, economic growth ignores its own material and physical limitations, and will only be beneficial with fair redistribution processes. Besides, the economic system upon which CSR is defined is itself questionable (O'Neill, 2015). Companies allege CSR is a good tool for systematising the contributions of their operations to development, since they have business-case justifications: higher purchasing power of the lowest classes, cost reduction, reputation improvement, etc. (Merino and Valor, 2011). However, not only no clear relationship between CSR and poverty eradication exists, but also CSR might even hinder it. CSR and its role in poverty reduction are defined based on capitalist and rational economic assumptions, further deepening the inequality gap between developed and developing nations. CSR initiatives and disclosure may only become truly ethical and social responsible if they consider all of the existing publics within underdeveloped contexts (Munshi and Kurian, 2005).

Community involvement with the forestry sector is crucial for CSR to contribute to social development in the CB region (Merino and Valor, 2011) and thus mechanisms that facilitate community involvement in decision making should be created (e.g. Jenkins, 2005). Priority should be given to citizens before stakeholders. Debate around CSR has been dominated by western perspectives, and thus it should be broadened to incorporate the perspectives and experiences of the CB communities (Dobers and Halme, 2009). For instance, poverty reduction is not included in current CSR definitions. In order to be able to tackle poverty in the region, a deep debate about the ideological foundations of CSR and the role of the CB forestry sector enterprises is called for. Besides, the conditions in which forestry activities favour or hinder development in the CB should be investigated, to contribute to regional social justice, eradication of poverty and environmental protection along hard sustainability lines (Merino and Valor, 2011).

CSR should be adapted to the CB forestry sector, considering the urgent social, environmental and economic challenges of the region, preferably with support from government or NGOs (Jamali and Mirshak, 2007). Critical research and debate is needed to understand the impact of CSR in the CB countries and the structural limitations and full potential of current approaches, considering alternatives beyond the business-case (e.g. Prieto-Carrón *et al.*, 2006).

In general, a growing number of forestry companies have been justifying their existence to a wide range of stakeholders, recognizing the social impact of the forestry sector by disclosing social and environmental performance (Li and Toppinen, 2011). Reflecting social demands about the forest sector, large forestry companies perceive and define CSR based on activities related with SFM and accountability over emerging economic, environmental and social problems (Panwar *et al.*, 2006; Vidal and Kozak, 2008). The forest sector has been adopting broader CSR and sustainability approaches, where large forest companies shape their social strategy the regional profile (Panwar *et al.*, 2006; Vidal and Kozak, 2008; Mikkilä and Toppinen, 2008). The larger enterprises are the ones that give the most attention to their environmental, communicational and risk management strategies, and that mostly get involved in CSR initiatives (Vidal and Kozak, 2008).

However, most studies in literature still focus the largest forestry companies in the world, which are mainly based in Europe, North America and Asia. The result is a misrepresentation of the knowledge of CSR practices in the forestry sector, both in terms of firm dimension and geography. The role of the CB tropical forests for global environmental sustainability in unquestionable. These forests also have a great significance for the livelihoods of millions of inhabitants of the region, besides playing a major role in the development of the region. Therefore, economic exploitation of forest resources should be performed parallel to ecosystem conservation and sustainable development of social and economic indicators. A region as important to mankind as the CB should definitely get more attention from researchers, given that CSR might be part of the solution to the vast array of social and environmental problems that still abound in the region.

4. Conclusions

Growing attention is being given to the social and environmental dimensions of corporate responsibility in the forestry sector practices. Companies of the forestry industry are under pressure to proactively innovate and stimulate their operations. The growth of ethical markets presents itself both as a threat and an opportunity for the forestry enterprises, which may benefit by changing their values, policies and operational processes through continuous learning and growth. However, little attention having been given to small and medium enterprises of the forestry sector. Furthermore, social responsibility of companies operating in developing countries such as the Congo Basin nations have also mainly been kept out of the focus of research by academia.

The Congo Basin tropical forests have a critical importance for the global social and economic development and environmental sustainability. Therefore, economic exploitation of these forests needs to be done with caution. CSR, together with sustainable forestry management, has the potential to allow companies in the region to promote development of the social and environmental conditions of forests and their communities. However, imported concepts and standards may turn into rhetoric if their only objective is to improve the corporate image in society, thus weakening the potential role of forestry companies in helping achieve sustainability and social development. A local approach may give CSR a boost to become a legitimate tool to help companies define their role in society and make the world a better place, but for that more research is needed.

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Track 5c. Sustainability Transitions, Innovation Systems and Social Inclusion

Managing networks which stimulate sustainability transitions

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Abstract

Innovative sustainability technologies play an important role for sustainable development, as they enable societies to maintain their lifestyles less carbon emissions, less waste generation and less resource use. In order for these technologies to be successfully adopted by users, it is often necessary that socio-cultural, institutional and legislative changes take place. Organizations can influence the environment in which such innovative technologies are to be implemented. This is called system-building. Companies that want to launch innovative sustainability technologies can collaborate in networks of actors from industry, government and research institutes to pro-actively build up a business ecosystem around their technology. Thereby, they stimulate sustainability transitions. In this paper, we examine how such networks can be managed effectively. The current literature on network management has mainly two perspectives: The public network management literature which focuses on management of government-driven networks, which have the aim to deliver a public service in an existing industry, such as health care or education. The innovation network management literature, on the other hand, focuses on the management of firm networks with the goal of developing an innovative product. So far, little research is done on how inter-organizational networks, which aim to create a supportive business ecosystem around an innovative technology, are to be managed. In order to fill this gap, we first reviewed the literature on public network management and innovation network management, to identify key factors of effective network management. Consecutively, we conducted a multiple-case study in the Dutch smart grids sector, to investigate if the identified key factors also apply to the management of system-building networks. Our study shows that most key factors of network management identified from the literature also apply to system-building networks. We found differences with regards to the key factors trust, network governance, network leadership and project management. Our paper is interesting for practitioners involved in network management, as it delivers a comprehensive overview of key factors for effective network management. Moreover, we contribute to the network management literature, by delivering insights into the management of networks in an emerging business field.

Keywords: technological sustainability innovations; system-building; network management; inter-organizational networks

Will women inclusiveness promote economic and social sustainability? An European case study

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Abstract

Human capital is key to societal and economic development. Given that in Europe the percentages of women and men graduates are similar, the exclusion, or under representation of one gender in decision making processes, implies that up to 51% of the highest qualified human capital could remain untapped. Such a strategy will lead to lower productivity, innovation and sustainability. Gender imbalance in positions linked to governance and administration of either public or private institutions, has been identified by the European Commission (EU) and by several national governments, as a grave constraint to the equilibrated development of the Union. Still, attempts undertaken to curb it were insufficient and the problem remains either unknown or disregarded, by the majority of citizens and institutions. In this work, two groups of five European countries each, were compared regarding women full societal inclusiveness, assessed as gender balance ratios in decision making structures / organizations and correspondent indicators of socio-economic performance, over the last decade. The first group included the southern and western peripheral countries, namely Cyprus, Greece, Ireland, Portugal and Spain, that for the past decades typically showed an economic performance below EU mean values. The second group consisted of northern countries, to some extent also peripheral ones: Denmark, Finland, Netherlands, Norway and Sweden, which present a continuous track record of high economic performance. Several indicators of gender balance in decision making positions were identified, such as the percentage of women holding seats in national parliaments, percentage of women ministers, percentage of women reaching the top of academic careers and percentage of women represented in executive boards of corporate institutions. The economic and social performance of each country was assessed using comparable indicators derived from GDP (sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products) values and from social indicators, such as unemployment ratios. The two sets of indicators were statistically analysed and compared. Results showed that significant relationships exist between indicators measuring women inclusiveness in responsibility sharing, at societal level and socio-economic performance of the respective countries. Europe presently faces critical challenges, among which the reversion of its aging demographic trend is a top priority. Conclusions of this work point out that gender parity in decision-making spheres must be urgently implemented, to guarantee the development of sustainable societies and desirable geo-strategical equilibrium at continental level.

Keywords: women empowerment, decision making, social sustainability, economic performance, gender balance

Improving workers wellbeing by means of corporate sustainability

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Abstract

Corporate sustainability policies have the potential to improve workers wellbeing in corporations. The present study explores how companies engaged in sustainability manage the work-related issues when they are introducing changes in their processes deployed from a sustainability perspective. In particular, the work design stage, in which work tasks are defined, was investigated. Based on the activity-centered ergonomics perspective, it is expected that corporations that disclose their responsibility with workers (an issue included in sustainability framework) are concerned about the well-being of this stakeholder when they design their work. Sustainable development can be seen as development aimed at improving the well-being of society as a whole (including future generations), enabled by an axiological perspective in decision-making processes, considering the limitations of environmental resources (Bolis et al., 2014). When sustainable development risks losing its meaning, work issues are included into social aspects of corporate sustainability (Elkington, 2002), and workers are considered important stakeholders for companies (Freeman, 1984). By means of three case studies, the results show that companies engaged and reference in sustainability disclose a systemic view in their corporate sustainability strategies. These strategies are deployed in the organization through some organizational paths (projects, culture, goals, etc.), but they fail to consider all related issues of sustainability (such as work) integrally across the organization. The research shows that corporate sustainability policies brought changes in workers' tasks. However, these policies do not explicitly involve employee of operational areas to make decisions about their work design. Sustainability discussion could represent an opportunity for workers wellbeing improvements in companies. In particular, human resources and health and safety department need to question corporate management about its real engagement in sustainability policies. Sustainability is linked to social values, so those department need to encourage the management to go beyond sustainability improvements focused mainly in the environmental field and strictly connected to economics gains in a win-win relations.

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How to unlock the potential of social innovation to contribute to sustainability goals? – An analysis of the requirements for a sustainable social innovation

Alex Haxeltine, Flor Avelino, Julia Wittmayer, Adina Dumitru, Iris Kunze and Tim O'Riordan

Abstract

Social innovation is now extremely prominent on the European policy agenda (note, for example, the report 'Empowering People, Driving Change', BEPA 2010, and its influence on EU policy agendas). Social innovation is furthermore widely argued to be an important means towards finding solutions to a range of societal challenges, not least that of achieving a sustainable development. To date however the field of social innovation has been under-theorised in general, and in particular has lacked an adequate theoretical and conceptual framework for understanding how the empirical phenomenon of social innovation actually links to processes of sustainability transition (and therefore how its contribution to sustainability can best be supported and potentials realised). In particular in both the policy discourse and research literature a naïve assumption is often made that increasing the number and reach of social innovations will of itself somehow necessarily contribute to improved societal conditions. However, empirical research shows that the reality is not so simple: a social innovation developed to address a local problem framing in reality often ends up having unforeseen impacts as it develops and expands, and not all of these are positive. Furthermore social innovation actors while rightly lauded for their often altruistic values and aspirations may also in reality end up pursuing vested interests and so the inclusivity (or not) of a particular social innovation process is a key dimension that must be addressed in understanding how social innovation can contribute to societal goals (whether 'environmental' such as climate change mitigation or 'social' such as social cohesion). Current attempts to integrate sustainability goals into a social innovation context suffer from being overly instrumental and focusing on indicators and valuation metrics that do not capture the systemic nature of the couplings between social innovation processes on the one hand and societal sustainability goals on the other hand. This paper: firstly characterises the limitations in how sustainability is currently addressed in the social innovation literature, thereby justifying the need for a better framework. Secondly: it presents a new conceptual framework that builds upon recent scholarship on sustainability transitions, social-ecological systems and transformative agency (e.g. Westley et al. 2013 paper in Ecology and Society) and recent theoretical advances and empirical case studies in a large European project on social innovation and transformative change (TRANSIT; Haxeltine et al. 2013; Avelino et al. 2014; see http://www.transitsocialinnovation.eu/). The paper makes use of a sustainability transformations lens to conceptualise the role of social innovation in dynamic societal change processes. Thirdly: the new framework is exemplified with several empirical examples of European social innovation networks that focus on sustainability goals. Finally, implications for how social innovation may contribute to sustainability goals are addressed (with a focus on the European context) in terms of some remarks on: i) the required enabling conditions in the socio-material context (including policy and governance); ii) appropriate strategies/tactics for achieving sustainable social innovation on the part of practitioners; and, iii) an assessment of some of the possible limitations of social innovation in addressing systemic challenges.

Rooftop Urban Agriculture as a community innovation in Toronto, Canada

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Abstract

For decades, Toronto has been a progressive advocate of Urban Agriculture policy, and more recently, Green Roofs, being the first North American City to adopt a Green Roof Bylaw. Where these two policy areas overlap, in the innovative and increasing practice of Rooftop Urban Agriculture (RUA), there is surprisingly little policy support. Despite this, those who practice RUA in Toronto have been doing so creating unique models, mostly with a focus on education and community building, regardless of whether they are corporate or civil society-led. This research provides an analysis of the Rooftop Urban Agriculture (RUA) community in Toronto by taking an inventory of participants and key players, and revealing network connections to explore the level of cohesion of the RUA community in Toronto. Consideration is given to the implications that this has on its growth, representation, and potential areas of engagement with other actors, including municipal decision makers. Semi-structured interviews reveal the driving values expressed by RUA practitioners and others involved with the practice, and the characteristics of this group's formation. Based on this information, RUA is identified in this work as an emerging Civic Food Network (CFN). Based on the findings of the network assessment, this research argues that the lack of an organized and cohesive RUA Network is hindering the progress of this emerging group and innovative practice, and the potential for valuable knowledge sharing that would enable its growth. Finally, recommendations are provided to address how those practicing rooftop agriculture can seek to maximize knowledge sharing within the RUA community and build connections to the City of Toronto to strengthen this emerging CFN.

Keywords: Rooftop Urban Agriculture, Local Food Networks, Sustainable local policy, Community Development, Knowledge Sharing, Innovation

The role of Triple Helix Intermediaries in Supporting the Transition to a Circular Economy: A Case Study of Scotland's Industrial Biotechnology Sector

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Abstract

The Circular Economy has been heralded by many as a viable vision to overcome the challenges of rapid population growth, economic stagnation and environmental destruction. Yet, the scale of transition is akin to the industrial revolution and the required timescale is in the order of decades. One of the most promising policy instruments for accelerating such a transition is the formation of 'protected spaces' for radical and sustainable niche innovations; a method that the Scottish Government is currently pursuing. Such spaces should not be considered to take the form of an organizational body or administrative platform, but as a 'societal network of innovation'. A number of studies exist on the role of policy in forming these spaces, yet little is known about how their networks can be internally nurtured. Intermediaries have been recently demonstrated to play an important role in the forming, strengthening and empowering of innovation networks, yet they have been significantly overlooked with regards to their role within strategic niche management. This paper aims to address this knowledge gap by drawing on the theoretical fields of (i) triple helix innovation systems and (ii) innovation intermediation to examine the role triple helix intermediaries currently play in nurturing protected spaces for science based sectors. The broader aim of this paper is to highlight the recent confluence of these fields in current niche management practice. Empirical analysis is provided through a case study of IBioIC, a triple helix intermediary whose goal is to grow Scotland's industrial biotechnology sector which is central to the national circular economy strategy. The paper will assess IBioIC's ability to (i) articulate expectations and visions, (ii) build social networks and (iii) facilitate learning. The paper will also explore the impact a triple helix approach has on IBioIC's success and highlight the role of such an intermediary in supporting a transition to a circular economy.

Keywords: Triple Helix, Innovation Intermediation, Sustainability Transitions, Circular Economy

Power and Social Change towards Sustainability. Contesting the Implications of Power Theories for Sustainability and Social Change Research.

Flor Avelino

Abstract

There is an increasing attention for processes of social change towards more sustainable societies. This attention is manifested in both public and academic discourses, often as 'transdisciplinary' discourses at the policy-science interface. Three examples of such discourses are: (1) 'sustainability transitions' (e.g. Grin et al. 2010, Markard et al. 2012), (2) 'social innovation' (e.g. Franz et al. 2012) and (3) 'socio-ecological transformation' (e.g. Moore et al. 2014). These fields of research on social change – and their respective conferences, journals and conceptual models – co-evolve with government policies at various levels (municipalities, national departments, EU agencies, UN, etc.). These discourses share an underlying notion of change and innovation as drivers for societal improvement, and an (implicit or explicit) belief in human knowledge and agency to change the world towards a more sustainable direction. In this enthusiasm for social change and sustainability, the 'dark' and 'unintended' effects of social change and innovation often tend to be underemphasised, as well as the fierce power struggles and inequalities that come with it. In response, several scholars have set out to include an explicit attention for power and politics in their discussion of innovation, social change and sustainability (e.g. Voß et al. 2007, 2009, Meadowcraft 2009, Avelino & Rotmans 2009, Smith & Stirling 2010, Kern 2011, Hoffman 2013, Geels 2014, Avelino & Wittmayer 2015). These endeavours demonstrate various challenges for more profoundly couching research on social change and sustainability in political theories of power. This paper discusses these challenges and sets out to broaden and deepen the theoretical basis for studying the implications of power for social innovation, sustainability transitions and socio-ecological transformation. Power is one of the most contested concepts in social and political theory; definitions are manifold and highly diverse. Rather than making a futile attempt to provide an overview of all power interpretations, the paper discusses six prevailing points of contestation in academic debates on power: 1. Power 'over' vs. power 'to'; 2. Centred vs. diffused; 3. Consensual vs. conflictual; 4. Constraining vs. enabling (i.e. structure vs. agency); 5. Power = knowledge vs. power ≠ knowledge; 6. Empowerment vs. disempowerment. For each of these points of contestations, this paper synthesises a literature review of how different scholars (e.g. Arendt 1969, Clegg 1989, Parsons 1967, Lukes 1974, Foucault 1977,1980,1982, Giddens 1984, Thomas & Velthouse 1990, Flyvbjerg 1998, Haugaard 2002) have dealt with the abovementioned points of contestation, what we can learn from that, and, most importantly, what these points of contestation imply for understanding and empirically investigating power in (1) sustainability transitions, (2) social innovation, and (3) socio-ecological transformation. Rather than 'choosing sides' within these power debates or attempting to 'solve' them, the challenge is to develop a heuristic overview of power contestations that can be used to systematically and meaningfully explore the role of power in processes of social change towards sustainability, remaining sensitive to various dimensions of power as discussed in the literature.

Keywords: Power theories, sustainability transitions, social innovation, socio-ecological transformation

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Connecting the disconnected – Inclusive spatially-based and localized innovation systems for societal transitions: The case of Philippi Innovation Hub

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Abstract

Our unjust and unequal world, requires dramatic measures for social inclusiveness, and can thus be considered one of the 'grandest' challenges of all time. Shifts are required at localized and 'grassroots' levels for regional and national economies to adopt novelty. Arguably, shifts requiring altered social configurations of networks and institutional arrangements to break the lock-ins of social unsustainability happen in geographic proximity. The key to fostering new institutions for development within developing contexts is also about creating physical and institutional platforms as meeting places. This is because new social networks based in these communities are heavily trust dependent and require face to face interactions. Furthermore, partnerships between under-resourced spaces and more developed societies don't just happen, they also require appropriate innovation policies, financing and innovation infrastructure support mechanisms and spaces. Philippi village is a response to this challenge of disconnect. It represents a newly constructed, localized and socially inclusive innovation hub in an under-resourced area in Cape Town. The primary aim of the research is to discover not only the extent of the disconnect of actors in the community to the physical innovation hub; but to seek avenues and pathways for connecting to wider sets of economic opportunities that exist not only spatially distant but also cognitively, socially, institutionally and organizationally. The sets of interviews provide diverse answers to these questions, allowing for some understanding of how innovation spaces, could potentially function in under-resourced areas. This knowledge may advance socially disconnected and underprivileged regions in developing countries.

Innovation and sustainability transitions: lessons from bottom-up initiatives

Isabel Salavisa, Maria de Fátima Ferreiro

Abstract

In a reflexive book on the innovation studies field (Fagerberg, Martin and Andresen, eds., 2013), the environmental issue is assigned great relevance by two authors. The first is Carlota Perez (Perez, 2013), who includes this issue as one of the big questions of a future agenda for a paradigm shift with the correlate effects on the innovation conditions of the weakest and poorest. Perez´s perspective is that of developing countries and her aim is the analysis of the ways they can thrive and innovate, meeting the new challenges. The second author is Luc Soete. He argues that there is an excessive creative destruction, a "short-termism" of the creative destruction. In line with David (2012), Soete analyses critically the post-war growth, in which "professional-use driven" innovation has continuously fed the creation of monopolistic profits through planned obsolescence and an unsustainable "innovation-led consumerism growth path" (Soete, 2013, p.136). His conclusion is that the environmental impact and ecological footprint of this model make it unsustainable in the developed world but also increasingly so in emerging countries, claiming for a shift in the process of research and innovation (Soete, 2013). The 'appropriate innovation' should then turn much more to the "bottom of the income pyramid" (Prahalad, 2005), giving as examples the fight against infectious diseases, water access and low price communications. This contribution questions the direction and aims of innovation (innovate in what? at what pace? for what? for whom?) in the context of a growth model which became incompatible with the basic equilibriums and conditions of the planet regeneration. Drawing on this framework, the aim of this paper is to analyse innovative environmentally-friendly solutions which are based mostly on new organizational forms and new patterns of behaviour and participation. Case studies are presented in two domains such as new patterns of food production and consumption in Portugal (e.g. short food supply chains). They represent social innovation – a kind of functional equivalent of "niches" in the transitions literature - which might deploy to a broader scale if appropriate policies and measures at local and national levels are adopted. These include Common Agricultural and Rural Development Policy, Cohesion Policy, and local policies as well as the involvement of a diversity of actors (e.g., local public administration, socioeconomic associations) with a crucial role in the development of bottom-up approaches aiming at sustainable responses to food production and consumption. A critical assessment of the cases, together with the identification of the challenges and opportunities will conclude the paper.

Keywords: sustainability transitions; innovation; sustainable growth; new patterns of food production; new patterns of consumption.

Experimental projects as learning settings for system building in sustainability transitions: the case of marine renewable energies

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Abstract

The paper addresses the role played by experimental projects in the process of development of new sustainable energy technologies, investigating how they promote learning, both about the technologies and about the economic, social and political processes required to construct a new system. For this purpose it analyses the case of the emerging marine renewable energy technologies, which are complex technologies whose full development and diffusion involves combining a variety of areas (both new and existing) with diverse industrial structures, technological and organisational practices, institutions and cultures, and thus requires mobilising, connecting and aligning substantially different actors. The analysis addresses the experimental projects with Portuguese involvement conducted, over time, in the wave energy and offshore wind energy fields, combining secondary data and interviews with key actors. It focuses on the behaviour of actors, as the entry point to investigate the processes at work. The objective is to understand whether and how sequences of experimental projects and the presence of "intermediary actors" – who connect between projects and conduct "aggregation activities" that turn contextual knowledge into generic knowledge – contribute to learning processes concerning technology stabilisation, actors' alignment and transformation of the institutional framework. The preliminary results offer an overview of the evolution of the most significant actors/networks and provide some indications towards roles played, as well as insights into the nature of learning processes that are at work in the emerging system.

Keywords: Sustainable energy transition; Experimental projects; Learning processes; System building; Renewable energies

1. Introduction

Emerging marine renewable energy technologies (MRET) are expected to contribute, simultaneously, to a sustainable energy transition, by extending the variety and scope of clean energy production, and to an ocean based growth, through the creation of new economic activities that can drive the transformation of traditional/declining industries related to the sea (EC, 2014). However, MRET are still relatively immature, as compared with other renewable energy technologies: there is a number of challenges that need to be overcome before they reach the commercial stage and some uncertainty regarding the way the process will unfold (Magnana et al, 2014). It is therefore important to understand how it is possible to accelerate the development of these technologies and the construction of a new system around them.

This paper discusses the role of experimental projects as settings for learning, not only about the technologies, but also about the economic, social and political processes required to construct a new system. Experimental projects have received particular attention in the socio-technical transitions literature, namely in the strategic niche management literature, which identifies socio-technical experiments as the locus for new niche formation and development (Kemp et al, 1998; Hoogma, et al, 2002). Recent advances to this literature, introduced by the socio-cognitive evolutionary perspective to technology development (Geels and Raven, 2006; Raven and Geels, 2010), provide an analytical framework to address this question. This approach moves the focus from single experimental projects to sequences of projects that build on each other and add to the niche trajectory. It introduces a distinction between the variety of individual experiments and a “global niche level”, defined along a social dimension - the emerging community of actors - and a cognitive dimension - the learning processes being enacted. Such learning processes require the conduction of purposeful “aggregation activities” that turn the contextual knowledge generated by individual projects into abstract, generic knowledge that can be shared by the niche community and base de development of new visions and agendas. Special attention is given to the role played by “intermediary actors” that move across projects and conduct aggregation activities (Geels and Deuten, 2006). Finally, an additional dimension – space - has also been added, by proposing that niche communities and their experimental activities and learning processes can span several spatial levels (Fontes et al, 2016).

These processes are expected to influence the niche trajectory and thus to shape the development of the emerging system. The objective of this paper is to explore this question empirically, by looking at the experiments that took place along time in the MRET field and investigate whether and how sequences of experimental projects and the presence of intermediary actors contribute to the development of this niche at two levels; i) by enabling the expansion of the community network; ii) by driving learning processes about the configuration of the new system.

2. Methods

MRET are a particularly interesting setting for this analysis. They are complex technological systems, whose final output entails performing a variety of activities related to the development, production and installation of energy conversion systems, and the operation of energy production facilities. Because this involves areas with no tradition of working together - energy and ocean – it requires connecting and aligning substantially different activities and actors. Moreover technologies have to be demonstrated at full scale in real sea conditions during long periods to prove viability and improve performance /costs. This entails high investment in stages still characterised by technological and market uncertainty, which requires public funding, but also capacity to attract private investors. At this level, energy utilities and other regime actors, which have become increasingly involved with renewable energies (Bergek et al, 2013), have also shown some interest in this emerging field. Finally, the production of energy at sea involves the use of a public space for a new economic activity, requiring regulatory changes (Wright, 2015). It also entails sharing that space with other economic and non-economic activities, which may lead to acceptance problems, namely among local communities. In this context experimental projects are particularly important to start delineating the new system and also negotiating it.

The paper conducts an analysis of the experimental projects, with Portuguese involvement, carried out as part of the process of development and diffusion of two marine renewable energy technologies: wave energy and floating offshore wind. The concept of experiment in transitions literature is relatively broad (Hoogma et al, 2002; Harborne and Hendry, 2007; Frishammar et al, 2015). In this case we look at projects from the initiative of technology developers, whose primary goal is to test and improve the technology, but that, given the system features described above, are expected to go much beyond technological aspects, contributing to actor interaction and learning at a variety of other levels, and reinforcing the supportive network. While the analysis is conducted from a country perspective, it is also acknowledged that processes taking place in the development of MRET have a multi-spatial scope, which is reflected in the conduction of both experimental projects and aggregation activities (Fontes et al, 2016).

The empirical analysis addresses the projects conducted over time, combining secondary data and interviews with key actors. It focuses on the actors involved in these projects and explores their potential influence in the construction of a system (Musiolik and Markard, 2011). The research is divided into three steps. The first step entails analysing all types of projects (research, experimental and structural) funded by national and European programmes in the field of wave energy and offshore wind, with Portuguese participation. Data is obtained from the EUROPA CORDIS database for European projects and from online repositories or official documents for national projects. Particular attention is given to experimental projects (that test or demonstrate technologies) and to structural projects (meta-projects that collect data about field activities, draw lessons and share information about best practices and obstacles, define future agendas), as proxy to "aggregation activities" (Geels and Raven, 2006). The objective of this step is to uncover the networks that have been formed over time and to identify the key Portuguese actors and the type of connections they establish. In particular we wish to understand which actors have moved along projects over time and pinpoint the type of projects along which they moved, as a first step to identify potential "intermediary actors" (Geels and Deuten, 2006). The second step involves focusing on the sub-set of projects that have conducted experimental activities in Portugal. The objective is to start exploring the role played by these projects in bringing in and aligning new actors, that may become part of the system being built at national level, as well as tracing the international connections being established. The number projects and actors involved in these steps are depicted in Figure 1.

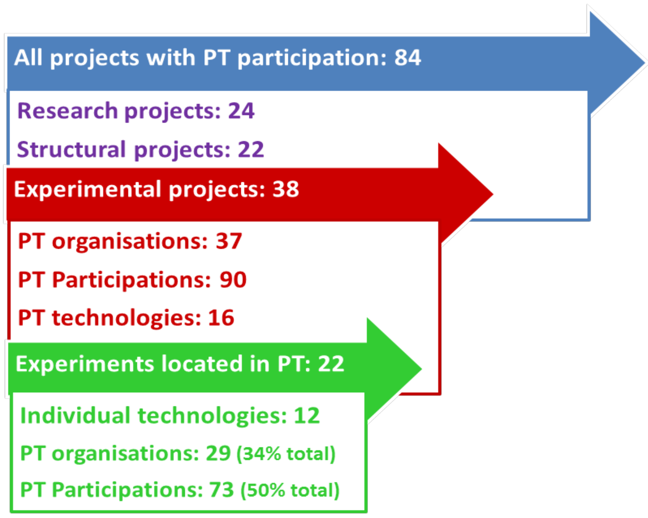


Figure 1. Empirical setting: projects and actors

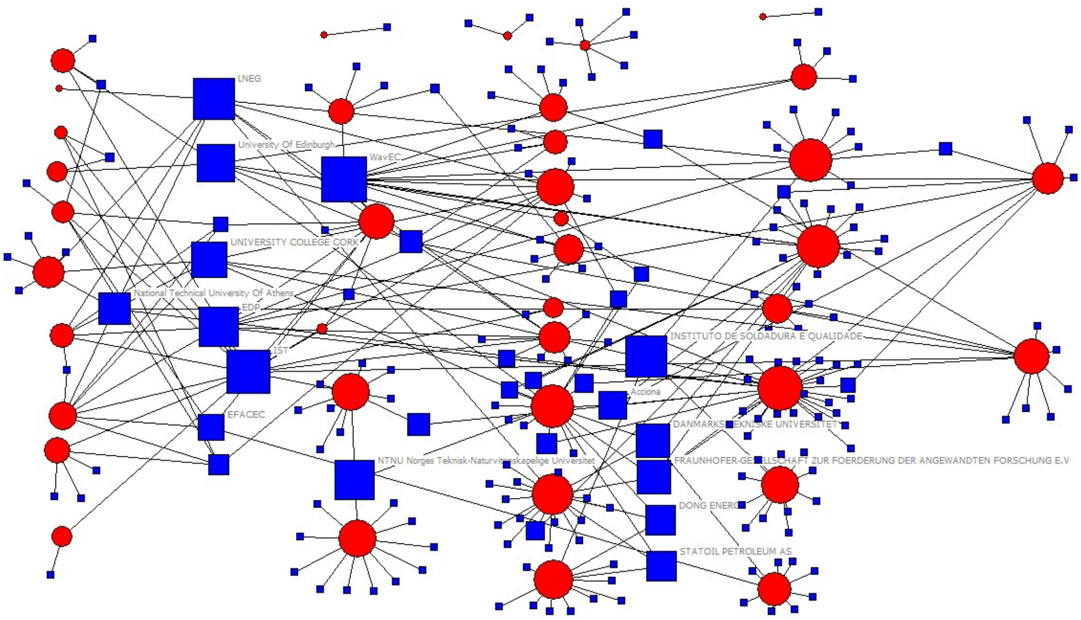
A third step involves looking in greater detail into two of the main technologies currently under development in Portugal: Waveroller in the case of wave energy and Windfloat in the case of floating offshore wind. This step is justified for two reasons. First, these technologies have a history of experimental activity along diverse stages in Portugal, permitting to trace their evolution and their impact on system construction. Second, it was realised that the network of partners in funded projects does not fully reflect the actual network of actors that participate in the experimental activities effectively conducted, with "non-core" actors going frequently unnoticed when using only this source of information. Thus, in the case of these technologies we will move beyond the funded projects and attempt to identify the principal actors that have been effectively involved in the experimental activities over time, using interviews and a variety of additional sources. In this paper we present mainly results from the two first steps.

3. Results and discussion

The analysis focuses on the behaviour of actors involved in these projects, as the entry point to investigate the processes at work. Through an actor approach the paper examines: i) changes in the size and composition of niche networks, which provides insights on the contribution of experimental projects to increase (or decrease) the attractiveness of the technological niche and also on their contribution to align actors from different origins; ii) the nature of actors that are involved in the experimental activities, which provides some insights into the extent to which these projects are also providing a setting to learn about market and industrial organisation, societal embeddedness and institution building: iii) the movement of actors (or groups of actors), both across experimental projects and between these and "structural projects" (i.e. projects that involve aggregation activities), which denotes the presence of "intermediary actors", whose presence contribute to reinforce learning processes; iv) the geographical scope of actors' actions and their influence on the conduction and outcomes of the experimental projects. Some preliminary findings are presented below.

Figure 2 illustrates some of the results obtained in step 1, showing the evolution of the experimental projects in wave energy and offshore wind and the networks formed around them over time.

The network reveals the involvement of several types of actors from different countries in the experiments, reflecting the multi-spatial nature of these activities. The size of the actors' nodes reveals their "betweenness centrality", a social network analysis measure that indicates the actors who have participated in many projects that can have diverse network compositions, acting as brokers between other actors. Among the most central actors is a group of Portuguese organisations (both research organisations and regime actors) that entered in the initial periods and maintained their engagement over time. They have acted as "intermediary actors": by participating in a sequence of projects and conveying knowledge between them; and by being involved in "aggregation activities" - both in the context of "structural projects" and (particularly in the case of wave energy) through engagement in field-level, often supranational, collective organisations and networks - to which they brought the experience gained in the experimental activities.



Legend: *Projects* - red circles; *Actors* – blue squares

Time - Each "column" of projects corresponds to a time period:

P1: before 2000; P2: 2000-2005; P3: 2006-2010; P4: 2011-2014; P5: 2015 and after

Actors are positioned in/near the period when they enter for the first time.

Figure 2. Network of experimental projects with Portuguese participation (1992-2015)

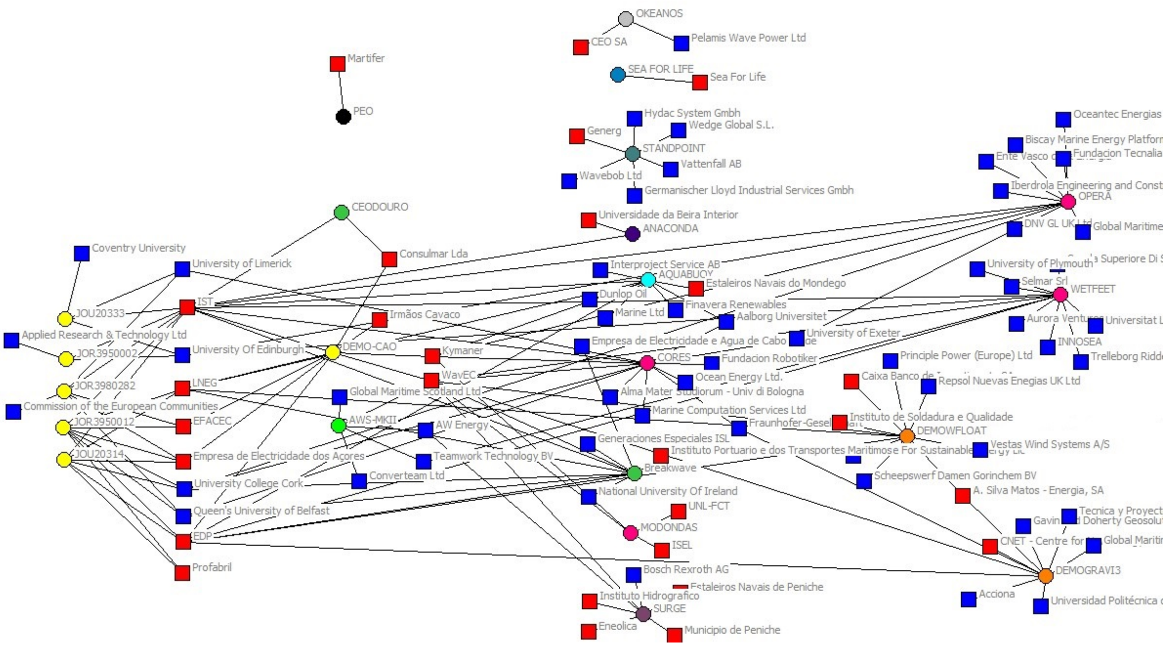
Tables 1 and 2 and Figures 3 and 4 illustrate some findings of step 2, which focused on the experimental projects conducted in Portugal. The projects were organised according to the 12 individual technologies that have been object of experimental activities. Only one of these technologies is in the field of offshore wind, which only recently registered some activity in Portugal, even if a Portuguese company is pioneering the emerging area of technologies for deepwaters. This contrasts with wave energy, where Portugal has a longstanding tradition, having been involved since the early 1980s and being one of the pioneers in the experimental activity in this field (Falcão, 2010). Table 1 presents some details of the technologies, namely the number of projects they generated, the data of the first project and whether activities are still pursued, and the nationality of the technology promoter. It shows that the projects involved technologies promoted both by Portuguese actors, and by foreign actors that identified Portugal as a favourable location, due to a combination of good natural conditions, favourable policies, and the extensive competencies and international networks of local actors (Fontes et al, 2016). The table also shows the number of Portuguese actors involved and their participations (for all the projects relative to each technology) and, since almost all projects included actors from more than one country, it also indicates their weight on the total actors and participations, respectively. Some of these technologies have already been abandoned; others ended-up not being pursued (at least in Portugal), mostly due to changes in the economic and political context associated with the financial crisis. But a small group is still active and is starting new projects. Moreover, after a period of decline, a new generation of Portuguese based technologies is emerging and a new set of foreign promoters is considering the conduction of experimental activities in Portugal, which may generate new experiments in the near future.

Table 1. Technologies object of the experimental projects conducted in Portugal

TECHNOLOGIES	No. projects	Tech promoter	First PT experiment	PT Actors		PT Participations	
				No.	% Total	No.	% Total
WAVE ENERGY							
Active							
PICO [(1)]	6	PT	1992	11	61.1	25	73.5
WAVEROLLER [(2)]	1	FI	2007	5	71.4	5	71.4
OWC [(3)]	4	PT	2008	6	19.4	12	29.3
Discontinued [(4)]							
AWS	1	UK	2005	1	20.0	1	20.0
FLOW	1	PT	2005	1	100.0	1	100.0
BREAKWATER	2	PT	2005	6	54.5	7	58.3
PELAMIS	1	UK	2006	1	50.0	1	50.0
WEGA	1	PT	2011	1	100.0	1	100.0
Not started [(5)]							
AQUABUOY	1	UK	2006	5	50.0	5	50.0
WAVEBOB	1	UK	2009	1	16.7	1	16.7
ANACONDA	1	UK	2009	2	100.0	2	100.0
OFFSHORE WIND							
Active							
OFFSHORE [(6)]	2	PT/US	2011	8	40.0	10	45.5

(1) A Pilot Plant was installed and has been in operation since the 1990s, but is currently under repairs.
(2) The 1st experiment conducted in 2007 was funded by private investors; only the second was funded by an EU project (in 2009). A new (pre-commercial) project was recently funded by the NER 300 EU mechanism and is expected to be installed in PT in 2017.
(3) Includes two international projects where the Portuguese OWC technology is being tested in combination with other technologies, from different (foreign) promoters, which explains the weight of non-PT actors.
(4) AWS and Pelamis were discontinued in PT but pursued elsewhere. Pelamis promoter went out of business. AWS is still operating and it is one of the technologies being tested in combination with the OWC, as referred in (3).
(5) Projects were conducted, but real sea experimental activities never started, mostly due to firms' inability to obtain the additional investment required.
(6) Encompass two different technologies being promoted by the same company: Windfloat (already tested at full scale) & GRAVI3 (whose sea level test is still being prepared). For Windfloat a new (pre-commercial) project was recently funded by NER 300 and is expected to be installed in PT in 2017.

Figure 3 presents the network of organisations involved in these experiments, distinguishing between Portuguese (red) and foreign (blue) actors. The extensive participation of foreign actors reflects the highly international nature of this field. The graphic shows an increase in the number of new actors, which reaches a peak in the period 2006-2010, registering a reduction during the financial crisis. It also shows that Portuguese actors that entered in early periods maintained their involvement in the subsequent projects, some of them moving between technologies.



Legend:

Projects: circles; each colour corresponds to a technology

Actors: squares; Red - Portuguese actors; Blue – foreign actors

Time: Each “column” of projects corresponds to a time period:

P1: before 2000; P2: 2000-2005; P3: 2006-2010; P4: 2011-2014; P5: 2015 and after

Actors are positioned in/near the period when they enter for the first time

Figure 3. Network of experimental activities taking place in Portugal (1992-2015)

The network expansion encompasses both core actors, i.e. actors directly involved in the development of the technology and external actors that join the emerging system. This is confirmed by Figure 4 that presents the actor participations by type of actor. It shows the involvement of two new types of actors: “coalition actors”, that is, external actors, usually large incumbent companies, which are gained to support the new technologies as partners or investors; and “complementary actors”, that is, actors from other sectors, in particular from energy and sea-related industries, which bring competences in downstream areas (Steen and Weaver, 2014). It should nevertheless be pointed out that the actual involvement of complementary actors, as well as of actors included in the “society” category, is likely to be higher that indicated by these numbers. In fact, a preliminary exploration of the experimental activities effectively conducted in the context of the technologies being examined in detail in step 3 (Waveroller and Windfloat), has revealed a much higher number of non-core actors involved in a great variety of activities. However, these tended be to contractors or supporters, rather than partners in funded projects. This group included, namely, several companies from those sea-related sectors to whose revitalisation MRET are expected to contribute (OTEO, 2014). This finding reinforces the idea that experimental projects are effectively contributing to bring into the system and align a set of heterogeneous actors, providing “blue-prints” for the new value chain being built.

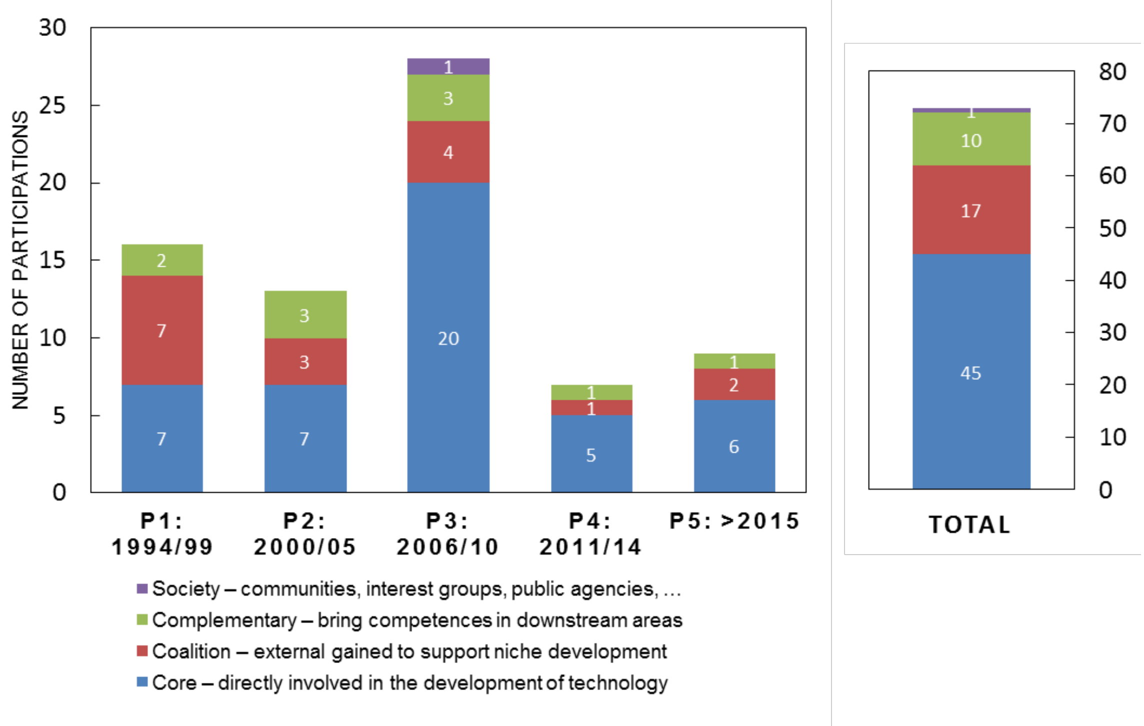


Figure 4. Portuguese actor participation in experiments conducted in Portugal, by period and type of actor (1992-2015)

Finally, Table 2 identifies the individual actors that moved between projects - distinguishing between those that only moved along projects within the same technology and those that also moved across technologies – and indicates the actors that were equally involved in "aggregation activities". Both the actors and the pattern of their activity are similar to the ones identified in the analysis of experimental projects in general (Figure 2), confirming the "intermediary" role played by a group of organisations. Different types of core actors perform this role, from research organisations and technology developers, to the collective organisation formed to speak for the new field. But it is also interesting to notice that a regime actor (the energy utility) is in this group, having become engaged early as a supportive (coalition) actor and becoming, over time, a core actor with activity in both wave energy and, particularly, floating offshore wind.

Table 2. Actors that moved between projects: individual actor participation by period

Name of actor (type)	Type organisation	P1	P2	P3	P4	P5	Total	Across Techs?	Structural Projects?
IST (core)	University	5	2	5		2	14	Yes	Yes
WAVEC (core)	Collective		2	5	1	2	10	Yes	Yes
EDP (coalition, later core)	Regime (Utility)	2	1	2	1	1	7	Yes	Yes
LNEG (core)	Research	2	1	2	1		6	Yes	Yes
Kymaner (core)	Tech developer		1	3		1	5	Yes	Yes
EFACEC (coalition)	Regime (Energy)	2	1				3	No	No
Consulmar (complem.)	Firm (Proj. Eng.)	1	1				2	Yes	No
A. Silva Matos (complem.)	Firm (Manufact.)				1	1	2	No	No

4. Discussion

The preliminary analysis of the experimental projects conducted in the MRET field permitted to obtain an overview of the most significant networks of actors, their changing composition over time and also the position achieved by some actors in those networks. These results provide some indications towards roles played and some insights into the nature of learning processes that are taking place in what concerns the configuration of the new system.

These insights concern, first of all, the structuring of the community network. The results show that experimental projects bring, into the emerging system, new actors, beyond the core group directly engaged in the development of the technologies; and contribute to their alignment, which is a critical step in the emergence of a new system (Cooke, 2012). In fact, the projects revealed new opportunities to organisations in adjacent areas, both established companies (e.g. in energy or sea-related activities) and new companies with transversal technologies (e.g. underwater robotics). In the case of actors in complementary areas, sequences of projects – even if they concern different technologies – not only provide immediate revenue opportunities, but can raise expectations about future markets and thus provide an incentive for new competence acquisition/adjustment (Caniëls and Romijn, 2008). These projects also create a context where heterogeneous actors start developing closer relationships and learn to operate together (Frishammar et al, 2015). Since continuity is critical to consolidate those effects, the reduction of activity registered during the financial crisis has been detrimental to the system evolution, even if the ongoing recovery appears to be creating new expectations. Finally, the continued location of experimental projects in particular sites (due to attractive conditions in terms of natural resources or local support; and/or strategic investments of their promoters) favoured a growing involvement of local organisations and is inducing embryonic clustering processes in at least two regions, with impacts on regional development and also a positive influence upon the public acceptance of marine renewable technologies (Coenen et al, 2010).

Projects were also found to be instrumental to attract incumbent companies, as investors or partners. The involvement of these companies is important since they bring resources and legitimacy, which are critical in a field still characterised by great uncertainty and where experimental costs are extremely high. But it can also have a downside, since these actors may show a lower commitment, and even abandon, if the results are below expectations (Bakker and Budde, 2012). They may also have their own agenda and attempt to influence the development trajectory according to their interests (Bergek et al, 2013). The involvement of Portuguese incumbent organisations in some of the technologies analysed provided examples of these positive and negative effects.

Finally, experimental projects were also found to enable and reinforce interactions between actors from diverse countries, driving a variety of exchanges at different spatial levels, which were further consolidated through the supranational performance of "aggregation activities" (Fontes et al, 2016). This multi-spatial nature of the field not only provided conditions for extensive knowledge flows, but also increased the opportunities for resource access (in the case of core actors) and for business (in the case of complementary actors). However, an excessive reliance on local experiments of technologies promoted by foreign developers also has its downsides. In fact, these actors tend to have lower motivation to resort to local (non-core) actors, thus reducing the local learning effects and also tend to show a lower commitment, often moving away if more favourable conditions emerge elsewhere (Løvdal and Neumann, 2011).

On the other hand, the research has provided important insights into the key role played by some actors in the process of learning about the configuration of the new system. As proposed by the socio-cognitive perspective (Geels and Raven, 2006), it was possible to identify a set of "intermediary actors", who were found to play the expected a role as conveyors of "local" knowledge obtained in individual projects (conducted at national and international level) and of abstract knowledge produced in the context of aggregation activities (Geels and Deuten, 2006). But, more importantly, the results suggest that these actors also act as coordinators in what concerns system structuring: they carry both experience on new modes of organisation and governance, and a "portfolio" of partners that form an emerging structure for the system; and they effectively shape the actual implementation in practice of the agendas being produced through aggregation activities.

5. Conclusion

This paper addressed the role played by experimental projects in the process of development of the emerging marine renewable energy technologies, investigating how they promote learning, not only about the technologies, but also the economic and social processes required to construct a new system. The research focused on the behaviour of the actors involved in these projects in order to understand the processes that are contributing to the structuring of the emerging system.

The paper presented preliminary findings of the research being conducted in what concerns: i) the early structuring of the community network, including the attraction and alignment of heterogeneous groups of actors; ii) the learning processes taking place as part of the configuration and governance of the new system and, particularly, the roles being played in this process by a set of actors – the "intermediary actors" - that move between projects, produce, codify and convey knowledge at various levels, and also act as coordinators of the system structuring process.

Those findings offer a first understanding of the processes that mark the construction of the new system. They will now need to be further developed, by going in greater detail into the actual activities that took place as part of the development of the technologies being object of experimental activities, namely by identifying the full set of actors involved and by defining more clearly the roles played and their influence on the configuration of the (emergent) system.

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Politics in a transition to low-carbon energy, Case study: Discourse analysis of reasons for investment in renewable energy by oil and gas companies in Thailand

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Abstract

Thailand submitted its Intended Nationally Determined Contributions (INDC) at the UNFCCC COP21 held in Paris, with the aim to reduce greenhouse gas emissions by 20-25% from its 2005 levels by 2030. The government seems confident the country could meet its pledges thanks to the recently implemented Alternative Energy Development Plan (AEDP), which aims to increase the uptake in renewable energy supply to 30% of all energy consumption. Oil and Gas (O&G) companies, a primary energy supplier, have found that their business operations lie at the center of the government's effort to cut down emissions, while being requested to enhance national energy security to ensure economic growth. Academic literature and media have long scrutinized big oil multinational corporations and the renewable energy investments they have made, which can be traced back to the first oil shocks in the 1970s. However, to what extent O&G companies -especially those which are state-owned in developing countries- welcome such disruptive renewable energy technology appears to be under examined. The present study thus targets Thailand's state-owned oil and gas company, PTT, and two of its associates- Thaioil Group and Bangchak Petroleum-, to attempt to improve understanding on how the O&G industry justifies its investments in renewable energy. The research objectives are first to investigate the companies' investment history in alternative and renewable energy sources in the past 15 years, and secondly to reveal the politics behind the companies' investment in a given renewable energy source. Socio-technical approaches to energy policy and development suggest that a technology has to be built into society if it is to be successful, and thus the study conducted a qualitative data analysis, in particular discourse analysis, to reveal the politics of the various companies. Any renewable energy technology in which the companies have invested requires a certain type of 'rhetoric' or 'discourse' to justify the choice of investment, especially during the development stage. Secondary data i.e. companies' annual reports as well as CEO's speeches from 2001 to 2014 were collected and critically analyzed through MAXQDA software. Furthermore, official statements of the Thai government in this period were also reviewed to add insights into companies' investment discourses. The findings suggest that all three oil and gas companies have mainly invested in biofuels, both ethanol and biodiesel production. Among them, Bangchak Petroleum appears to be actively diversifying its business portfolio towards green and clean energy sources, including Solar PV. Discourse analysis revealed a reiterated dominant discourse used by the companies when promoting alternative and renewable energy i.e. complying with government policy, enhancing energy security, reducing imported crude oil and increasing the uptake in environmental friendly energy. For biofuels, the companies also referred to the HM the King's initiative and helping farmers, which appear to be a rather unique discourse particular to Thailand. In conclusion, the study contributes to the debate regarding transition to a low carbon energy future, which would appear to be grounded as much on political reasons as it is on technological or economic factors.

Keywords: Energy transition; O&G companies; Thailand; discourse analysis

Social enterprise as an engine for sustainability transition

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Abstract

Embedded socio-ecological problems urgently require novel approaches with a long-term orientation, including reflexive and adaptive policy design and conceptualisations which move far beyond business as usual approaches and which meaningfully address underlying complexes of technologies and institutions. The transitions literature has stimulated debate to increasingly recognise the multi-dimensional shifts required for delivery of sustainable modes of production and consumption. However, transition studies have to date focused heavily on technological and on historical analyses. Within this emerging body of investigation, there is a need for research which more exclusively and explicitly addresses organisational and community level responses to sustainability in a strategic and forward looking manner. While there is growing consensus that human behaviours need to change to a more sustainable paradigm, community driven approaches, such as social enterprise, have yet to be explored as serious instruments of sustainability transition. Social enterprises sit within the third sector of the economy, typically where market or governmental failures exist in the provision of social welfare, and have increasingly become a key driver of social progress. The autonomous nature of the social-economic model applied by such organisations can represent a viable means to reduce state social welfare dependence, and as a proven model for social change. The capability of social enterprises to create both social and economic value is considered a 'win-win'. However, there are clear potentials for social enterprise models to be more extensively applied to address contemporary ecological challenges of neo-liberal market economies, moving towards 'win-win-win' outcomes across social, economic and ecological domains; particularly as these organisations are not motivated by a relentless profit imperative. This paper investigates the value of utilising social enterprises as a driver of sustainability at the community level, with an emphasis on application in the energy sector. Evidence from four social enterprises in the UK is presented and a socio-technical transitions conceptual framework is applied to analyse these social enterprise operations as a form of social innovation. The paper critically evaluates the characteristics of social enterprises which suggest potential for wider socio-technical systemic transformation and appraises the potential for such organisational models to act as 'engines of socio-technical transformation'. Barriers to the widespread diffusion of social enterprise models are identified, as well as operational and strategic challenges in actively delivering on the 'win-win-win' potential of these organisations for sustainability.

Keywords: Sustainability Transitions, Innovation, Socio-technical regimes, Energy, Social Enterprise

Introduction

Aims and objectives

This paper investigates the value of utilising social enterprises as a driver of sustainability at the community level, with an emphasis on application in the energy sector. Evidence from four social enterprise focused stakeholders in the UK is presented and a socio-technical transitions conceptual framework is applied to analyse these social enterprise operations as a form of social innovation. The paper critically evaluates the characteristics of social enterprises which suggest potential for wider socio-technical systemic transformation and appraises the potential for such organisational models to act as 'engines of socio-technical transformation'. Firstly, the academic literature regarding niche innovations is reviewed, sustainability transitions and social enterprises. Secondly, results from four semi-structured interviews with social enterprises from the Liverpool City Region in the UK explore their role within the context of a low-carbon future. A socio-technical transitions conceptual framework is applied here to analyse how social enterprise operations constitute a niche innovation. The potential for wider socio-technical systemic transformation together with the potential for such organisational models to act as 'engines of socio-technical transformation' is appraised. Barriers to the widespread diffusion of social enterprise models are identified, as well as operational and strategic challenges in actively delivering on the 'win-win-win' potential of these organisations for sustainability.

1.1. Niche Innovation and Sustainability Transitions

The concept of 'transition' has become increasingly central to futures-oriented thinking (Feola and Nunes, 2014). Deeply embedded socio-ecological problems urgently require novel approaches with a long-term orientation. The transitions literature has stimulated debate to increasingly recognise this and the multi-dimensional shifts required for delivery of sustainable modes of production and consumption, for instance. Within the Multi-Level Perspective (MLP) nested hierarchy, the widely cited theoretical framework applied by Geels and others, the niche level affords space for experimentation and new ideas to emerge (Geels and Schot, 2007). The MLP posits that transitions come about through interactions between processes at three levels: (a) niche-innovations afford space for new ideas to be tested and developed; (b) changes at the landscape level create pressure on the regime; and (c) destabilisation of the regime creates windows of opportunity for niche innovations to emerge. The alignment of these processes enables the breakthrough of novelties in mainstream markets where they compete with the existing regime (Geels and Schot, 2007). Niches act as 'incubation rooms' or 'protected space' protecting novelties against pressures of the mainstream, including forces of market selection for instance (Schot, 1998; Kemp *et al.*, 1998). Radical innovations break out of the niche-level when ongoing processes at the levels of regime and landscape create a 'window of opportunity', which allow these niche innovations can then go on to become integral to regimes (Geels and Schot, 2007).

There are significant challenges related to the diffusion of niche innovations, particularly related to the scale of niche innovations within a wider regime, making scale-up challenging and presenting difficulties with replication of conditions for success across wider regime environments (Charnock, 2007; Seyfang and Smith, 2007; Seyfang, 2010). Niche innovations are carried and developed by small networks of dedicated actors, often outsiders or fringe actors (Geels and Schot, 2007). While this assures that sustainable alternatives are considered and acted upon, gathering wider support can be challenging within the context of a regime change. Tensions and contradictions may occur with incumbent regimes as opening niche opportunities emerge and niches start to drive regime transformations (Geels and Schot, 2007; Seyfang and Smith, 2007).

Within this emerging body of investigation, there is a need for research which more exclusively and explicitly addresses organisational and community level responses to sustainability in a strategic and forward looking manner. While there is growing consensus that human behaviours need to change to a more sustainable paradigm, community driven approaches, such as social enterprise, have yet to be explored as serious instruments of sustainability transition.

1.2. Social Enterprise and Sustainability

'Social enterprise' is a collective term for a range of organizations that trade for a social purpose (Haugh, 2007). Cieslik (2016) describes social enterprises as organizations seeking market-based solutions to social problems. Social enterprises are neither typical charities nor typical businesses; rather they combine aspects of both (Ebrahim, Battilana, & Mair, 2014). Social enterprises target economic sustainability but within a wider social mission, reinvesting profits generated to achieve multiple bottom lines (Cieslik, 2016). The primary revenue source is commercial, relying on market activity instead of donations or grants operate and to scale their operations (Ebrahim *et al.*, 2014).

Social enterprises operate within the 'third sector' of the economy, typically where market or governmental failures exist in the provision of social welfare, and have increasingly become a key driver of social progress. In this context, the trend for communities to take greater responsibility for their own socioeconomic development has emerged alongside the withdrawal of services that have traditionally been provided by the public sector (Haugh, 2007). Debates on social enterprise, and more widely on the social economy can be contextualised within the perceived need to imagine alternatives to neoliberal capitalism and associated negative social and environmental impacts (Daya, 2014). The autonomous nature of the social-economic model applied by such organisations can represent a viable means to reduce state social welfare dependence, and can act as a model for social change. The capability of social enterprises to create both social and economic value is considered a 'win-win'. However, there are clear potentials for social enterprise models to be more extensively applied to address contemporary ecological challenges of neo-liberal market economies, moving towards 'win-win-win' outcomes across social, economic and ecological domains; particularly as these organisations are not motivated by a relentless profit imperative. The unique business models of social enterprises deliver multiple advantages when targeting sustainability-related outcomes. Community focused social enterprises hold the potential to ground sustainability-related policy and action in a more visible and meaningful way; for instance, community approaches are grounded in the everyday practicalities of energy use and lifestyle choices more-so than 'top-down' measures (Ockwell *et al.*, 2009).

Community-led social ventures therefore have the potential to deliver benefits over and above economic and financial outcomes as they are closely engaged with people with a shared interest in their creation and management (Haugh, 2007). Participation and empowerment are often forwarded as legitimizing factors for social enterprise (Cieslik, 2016). Social Enterprise has the potential to revitalize communities via meeting local needs, developing the capacity of a community to be independent and generating social capital between individuals and communities (Haugh, 2007). Social enterprises are visible to local individuals and those they are trying to influence and typically face-to-face contact between community members and representatives of social enterprises engender more trust compared to branding and marketing initiatives associated with larger corporations. Consequently, community level approaches and social enterprises allow for greater interactions with local actors and sustainability actions can be tailored to the needs of the community. Importantly, for energy focused social enterprises, local people are involved in active dialogue on future of the energy system for their community (Middlemiss and Parrish, 2010; Moloney *et al.*, 2010), fostering agency, ownership and engagement. Through interactive, inclusive and participatory approaches, social enterprises can become a powerful instrument to engage the public with sustainability.

However, to date, social enterprises have yet to be explored as serious instruments of sustainability transitions. Little research has been conducted that systematically interrogates the dynamics of the sector, including research into the values that drive social enterprise and power relationships that underpin and are shaped through its discourses, representations and practices (Daya, 2014). In fact, there have been very few systematic reviews undertaken in the social enterprise/social entrepreneurship/social field more broadly (Roy *et al.*, 2014). Given that radical innovations break out of the niche level during ongoing processes within the socio-technical landscape and regime create a 'window of opportunity', we investigate social enterprises as an innovation that create multiple positive outcomes across the pillars of sustainability. This study therefore represents a contribution to knowledge in the area of social enterprise research, as well as to the study of niche innovation in the transitions literature.

Methods

Qualitative research methods were employed in this study to provide contextual, explanatory and evaluative insights into the social enterprise landscape in Liverpool, UK. Qualitative enquiry methods were selected to enable key informants to share their knowledge in a non-constrained manner during data collection following methods described by Ritchie and Lewis (2003), and applied by Faherty and Morrissey (2014). Primary data were collated through a series of semi-structured interviews, framed in an open ended format (Hay 2000; Harding, 2013). As described by Wilson (2014), semi-structured interview methods are appropriate when there is some knowledge about the topics or issues under investigation, but further details or insights are required. In this study, semi-structured interviews capturing qualitative responses enabled sufficient flexibility to explore key factors whilst maintaining consistency of approach and scope with all participants, as argued by Harding (2013). The approach recognises that the content of each interview is unique, differing from the other interviews with regard to experiences, tone, personal and organisation involvement, etc. (Dierckx de Casterle, DeGastmans, Bryon, & Denier, 2012).

In this study, 4 Key Informants were strategically and purposefully selected for inclusion in data generation, based on their roles as prominent social enterprise stakeholders in the Liverpool City-region. Key Informants were not selected to provide an exhaustive or representative sample, but rather, for their capacity to provide insightful understanding of the practitioner perspective of the social enterprise and carbon reduction landscape in the Liverpool City-region. Potential interview candidates were contacted via both email and phone in order to arrange interview meetings. The interviews ranged from approximately 40-60min in duration and were conducted in person. An open-ended questioning technique was employed, with informants asked to provide information about their role in the organisation and the issues which they had observed in their experience in the social enterprise sector. Interviews were conducted between the 8th February 2016 and 23rd February 2016. Table 1 provides a summary of the Key Informants interviewed during the data collection phase, as well as their roles and a descriptor of their respective organisations.

Table 14. Summary of Key Informant interviews, Liverpool City-region Feb 2016

Key Informant	Professional Role	Organisation
Key Informant 1	Chief Executive Officer	Social enterprise (energy generation)
Key Informant 2	Chief Executive Officer	Social enterprise (energy use reduction)
Key Informant 3	Research Officer	Business support for social enterprise
Key Informant 4	Project Manager	Public-Private Partnership

All interviews were audio-recorded and transcribed to facilitate the qualitative analysis process. On completion, interview transcripts were double-checked for accuracy and completeness of the interview record and copies of written records were sent to respective interviewees for comment or correction, following the approach reported in Harding (2013). In analysis of this type, the use of pre-prepared frameworks or strictly organised questioning runs the risk of prematurely excluding rich data that may provide considerable insights (Dierckx de Casterle *et al.*, 2012). For this reason, standardised and detailed interview schedules were not produced, following methods reported in Faherty & Morrissey (2014). For each interview, an overview framework was used through which to provide some structure and this is presented in Table 2. Questions presented in Table 2 were supplemented and adapted according to the respective interviewee, with questioning changing in response to emerging discussion points and articulated perspectives (Friedl & Reichl (2016) apply a similar approach).

Table 15. Themes and indicative questions applied in semi-structured interview process

Interview theme	Indicative Questions
Organisation	Introduction to organisation?
	Role within organisation?
Sustainability / Climate change	Perception of sustainability issues?
	Role of Social Enterprise in greener economy?
Business Structure	Legal structures?
	Operation structure of organisation?

Income Streams	Types of income?
	Financial sustainability of sector?
Barriers within Sector	Barriers encountered to date?
	Policy implications?
Future considerations	Impact of your work?
	Future issues in medium/long term?

An interpretative approach was applied to data analysis by transcribing the interviews into written text, then condensing the data and coding it into themes, before final stages of reflection and synthesis of findings. This approach follows methods reported in Saldana (2013), Berg and Lune (2012) and Faherty and Morrissey (2014). Outputs from the qualitative analysis of interview transcripts provided a comprehensive characterisation of energy focused social enterprise, addressing internal and external barriers to social enterprise operating within this sector, including legal structures, income streams, interactions with private sector and policy. Figure 1 provides a schematic overview of the approach to thematic analysis that was applied for each of the written interview transcripts.

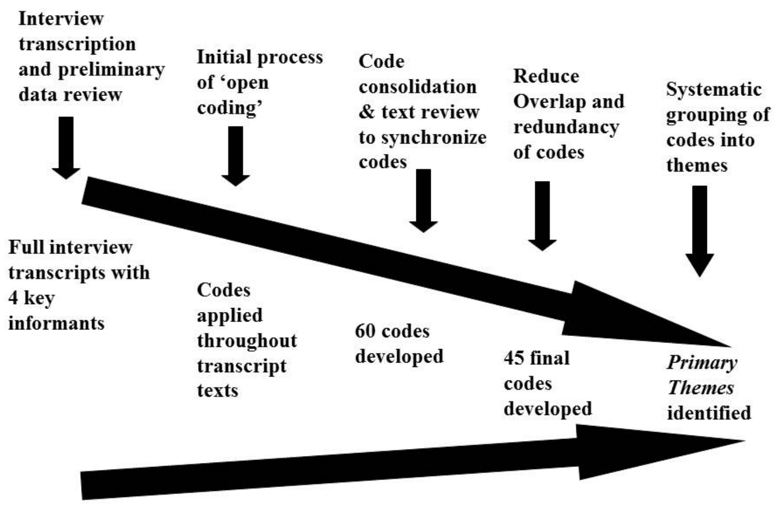

Figure 8. Coding process applied for thematic analysis

The process outlined in Figure 1 was both iterative and reflexive, meaning that upon identifying themes initially, the entire dataset was then re-interrogated to consolidate and better synchronise coded extracts and provide validation for identified themes. This process is described by Dierckx de Casterle *et al.* (2012), who argue that once final themes have been identified, researchers typically go through previous stages again, inevitably resulting in partial overlap and interaction between successive stages of analysis. Content analysis generated a short-list of common and critical themes, similar to the approaches reported in Shay *et al.* (2016) and Friedl & Reichl (2016).

Results and Discussion

Business structure

Over the last decade, a number of countries have developed new legal statuses to better fit the needs of social enterprises that are neither typical for-profits nor typical non-profits (Ebrahim *et al.*, 2014). For social enterprises, a multitude of different legal structures exist and can be applied in the energy sector, with a range of implications for the organisation depending on the legal structure adopted.

“We are a charity registered with the charity commission and we are also company limited by guarantee which makes us registered with Companies House as well.” (Key Informant 2)

Interestingly interview data suggest that the rationale for selecting one structure over another were not necessarily strategically assessed for optimal performance at the organisational level. The influence of similarly focused organisations in the region seems to be paramount in providing a model for chosen business structure. New social enterprises follow the template established in other similar organisations within their frame of reference.

“I went to a conference on community energy in London a few years ago and it was pretty much like everyone who’s big in community energy at the time was there talking about the projects they’d done and it was really incredible and then I went away and researched all the different groups and pretty much universally they were all community benefit societies.” (Key Informant 1)

There is some evidence that social enterprises within the community energy sector, which had originally set up as co-operatives, made a change to a Community Benefit Societies model. This model differs from a co-operative model in that the interests of a defined community drive the organisation as opposed to the interests of a discreet set of members. This seemingly small difference has had significant impact on the business models, and therefore viability of energy focused social enterprises.

“The community benefit society means you can trade for the benefit of a wider community, if you’re a co-operative you’re effectively trading for the benefit of your members” (Key Informant 1)

Although newly created legal forms may prove to be important tools in some countries, most social enterprises across Europe, still adopt legal forms that have existed for a long time, namely those of association, co-operative, company limited by guarantee or by share, Industrial and Provident Societies in the UK, etc. (Defourny & Nyssens, 2010). A likely future issue in terms of business structure, is the tendency of successful alternative economic structures to revert to a mainstream model (Johanisova, Crabtree, & Fra, 2013). Johanisova *et al.* (2013) discuss the case of the German and Austrian credit union movement. As members stopped identifying with their local credit union and became withdrawn from the decision-making process, the decision-making power of local credit union entities was eroded and many have lost their autonomy to the powerful federations.

Financial sustainability & conflicting priorities

Social enterprises income streams can come from a range of sources and the composition of these streams can impact on the legal structure of a given organisation. For the social enterprises interviewed, revenue streams consist of feed-in tariffs, grants, share offers and trading.

“So we actually set up a trading arm…to explore the opportunity of trading and providing that professional service to people on the open market.” (Key Informant 2)

From the financial perspective, data from interviews demonstrates the priority interviewees place on the need for social enterprises to become more financial sustainable through generating a larger proportion of their income through trade.

“So that’s the next step for community energy now is moving away from a subsidy based model to one where we just sell directly to customers” (Key Informant 1)

“As a result of that we try to encourage our membership to be much more focused on financial sustainability from a trading perspective to trade their way to sustainability and profitability and to ensure that they are secure and resilient in their business from selling goods and services to people who actually want them.” (Key Informant 3)

This view accords with evidence from the literature. Social enterprises are generally viewed as organizations characterised by a significant level of economic risk. Moreover, to be successful in bearing such risks over the medium-long term economic sustainability is a prerequisite (Defourny & Nyssens, 2010). The social enterprise's mission is only attainable if the social enterprise itself has a sustainable operation (Sodhi & Tang, 2011). In practice, many social enterprise managers continuously make trade-offs between increasing productivity for financial gain versus increasing productivity for social benefits (Zainon *et al.*, 2014).

"Sometimes there is a lack of focus within social enterprise on what needs to happen to make themselves financially sustainable long-term." (Key Informant 3)

Social enterprises thus face a unique governance challenge: how to handle the trade-offs between their social activities and their commercial ones, so as to generate enough revenues but without losing sight of their social purpose (Ebrahim *et al.*, 2014).

"The intention is to set up a business which is a self-funding, sustainable business but has very much a values based approach to what we do and has a clear intention to democratise the energy system as we move in to a post carbon energy system."(Key Informant 1)

Social enterprises that combine social and commercial activities in their core face a distinct challenge because their definition of success includes both dimensions; dual objectives are not necessarily aligned and may in fact be contradictory, potentially undermining the organisation's ultimate mission (Ebrahim et al., 2014). Evidence from interview data suggests that the issue with creating financial sustainability can be attributed to not only a lack of trading opportunities, but also to the social mind-set of the business leaders focused on multiple bottom line performance.

"If you're looking to specifically build a green economy in a market-based economy the problem with social enterprise is that it is not a cheaper option because there are all sorts of other concerns the impact on the bottom line." (Key Informant 3)

"One of the challenges for charities particularly is how much of the income is spent on beneficiaries and how much of it is corporate." (Key Informant 2)

Concern for the legitimacy of a social enterprise as a social organisation may lead to attempts to ensure that the business is fully sustainable from economic, social and environmental perspectives. However, the implication of this is that the costs in creating a fully ethical business can mean that consumer prices are uncompetitive.

"Sadly the end consumer might look at it and say well on a purely financial basis I can't afford to be giving business to a social enterprise, even though they are more ethical, because the price might be greater than with the traditional private company." (Key Informant 3)

Trade-offs emerge between addressing the demands of their paying customers who are viewed as key stakeholders for businesses, and addressing the needs of the beneficiaries of their social mission who are viewed as principal stakeholders in charities (Ebrahim *et al.*, 2014). As argued by Sekerka & Stimel (2011), organisations with a strong stakeholder or environmental perspective may not adapt to the practical realities of the bottom line, and accomplish no more than increasing the probability of going out of business.

The importance of social capital

Since social enterprises explicitly exist to benefit the community, and communities typically have a controlling stake in the organisation through democratic ownership structures, social enterprises are more likely to satisfy real needs (and less likely to externalise their costs), than for-profits (Johanisova *et al.*, 2013). The term social capital has been applied in the academic literature for many years and is used to describe social networks where trust and reciprocity are at the centre of transactions that are carried out for a common good as opposed to individualistic gain. In this context, Johanisova *et al.* (2013) identify the long term generation of positive externalities as a key defining feature of locally rooted enterprises, when compared to large multi-national corporations. Themes of positive externality, and social capital are evident from interviewee data.

"People who run social enterprises are very keen to treat their supply chain fairly, they're very keen to treat the people who work at those organisations in a fair manner." (Key Informant 3)

"We therefore need to empower people to make their own decisions and then invest in it and that to me is going to come through community and through engagement." Key Informant 2

Data from interviews reinforces that social capital is an important point of leverage for social enterprise when targeting organisational missions. This manifests in two related ways: in enhancing the credibility of the social enterprise and in providing a sense of legitimacy. Social and environmental profits flow to the community and consequently the economic profits flow back into the social enterprise within the ambit of social enterprise legitimacy (Zainon *et al.*, 2014). The local scale and focus of social enterprises is therefore critically important, and this is evident as a clear theme from interviewee data.

"Energy is something we all rely on and some of that when you put infrastructure locally should be rewarding the locals." – (Key Informant 4)

"You need to find that balance and find a way of favouring local people as much as possible by local people becoming members and building a local membership base." – (Key Informant 1)

<u>Niche-regime dynamics – the role of policy</u>

The relationship between social enterprise and the mainstream 'regime' would appear to be an uneasy one. Frequently changing environmental policies and interactions with private sectors energy companies presents significant challenge for social enterprise operations. In terms of changing environmental policy, several policy changes have had an effect on the organisations interviewed; for instance the rapidly changing policy positions of the Green Deal and the feed-in tariff for solar energy in the UK have had a disruptive and unsettling impact. The relationship between social enterprise and public policy can be described as uncertain at best. It is evident that radical policy changes can have a detrimental impact on the viability of a given social enterprise as a legitimate business rather than as just a charitable entity. According to Mikami (2014), the failure to define the social economy in an unambiguous way causes confusion in the system of domestic laws that regulates the social sector. Such problems are exacerbated by uncertainty across the environmental and energy policy landscape, as has been the case in the UK for the past number of years.

"The feed in tariff then created this whole business model and so taking it away has just messed it up…every now and again they decide to massively cut the feed in tariff so everyone's business model goes out. But now it's basically at zero there's nothing left." (Key Informant 1)

"It wasn't just solar, they cut the subsidies for hydro and wind and took them away a year early for wind." (Key Informant 1)

"We actually set up a trading arm … to explore the opportunity of trading and providing that professional service to people on the open market. However, the timing of it was such that the government axed the Home Information Packs, the whole market dropped." (Key Informant 2)

Such uncertainty is exacerbated by a reliance on top-down funding, and in particular, on grants and subsidies as an integral component of the social enterprise's revenue stream.

"So when there was a feed in tariff, which made projects profitable, then there seemed to be a way of encouraging a social enterprise to consider community energy…We are in new times as of December with a lower tariff…it makes the numbers a bit harder to reconcile." (Key Informant 4)

"I don't see our organisation not operating with the support of grants for a few years. Purely because the tradable opportunity that exists in our field was eco-and green deal, which were the opportunities to engage with householders and acting as a broker and introduce householders to measures." (Key Informant 2)

More generally, social enterprises broadly remain closely tied to the public sector and to public sector support. Support through public policies has to date, and still remains, a key channel for the diffusion of various models of social enterprise throughout Europe, for instance (Defourny & Nyssens, 2010).

Niche-regime dynamics - Relationships with other businesses

The relationship between social enterprises and private sector businesses can exist in two different forms, competition or collaboration. Both of these issues were discussed by the interviewees. In addition, network building is a theme that cut across both competition and collaboration, and was strongly emphasised in interview data:

Competing:

Mainstream businesses may not be interested in competing with social enterprises in certain "niche markets" that are too small to be profitable. If a social enterprise does subsequently prove to be highly profitable, then other big business may enter the market and compete (Sodhi & Tang, 2011). Social enterprises have certain competitive advantages over private companies, but may also be commercially unable to compete with much larger entities.

"There are fewer social enterprises winning larger contracts than would be accounted for by the percentage of the business economy that social enterprises make up" (Key Informant 3)

"I know that commercial investment is still going ahead and they want rates of return of 20%. If community groups only want a return 4% interest…you think that they'd have more room to manoeuvre."(Key Informant 4)

"At the moment there are a lot of small energy companies entering the energy market to compete with the big six. They're able to do that I think because they don't have some of the costs that the big six have." (Key Informant 4)

Collaboration:

Multi-dimensional social problems which no party can tackle on its own bring in the need for collaboration between business and social enterprises (Sakarya, Bodur, Yildirim-öktem, & Selekler-göksen, 2012). Adoption of collaborative strategies for social causes is primarily derived from financial resource dependence for social enterprises and from concerns for legitimacy for business enterprises (Sakarya *et al.*, 2012). However, interviewees expressed a certain level of scepticism of the motivation for, or the benefit of such collaborations.

"Private companies tend to fund social enterprises and charities out of their CSR budgets and it can be viewed, by some at least, as a way of giving a kind of whitewash to activities that are peripheral to the central mission almost as an organisation." (Key Informant 3)

".. this relationship between business and community and third sector charities and social enterprises, the danger that smaller organisations are taken advantage of or seen as a means to make a sale." (Key Informant 2)

Network building:

As social enterprise is inherently a hybrid form of organization, it can potentially strengthen the ties between various actors. In this sense, social enterprise as a collaborative partner is able may add considerable value to networks (Park & Wilding, 2014). Interview data suggests that there are key actors within energy focused social enterprises across the Liverpool City Region, and also efforts underway to build and enhance this network's capacity.

"We have worked with the Liverpool City Region Local Enterprise Partnership, specifically on their strategies and their economic development program and trying to make the social economy more of a strand in what they're doing." (Key Informant 3)

"The work we do with existing organisations, it's primarily around networking, so every couple of months we hold a social value networking event for all of our membership who can turn up ….and you know, bring your business card to make contact with each other." (Key Informant 3)

According to Park and Wilding (2014), social enterprise has the potential to link together a wide range of actors.

Innovation for regime transformation & Future outlook

While the energy sector is currently a difficult environment for social enterprises to attain financial sustainability, interviewed organisations were optimistic that this would still be a possibility in the future. Interviewees were also generally optimistic about the role of social enterprise in transforming the energy system to a low carbon model.

"We've identified the low carbon economy as a key sector of activity. So that means that we believe there are jobs and growth to come from green businesses and adapting the energy infrastructure of the region" (Key Informant 4)

"I do believe there will be opportunities going forward for us to trade more…." (Key Informant 2)

However, significant barriers identified included regulatory and policy uncertainty, as discussed and importantly, issues of scale and 'take off'. In transitions terms, 'windows of opportunity' emerge whereby innovations break out of the niche-level when ongoing processes at the levels of regime and landscape align (Geels, 2002). However, such processes do not typically occur unaided, or without policy support or government subsidy. In particular promising niches may require additional support to get to a position to challenge the existing regime. In this context, 'initial hurdle' and 'take off' were terms explicitly used by key informants.

"But they just wanted that little bit of funding to get them over the initial hurdle…. if they're looking to go and speak to someone at the other end of the country they need travel fares or they want to have business office accommodation for a week." (Key Informant 3)

"The costs to entry and the costs to setting up in that sort of structure are very, very low…It could be that were on the verge of a precipice where actually it just needs a little bit more of a push and you do achieve the sort of take-off speed that they need." (Key Informant 3)

This is a critical aspect in terms of the role of social enterprise within transition processes, and one in need of further research. According to Johanisova *et al.* (2013), dimensions of scale, place and the environment should be accorded more importance in the social enterprise discourse, something which the authors here wholeheartedly agree with. From a scale point of view, there was recognition that social enterprises were very much operating in a niche environment, and that considerable challenges existed in bridging the gap to the mainstream regime.

"You have maybe three or four people in an office in a provincial city in the north of England working to promote the green economy. Whereas there maybe 300,000 to 400,000 people across the country who are working for a big multinational energy corporations that don't have this on their radar." (Key Informant 3)

However, certain advantages of operating in niche, small scale were also recognised. Sekerka & Stimel (2011) argue that 'first-mover' firms are likely to reap advantages in the areas of innovation and culture change, which will help to ensure their future viability. Smaller firms are also better able to respond to changing circumstances and opportunities, as well as being able to take more risks.

"So they can take more risks and if they're smaller they can be more flexible and more nimble and they and just say things that bigger businesses can't say, they can put messages out and do things that maybe big businesses or other businesses can't quite do." (Key Informant 1)

For social enterprises in particular, the ability to operate without the same degree of commercial pressures as private organisations was recognised as an advantage.

"But if its community we don't need to make money, we just need to pay back the money that was invested. We don't need to be making 10% off the top so the figures would surely stack up for us on that basis." (Key Informant 1)

However, a lack of certainty clearly represents a major barrier to the innovative and competitive potential of social enterprises.

"It's still a bit murky at the moment to know where the value is going to be." (Key Informant 4)

Conclusions

The autonomous nature of the social-economic model applied by social enterprises can represent a viable means to target social, environmental and economic multiple-bottom lines. Such organisations can develop strong links to their local communities and provide positive externalities in generating financial revenue, while also remaining fully cognisant of, and structured towards social outcomes. There are clear potentials for social enterprise models to be more extensively applied to address contemporary ecological challenges of neo-liberal market economies, moving towards 'win-win-win' outcomes across social, economic and ecological domains; particularly as these organisations are not motivated by a relentless profit imperative. From a transitions perspective, this study has demonstrated that a number of barriers exist which in the medium-long term may limit the potential of social enterprises to deliver regime transformation, or to act as 'transitions engines'. Chief amongst these is a lack of clarity or certainty on the policy and regulatory landscape in which they operate. This is true in particular of the energy and environmental policy landscape, more-so than the regulatory landscape for social enterprises. Ad hoc and reactionary policy change in the UK has acted as a major challenge to energy focused social enterprises. It is clear that social enterprises are already playing an important role in the energy sector. However, there is considerable scope for this role to be scaled up, potentially with minimal grant or subsidy support. However, support for the 'take-off' stage was identified as being particularly important. What is also clear is that the social enterprise model could in fact deliver a regime transformation, the evidence suggests that this represents a realistic goal only in tandem with transformative innovation across the regime, including for example, associated changes in practices of consumer behaviour and expectation, and in wider consumer value considerations.

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Towards the ethical city: low carbon transitions in urban spaces

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Abstract

The 'urban transition' is above all a political if socio-cultural project, rather than purely a technological one. It involves imbricated bundles of social and technical processes, material and network; organisation and innovation. Growing interest in theories of transitions, empirical case studies of cities, and the larger project of 'looking beyond' targets and rational choice based market models in studies of decarbonisation all inform the scholarship of urban sustainability transitions. Innovation studies and emergent theories such as the Multi-level Perspective contribute to ideas of systemic change to low carbon, driven purposively by levers of policy, including by the creation of protected niches and spaces. In this paper, we argue that two relatively neglected aspects of low carbon urban transitions are spatial dimensions and distributional dimensions. Where and how do the spaces of the transition across the city matter, and how does space manifest in low carbon urban transitions? Who are the beneficiaries and what would constitute an ethical low carbon urban transition? To address these questions, the concept of ethical cities is introduced and defined in the context of low carbon urban transitions. While recognising that each city is unique and faces therefore a unique range of challenges and a unique set of possible transition 'pathways', cities also share common attributes that present both obduracy and dynamism. A series of city case study vignettes are presented to illustrate practical ways in which cities can consider environmental, social and governance dimensions of transitions in deliberative ways. Conclusions are drawn addressing how current ideas such as the MLP might be further enriched through deliberate attention the urban scale and ethical dimensions of transitioning.

Social inclusion, the natural environment and innovation: Sustainable development challenges in Colombia

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Abstract

From end-of-pipe pollution control to sustainable production-consumption systems, the sustainable development path has been demarcated by technological innovation. Innovation aiming at resource-efficient economic growth has received much attention, following the assumption that technological change is the most suitable (and scientifically informed) pathway to achieve and maintain human progress without compromising the ability of future generations to meet their own needs. However, in a globalised world characterised by high power imbalances, technological innovation deepens inequalities (Cozzens, 2007). Understanding this process requires more careful attention to social and political processes that take place beyond the laboratory and the firm (Bortagaray and Ordoñez-Matamoros, 2012; Khavul and Bruton, 2012). The multi-level perspective (MLP) is a framework broadly used to understand socio-technical change. Its application has spread widely especially in the sustainability transitions research field in the developed world (Markard et al, 2012). Such success has motivated MLP's application in other contexts, such as Sub-Saharan Africa and Asia (Berkhout et al 2009 and 2010; Romijn et al, 2010), raising several questions about socio-technical transformations in the developing world, e.g. which transformations?, for whom? and by whom? (Scoones et al, 2015). This paper aims to explore what innovation and socio-technical change for sustainability implies in the developing world. Specifically, we explore the question In which ways social inclusion, the natural environment and innovation are interrelated in developing a sustainable water sector in rural Colombia? In order to answer this question we analyse two programmes that the Colombian Administrative Department of Science, Technology and Innovation (Colciencias) run in 2012 and 2013, Ideas for Change and On Right Science, respectively, as instruments of the national strategy for social appropriation of science, technology and innovation. Both programmes aimed at improving the well-being of communities that had water-related problems by developing and using technological innovations. Our analysis is based on secondary data, namely policy documents and programme evaluation reports. Additionally, we conducted five interviews with policy makers and researchers involved with both programmes, in order to clarify and complement our findings from the analysis. We will argue that in poverty contexts, where human needs are not fully satisfied and social exclusion patterns reproduce systematically, technological innovations may contribute to solving the problem in a sustainable way if (and only if) social development aspects are taken into account. These aspects include visions and expectations about the future, community values, technical and political capacities, access to resources, among others. Our findings suggest that researchers interested in understanding socio-technical change for sustainability in the developing world need to enrich today's most popular frameworks in ways that make them more sensitive to social and political complexities. Questions and frameworks discussed by development scholars and social innovation researchers may inform this journey.

Keywords: innovation; social inclusion; sustainability; Colombia

Innovation for Green Industrialisation: Case Studies from Ethiopia's Manufacturing Sector

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Abstract

Based on historical trajectories of developed countries, industrialisation is often regarded as a key mechanism for low-income countries to develop and grow their economies, raise material living standards, and generate low-skilled mass employment beyond agriculture. However, industrialisation has also tended to result in environmental degradation, with associated detrimental impacts on the health and well-being of (usually poor) people. At the same time, increasing resource scarcity and global climate change are placing new constraints on traditional modes of industrialisation. Consequently, there is a need for more environmentally sustainable, or 'greener' forms of industrialisation. Innovation systems, and in particular sustainability-oriented innovations, are increasingly seen as crucial for realising the potential for greener industrialisation. However, evidence regarding green industrialisation and supporting innovation systems in a low-income country context is scarce. This paper addresses this knowledge gap by investigating the character and drivers of the emerging national innovation system in Ethiopia and analysing the extent to which it is in line with nurturing and sustaining green industrial development. The analysis is based on data collected from a survey of firms operating in three key manufacturing sub-sectors, namely, textiles, leather and cement. The paper identifies the actors involved in the national and sectoral innovation systems and maps their interrelationships. It also assesses the factors that are encouraging and inhibiting innovation at a firm level. The paper concludes with recommendations for policies that can foster innovation for green industrialisation. These include institutional mechanisms to strengthen national and sectoral innovation systems, as well as environmental regulations and economic incentives to foster firm-level green innovations.

Keywords: innovation system; green economy; industrial transformation; sustainability-oriented innovations; Ethiopia

Inclusive innovation and multi-regime dynamics: The case of mobile money in Kenya

Elsie Onsongo and Johan Schot

Abstract

Innovation—which has become an avenue for realising broad social goals—is at the core of transitions to sustainable development thinking, in particular the multilevel perspective (MLP) theory and the technological innovation systems approach. These theories have significant strengths in capturing a range of processes and actors that reproduce and change socio-technical systems. However, they present a poor conceptualisation of processes of inclusion and exclusion. This type of conceptualisation has been developed in the inclusive innovation literature, particularly the 'ladder of inclusive innovation'. We explore in this paper whether transition studies thinking and inclusive innovation models could profit from each other. Specifically, we explore the mutual benefits of MLP and the ladder of inclusive innovation through an in-depth case-study of M-Pesa, a mobile payments innovation in Kenya which has become an exemplar of inclusive innovation, and at the same time, represents a fast transition to a new financial services system. M-Pesa has been adopted pervasively not only among the unbanked segment of the population—the original target market segment, but also among middle- and high-income segment, with the current subscriber base standing at 73% of the adult population. M-Pesa was central to the transformation of the financial services system into one that integrates formal financial services, informal financial practices and mobile money. In the paper, we first outline contours of both frameworks, then apply them separately to analyse a rich case study dataset spanning from the early 1990s to 2015 collected from archival sources, observation, in-depth individual and focus-group interviews and household survey data. From these analyses, we elicit and compare the strengths of each framework with the view of cross-fertilising them. For instance, we find that used as an ex-post evaluation tool, the ladder enables us to explore whether and what type of inclusiveness manifests from a transition, such as whether emerging interactions between informal financial groups, commercial banks and M-Pesa fostered the sustained inclusion of the unbanked in the system or resulted in transitory or illusive inclusion. By analysing the M-Pesa case from the multi-level perspective, we discover new insights not elicited by the ladder. For instance, at the niche level, while the ladder helps to identify the excluded and their needs, the fitness of M-Pesa as the innovative solution to these needs, and the impact of M-Pesa, the MLP enables a broader discussion of the involvement of a diverse network of actors in the development of the platform (Vodafone UK, Safaricom Ltd, Central Bank of Kenya, Faulu Kenya, Sagentia Ltd), their shared vision and expectations of financial inclusion, the rules guiding their action and learning processes. The MLP also enables us to operationalize 'structure' and dynamics of change more comprehensively. Following the case study analyses, we find that these literatures have complementary merits. The MLP provides the vocabulary for explaining and understanding processes of change envisioned (but weakly defined) in the inclusive innovation literature, while perspectives from the inclusive innovation literature can facilitate the MLP's evaluation of the nature of the inclusiveness of unfolding transition dynamics.

Keywords: Inclusive innovation, multilevel perspective, multi-regime dynamics, mobile money, formal informal

Towards a better understanding of the concept of eco-innovation

Christoph Kiefer, Javier Carrillo Hermosilla, and Pablo Del Río González

Abstract

Eco-innovations reduce or neutralise negative impacts of economic activity or even generate positive impacts on the ecological environment. Therefore, they are not only desirable but fundamentally necessary for the transition towards more sustainable production and consumption patterns. Numerous studies on eco-innovations have been realised. Mostly with the help of qualitative studies, the phenomenon of eco-innovation has been described. Yet, knowledge generated by quantitative studies is still scare. Despite high academic interest in eco-innovations, a clearly defined common understanding of the concept of eco-innovations is missing due to a lack of empirical fundaments. Existing research is still fragmented, difficult to compare or aggregate and vastly very specialised in certain aspects. The aim of this study is to empirically investigate which aspects constitute a relevant contribution to the common understanding of the phenomenon of eco-innovation. The study is based on a four-dimension framework created by Carrillo-Hermosilla et al. (2010), including a design, user, product-service and governance dimension. An extensive literature review was conducted in order to aggregate the existing understanding in literature and academics about the dimensions of eco-innovation. Prior studies were examined for relevant aspects composing each dimension respectively. In a second step, those aspects were translated into quantifiable variables. For each variable, a specific question was designed and tested with a set of a dozen experts from academia and business. The study was targeted at Spanish industrial small and medium sized firms. 2821 firms were identified in the Iberian Balance Sheet Analysis System (SABI). 638 answers were recollected. For the analyses, only data from firms that developed or adopted an eco-innovation in the observation period was used. The analyses were thus realised on 197 “eco-innovative” firms. Principal Component and Cluster Analyses were conducted in order to reveal “underlying structures” in each dimension: The design dimension is composed of 5 components that refer to impacts on the input composition of the product, service or mixture of both, impact on the firm’s processes, impact on (direct) savings, various types of emissions and toxicity. The user dimension clearly distinguishes between internal and external users and intermediaries. The higher the implication of a user group in the eco-innovation process is, the more firms tend to anticipate that users' acceptance. The product-service dimension is composed of 4 components that are fundamental changes targeted toward new markets and new clients, the functioning of the value creation process, incremental advances in products or services for existing customers and completely new products or services. The governance dimension integrates impacts on productive processes as well as administrative processes and the organizational structure. The results of this study may help to generate an empirically based understanding of the concept of eco-innovation thus advancing in the aforementioned common understanding. As a consequence, future research may be more comparable and compatible. Practitioners may also benefit from a more clearly defined eco-innovation concept that can help them understand, and in a second step to pursue such innovations in their firms or governmental agencies.

Rethinking Strategic Sustainability Planning for the Electricity Sector in South Africa

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Abstract

South Africa's electricity sector is characterised by the unique social, political, and economic legacy of apartheid, which still impacts decision making and contemporary politics of low-carbon energy transitions profoundly. A series of processes is now converging to force the issue of sustainability to drive South Africa's low-carbon energy transitions, which provide both a description of a process of transformation from one energy system to another and a set of tools and concepts to explain and enable such transitions. Specifically, national electricity plans are policy approaches providing opportunities for integrated goal-oriented low-carbon energy transition management. Currently there is a pressing need to understand the potential nature of South Africa's emergent transitions, as it is a rapidly industrialised country whose economy is among the most energy intensive in the world. This raises the question of how a 'sustainability transitions' framework can be conceptualised to address the challenge of low-carbon electricity transitions in South Africa. This paper, therefore, critically reviews the strategic electricity planning process in South Africa, framed within an established sustainability transitions theoretical framework. From the literature, it was observed that the challenges facing South Africa's strategic electricity planning resulted from slow economic growth, with concomitant limited investments in infrastructure and demand for services; ambitious long-term national development planning aspirations, including related politics; differing views owing to different stakeholder preferences on electricity planning; and a lack of, or misalignment between, development policies and objectives. All these theoretical and practical gaps reveal that South Africa must rethink its current strategic electricity planning practice. A conceptual complexity-planning framework is proposed to ensure alignment of different, competing, and complex sustainability policy objectives within the electricity planning process. The conceptual planning framework process proposed emphasises the requirement to consider South Africa's political economy and its impact on the country's electricity planning process in terms of its governance and associated decision-making processes.

Keywords: Strategic electricity planning, Integrated Resource Plan, Complexity, Sustainability transition management, South Africa

Introduction

Strategic planning is an organised process of foresight, with set procedures to maximise and formulate the potential success of any plan (Flaherty, 2014; Bouhali et al., 2015). There are numerous approaches to strategic planning, with a common theme being responsiveness and effectiveness of each plan to the user or recipient, while keeping a clear vision of each institution and commitment to the overall mission (Hudson et al., 1979; Flaherty, 2014). Although strategic planning is associated with problem solving, its distinctive characteristic relates to clusters of interrelated decisions. The problem it addresses is coordination (Faludi, 1973; Faludi, 2013).

The general theory of strategic planning has three pillars: goal formulation, problem definition, and the associated social context (Rittel and Webber, 1973). In defining dilemmas faced by this theory, Rittel and Webber (1973) highlight that strategic planning challenges are inherently 'wicked', especially those of policy planning, as they are ill defined and rely on elusive political judgement for resolution.

These problems are defined as complex situations that cannot be definitely described as true or false, good or bad; often the advocated solutions cannot be tested, and most importantly, there are no enumerable options for solutions to these complex challenges (Hudson et al., 1979; Cilliers, 2000; Rotmans and Loorbach, 2009).

In response to wicked problems defining the strategic planning theory, 'clumsy solutions' have been advocated, as they advise on not-so-perfect solutions to uncertain, complex, and normative problems and rather search for viable solutions that are less perfect but responsive to different rationalities (Rittel and Webber, 1973; Hartmann, 2012). Strategic planning theorists constantly discuss different approaches to coping with wicked problems, and recent discussions have identified uncertainty, complexity, and normativity as inherent to strategic planning processes (Friedmann and Hudson, 1974; Hartmann, 2012).

The synoptic approach has dominated planning practice, especially development planning programmes (Forester, 2004). Synoptic planning has four classical elements: goal setting, identification of policy alternatives, evaluation of means against ends, and implementation of decisions (Hudson et al., 1979). Other schools of strategic planning or theories that depart from the limits of the synoptic approach include incremental, transactive, advocacy, and radical planning and other varying forms of contemporary planning traditions (Friedmann and Hudson, 1974; Hartmann, 2012).

Energy planning in the school of synoptic planning takes into account political aspects, and social and environmental considerations, and is influenced by historical data collected from previous energy plans of the country under examination (Hirst et al., 1995; Wang and Min, 1998; Montmasson-Clair and Ryan, 2014). According to the World Energy Council (1992), energy planning is a process of building and verifying strategies in an energy economy, while taking into account the analysis of energy supply and demand as well as the implementation means to ensure coverage of energy needs in a national or international context. It is also widely acknowledged that energy consumption is a reliable indicator of development and quality of life of a country, while satisfying a forecasted energy demand, over a certain time period, is the basis of energy planning (Cormio et al., 2003). It is viewed as a large-scale systems management process based on both 'hard' and 'soft' systemic methodologies, allowing systematic learning and understanding in learning, systematic implementation, and large-scale living systems, referred to as unifying the systems perspectives (Yeo, 1995).

Concepts of energy planning initially emerged in the 1970s during the oil crisis, with the increase in land-use costs and heightened environmental pressures. The power utilities in the United States of America then began to rethink how to minimise power supply cost. Over time, the objective of traditional electricity-planning frameworks has been to provide and secure cheap electricity supply to meet electricity demand (Vollans, 1995; Hu et al., 2010a). Energy-planning approaches are generally classified into three categories: planning by models, by analogy, and by enquiry (Cormio et al., 2003). However, with increasing public awareness of sustainability issues in relation to electricity demand and supply, planning frameworks have evolved. Integrated resource planning (IRP) focuses on the supply side of electricity planning and electricity demand-side management

(DSM) including the associated strategic planning sustainability issues (Hu et al., 2010b; Sampaio et al., 2013).

Despite the great potential provided by the various approaches to deal with complexities and uncertainties of today's strategic planning for delivery of sustainable electricity services, there are still a lack of coordination, misalignment, and minimal integration of the current approaches for the electricity sector, especially with other key strategic national plans and policies aimed at meeting sustainability goals. This requires modification of the existing strategic planning approaches such as the IRP to fit the new power utility business environment (Cormio et al., 2003; Malik and Sumaoy, 2003; D'Sa, 2005).

Against this backdrop, this paper posits a planning approach intervention that can be incorporated in the existing IRP as a way of building capacity for addressing the complexities (both historical and current) and gaps faced by the electricity sector specifically. A proposed framework will focus on the IRP as planning approach.

Integrated resource planning for electricity systems

The IRP is an approach that meets the estimated long-term requirements for electricity services during a specified period with a least-cost combination of supply and end-use efficiency measures, while incorporating equity, environmental protection, reliability, and other country-specific goals (D'Sa, 2005). The IRP has been promoted as a tool for government's macro-strategic planning process aimed at developing energy resource strategies and maximising related national benefits. It provides an integrated plan for the power system (Hu et al., 2010a). Figure 1 (D'Sa, 2005; Dixit et al., 2014) provides an overview of the IRP as electricity sector planning tool.

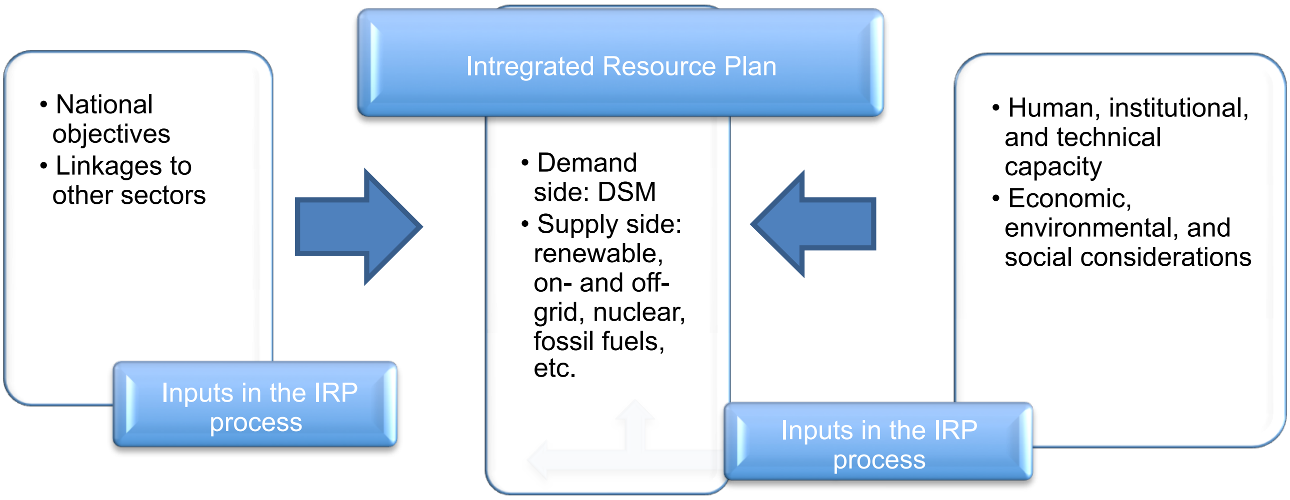

Figure 1. The Integrated Resource Plan: the approach.

The concept of the IRP has been introduced in most developing countries; however only a few utilities in these countries have developed a comprehensive plan based on an IRP (Malik and Sumaoy, 2003). China, Brazil, South Africa, India, and Thailand have each initiated unique approaches to developing the IRP (Dixit et al., 2014; Hu et al., 2010a; Hu et al., 2010b). Coincidentally, in these countries, privatisation and deregulation have influenced IRP development. This has prompted a modification of these IRPs to fit the new power utility business environment driven by various stakeholders with sometimes varying and competing sustainability objectives (Cormio et al., 2003; Malik and Sumaoy, 2003; D'Sa, 2005).

2. Methods

2.1 Scope for the proposed planning framework

Some of the gaps identified and observed in the IRP as a strategic planning approach come from its supply bias, stemming from the belief that augmenting generation capacity is the only effective way of meeting projected electricity demand. Consequently, forecasting tools utilised as part of the IRP process assume future capacity without considering demand reduction through increased efficiency (D'Sa, 2005). The competing roles and objectives of various institutions with a direct impact on the electricity sector result in further misalignment and lack of coordination. In this case, related subjects are treated as different sectors, and the controlling government departments are separate entities with related programmes planned, to whatever extent, independently of one another, for example, water conservation and human settlements. Lately, within the planning process itself, inclusion of external costs for electricity generation (externalities) is also becoming prevalent. The IRP is forced to be biased towards the inclusion of quantitative and qualitative costs and benefits caused by air pollution, water quality impacts, water consumption and pricing, greenhouse gas emissions, health costs, and socio-economic benefits of electrification. However, governance structures and processes to ensure the appropriate identification, assessment, and management of some of these externalities are still lacking (Vollans, 1995; Bakken and Lucas, 1996; Spalding-Fecher and Matibe, 2003).

Owing to the role played by electricity utilities specifically in developing countries, preoccupation with other competing complex sustainability policy objectives within the economy is prevalent, especially where restructuring of the electricity system is in progress and changes are expected in the position and jurisdiction of utilities. While the long-term forecasts traditionally used for integrated planning seem impractical, restructuring tends to preoccupy those in authority, to the exclusion of other important stakeholders and longer-term issues (Hu, 2010b; Prasad et al., 2014). Furthermore, limited coordination between energy demand and supply programmes contributes to challenges facing the IRP implementation process (Dixit et al., 2014; Montmasson-Clair and Ryan, 2014). Prevalent financial difficulties engulfing electricity utilities and consumers have resulted in troubled and debt-ridden electricity utilities, which have resorted to stopgap measures rather than long-term planning (Davidson and Mwakasonda, 2004; Rudd et al., 2008).

As indicated above, conventionally, the IRP as a strategic planning approach for delivery of electricity services poses complexities regarding practical development of the IRP(s). The above-mentioned challenges and gaps in the IRP as approach, thus, shape the scope of the proposed framework. The next section explores complexity and governance, with the aim of providing context for the proposed framework in this paper.

Theoretical framework: Complexity and governance

According to Loorbach (2010), an emerging paradigm for analysis of persistent problems is complex systems theory. This theory[9] originates in systems theory[10]. While a single complex systems theory does not exist, it has implications for the way in which structures of each wicked problem are conceived and managed (Cilliers, 2000; Rotmans and Loorbach, 2009). Complexity theory is still only a unifying principle and not a unifying theory that can help to understand and support transitions to sustainability. It serves as a theoretical framework for integrating various sustainability-based theories with various modelling methodologies for assessments to address diverse and complex challenges, while further matching the adaptive management requirements (pluri-focal, multiscale, multi-level, and adaptive) for transitions to sustainability (Rotmans and Loorbach, 2009; Loorbach, 2010; Peter and Swilling, 2014).

The persistent problems in complex systems theory are the superlative form of wicked problems, related to system failures,[11] and are characterised as complex, as they are embedded in societal structures, and uncertain, owing to their hardly reducible structural uncertainty. Peter and Swilling (2014) define the role of complexity theory as an overarching way of thinking, while understanding

[9] Complexity theory is the theory of multi-agent systems. Agency is attributed to all systems, sub-systems, and sub-system components and not just actors within a system (Peter and Swilling, 2014).

[10] Systems theory refers to a universal language to address complex patterns of interaction between different components in complex adaptive systems and offers a conceptual lens to analyse and understand societal and governance complexity (Cilliers, 2000).

[11] Technology bias, institutional barriers, path dependencies, competing views, etc. (Rotmans and Loorbach, 2009).

and acting on persistent problems, especially relating to the process of transitions to sustainability. Additionally, persistent problems tend to be difficult to manage (owing to a variety of actors/stakeholders with diverse interests and objectives), hard to grasp (as they are difficult to interpret), and highly ill-structured (Rittel and Webber, 1973; Rotmans and Loorbach, 2009; Loorbach, 2010).

According to Loorbach (2010) and Peter and Swilling (2014), certain complex systems may display certain qualitative characteristics more prominently than others. Complex systems have a large number of simple elements that interact dynamically, resulting in very non-linear interactions. The interactions, defined as direct and indirect feedback loops, are rich and have the ability to harness volatility and uncertainty for gain and not merely to withstand it. Elements within each complex system have a creative capacity for innovation, and their effect is propagated throughout each system. Elements also have a history and memory, which are of cardinal importance to the behaviour of the system and are distributed throughout it (Cilliers, 2000; Meadows and Wright, 2008). Complex systems themselves are open, as they exchange information with their environment, operate at conditions far from equilibrium, and are very heterogeneous and unpredictable. They also have adaptive characteristics, indicating that they can self-organise or self-disorganise, especially in relation to their internal structure, controls, functions, and processes, without intervention of an external agent. Self-organisation refers to the ability to develop a new system structure as a result of the system's internal constitution rather than external management. This system behaviour is determined by the nature of the interactions, not by what is contained within the elements. "Emergent as a characteristic refers to the rich, dynamic, unpredictability,[12] non-linearity and uncertainty of a complex system" (Peter and Swilling, 2014).

An understanding of these characteristics provides greater insight into such a complex, adaptive societal (CAS) system. In governance processes, stakeholders and their competing varying objectives co-evolve with these broader societal system dynamics (Rotmans and Loorbach, 2009). In terms of policy development (in this case, planning), governance frameworks focus on understanding and facilitating network processes around formulation and implementation of policy-persistent problems in the short and mid-term. In the long term, approaches giving special attention to learning, interaction, integration, and experimentation on the level of society instead of policy alone (i.e., understanding the CAS system dynamics) for persistent problems are required, driven by diversity, uncertainty, societal heterogeneity, and decreased possibilities for inducing long-term change by government (Loorbach, 2010).

In this context, Rotmans and Loorbach (2009), Loorbach (2010), and Peter and Swilling (2014) propose the recognition of certain principles to define a system of governance based on complexity. The principles include flexibility and adjustability at system level, the dynamics of the system to create feasible and non-feasible means, and insights into how the system works as an essential precondition for effective management. Additionally, long-term thinking should shape short-term policy in the context of persistent societal problems, while timing issues of each intervention should be crucial and strategic. Since managing a CAS system means using disequilibria and equilibria, relatively short periods of non-equilibrium should offer opportunities to direct the CAS system in a desirable direction (towards a new attractor). Creating space for agents to build up alternative regimes is crucial for innovation; thus stakeholders should be provided with a protected environment for innovation to take place. Lastly, a focus on (social) learning about different actor perspectives and a variety of options (requiring a wide playing field) are prerequisites for change. Participation from and interaction between stakeholders form a necessary basis for developing support for policies and for engaging actors in reframing problems and solutions through social learning. These principles provide an analytical lens to assess how various stakeholders can deal with complex societal issues at different levels, but also develop and implement strategies to influence governance processes (Rotmans and Loorbach, 2009; Loorbach, 2010; Peter and Swilling, 2014).

[12] For example, dynamic system modelling techniques are deployed to frame the conceptual model of the system and understand the unpredictable emergent behaviours of the system (Peter and Swilling, 2014).

Taking into consideration complex system characteristics and the principles for governance of a typical CAS system, Rotmans and Loorbach (2009) and Loorbach (2010) propose four governance spheres (Figure 2) as pillars of a transition management framework:

A strategic sphere: aimed at integrating and institutionalising long-term governance activities into the realm of policy making.

A tactical sphere: aimed at identifying interest-driven activities related to the dominant structures (regime) of societal (sub-) systems with the aim to drive integrated long-term governance.

An operational sphere: aimed at encouraging innovation of societal, technological, institutional, and behavioural practices that introduce or operationalise new structures, cultures, routines, or actors.

A reflective sphere: aimed at monitoring, assessing, and evaluating ongoing policies and societal changes (Rotmans and Loorbach, 2009; Loorbach, 2010).

Figure 2. The transition management framework based on governance.

The transition management framework on governance provides a practical approach to managing transitions of typical CAS systems, in this case, planning development approaches. For the IRP, this framework will aim to reshape this process through introducing a novel and practical planning intervention to guide the core IRP process, especially in developing countries currently faced with governance challenges due to different, competing, and complex sustainability policy objectives. This framework will be adapted as the basis for developing a conceptual framework for South Africa's electricity-planning governance process.

Case study: South Africa

South Africa's economy is energy intensive, as the country uses a large amount of energy for every rand of economic output and is among the world's most carbon-intensive economies (Alton et al., 2012). An abundance of coal resources and subsidised coal-fired electricity has led to reliance on energy-intensive mining and heavy industry as historical drivers of economic development (Alton et al., 2012). Over the past two decades, South Africa's economic growth (income) has proved to be the main driver of electricity consumption in South Africa, and vice versa (Eskom, 2011).

It is in this context that, owing to its role in the South African economy, the electricity sector has been tasked with supporting key policy imperatives articulated by South Africa's first extensive National Development Plan 2030. Currently, the National Development Plan 2030 provides strategic context for policies and planning instruments in South Africa (National Planning Commission, 2012). Some of the main strategic plans relevant to the electricity sector are shown in Table 1.

Table 16. Main strategic plans relevant to electricity sector.

Strategic plan	Description
(i) Integrated Resource Plan	30-year long-term plan for the South African electricity sector (Department of Energy, 2011).
(ii) New Growth Path	The bulk of green economy jobs will be in natural resources management in the short term, with renewable energy focus in the medium to long term (Economic Development Department, 2010).
(iii) National Strategy for Sustainable Development	The Integrated Resource Plan is one of the interventions that South Africa needs to implement to meet green economy objectives (Department of Environmental Affairs and Tourism, 2008; Department of Environmental Affairs, 2010).
(iv) National Water Resource Strategy (2nd edition)	Power generation remains a strategically important water use. Energy production capacity is expected to increase, as the Department of Energy is planning significant investment in new power-generation capacity. Current plans include building more water-efficient, dry-cooled, coal-fired power stations. However, these power stations are located in water-scarce areas and will strain available water resources. The return to service of older wet-cooled power stations has further burdened available water resources. The National Development Plan proposes the use of renewable energy sources to mitigate carbon emissions. Renewable energy, such as solar energy, may also need cooling water (Department of Water Affairs, 2013).

Additionally, other electricity-related policies and plans, as outputs of national strategic planning that support the specific policy objectives under the National Development Plan 2030, are presented in Table 2.

Table 17. Policies and plans that support specific policy objectives.

Policies and plans that are outputs of national strategic planning	Reference
White Paper on the Energy Policy of South Africa	Department of Minerals and Energy, 1998
National Climate Change Response (NCCR) White Paper	Department of Environmental Affairs, 2011
Industrial Policy Action Plan (IPAP)	Department of Trade and Industry, 2015
White Paper on the Renewable Energy Policy	Department of Minerals and Energy, 2003b
Energy Efficiency Strategy	Department of Minerals and Energy, 2005
Energy Security Master Plan for Electricity	Department of Minerals and Energy, 2007
Integrated Energy Plan	Department of Minerals and Energy, 2003a; Department of Energy, 2013

The above-mentioned plans and policies are aimed at supporting South Africa's strategic sustainability policy imperatives especially within the electricity sector. It should be noted that they have all been drafted by different national departments and ministries with diverse and varied constituencies and driven by different coalitions of interest groups. This has also directly led to challenges of non-alignment and poor coordination within the South African electricity planning process (Energy Research Centre, 2012; Electricity Governance Initiative of South Africa, 2013).

3.1 South Africa's electricity planning

In terms of long-term planning and related sustainability goals and objectives, the South African electricity sector is guided and driven by the IRP2010, which is a sub-set of the Integrated Energy Plan. South Africa's first National Integrated Resource Plan was completed by the National Energy Regulator of South Africa in 2002. The updated 2nd National Integrated Resource Plan was completed in 2004, and the 3rd National Integrated Resource Plan was completed in 2008. The current Integrated Resource Plan 2010 (IRP2010) was promulgated in May 2011. Previously, Eskom, the state-owned national utility, used to develop Integrated Strategic Electricity Plans providing strategic projections of supply-side electricity options to meet Eskom's long-term electricity load forecasts (Calland and Nakhooda, 2012; Eskom Archives, 2014).

According to the Department of Energy (2011), its long-term electricity-planning goal is to ensure sustainability, while taking into consideration technical, economic, and social constraints and externalities. It is through the IRP that South Africa has strategically planned for electricity, while considering climate change (the national conditional target to curb carbon emissions), water resources, the role of independent power producers, employment, regional development and integration, and security of supply. The IRP2010 sets concrete targets for additional new generation capacity until 2030, including renewable energy. These targets translate into new capacity of 9.6 GW of a nuclear fleet, 6.3 GW of coal, 11.4 GW of renewables (on-shore wind, solar photovoltaic (PV), and solar concentrated solar power (CSP)), and a further 11.0 GW of other generation sources (Electricity Governance Initiative of South Africa, 2013). Table 3 provides an overview of the current and future (as reflected in the IRP2010 for 2030) energy-generation share (Department of Energy, 2011). The flagship programme for implementing renewable energy is the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), tasked with deploying 3 725 MW of renewable energy by 2016 (Department of Energy, 2013).

Table 3. Energy generation share based on the IRP2010.

Energy generation share as per the IRP2010 energy-generation technology	**Current percentage**	**IRP2010 for 2030 percentage**
Coal	90	65
Nuclear	5	20
Hydro	5	5
Gas (combined-cycle gas turbine)	0	1
Peak (open-cycle gas turbine)	< 0.1	< 0.1
Renewables – including CSP, solar PV, and wind	0	9

South Africa's latest promulgated IRP2010 faces critique and gaps regarding outputs and overall methodological and governance approach (Electricity Governance Initiative of South Africa, 2013), including evidence that the current plan results are misaligned with other strategic plans and the specific policy imperatives of low-carbon growth and sustainable development. Institutional and governance arrangements for implementing electricity-related plans and policies are currently dispersed (Msimanga and Sebitosi, 2014). It has also been noted that the role of nuclear in South Africa's energy future is reflected in the plan and not in the country's National Development Plan 2030 due to financial constraints (Department of Energy, 2013; Msimanga and Sebitosi, 2014). On the nuclear fleet, a suggestion has been made that information on costs and capabilities of more flexible smaller modular nuclear reactors, far more suitable for South Africa, given the uncertainty of demand and the large renewable energy resources, could be taken into consideration (Energy Research Centre, 2013). Another gap cited is that a more integrated analysis approach could have been promoted to include interaction between the power and energy/water sectors and the rest of the economy. For example, electricity production is closely tied to the water sector. South Africa is expected to have a deficit of 234 gigalitres by 2025 as projected within national accounts published by Statistics South Africa. There is thus an urgent need for the country's electricity plan and the National Water Resource Strategy to be aligned (Energy Research Centre, 2013; Hedden, 2015; Pouris and Thopil, 2015). Other complex challenges include that environmental and social impact assessments are notably missing and constitute one of the major downfalls of the IRP process. Similarly, the economic and financial impacts of the proposed generation mix could have received more attention, while the contribution of the IRP and energy policy as a whole to the peripheral objectives (social, environmental, and industrial) has been marginal and is expected to remain so until security of supply is achieved (Montmasson-Clair and Ryan, 2014).

Another complexity is the increasing prevalence of renewable energy driven by independent power producers (IPPs) and small-scale embedded generation (SSEG) 'behind meters', resulting in a more decentralised and intermittent electricity supply for South Africa. This will affect various electricity sector actors that the electricity plan process has not considered. Various stakeholders have also cited that the plan pays little attention to grid planning and does not explicitly address the electricity grid in terms of where, geographically, future electricity will come from or who will produce it, including the geographical location of demand (Hedden, 2015). Additionally, the plan does not sufficiently define proposed IPP institutional and governance structures, including related existing barriers for renewable energy deployment in South Africa. It does not particularly deal with implementation mechanisms or rules and regulations (Eberhard and Gratwick, 2011; Montmasson-Clair and Ryan, 2014). The above points highlight current persistent complex challenges and gaps regarding the South African IRP2010.

3.2 South Africa's political economy: minerals-energy complex (MEC)

The origins of South Africa's electricity sector at the beginning of the 20th century were driven primarily by the requirements of the booming mining industry. Its electricity was inextricably bound with its dependence on abundant coal resources and cheap labour for the generation of cheap electricity for minerals-based, export-oriented industry (Bell and Farrell, 1997). This core structural complex economic system, due to the dominance of its socio-political regime, referred to as the minerals-energy complex, contextualises the country's politics of sustainability transitions (Spalding-Fecher, 2002).

The South African electricity sector has been embroiled within core political and economic interests giving rise to a historically specific system of accumulation, which constitutes the essence of the country's MEC. In its earlier stages, South Africa's MEC consisted of the interrelationship between coal, electricity, and gold mining (as core sectors) and later expanded into 'more complex relationships' between mining, electricity, [minerals] beneficiation, and crude oil- and coal-based petrochemicals industries (Baker, 2015; Baker et al., 2014; Baker et al., 2015).

Some literature argues that in no other country does the mining and energy relationship appear to have had as great an influence on the path of development over such a long period in its modern economic history. Additionally, with abundant coal reserves, South Africa has had a distinct comparative advantage in energy supply that has contributed to growth opportunities for the economy as a whole, while state-promoted developments in the MEC manufacturing sectors have also represented important and necessary steps towards full-scale industrialisation for the country (Bell and Farrell, 1997; Spalding-Fecher, 2002).

However, these major distinguishing features have also been widely and convincingly challenged in studies of the South African economy (Fine and Rustomjee, 1996; Eberhard, 2011). It has been argued that the MEC as a system of accumulation has had a determining and retarding effect on South African industrialisation and has led to the historical influence of a small number of large resource-based conglomerates over policy, now internationalised with privileged access to cheap energy, tax breaks, and infrastructure (Baker, 2015). The key sectors are still highly influential over the state and direction of the economy and have been attached institutionally to a highly concentrated structure of corporate capital, state-owned enterprises, and other organisations that have themselves reflected the underlying structure and balance of economic and political power (Baker et al., 2015).

To highlight how the MEC still characterises South Africa's electricity sector and continues to impact the contemporary politics of energy transitions, Baker et al. (2014), in their analysis of the IRP2010, highlight how the role of coal in the electricity plan has contributed to an increase in greenhouse gases (GHGs), owing to new coal introduced in absolute terms, and has further increased electricity prices for the country to cover the true costs of generation. The role of new IPPs and extent to which they can compete for resources and have access to the grid, especially while there are other players with entrenched vested interests, remain doubtful, since some players have more access to, and influence over, government decision makers. The current national industrial demand is still based on fundamentally unaltered energy-intensive end-user practices. Despite changes in the generation mix, the 'uniquely electricity-intensive' nature of South Africa's coal-fired economic growth strategy has not changed. Lastly, to highlight the overall complexity of electricity planning, they illustrate that an apparently technical exercise such as electricity modelling can be inherently political, revealing the level of institutional power traditional MEC stakeholders have, expressed as privileged access to decision makers, and the influential role that the regime incumbents continue to play in South African electricity policy making, despite the incremental steps to enter the regime made by emerging renewable energy players and, indeed, the nuclear industry (Baker et al., 2014).

3.3 Sustainability transitions in South Africa

Despite the MEC, the re-emergence of the green economy discourse since the onset of the global economic crisis in 2007/2008, as well as that of sustainability transitions, has gained momentum and generated a major discussion of the next wave of South Africa's development cycle (Swilling et al., 2015). Programmes are converging to force the issue of the sustainability of South Africa's electricity generation path. South Africa is already undergoing a transition from abundant electricity-generation resources to restraint imposed by sustainability constraints, ranging from the Renewable Energy Independent Power Producer Procurement Programme to wind-energy programmes, participation in the United Nations Framework Convention on Climate Change's Clean Development Mechanism under the Kyoto Protocol, the Energy and Environment Partnership, the Industrial Strategy Action Plan II, the Department of Science and Technology Energy Grand Challenge, the South African Energy Research, Development, and Innovation Strategy, the Renewable Energy Market Transformation Project, the assigning of carbon budgets to various energy-intensive sectors, the development of the Carbon Tax Policy process, and the various environmental levies, etc. (Trollip and Marquard, 2011; Baker et al., 2014; Department of Energy, 2016). This transitional shift in policy development and implementation has been termed low-carbon growth or transitioning to a low-carbon economy (Winkler and Marquard, 2009).

The above examples illustrate that unlike the orderly and managed processes for sustainability transitions normally observed in some of the literature the transition in South Africa has begun (Baker et al., 2014). Here, sustainability transitions refer to structural changes required for long-term and complex reconfigurations of technology, policy, infrastructure, scientific knowledge, and social, political, and cultural practices to ensure South Africa's sustainability goals. According to Swilling et al. (2015), sustainability transitions can only be envisaged if the state facilitates a long-term structural transformation process resulting in socio-technical transitions to more sustainable modes of production and consumption, with special reference to decarbonisation, resource efficiency, and ecosystem restoration (Baker et al., 2014; Swilling et al., 2015).

Results and Discussion

Proposed conceptual framework for South African electricity planning

Baker et al. (2015) suggest that national electricity plans potentially afford an opportunity for precisely the sort of integrated transition goal-oriented management plan that sustainability transitions literature would encourage (Baker et al., 2015). According to the Department of Energy (2011), South Africa's governance process for developing the IRP has three major stages: (i) agreement on input parameters; (ii) modelling scenarios and analysis; and (iii) development of the Integrated Resource Plan, based on the outcome of the analysis.

In terms of stakeholder engagement and consultation, a two-phased approach is followed; it includes the consultation on input parameters for the IRP modelling scenarios and analysis and the consultation on the favoured balanced scenario that becomes the draft IRP. Despite these consultations as part of its governance process, the South African IRP as a strategic planning approach still faces persistent and complex challenges.

The proposed conceptual framework (see Figure 3) is embedded in the existing key IRP process. It provides a governance-based approach to the existing South African strategic electricity planning process, taking into consideration South Africa's MEC challenges, and it is aimed to focus on learning, interaction, integration, and experimentation on the level of society instead of policy alone. Independent facilitation of this framework will contribute to the success of the overall strategic IRP process.

Phase 1: Sustainability vision for South African electricity planning: This level contributes to, and forms part of, Step 1 of the IRP process. The South African sustainability vision will have to be defined as it relates to electricity planning in terms of the country's long-term National Development Plan and national strategic plans and policies (Tables 1 and 2). This level will also focus on the key electricity sector stakeholders with different backgrounds, within which various perceptions of long-term planning and possible directions for sustainability transitions can be deliberately confronted with one another and subsequently integrated. Stakeholders will have different perceptions of South Africa's sustainability transitions from their specific backgrounds and perspectives (e.g., national government, business interests, Eskom/national utility, civil society). They should participate on a personal basis and not as representatives of their institutions or based on their organisational backgrounds (government, business, science, civil society). Loorbach (2010) proposes that stakeholders should be able to consider complex problems at a high level of abstraction, to look beyond the limits of their own discipline and background, to enjoy a certain level of authority within various networks, and to establish and explain visions of sustainability within their own networks, as well as have willingness to work in teams where there may be different views and openness to innovation instead of already having specific solutions in mind.

During this process, the key stakeholders would also be brought together to review the current complex persistent problems raised against the IRP process and to define a sustainability vision to guide South Africa's electricity-planning process. The aim of defining a sustainability vision would allow them to define short- and long-term objectives, action points, related projects, and instruments to realise these objectives. This level can be utilised to contribute and shape the IRP review process and its previous results.

Phase 2: Definition of transition paths and scenarios for South African electricity planning: This level contributes to, and forms part of, Step 2 of the IRP process, focused on data collection and updates of input parameters. As part of the latter, consideration of current barriers (regulatory, institutional, economic, consumer routines, electricity supply and demand issues, physical infrastructures, cost of specific technologies, and externalities) to planning will be prioritised. This level can be utilised to inform related scenarios for further exploration through developing transition scenarios, based on South Africa's sustainability vision. At this level, the stakeholders involved would have the capacity to 'translate' the defined sustainability transition electricity-planning vision and its consequences to the transition agenda of their own constituencies.

Phase 3: Innovative experiments to inform integrated resource planning scenarios and analysis: This level contributes to, and forms part of, Step 3 of the IRP process. Here various strategic initiatives, projects, and actions are carried out to broaden and scale up existing and planned initiatives and actions, with the aim of practically contributing to setting feasible scenarios and elaborating required IRP analysis. The focus should be on the scenarios in the context of defined sustainability transition visions to ensure a clear portfolio of related transition experiments that complement and strengthen one another, make a contribution to the sustainability transition objective, can be scaled up, and are significant and measurable.

Phase 4: Review of scenarios and analysis resulting in an integrated resource plan for South Africa: This level contributes to, and forms part of, Step 4 of the IRP process. At this level, the focus is on reflecting collectively on the IRP process, considering all previously mentioned challenges, including the latest solutions provided for improved planning in South Africa, thus outlining continued steps of the IRP process, rate of progress, and barriers to be removed, including future approaches. Results contribute directly to the reviewed IRP modelling and analysis, thus providing a consolidated process view, with clear direction on monitoring and review.

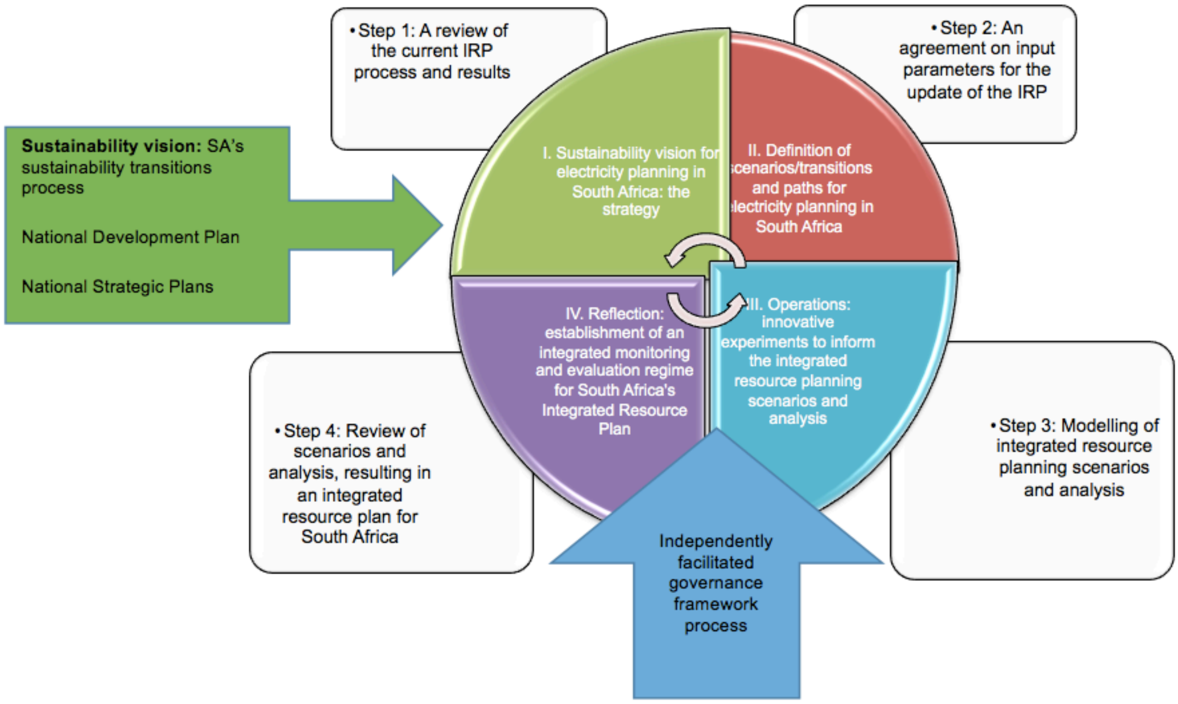

Figure 3. Electricity planning in South Africa: the sustainability transition governance framework.

Conclusion

In this paper, we have proposed a sustainability transition management framework for South African electricity planning. The proposed conceptual framework is embedded in the existing key IRP process.

Theoretical gaps in the current integrated electricity planning process have illustrated the need to rethink the current strategic electricity planning approach theory and practice, with South Africa's IRP as case study. A combination of the planning and complexity theory and practice approaches has been reviewed, together with a transition management framework, as basis for managing the transitioning of current persistent societal governance problems facing the IRP, grounded in South Africa's MEC system. This transition framework defines South Africa's IRP as a CAS and proposes a complexity-based governance process approach to ensure alignment of different, competing, complex sustainability policy objectives within the electricity planning process.

Finally, this framework attempts to manage diverse and varied constituencies, including their associated coalition interest groups, which have led to complex and persistent problems of non-alignment and poor coordination in South Africa.

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Energy Product Service Systems as core element of energy transition in the household sector: The Greenplay project

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Abstract

This paper focuses on Business Model innovation practices within the specific field of energy transition in the household sector. In recent years the value chain between the stakeholders involved in this field has been modified due to recent technological changes, which poses a threat for current companies and an opportunity for insiders. This research work is been carried out within the Greenplay project, which is an EU funded Horizon H2020 project. This project aims to develop new business models that reduce energy consumption in the household sector and can be successfully implemented. In this paper, we present a framework based on intersection of two group of categories. The first one is issued from energy transition presented by consumer behaviour, energy efficiency and renewable energy and the second is abstracted from Product-Service System (PSS). The methodology is based on defining the characteristics of a Product Service System in general followed by Smart PSS (integrated smart product and e-service) qualities and the current ESCo (Energy Service Company) business model characteristics. Finally based on aforementioned analysis on energy transition and Product-Service System, we discuss a set of Servicizing energy business models for energy transition in household sector. The main objective is to shed light on the ability of designing new business models (BMs), in household sector, as a result of integrating PSS with the emerging trends for sustainable energy. In this study, a systematic literature review is conducted related to energy business models. Furthermore, the proposed framework is a crossing classification based on criteria concerning PSS and various energy production and consumption BM. Finally the characteristics of an innovative business model for energy transition in household sector can be transposed to other sectors, mainly those who deal with Product Service System. In the second phase of the Greenplay project the authors will apply the proposed framework to the use cases identified in the project: households that are able to fine-tune their energy use thanks to smart meters that provide free access to data in real-time. The goal is to get feedback from researchers that have already implement innovative Business Models in this or other sector, as well as to discuss with researchers and practitioners that have analysed firms that have successfully innovated their business models. This feedback will allow us to adjust the framework before the experiment with the companies of the Greenplay project.

Keywords: Product-Service System, Energy, Business models, Households, Energy transition

Introduction

In the midst of the critical changes such as climate change, unstable oil prices, energy security and the rapid changes in energy technologies (Awerbuch, 2006; Kilian, 2006; Manabe and Wetherald, 1980; Popp et al., 2011) a more sustainable use of energy through renewable energy and energy efficiency is expected to play a crucial role. The business model of centralised energy production utility is questionable nowadays. Recently the "utilities spiral death" (Costello and Hemphill, 2014; Felder and Athawale, 2014) which is the reduction of utility revenues due to the decreasing of consumer numbers, was addressed since the market share of utilities has shrunk, while new insiders have appeared in the energy market mainly due to the rise of the distributed generation (DG) (Costello and Hemphill, 2014; Felder and Athawale, 2014). Recent studies indicate that electric utilities in the U.S consider that issues like energy storage, energy efficiency, utility-side renewable, response demand and distributed solar installations are key elements to be considered by utilities in order to keep the current electricity market share (Norbert, 2015; Utility Dive, 2015). In this context, the role of the consumers might be a key element for the future electricity system transition as the participation of the customer in the production (Engelken et al., 2016), the load management (Laicane et al., 2015) and energy efficiency (Caird et al., 2008) is increasing each year (Morris and Pehnt, 2012; Utility DIVE, n.d.).

New value propositions for the energy sector might be based on providing new services in this context. Indeed, Product Service Systems (PSS) have been discussed as sustainable alternatives of selling a product as it offers the possibility of decoupling consumption from the used product (Heiskanen and Jalas, 2003). Servicizing, which is about selling functionality instead of product, starts to emerge in the markets (Plepys et al., 2015) despite that, little academic work has handled the servicizing process of utilities business model (Hannon et al., 2013; Helms, 2016). Furthermore, integrating product and service, in order to create and deliver new value, usually causes less environmental impact (Baines et al., 2007).Providing energy as a service towards sustainability has been addressed in industrial, commercial and public sector as the “economies of scale” is more prominent (Irrek et al., 2013). Yet, few academic works have investigated energy services in the household sector.

The objectives of this paper is an attempt to link product-service system with energy consumption in household sector by identifying the potential business models (BMs) that could be used to reduce household consumption. The paper is structured as follows. Section 2 reviews the main characteristics of the new transformation in the energy sector. Besides, this section introduces the PSS concept. Section 3 introduces a framework based on a PSS classification and three energy transition criteria: consumer’s behaviour, efficiency and renewable energy. This framework is used to classify the review of the literature about the energy transition. Section 4 introduces the case study of the Greenplay European project and poses the scope and the research questions of the PhD work of the main author. Finally section 5 draws the conclusions.

Methods:

Our approach to define new business models in the given context is summarized as follows:

Determine the emerging business models in three energy transition areas which are inspired by French initiative for energy transition Négawatt (“The négaWatt energy scenario,” n.d.).

Presenting Product-Service System and defining its three categories.

Allocating and mapping the different energy business models into two axes’ framework. The first one is the energy transition areas and the second is the PSS categories.

The energy transition and PSS concept:

Characteristics of the energy transition:

The traditional electricity value chains are represented by production, distribution, and consumption subdivisions. This paper analyses the different perspectives of Servicizing energy’s BM along this value chain in the PSS framework by analysing the articles that tackled energy business models.

Recently, the rapid changes in technologies related to energy efficiency, energy storage and renewable technologies have tackled the “business as usual” practice of traditional electricity utilities (Norbert, 2015). With the new paradigm proposed by the “Smart Grid”, the producer of renewable energy has become the consumer itself, or a supplier for local consumers. The active role of the consumer makes the energy issue become more dynamic, evolving from a one direction flow to a two directions flow between utilities and consumers. For utilities, mitigating the risk behind energy demand reduction requires changing its traditional BM (Utility Dive, 2015). For the new entrants, servicizing may hold the market opportunity that enables them to put a feet in the market.

Different approaches are emerging that facilitate energy transition. Top down forces like regulations have put pressure on the utilities and have facilitated the emergence of Energy Service Companies ESCos (Hannon et al., 2015). In other cases, utilities have found a new market opportunity. This is the case for example of the two major energy utilities in Hawaii who were driven to innovate and overcome landlord and tenant split incentive to implement energy efficiency and renewable programs for households (Johnson et al., 2012). Bottom up approaches have also been considered as a key actors in the energy transition; as an example the number of energy cooperatives in Germany have raised from 136 utilities in 2008 to 888 in 2013 (Morris and Pehnt, 2012). Since the industrial revolution, five transformational technologies have deeply reformed the energy sector: water-powered machine, steam power, electrification, combustion engine and computerization (Hargroves and Smith, 2005). The new energy transition is considered by some authors as the sixth innovation wave platform (Nair and Paulose, 2014).

Some academic papers have discussed that servicizing energy BM towards cleaner and more efficient usage of energy, could structure the new BM for current utilities and new entrants (Hannon et al., 2013; Helms, 2016; Norbert, 2015; Richter, 2013, 2012; Shomali and Pinkse, 2016). Servicizing energy's BMs has different approaches, (1) it can refer to providing technological devices and associated services for energy efficiency or for micro generation. In this case there is a reduction of energy consumption or the generation of renewable energy. Or (2) can refer to the Demand Side Management (DSM) towards the optimization of the energy use. In this case, beyond the technological aspects, a consumer behaviour modification is explored. The result can be a reduction of the energy consumption or the modification of this consumption: in some cases the consumed energy amount can be constant but the time window of the consuming period may vary.

Product Service Systems

The Product-Service System (PSS) concept emerged in 1999 (Goedkoop, Van Halen, Te Riele, & Rommens, 1999). Mont et al. define PSS as "a system of product, services, supporting networks and infrastructure that is designed to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models" (Mont, 2002).

In general PSS has been classified in three major categories (Tukker and Tischner, 2006a):

Product-oriented: the provider selling the product with additional services.

Use-oriented: the provider keep the ownership of the product and sell the availability or use.

Result-oriented: the provider guarantee specific result to satisfy consumer need.

In general, the PSS goes beyond the physical product and provides a solution to a function or to the final need of the consumer. It combines the physical product with intangible services (Heiskanen and Jalas, 2003). Thus the value behind PSS is providing functionality which allows the provider to have the necessary freedom and a wide spectrum of variation of PSS in a single value that makes the PSS more flexible and capable to tackle the possible changes in the market, consumer's trends and stakeholders' expectations. Flexibility is essential for implementing successful PSS that brings out higher revenue (Rese and Gesing, 2013). PSS can bring together sustainability and competitiveness (Baines et al., 2007; Tukker and Tischner, 2006b). integrating service with product has the potential to decouple the materials from consumption that assigns to the motion from material product to immaterial service which, in its turn, will push companies to reduce cost through increasing energy efficiency and reducing the used material (Heiskanen and Jalas, 2003; Peruzzini and Germani, 2013).

The contextual factors (existing organization, institutions and networks that share practices, rules and interests) that control the value chain hinder obtaining the desired changes, so that a broader system approach is required rather than business-consumer approach (Tukker & Tischner 2006). (Ceschin, 2013) stressed that there is a need for companies to Focus on the contextual conditions that may facilitate or hamper the societal embeding of the PSS. Furthermore, the value in PSS is more related to the components in the context which includes not just the delivered product but also the ad-on service and the associated activities with consumers rather than the components themselves (Wallin et al., 2013).

In general the relationship between the consumer and suppler in the traditional selling process, is terminated after selling the product, while in PSS it is extended with major focus on usage phase to guarantee the desired results. Thus, more trust is required when dealing with PSS, indeed, a clear understanding of consumer expectations, his/her capability to deal with new technologies and division of responsibilities should be addressed (Di Francisco Kurak et al., 2013).

PSS in the energy sector

Criteria for energy PSS classification:

The major reason behind changing the energy production and consumption patterns is the need for more sustainable and cleaner source of energy. Many academic papers have focused on renewables, energy efficiency and distributed energy. In the same line, PSS has been considered a way of delivering value with less environmental impact by decoupling material and energy from consumption.

Conflict of interest between current regulatory policies which push towards reduce end-user consumption and the current BM of utility which profits from the amount of sold energy (Sousa et al., 2013). So that decoupling utility revenue from energy consumption would encourage utilities to participate more in energy efficiency, renewable energy technologies and demand side management. This split of utility revenue from consumption could be done by delivering more services than product.

Energy transition characterised by three aspects: changing the consumer behaviour, integrating new technologies for energy efficiency and developing renewable energies. ("The négaWatt energy scenario," n.d.).

Changing consumers' behaviour can be fostered by two different perspectives. On one hand the reduction of the energy consumption can be stimulated by modifying the way the consumers performs the actions to obtain a function. On the other hand, the consumer might be induced to modify the periods of energy consumption, for example from day time to night period in order to balance the electrical load management.

Changing the rooted patterns of energy consumption can occur through different incentives. It can be voluntary behaviour change through information and knowledge, or could be obtained by changing the contextual factors (e.g. energy prices) (Abrahamse et al., 2005). (Laicane et al., 2015) have showed a significant amount of peak reduction that has been obtained by altering consumers behaviour through useful information and feedback about their consumption obtained by smart meters.

Energy efficiency has contributed effectively to reduce CO_2 emissions by 10.2 billion tonnes of CO_2 since 1990 (International Energy Agency, 2015). It strengthens the energy security and aids in flattening the consumption load curve. It is a way of managing and limiting energy growth consumption (IEA, n.d.). Integrating new technologies for energy efficiency means delivering the same services by less energy or more services by using the same energy. Common examples include replacing incandescent bulb by LEDs that uses less energy and produces the same amount of light.

Finally, renewable energy has been considered a more sustainable source of energy that enables energy security due to its diversity. Its increasing share is expected to change the energy sector structure (Boston Consulting Group, 2010). A new trend for energy utility is expected to be developed which could be decentralized and small-size (Alanne and Saari, 2006). The role of energy utilities and how they could exploit RE technologies is not yet clear (Richter, 2012).

In the next section, new product-service systems in the energy sector will be described and classified following two criteria. On one hand the category of PSS regarding the servicitation level (product-oriented, use-oriented or result-oriented). On the other hand associating the PSS to a consumer behaviour modification, to a technology for energy efficiency or to a renewable energy.

A review of new Product-Service Systems for the energy transition

In this section, we classify the business models that aim to change consumer behaviour, and then we indicate the PSS category in these BMs. Many strategies can lead to change the consumer behaviour: "antecedent strategies" (e.g. commitment, target setting, information), "consequence strategies" (e.g. feedback, incentives and rewards) (Abrahamse et al., 2005). However, we will focus on models that can be included into the PSS framework the results are proposed in the Table 1 hereafter.

Table 1. The intersection between energy transition criteria and PSS categories

Energy transition criteria	PSS Classification		
	Product-oriented	Use-oriented	Result-oriented
Changing consumer Behaviour	(Valencia et al., 2015), (Laicane et al., 2015), (Behrangrad, 2015), (Bell et al., 2011)	(Behrangrad, 2015)	(Knol and De Vries, 2011)
Efficiency	(Bell et al., 2011), (Kobus et al., 2015), (Bertoldi and Rezessy, 2008)	(Sorrell, 2005), (Bertoldi et al., 2006)	(Sorrell, 2005), (Bertoldi et al., 2006), (Apajalahti et al., 2015)
Renewable energy	(Richter, 2012), (Gsodam et al., 2015)	(Richter, 2012), (Gsodam et al., 2015), (Liu et al., 2014)	(Kroposki et al., 2008), (Schoettl and Lehmann-Ortega, 2011)

Previous works (Laicane et al., 2015) indicates that smart meters provide useful information about appliance's consumption in households, and can lead to significant changes in load consumption, thus the load peak could be avoided. In the line with smart meters, the integration of smart product with e-service has been introduced as Smart Product-service System. An example about Smart PSS for energy efficiency is Wattcher (www.wattcher.nl) which is a sensor measures and displays energy consumption and enables consumers, through a web portal, to communicate and compare energy consumption (Valencia et al., 2015). We can describe these business models as Product-oriented PSS as these meters should be supported by other services like data process and supplemental services like comparing consumption with others as mentioned before.

Gamification is powerful way to educate people and influence the energy consumption. EnerCities is serious game that has some preliminary results that led to increase user awareness and more positive attitude towards some every-day energy related behaviours. Gamification for energy transition can be classified as result-oriented PSS as the game is more than the tangible product and the intangible information (Knol and De Vries, 2011).

On-bill financing is an innovative financing method that allows consumers to overcome up-front payment of implementing energy efficiency measures by providing the necessary loan and dividing it to small monthly payments that are cut from the amount of monthly bill savings. On-bill financing can lead to win-win situation and permits the energy companies to diffuse efficiency measures and renewable energy technologies (Johnson et al., 2012). this solution is a financial product served by utility which is coupled with energy efficiency services that lead to energy efficient improvements (Bell et al., 2011). Thus it could be classified as product-oriented PSS. Similarly White Certificate has been considered as a market mechanism for stimulating energy efficiency actions, it confirms that an specific amount of energy savings have been achieved by market actor as a results of energy efficiency improvement measures (Bertoldi and Rezessy, 2008). White certificates are tradable in the market, so that it is considered as a cost recovery mechanism. An positive relationship between providing energy services and white certificate in France has been noticed and tested (Duplessis et al., 2012). Thus White Certificate can be classified: a financial service for the user who can acquire a new energy efficient equipment.

Demand Side Management (DSM) has been introduced as a way of flatten the load curve of consumption, Two main services have become the major elements of the DSM (Behrangrad, 2015) Energy efficiency and Demand response (DS). The former is a model for incentivize customer to change their consumption pattern in order to reduce the electricity consumption. The former is a model for incentivize customer to change their consumption pattern in order to reduce the peak of the consumption in the load curve. “Business model involving load” includes both price incentives and consumption awareness that consumer needs in order to reduce the electricity cost of the load. This BM offers infrastructure to the consumer to receive price information at a suitable time and format. In other words it is about selling infrastructure, visualization devices and software (Behrangrad, 2015). This BM could be product-oriented PSS, when selling the infrastructure with the supporting software services or could be use-oriented PSS when the infrastructure is rented.

Energy Service Company (ESCo) is defined as “*a company that offers energy services which should include implementing energy efficiency projects (and other sustainable energy projects)”* (Bertodli et al., 2014). (Sorrel, 2005) has introduced two concepts “useful energy” and “final energy service” based on the analysis of ESCos activities. The idea behind “Useful energy” is to implement more efficient form of energy generation like Combined Heat and Power (CHP) so that the output is hot water, coolant or heat. The consumer will be charged by the unit of useful energy. That will make lower cost for consumer and enable ESCo from profiting from energy savings. The useful energy is a use-oriented PSS as it is obtained by primary conversion tool (e.g. CHP) (Sorrell, 2005).

Final energy service is about guaranteeing a specific results like room temperature or degree of lighting by conversion, control and distribution of the necessary technologies. That can be categorized as result-oriented PSS as the stream of services (lighting, heating) is obtained by secondary conversion tool (e.g. radiator or fluorescent) and can be consumed directly by the consumer (Sorrell, 2005).

(Bertoldi et al., 2006) presents Mini-ESCos as a business model that can propose energy efficiency measures to households as alternative for ESCo. Mini-ESCo could be the small facilities that used to provide maintenances and breakdown repair for households. Many reasons are behind this proposal, the lack of awareness of ESCo business, the cost comparing with savings (Pätäri et al., 2016). In addition, there is a the lack of trust towards large energy utilities (Holt and Wiser, 2007; Richter, 2012) and scepticism about the real motivation for utility to engage in households energy efficiency (Apajalahti et al., 2015). Households can shift their energy consumption to period when there is abundant of electricity that generated by solar panels by using smart appliances that can schedule their working hours to fit with weather and the sunny days (Kobus et al., 2015). This business model depends on efficient technologies and supporting services such energy management system and energy prices changes and it can be use-oriented PSS or product-oriented depending on the ownership.

Finally, some papers have tackled the energy transition and analyse the business model where the value can be shifted from selling energy as commodity to selling services. (Apajalahti et al., 2015) suggests that “ energy service-based business solution” such as light and heat can be an alternative model that grasps the efficiency benefits.

Among of the three different renewable energy BMs; lowest price, best technology and customer intimacy, the Investors prefer to select “customer intimacy” business model which is a service-dominated and service-centralised BM rather than an upstream production-dominated BM (Loock, 2012). The services attached to customer-side renewables may range from simple consulting services to a full services package including financing, ownership, operation and maintenance of the assets (Gsodam et al., 2015; Richter, 2012). Between purchasing and leasing of solar photovoltaic cell micro-generation, the leasing has become more popular option as the supporting service like regularly scheduled maintenances are often handled by the lessor. In addition, this kind of BM avoiding the up-front cost (Liu et al., 2014). “1st Generation PV business models” are more attractive BMs that overcome the market barriers and reach broader markets. The model is driven by third party rather than utility and own the PV systems, thus it reduces hassle and complexity for the consumer (Kroposki et al., 2008). While the ownership is linked to third party who controls the whole system, This BM is rather results-oriented PSS. Another result-oriented BM “Turnkey project provider” which is a more pure service BM. Consumer doesn’t own the PV and doesn’t want to be bothered by selecting and installing the PV. They just want reliable sources of energy, competitive prices and assurance of rapid-response service and supporting maintenance (Schoettl and Lehmann-Ortega, 2011).

Also utility may move from selling a commodity to providing energy services (Helms, 2016; Richter, 2013) and change their business model (Loock, 2012). Changing utility BM is confronted with many obstacles such as managing intangible assets like services, the lack of demand and willingness to pay for innovative services and the difficulty associated with simultaneously managing utility and service business (Helms, 2016). The “conflicting institutional demands” are sending confusing signals to utilities and consumer similarly (Apajalahti et al., 2015). Moreover, there is the lack of understanding of the importance of changing the business model in order to successfully exploit the new technologies “cognitive barriers to business model innovation”. Also the inability to allocate resources to new technologies or developing new BM for these technologies (Richter, 2013).

Discussion

This research work is developed in the framework of a European Union’s Horizon 2020 project called GreenPlay. This project seeks to reduce by 30% the electricity consumption in the household sector and will be validated through a large scale experiment based on 200 households situated in France and Spain.

The Greenplay system is composed by sensors, a smart monitoring platform and a game. The sensors installed at the user’s home measure global electricity, heating, water heating and temperature. The sensors are linked to GreenPlay system. The core of this system is a pervasive game i.e. eco-gestures in real life and thus electricity consumption reduction allows to earn points and evolve in the game.

The system allows to monitor real behaviour and possible long-term changes in the context of the participation of the customer in the load management (Apajalahti et al., 2015) and energy efficiency (Helms, 2016).

The use of game principles or “gamification” is an efficient tool to deal with behavioural modifications (Nieuwdrop, 2007), (Germaud, 2013).

(ABI AKLE et al., 2016) have identified nine projects working on pervasive and persuasive gaming for energy conservation.

The main research objective of the Greenplay project is to study the potential of combining game elements and instructional advices for modifying energy consumption. The combination of these two elements within a serious games offers some possibilities to encourage the immersion in context, the empowerment and the learning appetence of users.

Through this approach, the system identifies the use of energy and users’ behavior in the private sphere. This information can be used to identify decision variable for product design processes (building, home appliances, etc.), as well as an input for the development of innovative business models that rely the product and services associated to the building ecosystem.

Greenplay is a User-centred project. Consumer is more literate than before and there is emerging tendency to surpass price issue in order to consume green energy. The digital technology offers momentary channels of two side interactions which enable personalize energy experience and determine the specific needs of consumers, and gathering feedback and suggestion from consumers. Furthermore, automation of appliances and integrating energy with different household’s products and services would encourage consumer to engage and go further to become prosumer selling and buying energy.

All the consumer characteristics that mentioned above are confronted with the traditional business model of energy utilities which is still confined to the one way flow of power and information, dependency on economies of scale as cost structure, weak and broken relationship with consumers and reliance on fossil fuel as unlimited and inexpensive source of power.

Between the two ends, consumer expectations and utilities perspectives, the paper puts spotlight on PSS as a new business model that can match the two ends for more sustainable energy value chain. Thus, some supporting emerging concepts based on PSS framework are presented which support this hypothesis.

Channing consumer behaviour can be reached through PSS by offering real time devices (meters, sensors, etc.) coupled with supporting services (communication, sharing, advices etc.) that help consumer to change their aptitudes, become more active and reduce their energy consumption.

In the same line, these infrastructure and services can be used for avoiding the peak load of household electricity, by use-oriented or product-oriented PSS business models depending on the ownership.

This paper could be considered as the cornerstone of the PhD launched within the Greenplay project which aims to define energy business models that respond to the changes in the energy value chain. It poses questions related to the degree of sercivizing, interested stakeholders, user expectations, capability of utilities to take major role, possibility of new players as facilitators. In addition, it tackles the role of incentives factors and barriers such as dynamic prices and hampering factors like regulations and lack of trust of utilities. It addresses the issues related to up-front cost and the role of citizens and cooperatives.

Conclusions

We notice that there are emerging trends to servicizing energy utility's BM and to design BM for new entrants of energy markets. So that, we discussed the ability of PSS to embrace the upcoming changes in the energy system. Furthermore, based on academic review we point out to few BMs that underpin our proposal and map them according to their PSS categories (product-oriented, use-oriented and result-oriented) and their energy transition type (consumer behavior, efficiency and renewable energy). The new technological advancement, the literate consumer and tendency towards green energy, would bring out new form of product and services that need new PSS business model.

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Track 5d. Design for Sustainability

Session 5d-01

Session 5d-05

Session 5d-09

Life cycle assessment of Aveiro municipality (Portugal)

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Abstract

Cities face high environmental pressures mainly derived from growing resource consumption and pollution generation due to the increase of population in cities. In this context, urban metabolism studies have become particularly relevant for the environmental assessment of cities. One of the tools that is starting to be applied to evaluate the environmental performance of cities is life cycle assessment (LCA), which was primarily established for assessing the environmental impacts of products over their life cycle. The objective of this study was to evaluate the environmental impacts of the municipality of Aveiro, through LCA. Aveiro is a medium size municipality located in the central part of Portugal, near the Atlantic coastline. A consumption perspective was adopted and, therefore, the assessment refers to the activities required by the households living in Aveiro. The impacts evaluated were climate change (CC) and fossil fuel depletion (FFD). The input (energy, water, food, construction materials, packaging materials, etc.) and output (wastewater, air emissions, solid wastes) flows to and from the municipality were obtained based on statistical data. Data for the production of the inputs and the treatment of wastewater and solid waste were taken from LCA specific databases. The impacts obtained were 27.3 kg CO_2-eq./cap/day for CC and 7.9 kg oil eq./cap/day for FFD. The food, drinks and tobacco sector had higher impacts for CC (25%), followed by the electricity sector (23%), land transport (20%) and construction materials (7%). The sectors that contribute most to the FFD impact were the same as for CC but with different contributions: 25% for land transport, 25% for electricity sectors, 17% for food, drinks and tobacco and 9% for construction materials. In addition, LCA allowed the identification of the contribution of different products within each sector to the impacts. For both impact categories, the following products, all related with energy, had the largest contributions: electricity, diesel, gasoline, natural gas and jet fuel. Therefore, priority should be given to strategies for reducing the impacts related with these sectors and products in order to move the municipality towards a more sustainable consumption.

Keywords: Aveiro, energy consumption, greenhouse gas emissions, life cycle assessment

Environmental Sustainability and Impacts on Public Health of Bioethanol in Brazil

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Abstract

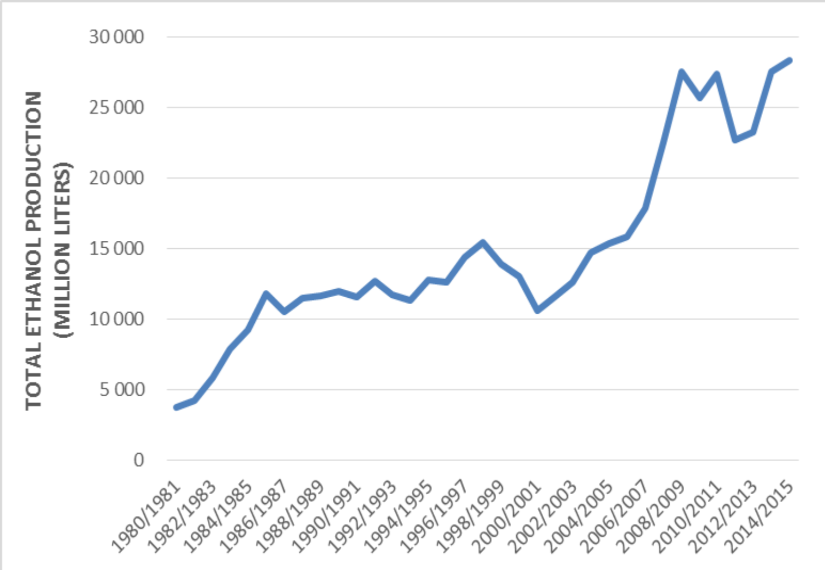
Biofuels have been branded as renewable, sustainable, and clean energy sources in combating fossil fuel uses and climate change; however, the way biofuel is produced influences its sustainability, and a systematic life-cycle perspective is needed. Brazil is the world´s second largest bioethanol producer (25% of the world production) following the United States. Brazilian bioethanol is mainly produced from sugarcane whose production is facing a rapid expansion. This paper aims to assess environmental and health impacts of bioethanol produced and used in Brazil. A "field-to-wheel" Life Cycle Assessment was conducted, addressing sugarcane cultivation, bioethanol production and use. Two types of harvesting operations were investigated and compared: manual harvesting with pre-harvest burning (with significant impacts on public health) and mechanical harvesting without pre-harvest burning. Health impacts were assessed focusing on the health effects of particulate matter, addressing primary and secondary $PM_{2.5}$ for Brazilian conditions. The LCA results showed that the agricultural phase contributed the most to the environmental impacts in the majority of the categories. Comparing with mechanical procedure, sugarcane production with manual harvesting has higher impacts on photochemical oxidant formation and particulate matter formation due to pre-harvest burning; however, it showed lower impacts on ozone depletion, terrestrial acidification, and fossil depletion mainly because of less use of fertilizer and diesel. The differences on climate change and eutrophication were less significant. The magnitude of health impacts associated with bioethanol depended on the type of agricultural operations applied. When sugarcane is harvested manually, agriculture production was the largest contributor of health impacts, which is six times higher than when it is harvested mechanically. Bioethanol production is also a main contributor to the health effects due to the particulate matter emissions on site. In conclusion, agricultural operations influence significantly the environmental and health impacts of bioethanol supply chain in Brazil, and mechanization of sugarcane harvesting can reduce impacts on public health.

Keywords: Environmental sustainability, Public health, Particulate matter, Bioethanol, Life cycle assessment

1. Introduction

In response to climate change mitigation and improving energy security, the production of biofuels has been increasing rapidly worldwide, from 115 million barrels in 2000 to 694 million barrels in 2012 (DOE, 2012). Bioethanol is one of the most important biofuel products, accounting for nearly 80% of the world biofuel production in 2012. The United States and Brazil dominate the world production and consumption of bioethanol with the main feedstock being corn and sugarcane respectively. As the second largest bioethanol producer, Brazil produced approximately 25% of the world´s ethanol in 2014 (DOE, 2012).

Fuel ethanol production in Brazil has a long history dated back to the early 20th century in response to the surplus of sugar and the burden of gasoline imports. The oil crisis in 1973 motivated the launch of the National Alcohol Program (Proalcool) (Walter et al., 2014). The production of ethanol in Brazil increased rapidly in the following decade. Due to the decrease of oil prices and the deregulation of ethanol industry, the production of ethanol flattened out since 1984. With the introduction of flex-fuel vehicles (FFVs), the production of ethanol has been increasing since 2003 driven by the domestic consumption. Despite the recent market disturbance of high sugar price, financial crisis and adverse weather conditions, the ethanol production in Brazil is predicted to reach 79.5 billion liters in 2022 (Walter et al., 2014). The production scale of ethanol in Brazil is shown in Figure 1 (UNICA, 2016).



Adapted from (UNICA, 2016)

Figure 1. Ethanol production in Brazil from 1980 to 2015

As the feedstock of ethanol, sugarcane production has been increasing from 257 Mt in 2001 to 653 Mt in 2014 (UNICA, 2016). The Brazilian government and the Sugarcane Industry Union (UNICA) have been promoting the sustainability of sugarcane production mainly through eliminating pre-harvest burning practices and establishing training programs. For instance, the State of São Paulo, the largest sugarcane producer in Brazil, has established the RenovAção program targeting sugarcane cutters replaced by the mechanization of sugarcane harvesting to help them find new job opportunities (UNICA, 2010). The ratio of mechanical harvesting of sugarcane has been increasing substantially. The evolution of the scale of mechanical harvesting in the State of São Paulo is presented in Table 1.

A number of life-cycle studies evaluated the environmental impacts associated with the supply chain of sugarcane ethanol in Brazil (Cavalett et al., 2013; Chagas et al., 2016; Galdos et al., 2013; Luo et al., 2009; Macedo et al., 2008; Ometto et al., 2009; Seabra et al., 2011;

Tsiropoulos et al., 2014); however, these studies often focused only on energy use and GHG emissions, and agricultural production scenarios are not differentiated. The characterization of particulate matter health effects in Life Cycle Assessment (LCA) studies is on the rise (Fantke et al., 2015; Gronlund et al., 2015; Humbert et al., 2011). The aims of this study are twofold: first, to assess the life-cycle environmental impacts of sugarcane ethanol with a focus on different agricultural production operations; second, to quantify the health effects of particulate matter emissions associated with the life cycle of sugarcane ethanol.

Table 1. The evolution of sugarcane harvesting systems in São Paulo (%)

Year	Mechanical Unburned	Mechanical Burned	Manual Burned	Manual Unburned
2005/2006	21	9.8	67	1.8
2007/2008	34	15	48	2.7
2008/2009	46	16	37	1.6
2009/2010	51	17	30	1.5
2010/2011	59	17	22	1.5
2011/2012	73	9.3	16	1.5
2012/2013	75	6.5	16	2.3
2013/2014	83	6.1	8.9	2.2

**Adapted from (CTC, 2012)*

2. Methods

A field-to-wheel LCA study was conducted, addressing sugarcane cultivation, bioethanol production and use as fuel in a light-duty car. Regarding cultivation, two alternative systems were compared, i) sugarcane harvested fully manually, and ii) fully mechanically. LCA is a methodology widely applied for assessing the environmental impacts of a product or service throughout its life cycle. LCA includes four phases: goal and scope definition; life cycle inventory analysis (LCI); life cycle impact assessment (LCIA), and interpretation. Further information about LCA can be found in a number of publications (e.g. Guinée et al., 2001; Malça et al., 2014).

2.1 System boundary

A simplified diagram of the product system is shown in Figure 2. The functional unit (FU) chosen is 10 000 km of driving in a standard light-duty car using hydrous ethanol (95%$_{v/v}$) as the only fuel. Assuming a fuel economy of 7.7 km/L and ethanol density of 0.79 kg/L, a reference flow of 1025 kg of ethanol is associated (Seabra et al., 2011). We assumed a sugarcane-ethanol productivity of 85 L/ton of sugarcane with the current technology, hence 15.3 tons of sugarcane are needed correspondingly. To transport the ethanol from distilleries to gas stations, an average distance of 200 km is assumed, taking the condition of the State of São Paulo as an example (UNICA, 2010).

In the agricultural phase, emissions from the production of inputs, transportation of inputs and sugarcane, production of agricultural equipment and machineries, and field emissions are included. In the industrial phase, it is assumed that the sugarcane mill only produces ethanol, with co-generation of heat and electricity from bagasse. The mill is self-sufficient in terms of energy use, and the surplus of electricity is sold to the grid. Energy allocation was applied to divide the environmental impacts between ethanol and bagasse electricity.

2.2 Life cycle Inventory

More than 90% of the sugarcane in Brazil is produced in the center-south region, and the LCI from Brazilian Bioethanol Science and Technology Laboratory (CTBE) representing the sugarcane production in the center-south with current technology and operation is applied (Chagas et al., 2016). The LCI is validated by literature review, expert opinions and company reports. The inventory for bioethanol production and use is based on Cavalett et al. (2013) which represents the latest data available in the Brazilian conditions. The inventory for bioethanol distribution is derived from the database Ecoinvent (Swiss Centre for Life Cycle Inventories, 2009) assuming a 16-32t lorry.

2.3 Life cycle impact assessment

We calculated eight mid-point impact categories from the ReCiPe 2008 LCIA method (Goedkoop et al., 2009): climate change, ozone depletion, terrestrial acidification, freshwater eutrophication, photochemical oxidant formation, particulate matter formation and fossil depletion.

We assessed the health effect of particulate matter based on characterization factors (CFs) for $PM_{2.5}$ calculated for Brazil, considering different emission sources and heights (Table 2). Burdens of disease included in calculating the CFs are based on Humbert (2010), including chronic mortality, acute respiratory and cardiovascular morbidity, chronic bronchitis, asthma attacks and restrictive activity days.

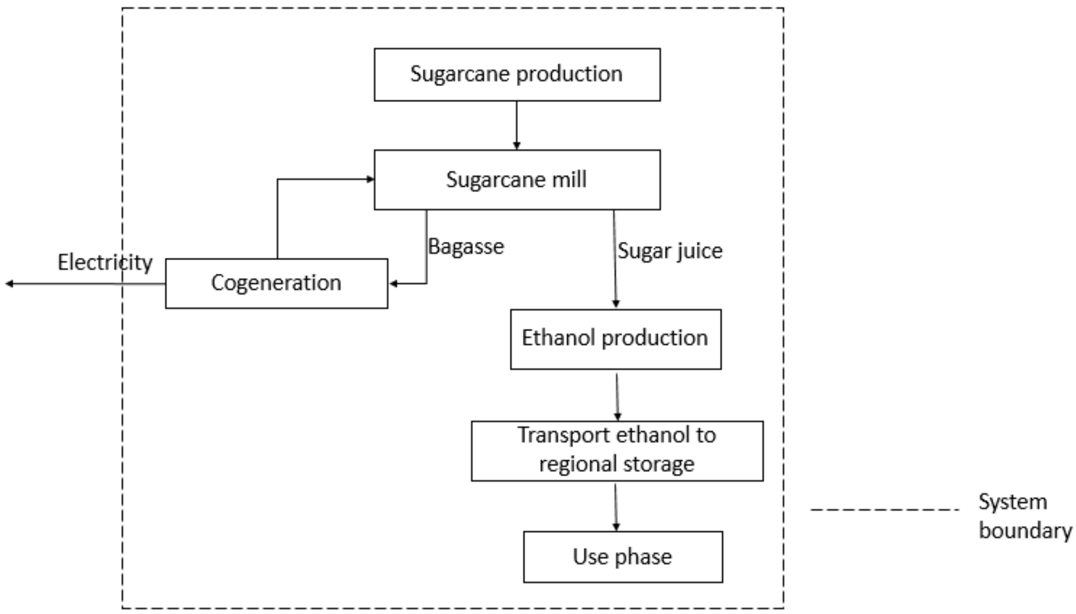


Figure 2. A simplified diagram of sugarcane ethanol product system

Table 2. Characterization factors of $PM_{2.5}$ applied in this study (DALY/kg $PM_{2.5}$ emitted)

Pollutant and stack height	Urban	Rural	Remote	Population-weighted
		Primary $PM_{2.5}$		
High stack	1.78E-03	6.58E-05	1.37E-05	7.67E-04
Low stack	2.33E-03	7.95E-05	1.37E-05	1.00E-03
Ground level	6.71E-03	1.51E-04	1.37E-05	2.84E-03
Emission-weighted average	3.97E-03	1.03E-04	1.37E-05	1.64E-03
		Secondary $PM_{2.5}$		
SO_2	1.36E-04	1.08E-04	1.51E-05	1.18E-04
NO_x	2.74E-05	2.33E-05	2.74E-06	2.47E-05
NH_3	2.33E-04	2.33E-04	3.15E-05	2.33E-04

3. Results and discussion

3.1 Environmental impacts

Results of LCIA of bioethanol showed that the highest environmental impacts are associated with the agricultural phase (Table 3; Figure 3). Except photochemical oxidant formation and particulate matter formation, sugarcane cultivation represented 78-97% of the environmental impacts in the categories. Mechanical harvesting is significantly environmentally preferable to manual harvesting within photochemical oxidant formation and particulate matter formation. Noticeably, in these two categories, when sugarcane was harvested manually, the agricultural phase contributed the most to the environmental impacts; however, when harvested mechanically, the industrial phase surpassed the agricultural phase becoming the number one contributor. Manual harvesting has better environmental performances on ozone depletion, terrestrial acidification and fossil depletion; however, the differences within climate change and freshwater eutrophication are less clear. Ethanol distribution contributed considerably to ozone depletion, freshwater eutrophication and fossil depletion following the agricultural phase, representing 9-21% of the impacts. Environmental impacts from the use phase of ethanol were significantly lower than the rest of the life cycle phases: bioethanol use accounted for 4% and 14% of the impacts on climate change and photochemical oxidant formation; while its impacts on other categories are all below 1%.

Regarding the processes associated with higher impacts, fertilizer field application was the main source of emissions for both manual and mechanical harvesting systems in terms of climate change, representing 31% and 44% of the impact respectively. Pre-harvest burning of sugarcane was the second largest contributor on climate change for the manual harvesting product system, accounting for 14% of the overall impact. More use of fertilizer and diesel in mechanical harvesting resulted in higher impacts on the categories of ozone depletion, terrestrial acidification, freshwater eutrophication, and fossil depletion compared to manual harvesting. Nitrogen oxides and PM_{10} emissions on site of distilleries from ethanol production were the main contributors to photochemical oxidant formation and particulate matter formation respectively.

Table 3. LCIA (quantitative results) of sugarcane ethanol in Brazil

		Life cycle phase				
Impact category	Unit/FU (10 000km)	Agricultural phase (manual harvesting)	Agricultural phase (mechanical harvesting)	Ethanol production	Ethanol distribution	Use phase
Climate change	kg CO2 eq	586.3	621.6	96	37.9	27.9
Ozone depletion	kgCFC-11 eq	2.3E-05	2.7	2.8E-07	6.0E-06	0
Terrestrial acidification	kg SO2 eq	20.5	24.1	2.3	0.2	0.3
Freshwater eutrophication	kg P eq	0.03	0.03	1.0E-03	3.0E-03	0
Marine eutrophication	kg N eq	6.7	10.2	0.1	1.0E-02	2.0E-02
Human toxicity	kg 1,4-DB eq	64.5	67.1	1.6	4.1	0
Photochemical oxidant formation	kg NMVOC	10.4	1.2	3.7	0.3	0.9
Particulate matter formation	kg PM10 eq	8.8	3.4	6.8	0.1	0.1
Fossil depletion	kg oil eq	101.9	119.3	1.1	13.2	0

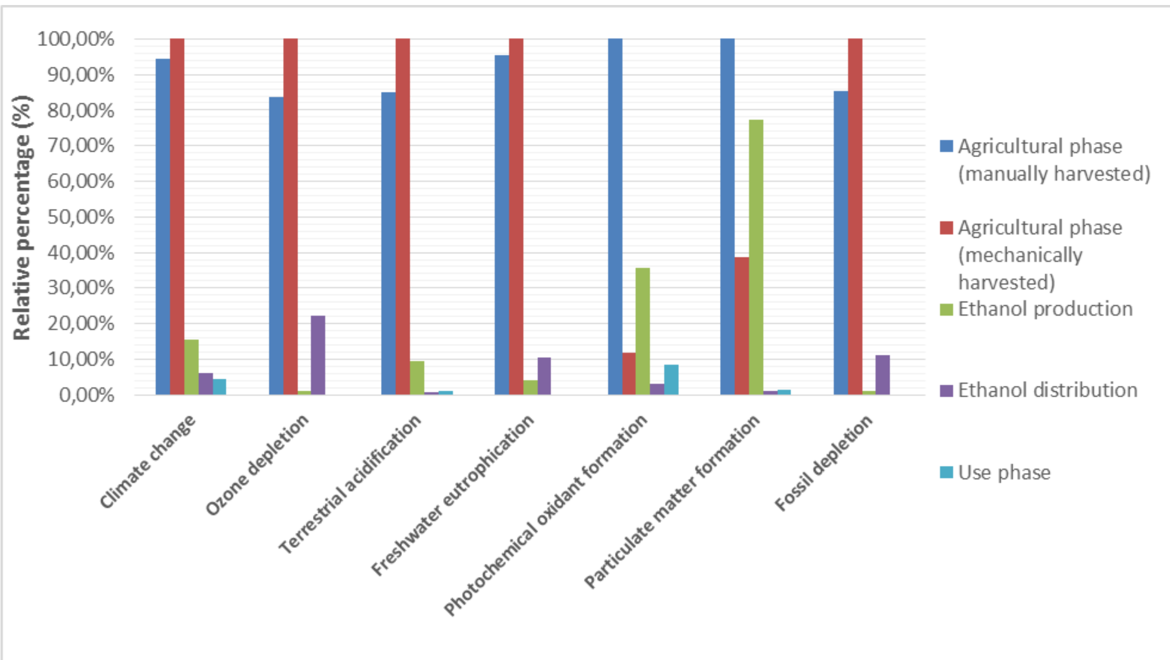
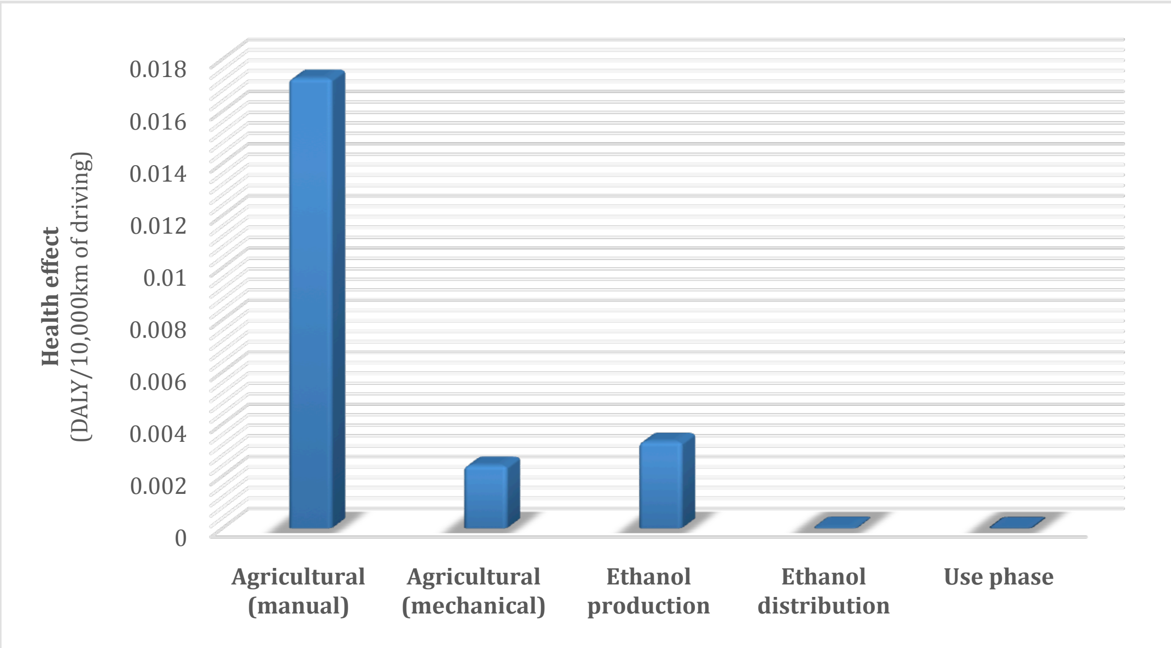


Figure 3. LCIA (relative results) of sugarcane ethanol in Brazil

3.2 Health effects of particulate matter

The inventory of primary and secondary $PM_{2.5}$ was aggregated and multiplied with the corresponding CFs up to the emission sources and heights. The results of health effects due to fine particulate matter emissions are shown in Figure 4. When sugarcane was harvested manually, the health effect from the agricultural phase was significantly higher than other life cycle phases due to pre-harvest burning, resulting in 0.017DALY/FU. However, when sugarcane was harvested mechanically, the industrial phase contributed the most to health effects from particulate matter emissions. The contributions of the ethanol distribution and use phases were insignificant compared with other life cycle phases. Overall, the ethanol product system with manual harvesting



accounted for 0.021DALY/FU, which is 2.6 times higher than the health effects when sugarcane was harvested mechanically.

Figure 4. Results of health effects due to $PM_{2.5}$ emissions

4. Conclusions

This study analyzed the life cycle environmental and health impacts of sugarcane ethanol in Brazil with manual and mechanical harvesting. The results showed that sugarcane production was the life cycle phase contributing the most to the environmental impacts of bioethanol. Agricultural operations, specifically harvesting manners influenced the magnitude of the environmental impacts considerably. This held true in all the categories included in this study, but most noticeably in photochemical oxidant formation and particulate matter formation mainly due to pre-harvest burning when sugarcane was harvested manually. When sugarcane was harvested mechanically, the industrial phase had worse performances than the agricultural phase on the two aforementioned categories. Fertilizer field application and diesel use in the agricultural machineries were the processes contributed the most to the environmental impacts in the agricultural phase.

In terms of health effects of particulate matter emissions, the results sustained that agricultural operations affected the magnitude of health effects significantly. Pre-harvest burning in manual sugarcane harvesting increased the health effects associated with sugarcane ethanol substantially. The industrial phase was also a main contributor to the health effects of Brazilian ethanol due to the particulate matter emissions on site of the distilleries.

Acknowledgments

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Economic and Ecological Influences on the Design and Adoption of New Vehicle Concepts

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Abstract

Integration of economic and ecological considerations with engineering ones in new vehicle concepts presents many challenges, not least of which is overcoming long established expectations of vehicles and their performance. Design choices are not only influenced by clear rational factors but also by many imperfectly rational ones, which interact in a complex way to shape the final vehicle artefact. It should therefore be of interest to model and explore how such factors interact and influence the design process, particularly when it comes to targeting limited resources towards achieving the maximum improvement in the design. The aim is to find out under what circumstances can specific improvements penetrate into the established vehicle design and where are the critical phase boundaries over which significant advancement may be achieved. This is especially relevant in light of the on-going adoption of new technologies aimed at reducing the environmental impacts of vehicles. This insight may enable the design and adoption of radically different vehicles that represent a tipping point for sustainable transportation. A methodology is introduced to dynamically explore the trade-offs in vehicle design. The engineered vehicle is recognised as being a sub-system within a much wider surrounding world. A broad model is introduced to include both rational performance properties and imperfectly rational forces, and the system is stepped forward in time. The methodology is applied to a case study in which new knowledge is introduced into the established design paradigm and its adoption is tracked under a number of starting conditions and assumptions. The results illustrate where a targeted improvement that compensates for inherent inertia may lead to greater adoption that is beneficial from a broader long-term perspective. The model behaves reasonably in the vicinity of boundary conditions but more work is needed to explore and refine the behaviour across multiple variables.

Keywords: Vehicle design, complex interdependencies, imperfectly rational decisions

1. Introduction

The development of resource efficient vehicles is a critical element in the creation of a strong and sustainable future society. For example, in Sweden vehicles constitute over 10% of national exports, contribute approximately 30% of national GHG emissions, and over 135,000 people are employed as a result of the industry (BIL Sweden, 2016). Such economic, ecological and societal factors have driven the increases in legislative and market pressures, which have stimulated the vehicle industry to begin to integrate sustainability considerations into their product development activities (Nemry et al., 2008). However, considerable efforts are still required.

Modern vehicle architecture has been evolving incrementally for more than 100 years through a traditional industrialised design process that is fundamentally top-down in nature (Minai et al., 2006; Kroll et al., 2001). This means that the functional requirement of the vehicle "to transport" is decomposed into many levels of sub-functions, until a level is reached where the sub-functional task may be realised using available solutions, e.g. engine, chassis, etc. Interdependencies between these tasks are often simplified or ignored to reduce complexity and cut development time.

This decomposition of the vehicle system is reflected in organisational structures within vehicle manufacturers. There, separate design teams work on separate tasks, such as an aerodynamics group, a noise and vibration group, etc. Their solutions, or sub-functional units, are assembled to perform the overall functional requirements of the vehicle. Resolving issues that emerge due to neglected interdependencies means that the development process is fundamentally iterative (Bar-Yam, 2006), with iterations to rework the sub-functional solutions.

The historical development of vehicle architecture through this process has been largely independent of more recent environmental considerations, and these must now be integrated. To significantly improve the environmental impacts of vehicles it is essential to influence their early-stage design process (Schöggl et al., 2014). Here the possibilities for innovation have not already been severely constrained, and a redesign or rethink (as described by the Charter and Chick (1997) four-step model) of the vehicle system is still possible. It is here also that 80% of the production costs, and the majority of its environmental and social impacts are determined.

Vehicle designers are, however, faced with a design paradox (Lindahl and Sundin, 2013). This means that the freedom to design improved vehicle solutions early in the design process is accompanied by an inability to discover what those solutions will yield; while knowledge of the shortcomings in a vehicle design late in the design process is accompanied by an inability to make significant improvements. This also implies that the effort or cost to modify a design increases as the process progresses to a maximum for the final vehicle. This design paradox makes influencing early-stage design challenging.

New vehicle generations are largely based on previous ones as a consequence of the design paradox. This uses assessed knowledge of the existing solution to overcome the lack of early-stage knowledge, and reduces development time and costs. It can be viewed as a reworking across generations. As such, it is highly conservative in nature, and the vehicle's structure remains largely based on century-old architecture.

The influence of environmental considerations on the established architecture remains limited. Environmentally motivated changes to vehicle sub-systems, such as the introduction of lightweight materials to reduce use-stage energy demand, may be characterised as repair or refine strategies (Charter and Chick, 1997) of the existing architecture. They are typically introduced on sub-systems with low interdependence with other sub-systems so as to avoid the need for large-scale reworking of the design.

The fact that a significant innovation potential is left in vehicle architecture has been noted by BMW (Neugebauer, 2015). They argue that systematic optimisation of single vehicle characteristics will lead to conflicts of interest that only can be solved by a holistic integrated approach, increasing the need for inter-disciplinary methods. In addition to new environmental considerations, with the introduction of autonomous vehicle concepts, the current balance between conflicting requirements such as safety versus comfort needs to be revisited.

It is therefore of interest to better understand the conditions necessary for "new knowledge" (e.g. technology, methods, ideas, etc.) to be adopted into an existing product structure or an established group such as a design team. It would potentially enable greater integration of sustainability in early-stage design through the creation of improved methods and processes. This could lead to radically improved solutions that are economically, environmentally, and socially sustainable.

In this paper a method is examined to investigate the relationship between new knowledge and the conservatism of the system into which it is introduced. The method is presented is presented in Section 2. The preliminary results of dynamic simulations with varying initial conditions are presented in Section 3 and discussed in Section 4. Conclusions to date are summarised in Section 5.

2. Method

The dynamic behaviour of the complex product development system is simulated on a network structure. The model follows closely that described and analysed by Braha and Bar-Yam (2006), albeit with a different interpretation of what the variables mean, their ranges of interest, and what the cases represent. For more detailed discussion of the analytical behaviour of this system, the reader is referred to this reference.

This chosen model is deliberately simple at present, but should be sufficient to capture general features of the propagation of new knowledge, such as a new technology or a new idea, into the system. The network on which the model is simulated consists of nodes connected together by links. Each node represents an actor or a task within the product development system, which could be a person, etc.

The dynamics of the system will be dependent on the topology of the network. Three important characteristics of a network are, firstly, the characteristic path length

(1)

where $d_{i,j}$ is the distance (number of links) between node i and node j and N is the total number of nodes; secondly, the clustering coefficient, which for node i is

(2)

where k_i is the number of connected neighbours or the degree of node i, and n_i is the number of links between these neighbours; and, thirdly, the average degree of all the nodes

(3)

In this model the nodes can have one of two states (although this could be extended to include more) – 0: "status quo" or 1: "new knowledge". Here, it is supposed that decisions to choose one state or the other are influenced by two factors – 1) a well-informed rationality and 2) a poorly informed imperfect rationality.

In the first case, if a new knowledge has an advantage, e.g. lower cost, over the status quo, then it should be adopted by the system, i.e. the system should converge on 1. This ought to be true even if the advantage is only small. This is viewed as a *rational* decision.

However, in the second case, it may be difficult to accurately assess this advantage due to a lack of knowledge. This could be because the full information needed to assess this knowledge is not available, and it could be thought of as having a wide statistical confidence interval perhaps because it is new and "unknown". Alternatively, it could be because the node in question does not have the capacity to understand the information available. This could perhaps be a team member who does not have the training to appreciate the subtleties of the information they have or the time to check the reliability of information, but are convinced by their colleagues' position when making a choice. This would also be consistent with a bounded rationality leading to an *imperfectly rational* decision.

The dynamics of the system are simulated as the state of each node can change, as the system is stepped forward in time at discrete intervals $1, 2, , T$ where T is the number of time-steps. The state of node i at time t is given as $s_i(t)$. Node states are synchronously updated based on the following stochastic rules:

If : with a probability (4)

and

If : with a probability (5)

Here tanh is the hyperbolic tangent function. Each node can be affected by the nodes that it shares a link with, i.e. its neighbours. $k_{it}=k_i-s_{jt}$ and represents the dynamic degree of influence of neighbour j has on node i at time t. αi is the sensitivity node i has to its neighbours influence, and ri is the relative cost benefit or objective advantage that the new knowledge has over the status quo. This could be thought of as the normalised cost of the two states, i.e. $ri=1-c1/c0$, $c0$ and $c1$ are the cost of state 0 and 1 respectively. It could represent a monetary cost, but also some other "usage cost" such as energy use, weight, etc. where it is desirable to have a lower value. Only situations where the new knowledge has a lower cost are considered here so $0\leq ri\leq 1$, as worse solutions are not of interest.

3. Results

Simulations have been performed on two non-directional network types. The first is a random graph generated using the Watts-Strogatz model (Watts and Strogatz, 1998) with a rewiring probability of 1. This approaches an Erdös-Rényi random graph (Erdös and Rényi, 1959). The second network is a scale-free graph generated with the Barabási-Albert model (Albert and Barabási, 2002). Both networks are shown in Figure 1. The properties of these network graphs are presented in Table 1.

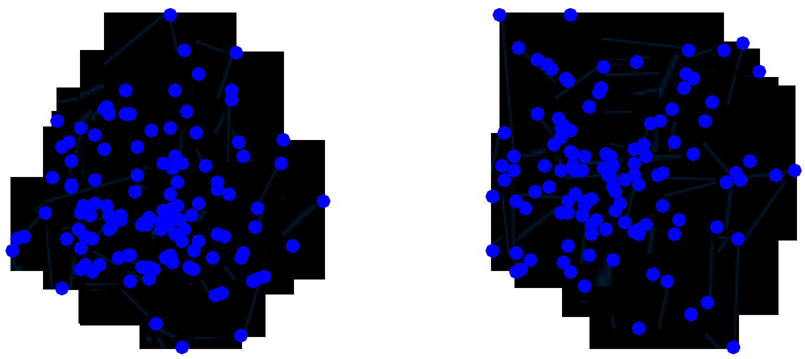

Figure 1. The random graph network (left) and the scale-free graph network (right).

Visually they appear quite similar as both have the same number of nodes, N, number of links, L, and average number of links per node, i.e. average degree, k. Additionally, they both have relative short characteristic path lengths, l. This means that they exhibit a small-world property. However they differ significantly when it comes to average clustering coefficient, C, with the random graph having a low value and the scale-free graph having a relatively high value.

Table 1. Graph properties for the two networks considered.

Graph					
Random	120	480	2.5105	0.0675	8
Scale-free	120	480	2.3891	0.2008	8

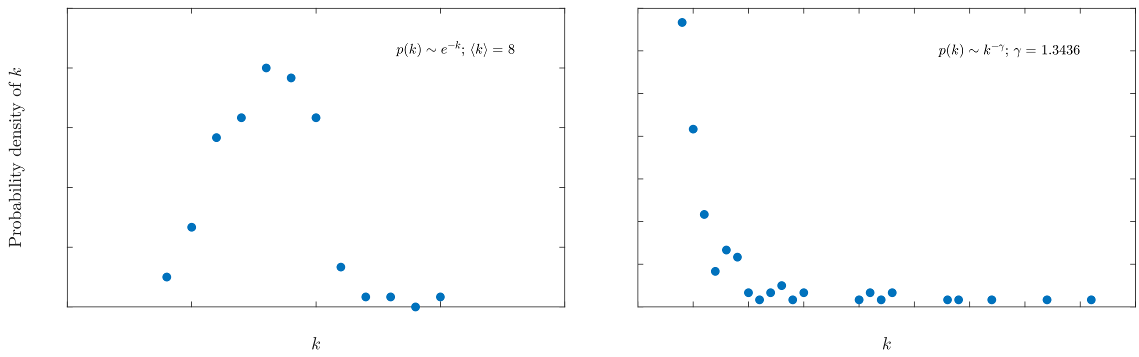

Figure 2. The degree distribution for the random graph (left) and the scale-free graph (right).

The topological difference between these networks is more apparent in the degree distributions shown in Figure 2. The random graph has a Poisson distribution centred about the average degree. The scale-free graph, however, follows a power-law (long-tail) distribution, meaning that it has many nodes with small degree and a few nodes with a high degree. These differences will have an effect on the dynamic behaviour of system simulated on them.

For the moment it is assumed that both r and α are homogeneous for the entire system. The dynamic behaviour of the system is firstly examined for each of these variables separately by setting one of them to zero and varying the other. This is shown in Figure 3. The simulations are run many times (typically 25 times) and averaged. The system converges towards either a 1 or a 0, but the convergence rate depends on the values chosen. There is little difference between the network types apart from some small deviations. These are due to differences in the starting conditions because of the stochastic assignment of the initial state.

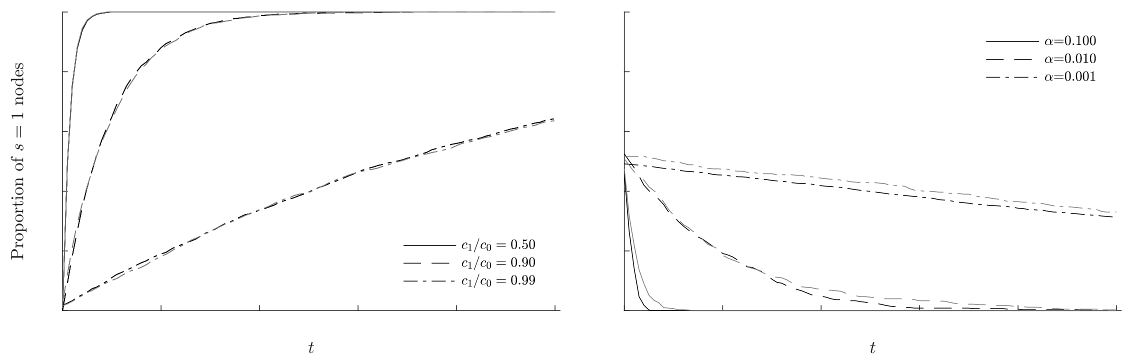

Figure 3. Dynamic behaviour for varying $c1/c0$ with $\alpha=0$ and $Ps=10=0.01$ (left), and for varying α with $c1/c0=1$ and $Ps=10=0.5$ (right). The simulations on the random graph are plotted with black lines and on the scale-free graph with grey lines.

Next, the combined effects of the rational and imperfectly rational forces are examined. The values investigated are for when there is little difference between the costs as this is of primary interest. The results of the simulations are shown in Figure 4. Here it can be seen that trade-offs between rational and imperfectly rational forces strongly influence the outcome. The simulations either converge to the state 1, or to an intermediate value that may be viewed as a “stalemate” situation.

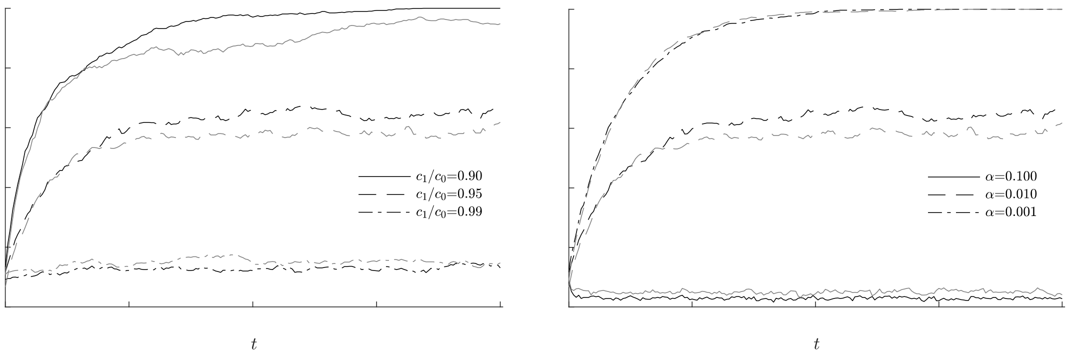

Figure 4. Dynamic behaviour for varying $c1/c0$ with $\alpha=0.01$ (left), and for varying α with $c1/c0=0.95$ (right). The simulations on the random graph are plotted with black lines and on the scale-free graph with grey lines. $Ps=10=0.1$.

The difference between the network types in Figure 4 is due to large fluctuations in the state as the system "fights" between the alternative states. This can be seen better in Figure 5, where the behaviour of a single case run is compared with the average over 25 runs.

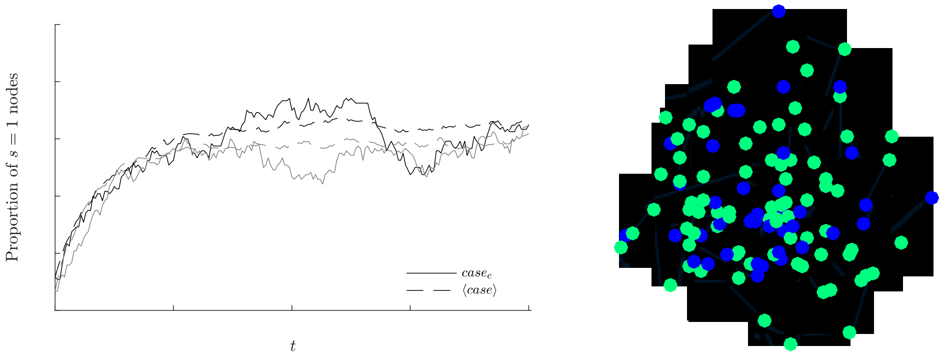

Figure 5. Dynamic behaviour for an individual case run and the average of many case runs (left). The simulations on the random graph are plotted with black lines and on the scale-free graph with grey lines. The random graph at $t=200$ for an individual case (right). $\alpha=0.01$ and $Ps=10=0.1$.

Finally, the effect of a targeted "improvement" is explored by decreasing the relative cost for some nodes. This could represent adding resources so that these nodes are perhaps "better educated" and can act more rationally. This targeted strategy is applied either to the most influential nodes (those with the highest degree), to the least influential nodes (those with the lowest degree), or randomly. These results are presented in Figure 6. The effect of the differences in the network topologies is clearly evident here. The systems converge quicker if the improvement strategy is applied to the most influential nodes rather than the least influential, which makes intuitive sense. This difference is greater on the scale-free graph because there is a greater spread in the level of influence of nodes. The effect of randomly applying the strategy is also notably different on the two networks, with the random solution following the high k value on the random graph, but the low k value on the scale-free graph. This is because the chances of randomly picking a relatively influential node are greater on the random graph due to the narrower spread of k values.

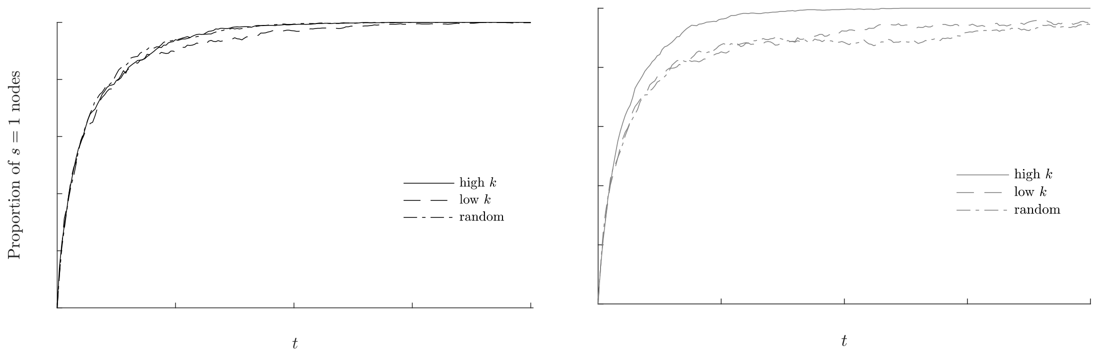

Figure 6. Dynamic behaviour with $c1/c0$ improved from 0.9 to 0.5 for 10% of the nodes selected based on their k value or randomly for the random graph (left) and the scale-free graph (right). $\alpha=0.01$ and $Ps=10=0.01$.

The effect of these improvement strategies on the time to converge to a state 1 is summarised in Table 2.

Table 2. Convergence time for the different improvement scenarios.

Graph	High	Low	Random
Random	141	311	146
Scale-free	124	444	278

4. Discussion

The results presented so far show that both rational and imperfectly rational factors can influence the outcome of the process. The topology of the network can also be important, particularly when it comes to efficiently making targeted changes.

More work is needed to include the directionality of links between nodes. Realistic networks are unlikely to be non-directional. In fact, they are more likely to have an asymmetry between the distribution of incoming and outgoing information flows (Braha and Bar-Yam, 2006). This means that it easier for a node to output lots of information than it is to take in and process information, which is consistent with the idea of bounded rationality. It has also been shown that there may be a cut-off on the in-degree distribution that may be attributed to the limited capacity of a node. These properties are likely to important for the integration of new ecological and economic considerations. Further investigation is needed to better understand the topology of networks in the vehicle design process.

Looking ahead, the integration of economic and ecological considerations in new vehicle concepts will require a broader understanding of the creative process, and the existent structures and habits that may impede it. A central idea to bear in mind about complex systems is that analysis and synthesis do not follow the same processes (Bar-Yam, 2006). The presented model could perhaps contribute to examining creative engineering set within a self-organising context, rather than within a mechanistic view. This supposes that creativity starts with a surprise to the existing habits, and involves a self-organising process in which abductive reasoning occurs allowing the expansion of well-structured sets of beliefs (Gonzalez and Haselager, 2005). Such insights and tools might then be used to create an environment where engineers are supported and encouraged to find radically improved and sustainable vehicle solutions (O'Reilly, 2016).

5. Conclusions

A methodology was presented in this paper to dynamically explore the economic, ecological and technical trade-offs in vehicle design decisions. This model includes both rational performance properties and imperfectly rational forces, and the system is stepped forward in time. The methodology was applied to a case study in which new knowledge is introduced into the established design paradigm and its adoption is tracked under a number of starting conditions and assumptions. The model behaves reasonably in the vicinity of boundary conditions. The system was observed to either converge to a uniform state of integrating the new knowledge or rejecting it, or fluctuating in a state of continuous conflict. The results also illustrated where a targeted improvement may lead to greater and faster adoption. More work is needed to explore and refine the behaviour across multiple heterogeneous variables. The work provides some useful insights in the dynamic behaviour of such systems and shows some potential that could be developed further.

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Paradigm shift in the Design for Sustainability of food packaging in self-service quest

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Abstract

In the scenario of fast growth of global population and its concentration in urban areas, two productive sectors are emphasized: the food and the food packaging industries. Both work together, meeting reciprocal demands of major importance to the global economy, for the social behavior and the practice of design professionals. While the production aims to meet the demand, it generates a significant increase in the average composition of residues, which currently reaches disproportionate volumes of manageability and environmental assimilation. Placed within the mentioned context, this research proposes an analysis of the Design for Sustainability in the food-packaging sector in self-service, specifically supermarkets, because they are considered a place of great concentration of both (food and packaging). It includes the analysis of how these sector and segment follow the needs and/or requirements of the debate on sustainable development, as well as how one can innovate in a scenario that requires ruptures with the current production and consumption forms when it comes to achieving broader goals. To this end, an exploratory research has been elaborated, through literature review and on-site visits to a specific type of supermarket, which have been currently presenting a proposal for solutions closer to behavioral changes and/or a displacement from the conventional production and consumption system. Initiatives have been identified in many countries, mostly, characterized by supermarkets that adopt attitudes such as, among others, the sale of bulk products; restriction to organic products only; and encouraging reusable packages. Therefore, consumers are encouraged to bring their own recyclable material containers, such as fabric or paper bags and glass bowls. For information regarding the products, shelves and counters are used, and thus, the packaging assumes a more neutral character. It also highlights the prioritization of local products, proposing the involvement of the surrounding community. It can be concluded that this is a movement to change the self-service system involving food packaging. The similar profile, raised among the surveyed establishments, may indicate an expanding trend, inserted in the concepts of the sustainability field, especially related to environmental and social responsibility. Most establishments are relatively new experiments and still require further operating time in order to obtain more conclusive findings. However, they already represent a new playing field for designers. In addition to theoretical analysis, these professionals can make a significant contribution and, along with the establishments, rediscover opportunities, such as new ways to display products, adequacy of bulk product dispensers or instruments to facilitate self-service. To this end, deep analysis and research also should follow, so the approaches do not evade the real intention and recommendation of Design for Sustainability in its major essence.

Keywords: Design for Sustainability, Packaging, Food, Self Service

1. Introduction

In the scenario of fast growth of global population and its concentration in urban areas, two productive sectors are emphasized: the food and the food packaging industries. Both work together, meeting reciprocal demands of major importance demands to the global economy, for the social behavior and the practice of design professionals.

The Brazilian food and beverage industry, for example, exports to more than one hundred markets and is the largest national employer industry (Costa et al., 2010). In terms of market data, in the first half of 2014 direct exports in the sector generated revenue of US$ 249 million and the level of employment reached 230,909 jobs, an increase of 719 jobs compared to June 2013 (ABRE, 2015).

In this market, the form and quality of food is influenced by important factors, such as the world population growth, as well as the displacement of rural population (stopping to provide food for themselves) to urban areas, pressing the demand for food. The aging of population, combined with reduced birth rates (increase of childless couples) with increasing life expectancy, indicates nutritional requirement changes of the consumed products. Increased educational levels and access to information, especially the internet, which among other things, extends cultural exchanges, even between countries, and the knowledge of new food and nutritional models (Costa et al., 2010).

The current packaging industry configuration, in turn, received a major boost with the rise of American supermarkets, during the 1930s, when sale and consumption forms were reconsidered through "self-service" (Cavalcanti and Chagas, 2006). The system in which consumers helped themselves to the desired products has become the standard way to facilitate the purchase and sale, reformulating packaging function.

The concept expanded, reaching Europe in the 1940s and Brazil, in the 1950s. The global packaging market is currently worth around US$ 800 billion, with an annual growth forecast ranging around 4% by 2018 (SMITHERS PIRA, 2013).

The economic factor supports the volume and visibility in the industrial production, because packaging has defined shapes and aggregated products brands (Pellegrino, 2014). In terms of segmentation, around 50% of production is destined for the food industry; 18% for beverage and 6% to 5% for the pharmaceutical, personal care and cosmetics industry, to name the major sectors (EY, 2013).

For these packages, functions are established, among them, to maintain the integrity of the product beyond the initial opening of the container; content protection; or its identification, including information on product usage (Stewart, 2010). The Brazilian Ministry for the Environment (BRAZIL - MMA, 2015) also points out that the package should provide safe product handling, property maintenance and legal information on composition and expiration, and even lot tracking. Furthermore, in some cases, packaging is required to extend the expiration date of products, avoiding waste.

However, while the production aims to fulfill a demand, it generates a significant increase in the average residue composition, which currently reaches disproportionate volumes of manageability and environmental assimilation (Cossu and Masi, 2013; Dias, 2002; Jayaraman et al., 2003; Menegat and Almeida, 2004; Stewart, 2010; Waldman, 2012). In Brazil, for example, the total municipal solid waste generation in 2014 was approximately 78.6 million tons, an increase of 2.9% compared to the previous year, a rate higher than the Brazilian population growth during the period, 0.9%. Whereas, of this amount, only 58% were forwarded to the appropriate disposal, such as recycling or landfills, improperly discarding around 81,000 tons/day (ABRELPE, 2014).

According Brazil-MMA (2012), the national average composition of dry solid waste - that is to say, those consisting of packages made from plastics, paper, glass and a several metals, as well as composite materials, such as packages referred to as "long life"- is 31.9%. Although the main component of urban waste is organic residues, with national average composition of 51.4%, household packaging stand out for the importance it represent within the economic context.

Within the mentioned context, this article presents part of the doctoral research on the Design for Sustainability focused on the food packaging in self-service sector - specifically supermarkets. To this end, an exploratory research was elaborated and, by means of literature review, associated with on-site visits to initiatives currently representing new proposals in the scenario here under study. Those, characterized by small and medium-sized stores, expressing a search for breaking the current conventional form, based on conscious and sustainable consumption principles.

2. Design for Sustainability

The precepts that introduced the so-called "Design for Sustainability" emerged with more emphasis in the 1960s and 1970s, with criticism and suggestions, regarding the development process, made by the authors Vance Packard (1963); Victor Papaneck (1971); Gui Bonsiepe (1973) and Fritz Schumacher (1973), as stated by Bhamra and Lofthouse (2007). To these authors, Vicente et al. (2012) also associates Buckminster Fuller, designer and architect, who since the 1930s expressed concerns regarding a more efficient use of resources in his projects.

These approaches were based on debates on global issues, such as climate change, hunger, social inequality and diseases.

In 1994 the "triple bottom line", term denominated by John Elkington, was given prominence, aiming to encourage businesses to merge economic, social and environmental issues (Elkington, 2007a). To that extend, Vezzoli (2010) explores the environmental dimension and links the social dimension to ethical and the economic dimension to political. As environmental dimension (chemical and physical), he means to not overpass the 'resilience' of the biosphere and geosphere, in other words, the ability to absorb the impacts of human actions without causing an irreversible phenomenon of degradation. The socio-ethical dimension refers to meeting the same degree of 'satisfaction' for future generations and equity in the distribution of resources. In addition, in the economic and political dimension, to enable economically viable solutions in a market somewhat ruled.

Recently the UN - United Nations included another dimension, named "World Vision", referring to the relationship between mankind and self and the spirituality maintaining the relationships established with other living beings, demonstrating the ethics and responsibility that there should be in actions.

In Sachs approaches (2002), sustainability comprises eight dimensions, which, in addition to those suggested by Elkington, included cultural, ecological, territorial, national and international politics.

Elkington (2007b) also suggests that sustainability can be observed through a series of waves successively affecting politicians, enterprises, regulatory agencies and the financial markets.

The first wave includes the 1960s and 1970s, with the launching of the book “Silent Spring” by Rachel Carson and the rise of NGOs such as WWF - World Wide Fund for Nature, Friends of the Earth and Greenpeace, working for changes in government policies and regulations.

The second wave occurs in the 1980s and 1990s. More specifically in 1987, when the term "Sustainable Development" appeared for the first time via the report "Our Common Future", also known as the Brundtland Report, draw by the World Commission on Environment and Development. The Report did not stablished specific targets, but set balancing factors to be achieved.

A series of economic crises and environmental disasters led to the development of environment legislation and safety regulation, as well as the concepts of auditing and company commitment reports.

In 1988, the Green Consumer Guide was launched, selling over a million copies. The companies started, for a short time, to change their products design, but the situation was reversed in the 1990s with globalization.

The third wave began in the 2000s with the first World Social Forum, in opposition to the World Economic Forum, bringing together NGOs activists from around the world, campaigning on issues such as trade justice and debt as well as scarcity and exploitation of water. Corporate governance and responsibility became core financial market issues.

A fourth wave is rising for businesses and, according to Elkington (2007b), it is less focused on compliance and citizenship, moving towards creativity, innovation, business solutions and market incentives.

In this context, Bhamra and Lofthouse (2007) point out that several approaches appeared in the

Design sphere, such as Green Design and consumerism; Responsible Design and ethical consumption; Ecodesign and Sustainability; and Feminist Design. The projects began to emphasize social responsibility, human rights, environmental and ethical issues, to the detriment of projects aimed only at profit.

Essentially, Design will pursue different forms of approach and terminology, following social movements, which can be summarized as Green Design; Ecodesign; and Design for Sustainability (Bhamra and Lofthouse, 2007; Vicente et al., 2012). Figure 1 identifies the relationship between these, locating them in different decades.

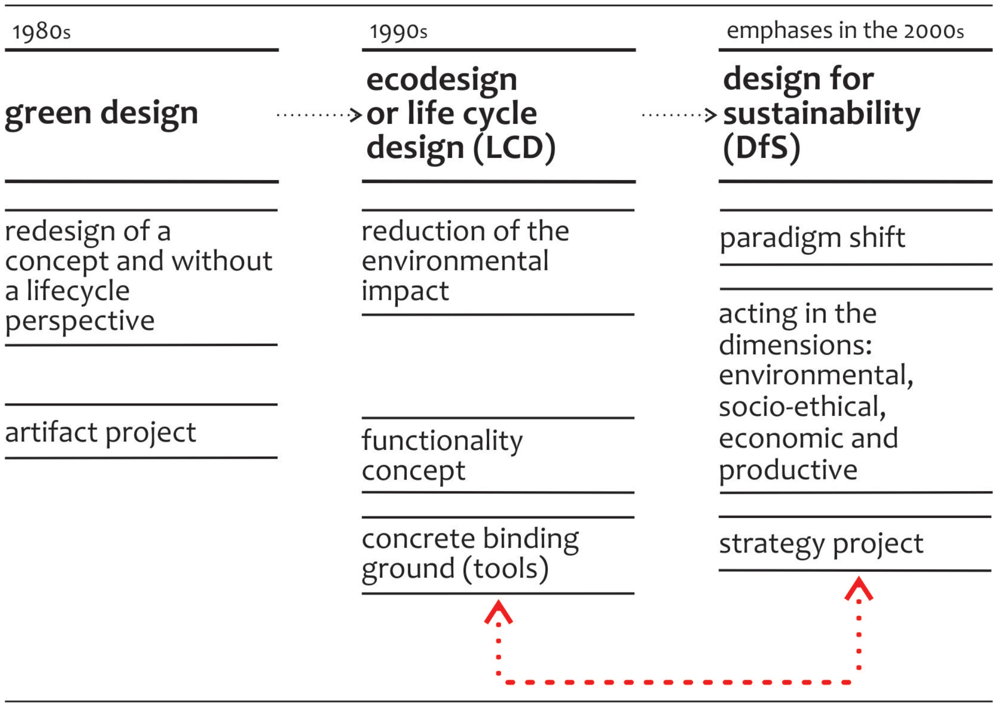

Figure 1.Relationship among Green Design, Ecodesign and Design for Sustainability.

Green Design focuses primarily on one or two aspects of a product environmental impact, such as use of recycled or recyclable materials and reduction of energy consumption. This implies the use of less material to perform the same function and recover some value from the material through reuse or recycling.

Usually, Green Design relates to redesign the same product concept without a lifecycle perspective. This approach has been more widely developed throughout the 1980s, simultaneously to the Green Consumerism movement. This model has led to misunderstandings, such as to consider that environmentally friendly products could have no impact on the environment (which is counterproductive), or a low-tech reference, with inferior materials.

Ecodesign, also referred to as LCD – Life Cycle Design, is characterized by a model that considers each stage of the products lifecycle in order to reduce adverse environmental impacts, associated with all other traditional design criteria, such as ergonomic, functional and aesthetic.

To that end, and considering the close relationship among design, production and consumption, there is a need to know, in a systematically way, the potential impacts so that project decisions are adequate and efficient. Its goal is to create a product or service systemic idea, in which materials and energy inputs, as well as the impact of all emissions and waste, are reduced to a minimum, either in quantitative or qualitative terms, thus evaluating the harmfulness of its effects. It is characterized by a very comprehensive process and variability depending on the size of the manufacturer, legislation and product type, among others (Manzini and Vezzoli, 2005; Vezzoli, 2010).

In the 1990s, digital tools were created for the Life Cycle Design, aiming the incorporation of environmental issues in the project development (Fuad-Luke, 2002).

However, in 2000 a paradigm shift in the production and consumption system can be observed (Green Design and Ecodesign). The Design for Sustainability (DfS) intends to act in the three considered dimensions of sustainable development: environmental, socio-ethical, economic and political. To this end, it has been defining strategies, methodologies and tools in order to incorporate these elements of sustainability in project activity. Some approaches stand out: usability, social responsibility, legislation implementation, eco-innovation, product-service system, human wellbeing, co-creation and radical change.

For Manzini and Vezzoli (2005), Life Cycle Design is a methodology inseparable from Design for Sustainability, because both are complementary activities for the development of sustainable products and services. The strategic nature of Design for Sustainability allows Life Cycle Design to go beyond the limits of redesign existing products. By contrast, Life Cycle Design provides a solid foundation base.

Directing these approaches to the packaging design industry, Manzini (1992) establishes a scenario consisting of three different levels. The first is called 'packaging eco-redesign' characterized by the involvement of purely technical actions and not requiring any changes in lifestyle and consumption. The only social component reference, that is to say, the market, may be regarding a certain 'ecological sensitivity' as to the choice at the time of purchase.

At this level, solutions such as environmental labels can play a positive role in terms of information and, subsequently, guide consumption. It is also at this level that the disposal of highly toxic products; minimization of the exploitation of raw materials and energy (wall thickness reduction, packaging weight reduction, etc.); the use of recycled and recyclable materials, among others, can be considered.

The second level is called ‘design of new packaging solutions replacing the present ones'. This requires partial changes in consumption and lifestyle. These changes must be socially accepted. In this case, technical and productive innovation can search environmental quality more freely. Its limit is the difficulty of introducing sustainable solutions for different cultural values and behaviors.

The author suggests, for example, for the packaged product itself to be able to be recreated in order to require less packaging (from the elimination of need for protection to the creation of ‘edible packaging'). For secondary returnable containers to be inserted in logistics. For communication and information skills to be placed on the shelf displaying the product, and so, the packaging can be more neutral. For the development of 'usage tools', designed for the product and allowing easy reuse. Acting on these issues, the requested change reflects substantially in the distribution system, which should play a more complex role.

The third level is called 'proposal for new production and consumption scenarios corresponding to new lifestyles'. This requires the highest level of social acceptance. According to Manzini (1992), at this level designers may play an outstanding, but limited, role in the collection, interpretation, re-consideration and stimulating socially produced ideas. In this case, new quality criteria in production, distribution and consumption override the application of new technologies or production opportunities. Such qualities must be environmentally sustainable, socially acceptable and culturally attractive at the same time.

In fact, the problem is to set a trend opposite to the currently one, for example, changing a 'product of increasingly simplified use' to a tendency in which the product requires increased consumer awareness and active participation. Interventions at this level imply that the focus of interest is not so much in a special packaging, but in a system that allows the minimization of packaging by maximizing the quality of its use. These measures can be pursued in a broader sense, and may involve the elimination of packaging.

Considering the premises, this study intended to research initiatives in the food-packaging sector in self-service (supermarkets), here in analysis, aimed to propose new paths to sustainability, in a close approach with the proposition of Manzini, mentioned above, as new production and consumption scenarios corresponding to new lifestyles.

3. Paradigm Shift

The motto "do more with less" has its roots in the first industrialization, when Henry Ford himself established operating policies of lean and clean, saving millions of dollars by reducing waste and setting standards to the assembly line (Braungart and McDonough, 2013). This precept influenced, years later, the proposal to the linking between efficiency and environmental sustainability. This, perhaps, was most notoriously articulated in the report Our Common Future (mentioned above), when implying that industrial operations are more efficient when generating less pollution and waste.

However, the World Business Council for Sustainable Development (WBCSD) would only officially coin the term “eco-efficiency” five years later, during the Rio 92 Conference - Earth Summit.

Since then, eco-efficiency is considered a philosophy that encourages business to seek environmental improvements that also yield economic benefits, making the human industry from a system that takes, makes and wastes in a system that integrates economic, environmental and ethical concerns. Currently, industries around the world consider eco-efficiency the strategy of choice for change.

There are warning, however, that ecological efficiency opportunities may occur at any stage of a product lifecycle and that this fact does not automatically lead to sustainability, for improving in relative terms (impact value) may mean increase the overall impact of an activity and create unacceptable or irreversible damage. Critics claim that incremental improvements in efficiency distract from the innovation necessary to achieve real improvements and behavioral changes. Arguing that the environmental footprint of the wealthy is too big, they require sufficiency instead of efficiency (Bhamra and Lofthouse, 2007).

This precept aligns with the approaches of Braungart and McDonough (2013) when pointing out that reduction is a core principle of eco-efficiency. However, decrease of toxic waste, or the amount of raw materials used, or the size of the product, do not stop depletion and destruction, only slows them down, allowing their occurrence on a smaller scale and for a longer period.

One of the examples mentioned by the authors is on the disposal of waste. When these are incinerated, it is argued that the procedure is healthier than grounding and has energy generating potential. However, the materials are not designed to be burned safely and may release dioxins and other toxins when incinerated, becoming another problem.

The same applies to composting or recycling. In the case of composting, if the materials are not also specifically designed to become healthy food for nature they can develop into a problem. In the case of recycling, the creative use of materials considered recyclable can be a mistake, "despite good intentions."

In this sense, eco-efficiency is not a successful long-term strategy. Its superficiality works only within the system that caused the problem in the first place, and only differs in moral proscriptions and punitive measures (in reference to government regulations).

In this regard, it is suggested that better than to focus on efficiency, which is anchored in the old model, should be to embrace the challenge to be effective towards a rich mixture of considerations and desires. Thus, to consider the term 'eco-effectiveness' as a concept from which to 'expected more, not less'. This does not mean making industries and systems smaller, as in the eco-efficiency premises, but design them to become bigger and better, to replenish, restore and nourish the rest of the world. Thus, efficiency can be considered a tool that, within the concept of eco-effectiveness, supports a broader and deeper view to 'do the right things instead of doing the wrong things less badly' (Braungart and McDonough, 2013).

This premise can also be associated with some findings of Manzini and Vezzoli (2005). Based on the notion that the current society is measured in terms of population growth and consumption of raw materials, the authors state that at the prospect of achieving a sustainable scenario, the discontinuity of this model should be verified. This discontinuity should reach all system dimensions: physical (the flow of material and energy); economic; institutional (relationship between social actors); ethics; aesthetics and cultural (the criteria of value and judgments of quality that socially legitimize the system).

Despite the difficulty of being able to predict exactly how this discontinuity may occur, the same authors also note that we have entered a transition phase, which should be long and intends to promote management, seeking to minimize risk and increase opportunities.

In a radical perspective, they establish the hypothesis around the possible appearance of multiple sustainable societies, completely dissimilar from one another. This fact will be influenced by the forms of the transition, that is to say, the behavior of social actors, the rise of new cultures, the balance of power established and the creation of new institutions. In other words, the transition to sustainability will be, besides diversified, a major social, cultural and technological innovation process. One of the paths to be followed is the recognition, by a large number of people, that the transition is an opportunity to improve well-being level. This will occur with the transformation of value judgment and criteria to interpret a well-being idea, that is, a profound change in the current dominant culture.

4. Methods

Considering the approaches here exposed, the research sought to identify how the food-packaging sector in self-service can be effectively positioned in search for the so-called Design for Sustainability. It also sought an association to the theory of Manzini, previously mentioned, when referring to the 'proposal for new production and consumption scenarios corresponding to new lifestyles'. This also highlighted as opportunity for designers in effective terms of projects and participation/influence in new paradigms that achieve sustainability.

Thus, an exploratory research has been elaborated, by means of bibliographic review, of a specific kind of supermarket. This stands out for the proposition of solutions closer to behavioral change and/or production and consumption displacement from the conventional system.

The supermarkets were surveyed separately and later a Comparative Analysis Framework was elaborated, with the distinction of the following: name of the establishment, location (city(s)/country), opening date, owner(s), proposal, philosophy/mission, products and services, features, store size, related sites and important links.

The survey was conducted from November 2015 to February 2016. It comprehended digital media, such as websites made available by the companies: official websites, Facebook pages, Blogs, corporate videos, as well as articles from the press, like magazines and online newspapers.

The survey also included four on-site visits in the city of Curitiba, Brazil, two in Lisbon and one in Porto, Portugal.

The tool has the main purpose of defining the profile of the proposal of this kind of supermarket, as well as its operation and needs, allowing the recognition of new approaches for designers in the Design for Sustainability context.

5. Results and Discussion

For the Comparative Analysis Framework twenty-three small and medium-sized supermarkets, of approximately 100 m^2 to 400 m^2 and offering around 1000 to 8000 items were listed. These are located in nine different countries: one in Germany; one in Austria; five in Brazil; five in Spain; two in England; two in Italy; five in Portugal; one in Switzerland; and one in the United States.

Most of the stores opened between 2000 and 2015. The year of 2011 stands out for the number openings, a total of six, being: one in the United States, two in Spain, one in Portugal and two in Brazil. Only two stores surveyed refer to other dates, one inaugurated in 1974 - considered a pioneer in Portugal - and another in 1990, in Brazil, both of which are restructured for an updated language.

Among the main common features the establishments distinguish as their philosophy or mission, these can be highlighted:

a) Reduce the volume of packaging residue;

b) Reduce food waste ("buy only what you need" concept);

c) Promote local and seasonal purchase ("km 0" concept)

d) Promote responsible purchase with sustainable consumption

e) Promote healthy eating

f) Promote sustainable health and life

Some descriptions provided by the companies epitomize the concept that can align all of them, such as, "We want to inspire more people with our passion for nature and food. We want to sensitize everyone to be more ecologically responsible. We believe that the time to make known the quality of organic products has come"; or "The resources of our planet are limited, some are already scarce. We have to be more responsible, to safeguard the natural balance of the ecosystem and the typical range of flora and fauna of our fields"; or even "Our ecological commitment involves producers, distributors, employees and customers, which together with other trades of ecological products daily strengthen the respect and love for the environment we live in".

Thus, the range of products offered by the stores is also quite similar. Products have organic certification and/or are from known and reliable sources, engaged in sustainable practices. In other words, the products are free of pesticides, do not contain any chemicals or synthetic additives - such as preservatives, pesticides, growth accelerators or genetically modified organisms.

These establishments state their given preference to local producers, stimulating local trade growth and stressing the concern over the reduction of energy costs and pollution generated by transport from distant locations. Some call themselves "Zero km", a term referring to this sort of attitude. At the same time, they do not use convenient distribution channels, eliminating intermediaries, reducing costs and ensuring fairer selling prices.

All stores offer bulk products. One of them states: "Our proposal is to sell food in a half-forgotten model but, in a new format, very valid for new habits and the new social reality." All also praise that bulk sale enables them to sell higher quality products at a fair price. Another important factor is for the consumers to be able to purchase just enough product, according to their specific needs thus, avoiding waste. This can also be associated to packaging reduction, therefore, residue reduction.

Among the products there are: cereals (ex.: whole-grain rice, wheat, rye, oat, barley, quinoa, corn, millet), leguminous (ex.: beans, chickpeas, lentils, peas, lupine), dry fruits, cookies, teas and infusions, coffee, oleaginous (ex.: sunflower seed, flaxseed, almond, sesame seeds, peanuts, pumpkin seeds, pistachios, nuts), pasta, spices, sauces, olives, salts, sugars, oils, jellies, jams, breads, dairy products, eggs, fresh vegetables and fruits. Juices, wines and craft beers can be found in bulk or already bottled.

Most also have organic cleaning products in bulk, such as soaps and detergents (for home, clothing and dishwasher).

The establishments are concerned about the seasonality of fresh products, valuing the product according to the time of the season. According to them, the main advantages are cost and nutritional benefits.

It is also observed the outline of special sessions, with designations for vegetarian, dietetic, gluten-free and other specifics products, such as babies and children goods. In this case, there is an allusion to the term "alimentary pedagogy" following the proposal to educate children about “healthy habits" from an early age.

Regarding the consumption of meat, of all stores surveyed, thirteen do not market it. The other ten do, however, most of them provide only the sausages and processed meat. There is clear concern regarding the origin of animal products. It relates to the animals being raised with dignity and stress-free, fed a natural feed and in appropriate spaces. This information is also included in other animal products, such as dairy.

Among other recognized factors regarding the product supply, those of sea origin present a "sustainable fishing" certification, and for eggs, there is information regarding their origin from certified organic chicken farms, raised on natural diets and allowed to roam freely.

Other products are also offered, but there is no common way to all the stores. This is the case of dietary supplements; cosmetics; personal hygiene products; and pet food, all of organic origin. Cookbooks, nutrition and environmental education literature can also be found.

Regarding the time of purchase, customers are invited to bring their own reusable containers such as bags, bottles, flasks, etc. These are weighed before being filled with the desired product and the value then deducted from the final weight.

Thus, the self-service system prevails. One of the stores informs that its slogan is "pick, weigh and pay" fundament followed by all. The clients themselves are responsible for weighing their containers (when they have one) and filling it according to their personal need and choice. The whole process is induced to what many call "conscious, sustainable and responsible purchase" and three of the surveyed establishments refer to the concept as "slow food".

The stores also sale containers to costumer who do not carry their own. One of the establishments, for example, offers bags made from potato starch or paper, pointing out its biodegradability character. Plastic material is dismissed and/or avoided in all stores.

In this sense, some provide information such as: guidelines on the use of opaque glass bottles for oils, for the product is light sensitive; or bags made from cotton or linen for the purchase of breads, cakes, fruits and vegetables, because they absorb excess moisture. They also recommend well-sealed containers for dry products such as cereals, leguminous, spices and teas.

In addition to the space for the marketing of the listed products, eleven of the stores surveyed have restaurant, and three have coffee shops. In these, the products sold at the stores are used as ingredients and referred as "healthy and nutritious." An expression that stands out is the following: "products that are not only good but also healthy because of the way they are made". This fact is highlighted as relevant to the marketing of the products; informing clients' new ways they are able to prepare and consume them. In contrast, there is also a waste reduction goal, having a website from one of the stores stating their preference for products close to their due date. One of the supermarkets also refers to the whole concept as "good environmental sense and business logic", since it reduces residues destined for landfill, highlighting the fact that the store destines its organic residues for composting.

Prepared foods can be consumed on the store or taken home. On the menu of the restaurants there are soups, salads, juices, pasta and cereals and, in the coffee shops homemade cakes, sandwiches, teas and coffees.

Another interesting factor is how food preparation also enables those who work in the kitchen to learn, including food hygiene, and increase their knowledge about some products that differ from the usual habits of cooking for most people. These are also passed on to customers who wish so.

Regarding the physical configuration of the establishments, there has been a distinct concern regarding layout and furniture (Figures 2 and 3). There is an explicit intention to be seen as a distinguish business, attentive to detail and eager to provide assurance to customers. There is no excessive advertising posters or exploitation of trademarks and information about the products are usually found on shelves or counters. The general idea is to create a welcoming environment in which the client "feels at home" and can make a serene, conscious purchase. Strident background music is avoided. The corporate image, through logotype and its applications, remits the concern to a minimum of excess, a "clean" atmosphere.

Figure 2. Example 1 of researched supermarket. Photo: Mencari (2015).

Figure 3. Example 2 of researched supermarket. Photo: Paul Bauer (2015)

Most initiatives come from private individuals, enabling the stores to walk the sidelines of major business agreements in terms of lobbying and market assessments. Individually, in pairs, or groups of up to five people, these shop owners decided to open their own business, for they are already part of the discussions on sustainability, environment, nutrition and/or any questions that induced them to seek a change of life.

One of the stores stands out due to its proposition to create a cooperative in which the customers are invited to work for a few hours (ex.: replenishing shelves, cleaning, cooking, etc.) in exchange for discounts on purchases. The idea has been a success, with the number of accessions higher than expected and the possibility of discounts higher than those planned at the beginning of the proposal.

Five establishments expanded their physical store activity for online stores associated with delivery service. In one of the stores, this is even done by bicycle.

A profile of the business owners shows they are mostly young people for who the internet is very important. The institutional websites are mostly well designed, with high quality images and plenty of available information. In addition to this, they all make use of other digital media, such as Facebook, YouTube, Instagram and Blogs.

In these means one can find, in addition to the full range of products, their history and properties, how to use them, curiosities, therapeutic characteristics, recipes and cooking tips. Among other additional information, there are explanations on organic farming, global warming and global environmental issues. One of the sites, for example, teaches how to make compost, plant tuber and vegetables.

In these media are also disclosed events held by the stores, an item common to all. Among them, one can find cooking and essential oils workshops, tasting and film sessions or happy hour with local artists. Some stores also lease specific areas to external affairs, such as birthday parties and corporate events. Two of them also hold seminars for candidates of their franchise system.

Among the differences, regarding the proposal, there is a hair salon belonging to one of the stores in which they use only henna and vegetable dyes, completely avoiding products that can damage the scalp, such as perms.

In specifying the profile of the targeted audience, most of the stores surveyed point out those individuals concerned about environmental issues, willing to reduce waste and with a diet based on healthy habits. These can be young people, who recently left the house of their parents and new parents who want to create new eating habits. There is also consumers who use organic products only for their children. However, it also covers singles and seniors who need small amounts of product and large families, shopping with children and starting the process of teaching how to shop.

The following statement, from one of the stores, exemplifies a context common to all: "Our customers are those who, fleeing the standardized purchase offered by department stores, look for a neighborhood business. The client does not value only the purchase itself, but the emotion associated with it." Another store states the following: "Our mission is to make organic products the most affordable for everyone, regardless of consumer preferences and individual purchasing power."

The research here in progress, sought to identify whether the proposal of these stores is successful and represent an economically viable business. The three oldest establishments, started respectively in 1974, 1990 and 2000, have become traditional selling points in their areas and, probably due to their pioneer spirit, established a customer portfolio, enabling improvements and growth. They display some flexibility regarding the use of packaging, making available, for example, plastic containers.

Among the establishments surveyed only two detail their history, showing positive and negative aspects. The older of the two opened in 2006, in the city of London, and is considered a precursor among the successors. In 2014, it threatened to go out of business. However, in 2015 it revived sales through a partnership with an organic products company, which according to them, allowed the "corner store" to turn into a supermarket, confirming an enlarged proposal format. Online sales have also intensified and are greatly responsible for restoring the enterprise.

The other establishment to expose its situation opened in 2011, in the United States. It says that after two years of operation the initial enthusiasm did not result in profit, despite the positive feedback from the surrounding community. For the store, its main weaknesses are related to consumer habits (people are not prepared to shop completely without package); the difficulty of bulk products brands - some of the most popular products are not viable for the package-free idea; and the lack of time and customer effort to better understand the relationship of prices (the value of the kilogram seems high at first, but when broken down into grams, for example, it becomes affordable).

However, the company did not give up and continues to focus on consumer education/information. It decided to make some product adjustment and keep three major initial ideas: zero waste, local food and community. With regard to this, every six months a new local partnership with a non-profit institution is made (ex.: animal protection society, human trafficking, etc.) and thus, it increases awareness about the organization and raises funds - a donation of 5 cents per customer that reuses a container. It also continues holding events on recycling, zero waste and local food system to attract and educate consumers.

6. Conclusions

The concepts of sustainable development anchored in the critics, over the decades, by several authors, reflect in the design area searching for a more holistic reading (environmental, social, ethical, economic and political) of the ongoing global issues.

In this sense, the Design for Sustainability is configured as an important contribution for it may involve more radical changes, associated with the rereading of paradigms. It involves analysis and discussion about eco-efficiency to effectively achieve the necessary innovation to real improvements and behavioral changes.

The proposed, and hitherto held, research shows initiatives in several countries in order to modify production patterns and consumption in sectors involving food packaging in self-service, in line with the principles of Design for Sustainability.

Through an exploratory research, with literature review and developing of a Comparative Analysis Framework, associated with on-site visits, it was possible to draw a profile of these initiatives. These are configured as small and medium-sized supermarkets, founded by people involved in environmental issues and unrelated to the business agreements of large enterprises, allowing costs reduction. They advocate for responsible and sustainable consumption, prioritizing food quality. For this, they validate the organic farming origin of food, in other words, free of synthetic fertilizer or pesticides, and follow seasonal production. In addition to healthy eating, this fact is associated with the concern to avoid the degradation of farming environment, the contamination of soil, air and rivers.

Local suppliers are also prioritized in order to reduce the "ecological footprint", for it avoids shipping and handling of products from distant locations.

Another characteristic feature is the proposal to reduce packaging waste. In this regard, most of the products are sold in bulk. Returnable and recyclable packages, such as, fabric or paper bags and glass jars, are a priority. Self-service is intensified bearing in mind that the consumers are responsible for packing and weighing the purchases, as well as bringing their own containers. There is an incentive for a greater involvement of the consumer in the purchase process or even store management.

Bulk products also intend to stimulate the consumption of minimally processed products, avoid waste and buy only the necessary for each specific situation (concept "buy only what you need").

Shelves and counters are used for communication and information relevant to the products, so, packages take a more neutral character. The same applies to the whole environment, which does not exhibits posters and advertisements in excess.

This research can therefore concluded that there is, in the consumer market, a movement for the change of the current form of production and consumption in the self-service system involving food packaging. The similar profile among the surveyed establishments may indicates an expanding tendency, which involves sustainability and social responsibility concepts, human rights, environmental and ethical issues to the detriment of projects aimed only (but also) at profit.

Being configured as a new proposal related to behavior change, the communication and information process, both inside and outside the stores is relevant. For well-informed consumers can participate consciously and proactively, an issue critical to the success and continuity of design.

Most establishments are relatively new experiences and require further operating time in order for more conclusive analysis results to be obtained. However, from the moment, they represent a new playing field for designers. In addition to theoretical analysis, these professionals can effectively contribute by rediscovering, along with the establishments, opportunities such as: new ways to display products; ergonomic and functional bulk product dispensers; tools to facilitate self-service; among others.

To this end, deep analysis and research also should succeed, so the approaches do not escape the real intention and recommendation of Design for Sustainability in its major essence.

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Sustainable development of non-structural materials for the construction of rural housing in Ráquira, Boyaca, Colombia

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Abstract

The project was developed in Ráquira in a rural area located 120 km from Bogota, the inhabitants of this sector as a source of income are making crafts, agriculture or used in coal mines recently opened. In this area traditionally built with earth and from some thirty years ago, cement and brick displaced the technique. The construction with these new materials is more expensive for a farmer in this sector, but also pollute more in their construction processes. The materials used, brick, cement, sand, steel, are not manufactured in the region (Ráquira Boyaca) and are transported from Bogota or Tunja, this not only increases the price but the carbon footprint of each of these elements. The study area has a moderately low rate of rainfall below normal between 30-60% according to IDEAM, and none of the houses advantage of this location, to utilize alternative sources of energy generation, the inhabitants abandoned techniques sustainable construction led by the post-industrial trend of the 20s that made these is seen as something poor and obsolete. Currently the land use as building material in Colombia is going through a rediscovery, reattachment through sustainable characteristics of this material and its history. The earth as a building material not only has a number of good features to be 100% sustainable but is also an economical material and easily accessible for users of these rural households, farmers in Ráquira. A case study of a home built with Adobe over thirty years was made, there adobe samples were taken and the first trials with earth and lime coatings were made. Tests were performed by mixing different materials in the manufacture of adobe, 10 samples were made and 3 prototypes panels face, trying different materials, sisal, hay, recycled rubber wood in very small sections, wire mesh steel, in addition to testing different support materials, tested different materials to give him the land more stability and strength. A module housing is built at the home of Mrs Fanny and the panel better throw in the tests carried out was applied. The main result is a panel made of wood, with two diagonal elements for added stiffness and built with two layers of earth, each supported on a steel mesh, steel mesh are attached to frame forming the steel panel between these two layers an air chamber that serves as thermal and acoustic insulation is created. This panel is in the process of obtaining a patent in Colombia. It is possible to build sustainable rural housing in Colombia, redesigning ancestral construction techniques such as adobe, changing and improving some components that shape to be applied in the construction of rural dwellings.

Keywords: earthen panel, sustainability, design, Colombia, architecture

1. Introduction

The Commission formalized the definition of sustainable development for the Environment in the UN document known as Brundtland report (1987). This definition addresses the needs of environmental resources for present and future generations and defines sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." (Alvarez, 2010).

This definition has been adapted to the particular needs of each sector in the field of architecture for example; the study Norman Foster + Partners, sustainable architecture defines how "the creation of buildings that are efficient in terms of energy consumption, health, comfort and flexibility in use and are designed to have a long life". (Foster, 2003)

The Building Services Research and Information Association (Association for Information and Research Facility Buildings, BSRIA) have defined sustainable construction as "the creation and management of healthy buildings based on ecological principles and the efficient use of resources". (Kibert, 2009)

The concept of "sustainable development" has numerous variables but a common denominator, which is based on growth and social welfare; it must ensure the conservation of environmental resources by the present generation, for the benefit of future generations.

The materials used in the construction exert environmental impact caused by the extraction, processing, transport, use and disposal. This impact occurs on the global and regional level affecting the climate, biodiversity and health of people.

At the same time, there is no unified methodology that works as a guide for those responsible for choosing the materials to be used in construction. Usually, the concept of "energy incorporated "is linked to the lifetime of a building; the materials used represent 10% of the energy consumed by the use of the building. However, this concept serves to highlight the elevated energy costs associated with the transportation of bulky materials (stone, aggregates, bricks or concrete) and the processing of some very light materials used (aluminium).

There are three principles derived from the concept of incorporated energy:

Local supply of heavy materials: materials like stone, aggregates, bricks, etc., they must be obtained from quarries or manufacturers located near the work, to save energy in transport and reduce the environmental impact caused by noise and pollution. Ideally, the materials could be produced in situ (such as sun-baked bricks are usually developed in Africa or the Middle East as part of the construction process) or obtained within a reasonable radius (10km). Applying this principle; plus, it reduces environmental impact, would help to strengthen local construction techniques and generate employment for the community where the project is developed.

Global supply of lightweight materials: in the case of materials such as aluminium and PVC, most of the embodied energy comes from the manufacturing process. "However, once the energy has allowed the manufacturing process is developed, the company has a reserve of material resources that can be used, reused or recycled. This represents a capital reserve deposited in buildings releasable at the end of life "(Edwards, 2013)

Lightweight materials play important roles in energy during its lifetime, which reduces embodied energy load. In the case of aluminium, to cite one example, how properties have reduced cooling requirements in buildings because it helps to capture solar energy; with the pass of time energy obtained compensates for its high-embodied energy. (Bellart, 2009)

Recycling potential: not only considered the beginning of the process incorporated into energy, but also will be necessary to use in the final stage of life of the building, demolition. Reuse and recycling, and ensuring residual energy is extracted before the material is deposited in a landfill; are considerations that should influence the initial selection of materials. For example, through combustion in an incineration for electricity generation or in fertilizer production by a fermentation process that decomposes materials useful by chemicals products or plants. (Coccato, 2008)

This design is thought in away in which that the building components and its parts can be reused and recycled, it also results as the easiest way to save energy with respect to the materials. The concept of Reuse refers to the destination of a material to a new use without undergoing significant transformation process. Recycling means that the material is processed to become a new product. Energy is one of the factors that determine the sustainability of a product, it is important to consider other impacts, such as the depletion of resources, water pollution and air pollution, damage to the landscape heritage, ecological and cultural product of logging and quarrying. (Energy, 2007)

2. Methods

This project was developed following two research Methods; in the first stage, qualitative techniques were implemented: interviews, surveys and case study applied to the Candelaria's desert population. The main objective was to determine and identify materials typology, used in the zone, for the construction of houses. Architecture students carried out surveys; processed data for the qualitative analysis, during the second stage quantitative techniques, case study and prototyping were used.

The house selected for the case study, was chosen for its antiquity and the materials under which it was built. (Earthen bricks, adobe) the analysis started by making an architectural drawing and photographic reconnaissance.

After this initial analysis some adobes were taken and mixing earth with lime to be used as a coating, see Figure 1. Based showing the adobe Fanny's house, with the first prototype, gaveras were created (wood moulds for making adobe) to prove that sustainable materials could improve the resistance of the earth. Recycled rubber, sisal, horse droppings and cement among others were used.

The next phase of this project a scientific method was applied to determine the mix and the materials that best worked with the earthen. Built three panels in wood, each with a material in its different core, the goal was to simulate different types of Bahareque (construction technique of Colombian indigenous). In each of these panels was tested with a mixture of earth and cement, determine the resistance to horizontal movement and the degree of adhesion of this mixture to the material that served as support, we finally managed to get a stable mixture and the core material will not deform under the weight of the earth.

From these tests, a panel that was used in the construction of a prototype timber in the home of Mrs. Fanny in the desert Ráquira and the patent registration was initiated and is pending approval by the official agency.

Figure 1. The Fanny's house, old earthen bricks used in the first test.

3. Results

In the first stage, these were the results of mixing materials and earthen Adobe bricks, the objective was to find a material with better resistance than Adobe bricks. Each mixture was subjected to a compression test, only because the objective of this research was not to find a seismic-resistant material, but a sustainable material that worked as structural enclosure. See table 1.

Table 1.Testing different materials in Adobe bricks fabrication

ID	% Earthen	% Ceme nt	% Recycled rubber tire	% Horse droppings	% Hay	% Dramix	% Ceramic ships	Resistance to compression Kg/cm2
1	82	4	-	-	4	10	-	44,5
2	88	2	10	-	-	-	-	34
3	90	6	-	-	4	-	-	74
4	80	4	-	-	4	-	10	15,5

The results were clear, the mixture improved the resistance to compression, 90% of earth, 6% grey cement, 4% hay; these percentages were used in the manufacturing of the panels in Bahareque. In the research, process took four mixtures of more outstanding materials and taking data BEDEC the ITEC (Catalan Institute of Construction) calculate CO2 emissions of these adobe bricks from aspect mix 3, it generated less emission than other tests. See Table 2.

Table 2.Kg/m2, CO2 materials emissions

ID	Earthen	Ceme nt	Recycled rubber tire	Horse droppings	Hay	Dramix	Ceramic ships	Total emissions CO2 kg/m2
1	0,001	2,57	-	-	0.013	11,43	-	14,014
2	0,001	2,57	4,5	-	-	-	-	7,071
3	0,001	2,57	-	-	0,013	-	-	2,584
4	0,001	2,57	-	-	0,013	-	0,5	3,084

In the manufacturing process of the adobes, it was found that adobe bricks have a very high weight, almost 10kg per unit. Due to the weight of the bricks and based on the fact that construction of houses would is carried out by women of the region this material was discarded. this information was used from this phase to the fabrication of a stable mixture.

First Panel

CO2 emissions, distribution of materials:

1. Earth Thermal Inertia: 1000 J / kg • ° C, CO2 emissions: 0,001 kg / m2, Percentage used in the mix 94%

2. Wood frame, CO2 emissions: 0,99Kg / m2

3. Fique's tissue CO2 emissions: 0.1 Kg / m2

4. Cement, CO2 emissions: 2,57Kg / m2 Percentage used in the mix 6%

Total CO2, emissions: 2,25m2x 3,341Kg / m2 = 7,517Kg

See Fig. 2

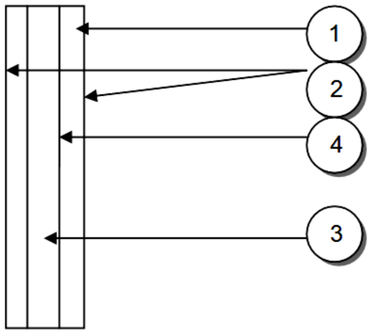

Figure 2. First panel, materials description section

On the next stage, the construction of Bahareque's models was implemented. The first panel, wood, cloth sisal and earth mixture 90% and cement 10%, resulted in a very unstable panel, in this frame it was determined that the fabric of pine has little resistance in addition to raise manufacturing costs. Weaving Fique was not well anchored to the wooden frame and also show much instability when putting on the mixing, this instability resulted in an effect of runoff of the mixture, sisal fibres adhere very well to the earth, which does not favoured their use in rural households. See Fig. 3 y 4.

Figure 3.Panel 1, Fique's tissue model

Figure 4. First Panel, Fique's tissue with earthen cement mixture

The second panel was made from a mixture of wood, hay, galvanized steel net, earth and cement. This module worked quite well but the hay is a very soft material and did not attach it to the wooden structure, circles were printed in this panel to reduce cracks by drying earth. In this frame, it was found that the hay that works as thermal insulation and rubber improved crushing strength with earth mix.

Dimension: 60cm x 60cm x 15cm

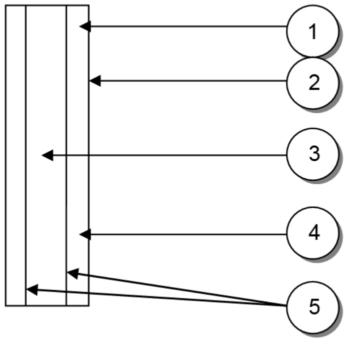

Figure 5. Second panel, materials description section

CO2 emissions, distribution of materials:

1. Earth, Thermal Inertia: 1000 J / kg • ° C, CO2 emissions: 0,001 kg / m2

Percentage used in the mix 95%

2. Wood Frame, CO2 emissions: 0,99Kg / m2

3. Hay, CO2 emissions: 0.013kg / m2

4. Rubber crushed, CO2 emissions: 1.3kg / m2 Percentage used in the mixture 5%.

5. Henhouse Mesh type, CO2 Emissions: 10, 5 Kg/m2

CO2 Total emissions: 0,36m2 x 12,804Kg/m2= 4,609Kg. See Fig. 5.

Figure 6. Second Panel, Hay between two steel mesh.

Third Panel was observed that the steel mesh type vein adheres well to earth, however needs some reinforcements to prevent buckling, the use of steel increased CO2 emissions of this prototype. The final prototype constructed in Mrs Fanny's house was based on this test. See

Figure 7 y 8.

Dimension: 1,50m x 1,50m x 14cm.

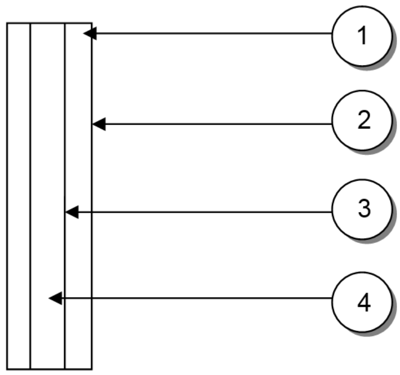

Figure 7. Third Panel, Hay between two steel mesh.

CO2 emissions, distribution of materials:

1. Earth, Thermal Inertia: 1000 J / kg • ° C, CO2 emissions: 0,001 kg / m2, Percentage used in the mix 94%
2. Wood Frame (Pino Sabanero), CO2 emissions: 0,99kg / m2
3. Steel wire, CO2 emissions 61,43Kg / m2
4. Cement, CO2 emissions: 2,57kg / m2, Percentage used in the mix 6%

CO2Total emissions: 1,5m x 1,5m = 2,25m2 x 64,991Kg/m2= 146Kg

Figure 8. Third Panel, steel mesh core with two earthen mixtures layers.

4. Discussion

The material earth used by pre-Columbian cultures for making Bahareque and which was built in our country was gradually replaced by cement in the twenties when the materials that emerged from the industrial revolution came to our country, steel and cement, then the earth was seen as a risk associated with material poverty and was replaced by new alternative. (Riveros, 2007)

Currently the earth used as building material in our country is going through a rediscovery and redeployment thanks to the sustainable characteristics of this material and its history. The earth as a building material not only has a number of good features to be 100% sustainable but is also an economic and easy accessibility for user's material.

Traditionally this material has four ways to be worked as a construction material are adobe, rammed earth, the mud and the BTC (Block compact earth), the latter in Colombia was named in the sixties CINVA-RAM thanks to a research conducted at the National University of Colombia and had as main objective to facilitate the construction of housing with these elements. Investigations are focusing on adding sustainable earth mix that will allow it to withstand compressive loads and improve their physical qualities materials.

5. Conclusions

The panel Bahareque developed in this project is unique in its type meets a requirement of environment, has a very low cost and is sustainable by incorporating materials with low CO2 emissions in their manufacture, the panel is an assembly made with products already processed and ready for use, the only manufactured element is the mixture of earth and cement. It is primarily intended for rural housing construction thanks to the ease they would get the material, however its use in rural areas is not excluded.

It is possible to resume traditional construction techniques and adapt them in order to improve them more adaptable to the current environment, in this case a material replacement as the bamboo prohibited for ecological reasons in this region of Colombia. It is a changed by a mesh-like vein, the adhesion of the mixture of earth and cement were improved, one of the most interesting aspects of this panel is the easy assembly by not having to take the network is done in the traditional Bahareque. The earth use as building material in rural areas of Colombia is clearly justified in this project, not only for the product sustainability of low CO2 emissions of materials used but by the economy of the same thing decisive for residents this zone. See Figure 9.

Reintroduction of traditionally used in building rural housing in Colombia sustainable materials is necessary. Latin American countries have a very restrictive earthquake resistant regulations and this has been the main excuse not to investigate, or use the earth as a building material. However, it is possible to reach a compromise, in which the wood in the structure and earth elements of the facade that are not structural in Chile and is being built in this way and we believe that in Colombia it is possible to reintroduce these construction techniques used.

Figure 9. Women residents working in the final Bahareque's panel.

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Design for sustainability models: a review from the perspective of design management, sustainability management and social responsibility

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Abstract

Design for sustainability (DfS), also designated as sustainable product development, is considered a key factor for sustainable development. Products are placed in the interface between production and consumption, therefore the consideration of sustainability criteria early in their development phase, to (incrementally or radically) improve them throughout the life cycle, opens up for innovations that contribute to tackle major sustainability problems in the context of a globalized economy. DfS can be defined as a holistic design approach to problem solving and to societal well-being that enables to integrate and assess the sustainability dimensions (environmental, social and economic) in different stages of the product innovation process towards the required scale of incremental and/or radical innovations. In recent years several models and frameworks have been proposed to support the operationalization of DfS in companies and value chains, but the diversity of approaches makes it difficult for researchers, practitioners at large, educators and trainers to gain a common overview on the subject. This is an obstacle to the practical implementation of DfS, ultimately hampering the prospects of a wide uptake from industry and professionals involved in design; therefore the related potential sustainability gains remain relatively unexploited. This paper proposes that the adoption of DfS is more likely to be successful if linked to the broader corporate sustainability management and thus an analytical framework to systematically analyse existing DfS models has been developed and applied; its conceptual foundations are lying, besides corporate sustainability management and social responsibility, in the design management theory. The identification of DfS models for analysis was carried out through an extensive literature review using the most relevant academic databases. The findings show that there are different understandings of DfS and therefore different authors specify different aspects to be included in the DfS models they propose. While some have focused on high level models that guide companies in establishing a vision and concepts for (more) sustainable products, others offer more instrumental approaches to guide the different phases of typical product development stages. Furthermore, the social dimension of DfS is still poorly established and tackled in a multi-level, non-systemized way. Full integration of environmental, social and economic criteria in design, rooted in stakeholder dialogue and validated by assessment methods, is not a common feature in the reviewed models. The review confirmed the lack of coordination between DfS models and sustainability-related strategies and practices at corporate level. The paper concludes with promising research directions in the field of DfS.

Keywords: Design for sustainability; design management; DfS models; sustainability management; social responsibility.

Integrating Design for Sustainability and Life Cycle Assessment – an example of a multi-material car component

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Abstract

Early phases of product development are very important not only for the reduction of costs but also for the improvement of a product's sustainability performance. This particularly holds true for innovative lightweight technologies in the automotive industry since they require new materials and developing new practices and processes, on which there is only insufficient data and experience concerning their sustainability performance available. This lack of information and a high uncertainty hinder the application of a classical Life Cycle Assessment (LCA), which requires detailed information and focuses only on environmental impacts. In order to support engineers and designers with integrating a comprehensive life cycle sustainability perspective in the early product development process, literature suggests the application of “Eco-Design” or “Design for Sustainability” approaches. Examples for such methods are the Eco-Design Checklist by Brezet & van Hemel (1997), the Design for Sustainability Impact Profile of the United Nations Environment Program (2009), the Method for Sustainable Product Development by Byggeth et al. (2007) or the Checklist for Sustainability Product Development (CSPD) by Schöggl et al. (2016). In contrast to the former tools the CSPD provides a method, which allows the integration of a full life cycle perspective into early phases considering all three dimensions of sustainability (environment, society, economy). Because of its characteristics it is also applicable for automotive lightweight technologies. This paper illustrates how the “Checklist for Sustainable Product Development” and Life Cycle Assessment can be applied together for optimizing the sustainability performance of a product during the development of a lightweight front hood. This case study first, outlines how the application of the CSPD can complement a LCA by allowing the qualitative assessment and valuation of environmental, social and economic aspects, fostering sustainability awareness and life cycle thinking among designers and engineers and supporting decisions over different product variants based on the sustainability evaluation. Second, it shows how a LCA and the CSPD were applied for continuously evaluating, comparing and improving three different variants of the lightweight front hood over a period of 4 years. Third, the results of the comparative LCAs and the sustainability evaluations with the CSPD are presented. They highlight the importance of an integrated approach towards sustainable product development and emphasize the importance of selecting, preparing and applying a set of appropriate decision support tools for achieving sustainability related improvements of a product. Based on these results finally, success factors for such an integrated approach are discussed and an application sequence is conceptualized.

Keywords: Sustainable product development, design for sustainability, eco-design, framework for strategic sustainable development, automotive industry, lightweight materials

Holistic Life Cycle Perspectives: Learnings from Life Cycle Assessments in Automotive and Energy Industries

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Abstract

The Life Cycle Assessment (LCA) approach allows to evaluate the environmental impacts along the whole life cycle of a product or product system – starting from raw material extraction, over production and use, to disposal and/or recycling. Till this day, LCA is the only environmental impact assessment method, which is regulated within the framework of an international standard. Although LCA is well-established in practice – to a greater or lesser extent depending on product type and field of industry – the methodology shows various weaknesses and open-end questions, which appear during the application. Also, it can be assumed that the improved utilization of synergies to other methods and tools would imply a higher grade of implementing life cycle thinking to daily business routines. The aim of the paper is to understand the application and complexity of LCA in different industries and for different purposes. It compares frameworks, contents and parameters for the selected case studies and shows critical aspects within the LCA approach. The contribution for identifying and capturing potential fields of improvement regarding environmental performance and a decrease of environmental impacts of products and product systems is analyzed. Furthermore, methodological aspects and links to social and economic issues will be discussed. Based on the ISO 14040 standard, LCA studies were conducted in automotive and energy industries. To illustrate and analyze the application of the LCA methodology a matrix was developed to identify obligatory and optional parameters and their level of detail to achieve meaningful LCA studies. Practical applications can highlight limitations of the LCA approach and support the further development of the methodology. As well, empirical findings forward the acquisition of experience regarding the suitability of LCA with techno-economic complements and disclose synergy effects. To guarantee objective LCA results, criteria or minimum standards related to branches or sectors could improve the quality and comparability of studies. This would imply a continuous advancement of the approach, to eliminate misleading results caused by critical aspects, like data collection and level of detail within LCA studies. In addition to it, a further development regarding connections to social and economic issues and synergies with other methods from the techno-economic sphere are demanded. This shall aim at a stronger implementation and the capture of synergies and harmonization with techno-economic methods and tools, with the overall objective to contribute to a sustainable development.

Keywords: Environmental Impact Assessment, Life Cycle Assessment, Techno-economy, Automotive Industry, Energy Industry

Community-based research for innovation and design: in the case of Qinghai

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Abstract

In China, most water quality monitoring projects are dominated by governments or NGOs, and solutions of water pollution including products and strategies are normally designed by experts in different fields. It is also wildly accepted that technology-centered method is extremely necessary to improve productivity of water protection activities. However, some places in which ethnical minorities live, their behaviour and values are deeply influenced by culture norms and social environment, so the lack of local cultural knowledge and unequal involvement of local community participants in collaboration lead to frequent problems in design process. The hypothesis of this paper is that whether a new community-based research which puts more emphasis on community structures and local organizations can be used as an effective way, reducing knowledge barriers in preparation for product-service system design in the context of water quality monitoring. This hypothesis was tested by a trans-disciplinary research team including design researchers, in cooperation with local NGOs for two weeks in Zarong(□□) and Ganda(□□), two of villages in Qinghai province in China. Water quality of Qinghai is extremely important since headwaters of main rivers in China are located over there. To test the feasibility, first of all, through field studies and interviews, we found that their social forms and community structures are completely different from major cities in China because of Buddhism beliefs, and their current water protection activities nearly all combine with religious events, so it is crucial to change design thinking pattern and pay more attention to community studies before design process. Then we defined three main culture-based community structures including temple-centered community, family-oriented community and cooperative-oriented community, which are highly associated with nomadic culture and Buddhism belief. Based on religious community structures, the authors developed a possible model of product-service system, which helps local communities to change their ways of water protection from reliance on culture to a combination of culture and technology. The findings will contribute to water system design including output of product prototype and strategic design in Qinghai. The culture-based approach discussed in this paper provides a starting point for increasing community engagement with design practices and research.

Keywords: Community-Based Research, Community Engagement, Water Quality Monitoring, Product-Service System

1. Introduction

New channel is a project that concerns Design for Social Innovation (Brown and Wyatt, 2010). This project was organised by Hunan University, and our team has carried out empirical studies of our practices in rural communities such as Hunan Province, Xinjiang Province and Sichuan Province in China from 2009 to 2015.

As a part of the “New channel” Social innovation and design project in rural China, this research has been carried out at Zarong and Ganda, two villages of Yushu Tibetan Autonomous Prefecture in Qinghai Province.

Yushu is located in Sanjiangyuan National Nature Reserve (SNNR), which is the area of the Tibetan Plateau. The SNNR was established to protect the headwaters of three rivers, including the Yellow River, the Yangtze River, and the Mekong River (called Lancang River in China).

In addition to this, this area is also Tibetan Minority's main residential area. Tibetan nationality is one of the major ethnic minorities in western China, with a population of 6.4 million (2013 year-end statistics of the Chinese government). Most Tibetan people are devout Buddhists, and observe Tibetan Buddhism. A large number of temples and monasteries are constructed in Tibetan areas, and Lamaseries spread all over there.

2. Methods

Sanders and Steppers (2008) highlighted "we are designing for the future experience of people, communities and cultures who now are connected and informed in ways that were unimaginable even 10 years ago". Meeting global challenges requires people from diverse disciplines to engage in bottom-up actions and idea generation (James, 2001). This changes the role of various disciplines including design, as more designers want to engage in solving relevant problems (Robertson and Sobol, 2011) and provide useful design solutions. Fleischmann (2013) mentioned that "key in the process is to learn from and with others, to work in inter-, multi- or transdisciplinary teams and to involve the people who would benefit from the product, service or process in the social innovation process". As an effective approach to handle such challenges, co-creation requires all who are involved to develop empathy, to share and to accept equal partnership (Fleischmann, 2013).

This research undertook the Community-based participatory research(Israel et al., 1998), which is a participatory approach (Israel et al., 2008), collaborating with design researchers, local community members, and NGO representatives. We defined community structures based on the findings of field studies, observation and semi-structured interviews as well as literature reviews. Then, in the process of design practice including product-service and system design, we used the community centered design (CCD) method, focusing on the interaction between humans and how it is facilitated by technology (DePaula, 2003).

3. Results and discussion

3.1 Buddhism-based community in Tibet

Based on the explanation that a community is a group or network of people who are connected by durable relations, and who mutually define that relationship as important to their social identity and social practice (James et al., 2012), we identified the Tibetan community as our macro-geographical research object. The community structure in Tibetan rural areas is totally different from it in mainland countryside in China. For example, temple-centered education system replaces most schools to educate Tibetan people.

Durkheim (1964) suggested that the ideal links between community members as a social based on its own culture may be realized in the social innovation process. We also found Tibetan Buddhism has a huge influence on local community activities, and religion has become their norm in their daily and social lives. We selected Ganda and Zarong villages as our research targets. We finally concluded three main community structures. On the other hand, a local NGO has launched many environmental campaigns and make efforts to raise residents' awareness. The existence of this organization is extremely significant since this NGO help local change their ways to do relevant environmental protections, so we also discuss the role of this NGO in the local community structure.

3.1.1 Temple- centered community

Temples play a key role in local development, especially in a variety of local activities. Many Buddhist temples and monasteries are constructed with the financial assistance of local villages and individuals. Based on the findings of preliminary research, four striking features of temple-centered community are identified (Table 1). Temples are places where villagers engage in

Buddhist ceremonies, and it is also a main responsibility for temples to pray for a peaceful and happy community. In addition to that, Tibetan temples have rigid hierarchy and a completed system of examining and assessment. The temple education system is made up by three levels, including Laji (□□), Zhacang (□□) and Kangcun (□□). These temples are organized by the highest temple, and each local temple has departments with different responsibilities.

Table 1. Four striking features of temple-centered community

Features	Function	Main activities
Religion	Religious Building	Buddhist ceremonies/Chant sutras
Education	Schools	Monks debating/ Lectures by Living Buddha
Culture	Places for traditional culture learning	Learning Tibetan calligraphy/language/medicine
Environmental Protection	Meeting place	Meetings with local governments and organizations

3.1.2 Family- united community

On the other hand, family-united small communities are situated along rivers one by one. Based on findings of field work and interviews in the Ganda village, Figure 1 shows that there are nine riverside residential areas along main streams of Zhaqu River, and a small community consists of three generations, including elderly, parents and children. One community is closely connected with other eight communities.

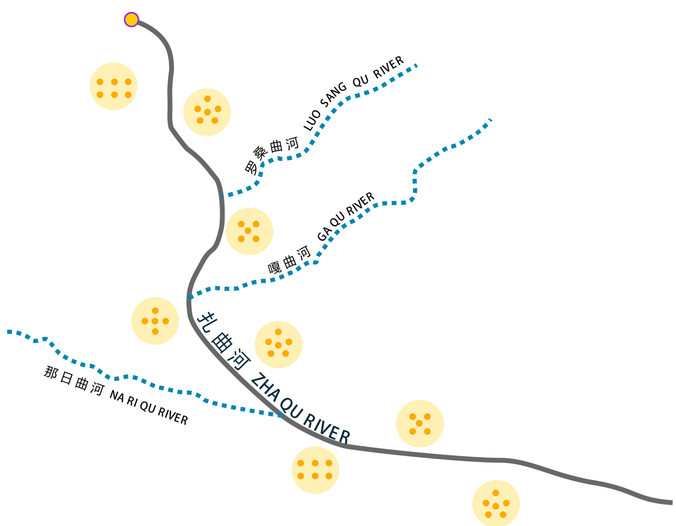

Figure 1. Nine family-united communities along the Zhaqu river Example of figure.

One of the most obvious examples is, two communities are mostly blood related, and therefore villagers are relatives, but in practice individuals are often very independent or isolated from one another.

In community-based studies, individuals can be considered to reside within households, which are located within neighborhoods, which in turn are located within cities or counties (Gulliford, 1999). It would be an effect way to find out social links by observing individual subjects, because they are usually clustered within higher-level units of social organization. In order to find out relevant links, this project also carried out an observation of a typical woman about her daily, religious and social activities in Zarong, which can be beneficial to reveal the interaction between a small community and individuals. The result had been displayed in Table 2.

Table 2. An observation of daily, religious and social activities of a typical woman in Zarong

Time	Daily/Religious /Community activity	Activity content
Early morning	The daily activity	Make a fire
		milking
		Put yaks out to pasture
		Pick up yak dung
Morning		Eat breakfast
	The religious activity	Light a Suyou candle for Buddhist ceremonies
		Pay respect to Buddha
		Kowtow to Buddha
		Chant sutras
Afternoon	The daily activity	Chat with others
		Make yogurt/do domestic work
Evening	The daily activity	Cook dinner
	The religious activity	Chant sutras
	The community activity	Meeting

3.1.3 Cooperative-oriented community

High altitude and highland climate lead to the reliance of raising livestock such as yaks and cultivating highland barley. Natural conditions put a huge limit on local residents' way of living and production, but the cooperative-oriented community improves their work productivity.

Based on interviews of two typical cooperatives in two villages (Figure2), we found forms of these two communities are totally different (Figure 3). The comparison of them contributes to our deeper understanding of their community involvement at a local level. In Zarong village, individuals and family are involved in cooperative-oriented community, and information, such as distribution channels of dairy products and cultivation techniques, are shared among different communities. Compared with before, their income has increased slightly because of cooperation. While in Zarong, young people are the main force in community activities, since they are willing to learn cutting-edge technology and update knowledge. They play a role model for other individuals, and more residents have engaged in meaningful community activities voluntarily, such as picking up rubbish in rivers. Another feature of youth community in Zarong is that old people help younger generation learn traditions, which can be beneficial to inherit local culture. For example, elderly organize them to read Tibetan books and learn to speak Tibetan language at weekends.

Figure 2. Community in Ganda and Zarong villages

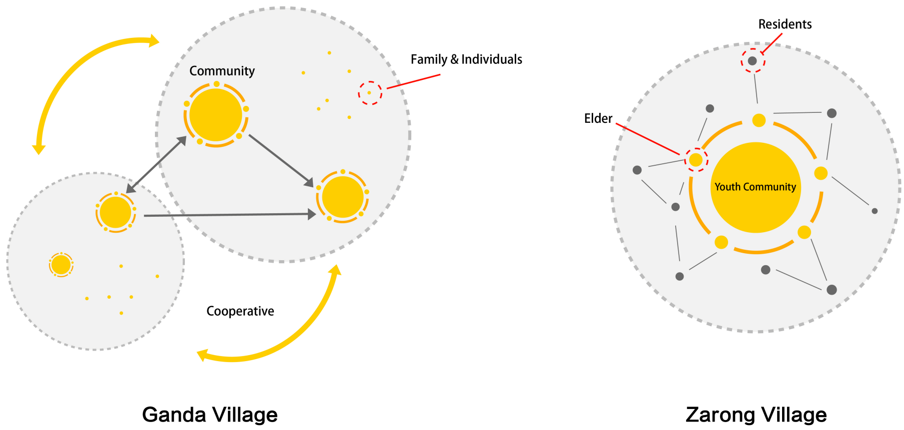

Figure 3. Forms of community in Ganda and Zarong villages

3.2 Changes of community due to the involvement of the local NGO

These three main communities' activities can be regarded as a "bottom-up" way, while the involvement of local NGO created a "top-down" path. This organization has launched a variety of campaigns to raise the public's awareness, and these activities motivated individuals to take action to protect local environment. For example, this NGO took advantage of Buddhism, inviting Lamas to talk about the importance of water protection, and they emphasized that Le (a god in Tibetan Buddhism) only live in clean water, so local dwellers believe it is essential to protect local areas.

On the other hand, this NGO has helped optimize local community structures and introduced other professional institutions to handle issues in Tibetan areas. For example, they helped youth community to set up four teams, including plant team, bird team, water team and wildlife team, to organize protection activities with different themes. The help of medium, research institutions, charities and companies just like a bridge, served local communities and connected outside and the local (Figure 4).

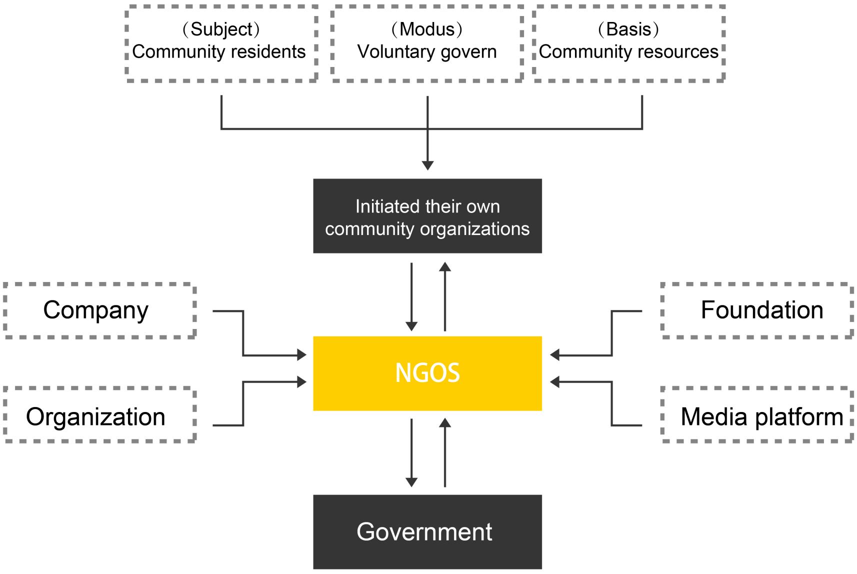

Figure 4. Involvement of local NGO

This NGO plans to connect small communities like Ganda and Zarong villages, and build a community network in the future. With the help of the NGO, Ganda and Zarong village will become typical communities and stimulate other villages to organize meaningful activities (Figure 5).

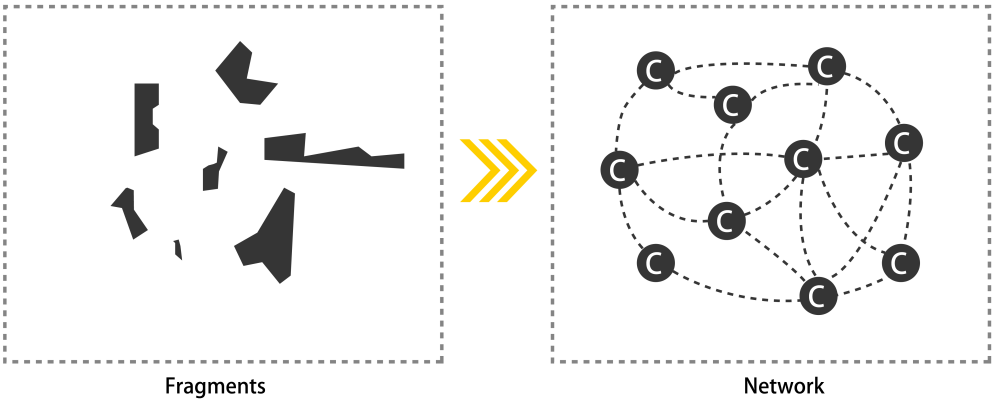

Figure 5. Future community network

3.3 Design based on community research

Based on the findings of community research, we found that local individuals and communities highly rely on their religious ways to protect water. The NGO use some portable devices donated by other organizations to collect data of water quality.

The project team collaborated with the local NGO and local communities, using a monitoring device designed by our group to detect water quality, which can provide technical support for the local water protection. Water samples of 25 rivers were collected, and we used positioning system to record location, altitude and air pressure, uploading photos and videos to iCloud. Meanwhile, the data of real-time water quality, including water temperature, PH, Dissolved Oxygen, TDS, conductance and salinity, were also uploaded to iCloud. The initial product-service system of local water monitoring was created (Figure 6). Individuals and organizations have easy access to know water quality nearby by their smart phones if they install the App we designed. Our aim of this design is to boost the community involvement of social members and improve social links between their environmental activities and daily lives.

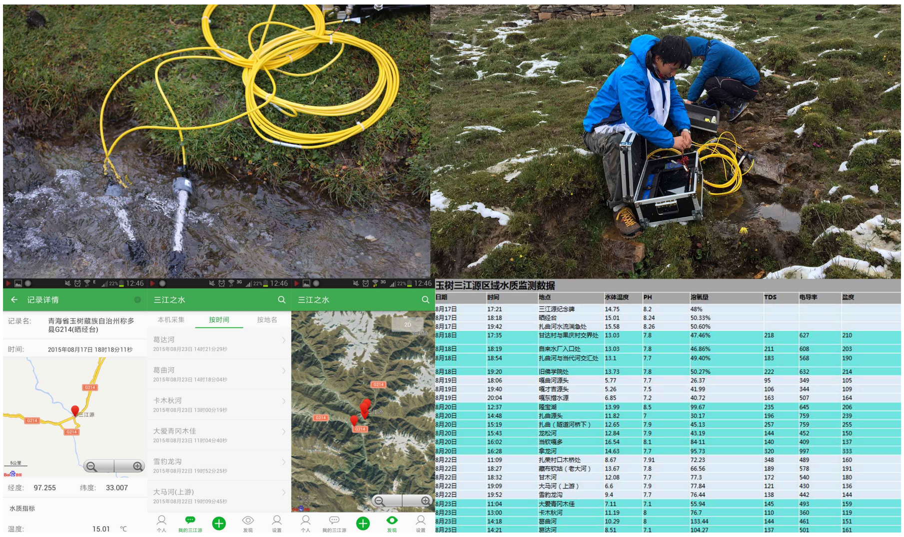

Figure 6. Product-service system for local water monitoring

In addition, we designed a local system, which can promote the wellbeing and sustainable development of Tibetan villages (Figure 7). Key words, including environment, sustainability, wellbeing and culture, were come up with, which would be regarded as the crucial features of Tibetan ecology environment. In this system, we highlight the importance of temples and local NGOs. Temples mainly take responsibilities of education and cultural inheritance in Tibetan areas; Local NGOs, through the interaction with local governments, boost the external and internal social resources to alternate and update. In this new network, authors emphasized we should give priority to community individuals, since they are much more familiar with Tibetan environment, and they can take advantage of local resources more effectively, which means their involvement would improve productivity of community activities. What's more important is that the help from the third party is of great value. For example, designers can design products and systems by professional design methods as well as tools to tackle some local problems.

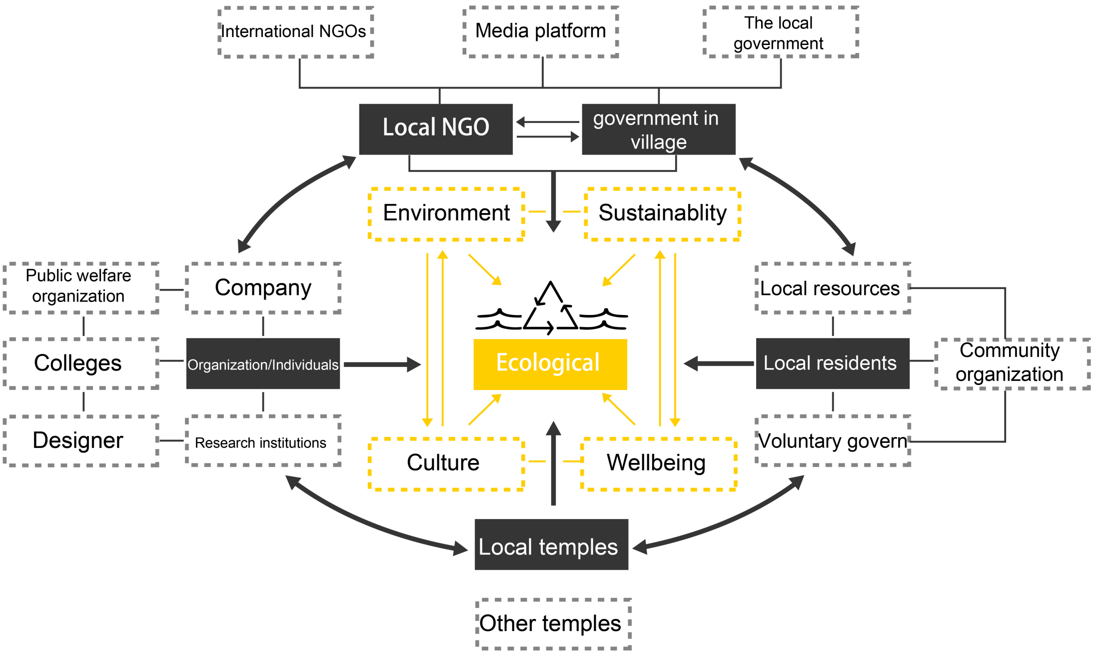

Figure 7. System design

4. Conclusions

We believe that an effective approach to social design is to follow Manzini's (2011) guidance- a "small, local open and connected" community. But rural realities, such as different knowledge backgrounds and infrastructure issues challenge the designer's role, and lead to the exploration of new design approaches. The best way to face such challenges is to combine community studies and practical design.

In the case of Qinghai program presented in this paper, this research reaches a conclusion that findings of community studies are significant for the design process. There is a need for design researchers to have a deep understanding of local community structures. Therefore subsequent product-service system and strategy design would highly meet local communities' demands.

On the other hand, various research approaches, such as co-design, interviews, field studies and observation, should be involved in community-based research flexibly, which can help designers find design opportunities efficiently. All stakeholders should also communicate with each other, with the local residents' participation, which can stimulate innovative and creative ideas.

Therefore the result shows the hypothesis of this research that a community-based research which puts more emphasis on community structures and local organizations could attain multiple functions.

As a long-term social innovation and design program, we will keep our research attention on the community-based research to benefit the development of Tibetan rural regions including Ganda and Zarong village. We hope the issues and approaches discussed in this paper will inspire further research in developing regions.

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Social Life Cycle Analysis as a Tool for Sustainable Management of Construction and Demolition Wastes in Municipal Services

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Abstract

Construction and demolition wastes (CDW) have received increasing attention around the world, during the past decades. It is identified as a priority waste stream due to its significant amounts, large volume and heterogeneous constitution, with high recycling and reuse potential. Its management involves economy, infra-structures (landfill capacities), and environment (efficient use of natural resources and mitigation of impacts). The growing awareness of the importance of environmental protection has increased the interest in the development of methods that better understand and address CDW impacts. Recently there is a particular onus towards sustainability and a holistic integrated life-cycle approach, the waste hierarchy and the polluter-pay principle and producer responsibility have also been applied to construction waste. Life Cycle Assessment (LCA) already fulfils one of the main requirements of sustainability assessment (environment), and nowadays a shift has occurred to a more comprehensive assessment, which includes economic and social aspects. Social and socio-economic LCA (S-LCA) contribute to the full assessment of products and services within the context of sustainable development. This work proposes a model for CDW municipal management based on S-LCA. S-LCA has been guided by an environmental perspective accepting that municipal services are responsible for CDW management and seek to conduct the services in a more responsible way transforming the CDW problem into an opportunity for the future. Management of CDW deposited illegally translates aesthetic and environmental impacts on public/private areas (for the city), which may lead to high costs for the municipality. Therefore, it is intended to present a model that collect information for helping the improvement of municipal services social performances on key issues or in problem areas that have been identified in the region as in needing improvement, since CDW may represent a means of revenue for answer social needs in the municipalities. The model developed is focused on: (i) stakeholder importance; importance of geographical location of hotspots information for inventory and impact assessment; (iii) integration of different management assessment practices; (iv) use of a set of tailored impact subcategories considering different assessment practices and new if needed; (v) selection and use indicators; (vi) inclusion of relevant subjective data; and (viii) creation of a scorecard or matrix to retrieve the prominent results.

Keywords: Life cycle analysis, Construction and demolition wastes, Model, Environmental impacts, Municipalities management.

Insights from Social Practice Theory for Effective Energy Policies in University Campuses

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Keywords: Energy Consumption, Human Factor, Social Practice Theory.

Abstract

The key assumption from which this study starts is that tackle global climate change is not simply, or not only, a matter of finding more efficient ways (mostly technological or relying on urban teleconnections) of meeting untouchable human quests. While the concept of sustainable development was born having mainly production-oriented policies as institutional outcomes, the co-responsibility of consumers resulted later on in more demand-side policies. The active involvement of the users by means of purchase choices and the adoption of more sustainable lifestyles gave new sense to apparently consolidated concepts about the energy transition and the role of the society aside the one of technology. Therefore, adopting a socio-technical approach this paper investigates the changing definitions regarding comfort and the decision-making mechanism of consumption practices, believed to be pivotal for energy reduction policies in public buildings. The co-design of an app for HVAC control via users' real-time feedbacks was the opportunity to explore people perception about "energy consumption" and "comfort" in university campuses. The Design Studio Methodology allowed inserting other energy-related items than the ones suggested by current literature (i.e. thermo-igrometric, air quality, brightness, crowding and noise discomfort data). Such quantitative measures have been anyhow collected in the equipped classrooms in the university campus taken as case study to further match the objective comfort levels and the subjective time-aligned user feedbacks on rooms' conditions. This paper demonstrates how taking advantage of users' expressed needs may be shift the attention of policy makers to several neglected aspect impacting the workplace comfort, like cosy sofas or colourful interiors, possibly cheaper and more controllable than the main stream ones, like greener energy supply, smart appliances and centralised controlling systems. A wider audience crossed with real-time quantitative parameters can provide evidences for the effectiveness of this approach in reducing energy consumption in public building. Acting wisely and surgically on certain human factors and collective thresholds of discomfort acceptances can un-lock the social potential for the change. Current technical trajectories are becoming ultimately unsustainable, but in parallel user awareness of impacts can make comfort "just" a highly negotiable socio-cultural construct.

1. Introduction

The idea that human activities have caused deleterious and irreversible effects on Earth's ecosystem is finding growing support. However, from the political and institutional points of view, a concrete attention toward environmental issues only began to develop in the aftermath of the first energy crises of the 1970s, mainly as a consequence of their effects on economic development (Robèrt et al, 2002). In that climate of "concern" for the environment accompanied by a strong desire for progress, the concept of "sustainable development" was born having as institutional outcomes production-oriented policies. The responsibility for the management of the environmental resources was then attributed to the actors of the productive sectors. The objective of the reduction of the environmental impacts was attributed to the direct intervention of corporate actors (Wallner, 1999). Lately, this paradigm expanded till reaching a progressive adherence to the attribution of co-responsibility to consumers. They have been recognized to have the power to influence production and supply by means of their purchase choices and the adoption of environmental-concerned lifestyles. As a result of this conceptual improvement, demand-side policies were elaborated, with the aim of spreading awareness among citizens, to become more actively involved in the transition toward sustainable consumption choices (Chappells † & Shove ‡, 2005). These socio-technical transitions to sustainability are not easy to be put in practice, since current energy, transport, and food supply systems are stabilized by lock-in mechanisms (involving complex financial cycles, self-induced behavioural patterns, unveiled interests, inertial infrastructures, political subsidies and global regulations) (Geels, 2004). However, radical innovations can disrupt these consumption mechanism breaking in certain niches, where dedicated actors nurture alignment and development on multiple dimensions to create new fit-on-purpose configurations (Rip & Kemp, 1998). The key assumption from which this study starts is that tackle global climate change is not simply, or not only, a matter of finding more efficient ways (mostly technological or relying on urban teleconnections (Seto et al, 2012)) of meeting untouchable human quests. It is instead urgent and effective to challenge the current passive adoption of energy consumption practices, comfort quests and the apparently implacable trajectory of increased resources depletion implementing very local social practice of sustainability. Possible local niche-innovators are pointed out in this paper as university campuses, where the living lab paradigm transforms them into test bed for social experiments and good practices toward wider urban sustainability. In particular, the quest for comfort is explored as one of the main responsible for increasing energy and resources consumption. In public building, this quest is usually not accompanied by user awareness about environmental impacts and societal consequences of high comfort levels requiring high energy consumption. This paper describes an exploratory research that aims to: i) Frame socio-technical research approaches into the study of energy consumption practice; ii) Give insights for tailoring energy policy in university campus starting from the socio-technical analysis of users and context; iii) Suggest effective user engagement methodology for comfort quest interceptions in university campuses. Therefore, the structure of the paper is the following: in par. 1, relevant literature on comfort quest and its relation to consumption practice is discussed; par. 2 presents the case study, its socio-technical context of and the methodology used for a co-design workshop (par. 2.2). Preliminary results about "energy" and "comfort" users' perceptions (par. 2.3) are presented. Although part of a project for the design of an HVAC management software which responds to user feedbacks about comfort, these results gave chances to explore a new emerging definition of comfort by campus users in light of the literature and research goals is presented, as well as a reflection on the limitations of this research (par. 2.4). Final conclusions (par. 3) are shared leading up to recommendations for follow-up researches on energy reduction policies in university campuses.

2. Practices and infrastructures of consumption

2.1. The right to the comfort

In the definition of new solutions for climate change, energy efficiency and sustainability paths, the social component is gaining an increasingly fundamental a role. The practical use of energy can be described both as socially organized and technologically structured (Lutzenhiser, 1994). Throughout history, the connection between society and nature is considerably changed, principally for the incredibly growing technological progress and the intensive exploitation of different energy resources. This transformation involved the comfort dimension as well. During the last century, comfort levels became standardized around certain parameters, the quest for higher comfort has become more and more relevant in the energy consumption factors array (Shove, 2010). Once considered a luxury, an elitist privilege, it became a primary good and seen as something that people have a right to expect (Shove, 2007). Nowadays the majority of global population, who lives and works principally in urbanized areas, performs the everyday life activities inside microclimatic regimes, or rather buildings (or building systems) that are at least partially climatically and intensively controlled. To maintain the standardized comfort levels, these buildings - both domestic and public - use a big amount of energy and produce a high impact on the environment. Therefore, it is necessary to keep in consideration the comfort dimension in its interaction with the technical system (architectonic specificities, HVAC features) and the social one (people habits and behaviours, choices, gripes) (Shove, Pantzar, & Watson, 2012). Comfort levels are typically defined as the result of a feeling of psycho-physical well-being experienced by a person; it results from a combination of environmental factors - such as humidity, temperature, brightness - and individual perception (Chappells † & Shove ‡, 2005). Focusing on those psychological and physical parameters, research on comfort has been often linked to technical and behavioural sciences; for this reason, social factors have been usually excluded from the analysis (Höppe, 2002). Recently, social research improved this definition (Hargreaves, 2011; Shove & Walker, 2014; Strengers, 2012): comfort is not just a feeling, but it may be intended as a dimension that is shaped within a culturally collective frame, more or less shared, and then takes place in a context of experiential sensory perception by individual subjects. The quest for comfort plays indeed a crucial role in our daily life, but also in our global impact on the environment. Comfort is closely related to progress, mass consumption and throwaway-lifestyles. In the 'homo comfort' society (Boni, 2014) technology mediates daily activities, making possible to achieve the desired levels of well being with technical development and electronic devices. The totality of human existence in developed countries is grounded to patterns of consumption hardly avoidable at current pace. This is why criticizing the current quest for comfort and calling for more sustainable lifestyle often results in sterile polemics or unheard voices (Devine-Wright, 2014). Cases of people completely turning their lifestyle toward a model of self-sufficiency are still rare and not scalable to actual urban sets (Princen, 2003). Nevertheless, recognizing comfort as an integral part of daily life seems essential to address the issue of path-dependency maintaining both an artificial condition of normal achievability of it (claimed and expected) and the locking-in mechanism of the complex energy systems.

2.2 Energy, the invisible (especially in public buildings)

Aside the right to the comfort, another barrier for the transition toward a low carbon society lays in the configuration of energy itself: not a tangible good, neither visible (and after that assumption, the plethora of projects for making energy visible (Gustafsson & Gyllenswärd, 2005; Pierce, Odom, & Blevis, 2008; Nye et al, 2010). Furthermore, human actions are not generally aimed at consuming energy: energy is what allows the deployment of common daily practices, defined as inconspicuous consumptions (Shove, 2010). People wash, clean, write, have fun, cook, warm up, or use t-shirts, packaging, furniture, food, without considering – or without knowing – the environmental or social consequences of their consumer choices. In this sense, energy consumption is embedded in everyday activity, although unconsciously. Environmental policies have thus been evolving toward a participatory dimension, from the early oriented output till latest demand-side policies. To this extend, the study of consumption practices conducted within existing buildings consider both the complexity of physical structures (historical period, architectural features, different materials) and their equally complex infrastructures, both human and virtual. As Janda (Janda, 2011) warns, "buildings do not use energy: people do": physical considerations, technical and economic analysis of the construction is useless if not supported by consumer actors in the scene they are playing in. Consumption practices are typically studied through economic, psychological and sociological approaches (Hargreaves, 2011; Graham-Hanssen, 2014) in order to identify behaviours, practices and choices implemented in indoor environments (public or private, individually or collectively). Consumption practice as an entity is configured by a series of interrelated elements that make it recognizable, understandable and describable. These elements are declined in different ways (Table 1) after Schatzki definition of practice as an entity "unfolding in temporally and spatially dispersed nexus of doings and sayings" (Schatzki, 1996, p.89); to be produced and reproduced, practice must be understood, organized according to rules and principles and loaded with meaning by the plaintiff through "teleoaffective structure". Applying the practice theory to energy consumption appears crucial for redefining the relationship between individual and society, usually understood as opposing concepts. To overcome this dichotomy catching the deeper relationships between structure and individuals, Giddens conceives social practices as "mediating concept between action and structure" (Røpke, 2009, p. 2491). Society is here conceived as the result of social practices produced and reproduced in time and in space.

Within the practice lies the site of the social (Spaargaren & Oosterveer, 2010), realized in the network of relationships that actors huddle while playing such practices. Different contributions to social practices according to different authors are shown in Table 1.

Table 1. Key-elements for the definition of the practice-as-entity according to different authors. Source: (Gram-Hanssen, 2008).

Schatzki	*Warde*	*Shove-Pantazar*	*Reckwitz*
Practical understanding	Understandings	Competences	Body
			Mind
			The Agent
			Structure/Process
Rules	Procedures		Knowledge Discourse/Language
Teleo-affective structures	Engagement	Meanings	
	Items of consumption	Products	Things

Practical theory applied to the field of consumption "reconstitutes the actor's role in social processes without losing sight of the broader structures, which influence social action" and at the same time they allow the realization (Cellamare et al, 2011, p.36). It also highlights the skills that actors have staked in conducting some practice, thus revealing possibilities of intervention for change. At the same time, this system can be contextualized in a daily repetition, i.e. “routinized behaviours” identifiable collectively, but reproduced on an individual level (Evans et al, 2012, p.116).

In this sense, the locus of consumption practice is identified in a daily complex socio-technical system. The materiality of energy becomes meaningless following the increasing technical and technological mediation intervention in the relationship between energy and practitioners. The recursive activities of production and reproduction of everyday practices help to reinforce the invisibility of energy, mainly because of a lack of awareness about the environmental impact of routine practices (Røpke, 2009), especially in public buildings.

The introduction of ICT solutions for the energy monitoring and user awareness is based on the information deficit model. Accordingly, information delivered via apps or home displays should increase user awareness in relation to energy consumption, carrying out cost-effectiveness analysis and implement friendly info graphics. However, his type of solution presents many limitations especially in the case of public buildings (Darby, 2006). First of all, users do not appear to be stimulated by any economic advantage after their choices. Then, the possibility of tuning comfort levels in public building, with high number of heterogeneous users, is usually very limited. The impacts after individual choices always appear poor, if compared to the repercussion of what it is produced collectively. Third, a collective environment requires a stronger, and sometime difficult mediation of behaviours and wide-range choices compared to a domestic one.

2.3. Energy users in university building

More specifically, in the context of a university campus, single students are certainly given the possibility to act over lighting equipment, and sometimes on HVAC systems, too. But if a planned, collective action could record a significant reduction of the energy consumed by all the campus, it has been quite difficult to highlight best cases in this respect in current literature reviews (Di

Stefano, 2000; Venetoulis, 2001). In contexts where the structural system is configured in a rigid form - like most of the public and, among these, university buildings - adaptation appears as the only solution that can be undertaken by users, along with the complaint. Since making complaints is not always possible or convenient, as top-down answers are not always feasible in buildings with low flexibility of use and management, adaptation represent the most applied remedy.

This actual unsatisfactory situation regarding energy user engagement can be labelled as the classical hirschmaninian "forced loyalty", (Hirschman, 1970) where individuals (or groups of individuals, or institutions) facing dissatisfaction react in three ways: exiting (abandoning the source of dissatisfaction), raising the voice (to communicate their disappointment), and being loyal (keeping the relation with the object anyway). In the case of energy feedbacks in university buildings, the possibilities of raising the voice are discouraged, being the energy manager often unreachable, or the building too old for allowing any sort of intervention; the exit strategy is often significantly expensive in terms of both time and efforts, if not impossible. What remains to users is to be loyal to the system, and deal with its dissatisfactory conditions, sometimes autonomously fixed by single devices (fans, electric heaters, humidifier, dryers, etc.) that make bills raise up but reach desiderate comfort levels (Sunikka-Blank & Galvin, 2012). Factors affecting comfort conditions in the workplace are not only very important for physiological and psychological reasons, but also play a significant economical role. It has been demonstrated that they strongly influence the occupants' productivity, above all in University, whose knowledge transfer mission is fostered above all in the informal moments of sharing the same physical space (Leaman & Bordass, 1999). However, comfort issues do not yet play a major role in the day-to-day operation of university buildings, mostly due to a lack of understanding of human comfort and its in situ assessment. In fact, while several scientific studies put important findings as the basis of national and international standards, they only focused on correlations for thermal comfort criteria or on health issues. Fewer publications can be found on the interrelationships between different indoor environmental parameters and the impact of individual satisfaction parameters on the overall satisfaction with workplaces (De Dear & Brager, 2002; Nicol & Humphreys, 2002; Wagner et al, 2007).

Conclusions from literature and resulting research goals

From the literature review it emerged that by engaging beneficiaries, energy reduction is within reach. Evidences from various authors support both 'push' methods as well as participatory and creativity stimulating approaches. Therefore, the following points are used to design an appropriate methodology to engage campus users in energy reduction policies:

- Use community empowerment framework to support proposed actions avoiding feeling of helplessness or not usefulness

- Choose a friendly language, youngster syntax and only meaningful information, i.e., those people may use as basis for action

- Make use of social media (i.e. twitter and other mobile apps) to influence decision-making

- Make use of interaction between peers to support the process of adopting new measures and/or changing behaviours.

- Favour diversity over expertise amongst participants to foster creative solutions and nurture empowerment.

In 2015, the Campus Luigi Einaudi (CLE), one of the 120 buildings of the University of Turin (UNITO), Italy, has been used as test bed for a one-year project named ComfortSense (CS). That project was the test bed for applying the methodological approach drawn from the literature review. A co-design workshop has been chosen to make people aware of their own position in a change process through. If the exact contents and results of the workshop are less relevant, this awareness is a first step to increasing their willingness to change, since creativity and collaboration oriented approaches can stimulate new trains of thought and new connections. With the focus on campus users, these consideration lead to new ideas in terms of contents (e.g., IT products for real time feed backs on comfort levels) and empowerment (active realisation of the individual's power to invoke changes). Based on these items, the following research goals (RG) for the CS project were derived:

- RG1: Explore new comfort definitions by actual campus users as a kick-start for appropriate energy policy in university buildings;

- RG2: Explore the effect of co-design13 approaches on the level of engagement of direct beneficiaries

- RG3: Ex-post evaluation on energy consumption after having given the user the possibility to act over innovative comfort parameters through mobile apps and remote controlling on temperatures.

This paper related only to the RG1. However, it constitutes the necessary base for RG2 and RG3 achievement in the forthcoming years.

3. The co-design of an energy monitoring software at Campus Luigi Einaudi in Turin

Participatory design is a useful method to tailor ICT solutions on actors' need, since it screens the characteristics increasing the usability of the final product through the joined efforts of participants. In fact, an energy feedback system can be considered effective only if understood and used for final changes in energy consumption (both in terms of quantity and quality). Therefore, for the CS project a preliminary analysis of the socio-technical context has been carried out to overcome barriers after the introduction of new feedback systems into "forced loyalty" situations.

Users sample took into account the following features:

- Familiarity with the places of consumption (i.e. the case study);
- Competencies users have, what they are able to understand;
- Socio-demographics data;
- Motivations;
- Information that could be considered important given their level of knowledge of the technical systems;
- Ways information is interpreted;
- Most appropriate timing for data transmission and reception.

3.1. The case study

The CLE building has been selected because its extremely higher energy consumption in comparison with other UNITO buildings (Figure 7). The aim of the project was to develop an ICT infrastructure to implement information flows regarding the socio-technical of buildings and users. The solution provided was a mobile app revealing both subjective comfort levels of users (through their own feedbacks), and environment objective parameters (through smart sensors in equipped rooms). This study focuses on the outcomes of the co-design activity of this app, which provided evidences on: i) How a specific context can influence the development of an ICT solution; ii) How the concept of comfort is declined inside university campuses; iii) How considering psychophysical feedbacks is not always the best option for achieving energy efficiency in public buildings. The sociotechnical system considered in this study is represented schematically in Figure 1: the black arrow represents input, the white one output. Dotted lines are practices immerged in the object we are considering as part of social components influenced and influencing technical infrastructures. Outside the borders, a feedback loop (dashed line) goes in and out the CS goal of decoupling comfort and energy consumptions information flows.

13 For both research goals, "design" does not just focus on product features but on an entire process that uses design tools and techniques.

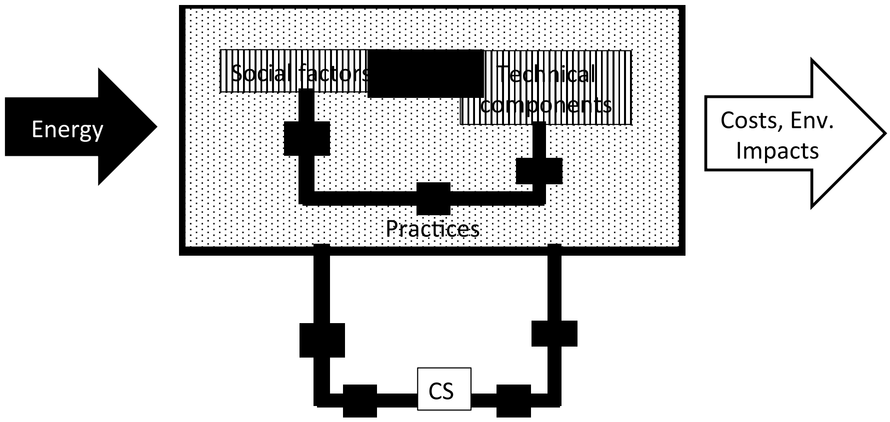

Figure 1. The socio-technical system of the CLE case study context. Source: re-elaborated from (Surano, 2015).

The CLE unit belongs in turn to a bigger university campus, which can be understood as a broad socio-technical system divided into partially independent subsystems. Analyses can be carried out in individual structures, but they cannot be separated from a macro consideration of the system they are inserted in. The social component includes students, administrative staff, teachers and temporary visitors. The CLE was opened in September 2012 and in the course of two years achieved a very high energy consumption for the type of activities carried out in framework; this consumption was produced by the intensive work of the HVAC especially in summer (Figure 8). The paradox that led to choose this case study was that despite the elevated energy consumption, CLE's users complaint about internal discomfort increased overtime. The CS project had the task of implementing the information flows between social component and system technology at CLE, trying to fix discomfort problems while reducing energy use and costs.

3.2. Methodology

The co-design activity of software for energy control according to users' comfort feedbacks consisted of three phases: i) socio-technical system framing and selection of participants; ii) questionnaires; iii) co-design workshop.

The first phase lasted three months, and produces internal reports regarding the socio-technical system of UNITO and CLE in terms of energy consumption practices. Then, a sample of 33 representative campus users was selected to take into account the most influent target of campus energy consumers, according to the features listed in par. 2. The focus has been on students who constitute the most numerous part of University's building users and account for collective action, more effective on wider audience of people. Eventually, a questionnaire about energy and comfort perceptions was distributed and gave the kick for the workshop activity. The co-design has been conducted with the of the industrial partner of CS using the Design Studio Methodology, based on the ideas generation process of working teams through fast steps. The purpose was to develop five prototypes of ICT solution concerning the comfort of users in the Campus environment. This methodology provided different opportunities for individual and group works, spread on time but organized at fast pace. The intention at the base is to generate many ideas and solutions quickly through sketching, iteration and critique. Ideas may come from anyone, allowing for divergence and then convergences, bringing the whole team together and finally creating a shared understanding and knowledge of the problem. At the beginning and at the end of the co-design activity, a compact questionnaire was distributed to the sample of students. This was to track their entrance and outgoing mind-sets about the core topics of the CS project. Categories from feedbacks socio-technical analysis are drawn from the relevant literature review (Bonino et al, 2012; Darby, 2006; Hargreaves et al, 2010; Kramers & Svane, 2011) and then they have been reinterpreted and adapted to the CS project extents (Table 2). They have been used to compare the prototypes and highlight the main differences and similarities in light of student's redefinition of comfort. Deeper description of these categories can be found in Appendix B. Aside this qualitative data collection, further steps of CS envisage a quantitative analysis of temperature, humidity, crowding and CO2 levels inside the monitored study-rooms thanks to sensors provided by the industrial partner of the project. These equipment (Figure 5 and Figure 6 in Appendix A) consisted in indoor sensors of temperature, humidity, CO2, crowding, and wearable sensors of temperature, humidity, brightness, location and CO2. An Android app given to users merge all the previous data with geo-localised and time-referred feedbacks about hydrothermal comfort perceptions, light comfort, crowding sensations, global subjective comfort, weight, sex, age, clothing and physical activity. Although these steps are not part of the present study, a brief overview of possible outcomes from qualitative-quantitative data matching is shown in the discussion.

Table 2. Categories for user feedback analysis readapted from (Bonino et al, 2012; Darby, 2006; Hargreaves et al, 2010; Kramers & Svane, 2011)

Original categories	Reinterpretation	Description
Time reference	Time reference	Frequency and timing of received/sent data
Granularity	Spatial granularity	Spatial details of the context from data
Medium	ICT infrastructure	Elements composing the system
	Socio-technical interaction	Interactions in the system
Captology level	Engagement methods	Methods to involve users in ICT use
/	End users	Targets of ICT solutions
/	Topics	ICT fields of application

3.3. Results

3.3.1. The energy practices of CLE

The relationship between technical and social component within the CLE resulted mainly as a one-way information flow between the technical system and the users. The observed consumption practices can be described as unconscious and indirect. In order to explore in mayor depth, the meaning that the actors attribute energy consumption in public buildings, a questionnaire was handed out to the workshop participants. Despite answers have not statistical value and are not yet coupled with a quantitative analysis, interesting insights emerged. According to our sample, elements influencing the CLE energy consumption are: electric appliances, night-time costs, and daily activities (Figure 7). Less regarded elements were all correlated to occasional events or less massive practices. This could highlight a general idea of energy consumption as due to both technical and social components. Moreover, the idea of energy consumption deploys in "continuity" (everyday, daytime and night-time). This means that workshop attendees were pretty conscious of the energy behaviour of this specific socio-technical system. Down line of first observations and questionnaire's answers, practices conducted at CLE can be distinguished as in Table 3.

Table 3. Energy consumption practices observed at CLE, University of Turin, along the *ComfortSense* Project (Surano, 2015).

Formal	Macro practices closely related to the functions running at CLE (like studying in the library, attending lectures or working in the office);
Informal	Macro practices conducted in the context but not directly related to the function of the context (like talking with friends, relax between classes, drinking together in the bar after work, and so on);
Derived	Micro practices implemented only to be physically present in the environment or to pursue formal / informal practices (take the bus, use the toilet, eat, photocopy, and so on);
Unaware	Micro practices affecting the framework without the actor realizes it, such as energy consumption to maintain a certain comfort standard.

These practices, identified as disaggregated for analytical purposes, are in fact related to each other in a very complex and nested frame. Also, the distinction between macro and micro practices is a simplification allowed from the special kind of context we are analysing. Indeed, in university campuses can occur that some users spend time in the buildings with different purposes. For example, occupying a place library can certainly be linked to the practice of study, but it is not uncommon to see actors who benefit from the library to consult mates or have a place to connect their laptop for purposes other than study. Thus, identified practices in Table 3 can be configured both as collectively and as entities; they are then reproduced with different modes in individual performance. The power consumption in a university can be defined as the unwitting product of daily practices intended primarily as demands on the energy supply of the socio-technical system. The practice systems there inserted is the set of activities for which the energy is delivered in specific space-time coordinates.

3.3.2. The comfort definition at CLE

During the workshop, held in Italian, participants were asked to write down three concepts or elements immediately associated to the word of "comfort". After that, they were asked to point out the most relevant elements affecting the perception of comfort, out of some terms in a given list. As shown in Figure 8, the majority wrote the word "comfort", which in Italian means “material” comfort, doing something in an easy way of. "Easiness", "well-being ", "safety" "ease" "relax" were relevant terms as well. Not so relevant, but still interesting, terms like "hydro massage and couch", "silence", "health" "personal spaces" "quality" and so on, revealed a not-shared position around the concept definition. When asked about comfort perceptions, terms like temperature, brightness, crowding and air quality gained significant success, followed by harmony, on-going activity, emotional state, noise, Wi-Fi network and so on (Figure 8, Appendix A). Table 4 shows the five ICT solutions proposed by the workshop attendee students downstream the three phases in par. 2.2, all relating the concept of comfort to specific discomfort conditions. Two out of five regard the recycling, since CLE was lacking of a proper recycling system at the time of the questionnaires. The remaining three solutions are related to the concept of usability of spaces and places. “Places 5B” was thought to solve the problem of the improper use of the campus library and its consequent overcrowding; “CLEbus” took care of the mobility inside and outside the CLE, organize schedules and transfers logistic; “Smart CLE” did the same but adding news and hints about lessons, seminars, university life events and so on. Energy monitoring is explicitly inserted in just one solution, the “Green is Free”, where the app displays the amount of water, oil and CO2 saved after each recycling actions.

Table 3. Energy consumption practices observed at CLE, University of Turin, along the *ComfortSense* Project (Surano, 2015).

	Time reference	**Spatial granularity**	**ICT infrastructure**	**Engagement methods**	**Socio-technical interaction**	**End-users**	**Topics**
5B Places	Real time	Single area of the building (library)	Mobile app + Sensors (temperature and crowd)	Simple real time data report	Oneway: from technical components to users	Students	Crowding, livable spaces, living comfort
CLEbus	Real time and simulation	Urban area and single building	Mobile app + Sensors (GPS and crowd)	Real time data, simulations, social network, map and news	Threeway: from technical components to users; from users to users; users feedback to the technical components	Students and people working in the building	Mobility, time organization, community, ORIENTEERING
Green is free	Real time and historical records	Single area + green facilities	Mobile app + green facilities + Smart card	Real time data display, historical data visualization, gaming	One way: from technical components to users	Students, General University public	Recycling, good practices
CLEan	Real time data, Historical records	Building	Mobile app + hardware	Real time data + notifications /information + gaming + map	One way: from technical components to users	Students	Recycling
Smart CLE	Real time data, Historical records	Building	Mobile app	Map, news, lessons list, utilities, users experience	Two ways: from technical components to users; users feedback for other users	Students, but different targets	Usability of the place/space

3.4. Discussion

Comparing the two set of answers related to energy and comfort perceptions and beliefs can give meaningful insights for the discussion. A general perception of comfort in continuity to psychophysical studies inserted new elements, and excluded others that were considered relevant from the literature review (like humidity, weather conditions, appetite, clothing, air pressure, air velocity). Enlarging the meaning of "perception", in the brainstorming phase the comfort dimension assumed a wider range of definitions, quite in line with the cultural context of the workshops attendees. In fact, major accordance has been given to psychophysical parameters quite different from those considered relevant by the CS project. A strong influence seems to come from the material realm (like “softness” or “accessories possession”) and from a general perception of facility and ease. Unexpectedly, energy utilities or physical parameters received less attention. However, these considerations have to be weighted along the limits of this case study. The very limited sample of students (33) has been left free to interpret the idea of comfort and decline this into concrete ICT solutions for its achievement. No hints about electric energy or specific sensors were given. These outputs highlight three main issues: i) Energy consumption in public buildings is felt like something produced collectively and in continuity; ii) Comfort concept has several possible declinations rather that a simple perception; iii) Comfort perception seems to strongly depend on the physical usability of places. These considerations open further and wider research trajectories: if a greater, and more representative sample of campus users may confirm these insights, an innovative focus for energy reduction policies in campus design and operation management can be set. Rather than acting on temperature and air quality, equipping rooms with sensors, and processing big data on energy analysis, maybe could be meaningful to operate on comfortable facilities, like comfortable chairs, cosy interiors, chromo-therapy led lights design and others architectural features not normally applied in public building.

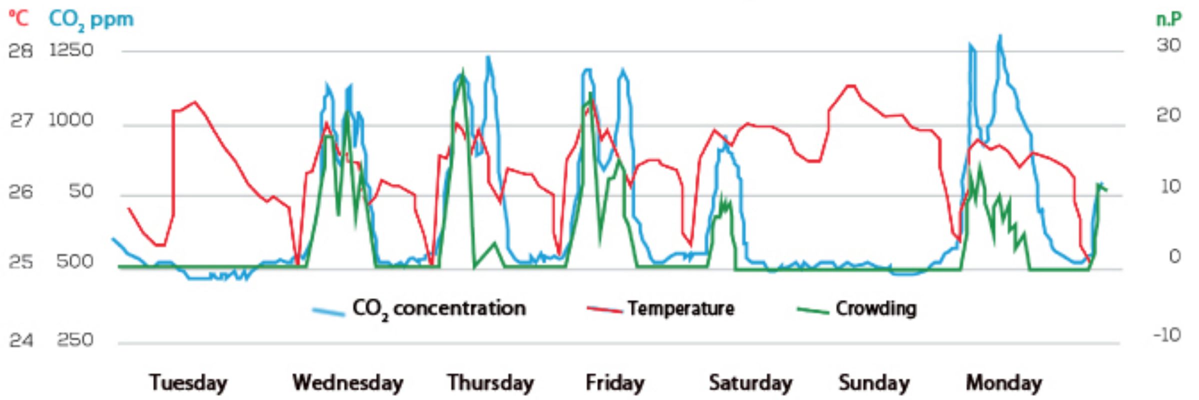

Figure 2. CO_2, temperature and crowding values as registered in the out-aloud study room at CLE, Turin, from 2 to 8 June 2015.

Empirical evidences may reinforce these hypotheses, after having synchronized user feedback on comforts and quantitative data analysis in the monitored room. As shown in Figure 2, the inside temperature does not seem to follow any crowding or CO2 path (Wednesday, Thursday and Friday present similar paths, except for temperature drops in late evenings presumably for the empty rooms on Thursday). From findings in par. 2.3 it can be expected that the CO2 concentration can affect comfort perception less than crowding (especially on Monday, the two paths seems quite mismatched). If the real time feedback confirms so, active policy on space optimization and controlled access to the study room can create greater comfort condition and cheaper energy reduction results than expensive and complicated automated window openings (for air change and set point temperature re-gaining) or new chillers.

4. Conclusions

The key assumption from which this study starts is that tackling global climate change is not simply, or not only, a matter of finding more efficient ways (mostly technological or urban teleconnected) of meeting untouchable human quests. While the concept of sustainable development was born having mainly production-oriented policies as institutional outcomes, the co-responsibility of consumers resulted later on in more demand-side policies. The active involvement of the users by means of purchase choices and the adoption of more sustainable lifestyles gave new sense to apparently consolidated concepts about the energy transition and the role of the society aside the one of technology. Therefore, adopting a socio-technical approach, this paper investigates the changing definitions regarding comfort and the decision-making mechanism in consumption practices, believed to be pivotal for energy reduction policies in public buildings.

The adoption of a socio-technical approach arises from the literature review outlined in par.1. The concept of comfort has been indeed usually related to physical and psychological parameters (par. 1.1), trying to analyse individual votes around standardized termohygrometric levels. However, as seen in par. 1.2, the social practice theory allows enlarging the comfort dimension to a wider range of factors combined in complex landscapes, from social interaction to collective perceptions, daily practices and cultural environments.

Current strategy for comfort achievement in public building mixes two apparently opposite orientations: product-oriented and demand-sided policies. In the latter, ICT is gaining prominence, as they are seen by the neo-functionalist narrative as tools to match energy demand and offer, enhancing the efficiency of the distribution systems and nurturing the market of smart appliances and current lifestyles.

However, social practice theories on energy consumption outlined relevant human factors that constitute the ground for acting on comfort parameters. Consolidated practices, barriers, opinions and cultural backgrounds could invalidate or facilitate the whole energy transition management. In this perspective, the energy consumption is considered as the product, more or less conscious or desired, generated in the recursive systems of practices of everyday life.

To detect and analyse the material component of the daily reproduction of consumption practices in a university campus, a case study located in Turin has been taken. The co-design of an app with students for HVAC controls via users' real-time feedbacks involved a sample of participants in the Campus Luigi Einaudi at the University of Turin, IT. The Design Studio Methodology was used to identify technical and social barriers to change, structural lock-ins and path dependencies. The questionnaires and open brainstorming sessions about "energy" and "comfort" perceptions constituted the opportunity to explore users' inconspicuous consumption practices inside the and outside the campus buildings. Three main issues came out:

Energy consumption in public buildings is felt like something produced collectively and in continuity, thus offering margin of intervention on communities like university campuses, where education for sustainability is an urgent call;

- Comfort concept has several possible declinations rather that a simple perception; as a primary good, if not as a right, it is considered easily achievable thanks to the progress of technology that satisfy almost every need quickly and effortless;
- Comfort perception seems to strongly depend on the physical usability of places: comfortable and cosy environments, with nice sofas and interior design care, relax areas and late-night cafes for community building are part of the comfort even more than humidity or temperatures.

Eventually, this study brings two main results in the motivational comfort research field:

i) Practice theory applied to energy consumption allows identifying the practices of consumption engaging users in the place they are pursued. This is of outmost importance in in public buildings, were inconspicuous consumption practices are prevalent and there is little possibility of direct intervention from the users.

ii) Co-design workshops showed how comfort can have several facets according to the level of engagement and expectation of users: considering the local human factor when designing policy for public building energy management may outline unexpected (and cheaper and easier to achieve) variables relevant to actual users.

Further research on the factors that make users more flexible in accept lower internal comfort levels' is needed, by coupling the qualitative data coming from the socio-technical approach and a quantitative analysis from smart sensors both fixed and wearable. In fact, if rebound and pre-bound effects put uncertainties on the efficacy of current energy policies, innovative EU research directives push to tune certain comfort parameters – like indoor temperature – around users' activities, to increase threshold of lower temperature acceptances and therefore reduce the energy consumption especially in public buildings.

To address the issue, an interdisciplinary perspective with sociologist, urban planners, architects and IT engineer seems to be the elective strategy to fill the cognitive and spatial gap between the places of production and the places of consumption. Of course, a remarkable rearrangement of both economic systems and of logistic infrastructures is required, as well as a political pledge by all big countries to increase people's awareness in the short and in the long term.

Acknowledgement

This study was born after the preliminary result of ComfortSense, an interdisciplinary project coordinated by the University of Turin in collaboration with several private enterprise and start-ups in the city of Turin, that are visible on the project website. ComfortSense is funded by the "Programma Operativo Regionale" 2007/2013 (POR), the regional tool regulating the European "Fondo Europeo di Sviluppo Regionale (FESR)". It aims to take advantage of the "Internet of Thing" and the "Smart Cities Technology" in order to improve building energy efficiency and people's comfort. More info: http://www.craftinglab.it/comfortsense/.

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Appendix A

Figure 3. The CLE, University of Turin, IT. Photo courtesy of www.futura.unito.it

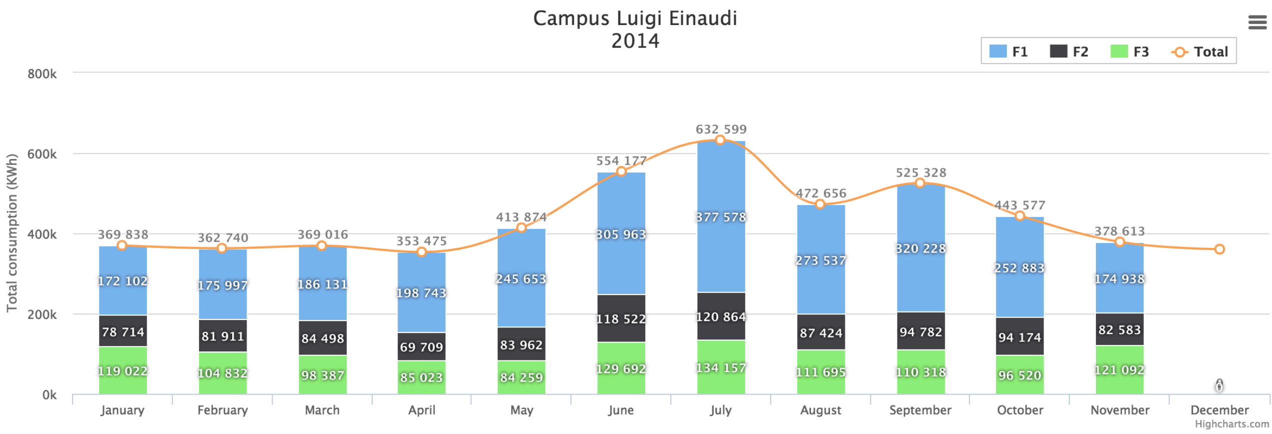

Figure 4. The CLE electric energy consumption in 2014. Source: http://www.green.unito.it/graphs-consumption/single_building_page.php

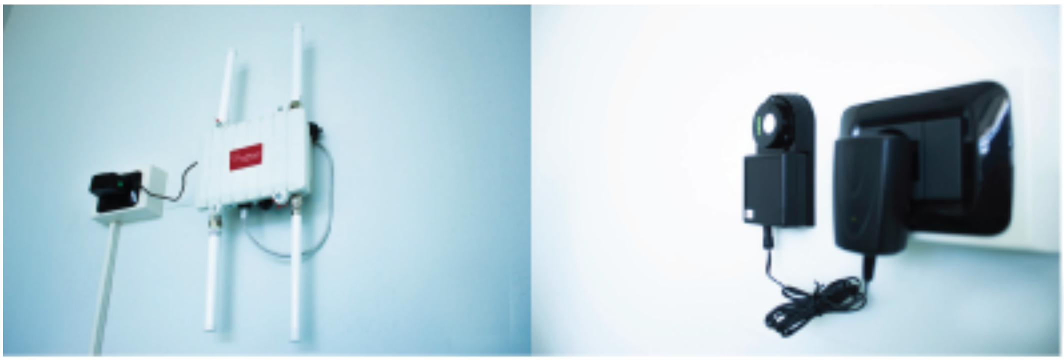

Figure 5. Crowd-sensor (left) and temperature, humidity and CO_2 sensor (right) installed in the out-loud study room at CLE.

Figure 6. Thermostat for temperature regulation (left) and wearable smart sensor (right) for temperature and humidity measurements used in the ComfortSense Project

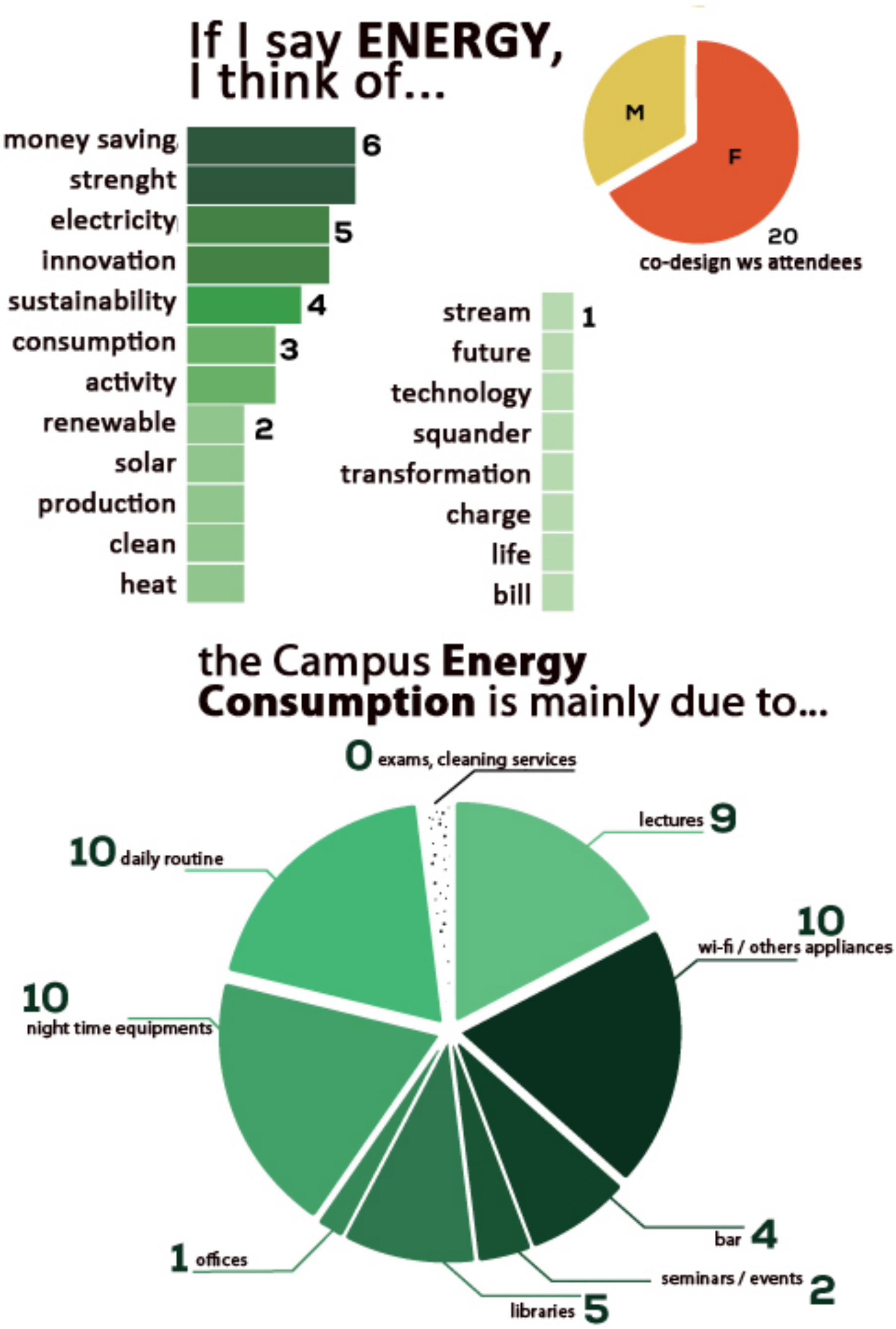

Figure 7. Answers related to energy-issues brainstorming in the co-design workshop held at CLE, June 2015

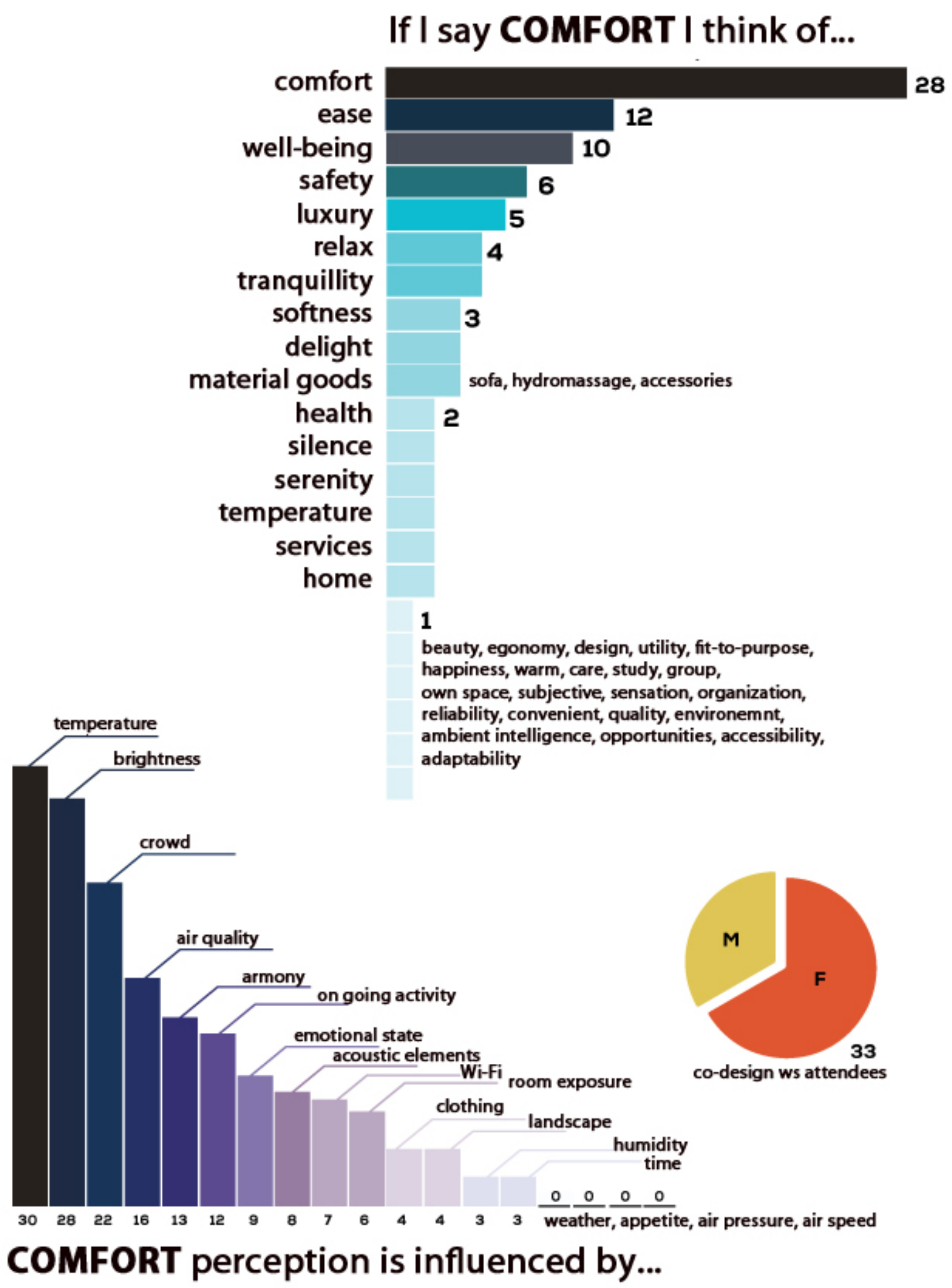

Figure 8. Answers related to comfort-issues brainstorming in the co-design workshop held at CLE, June 2015

Appendix B

Strategies

Strategies withstanding final products can be of two types: antecedent or consequent. In the first case, the aim is to foster possible changes in user's consumption style; in the second case, the aim is to update the user about his/her consumption profile. It is not possible to identify the best strategy before an evaluation of the context and user's peculiarities. Furthermore, these strategies could be mixed to be more effective in the path through awareness increase of energy savings.

Table 5. The two types of strategies withstanding the final products evaluation of ICT feedbacks to users

Antecedent	Information: suggestions and information provided to the user prior consumption and/or purchase choices
	Goal setting: prior set for a certain energy target
	Commitment: higher effort requires users evaluating and modifying sensitively their own behaviour concerning energy consumption
Consequent	Feedback: show the user the amount of consumed energy
	Reward: economic or social rewards after user's virtuous behaviours
	Criticism: display of comparative analysis between users' consumption profiles

Time reference

The main difference in temporal terms in existing products consists in the reception of information in real time or having access to historic data. One solution clearly does not exclude the other, as the two settings can be used in mixed way to make comparisons. While long-term data are easier to obtain - as seen in the case of monthly bill - real time data are available only if there are specific technical settings; for example, these data in home consumption are available just if devices are provided with sensors allowing real time survey. The evaluation about which time reference is pertinent for a certain product is to be done depending on the context needs; for example, if in a collective-use environment - as an university campus - a real time data could even result contrasting, in a domestic context could be possible to obtain more significant outcome. In fact, in the first case, consumption is created by the mix of a lot of people actions and therefore is not changeable immediately; on the contrary, in a domestic context, actors are less and a consumption real time visualisation could highlight behaviours with negative consequences on energy consumption, facilitating the user's comprehension and acknowledgment.

Spatial granularity

Similar to temporal reference, granularity indicates the spatial detail level hypothetically reached by a final product. However, desired data could not be available depending on that context; in this sense, it must be considered that some kind of energy can be more easily monitored rather than others and that the level of simplicity to trace and use some specific data could change from a context to another.

Medium

The medium is composed by two elements: the kind of software and the kind of device that support the preferred software. The first one is about representation and interaction on a digital level between the users and the available information; the second one is about the physical device on which the information is received. Two different examples - thought for different aims - can be a 3D visualisation solution on a public display in an office or a smartphone application with an energy game; it is clear how the two factors can be combined to produce final solutions which are diametrically different. Each setting will have a different impact on final user, which is a fundamental consideration as to adapt the tool to the context. 3D solution can provide an environment visualisation much more similar to the reality, demanding a minimal abstraction skill to the user.

Advanced features

Besides receiving information about consumption and visualising used energy, user could be engaged in a more complete way, by sending suggestions and alerts to the users or by interacting in the very middle of virtual communities through social media.

Captology level

The level of persuasiveness of the solution is strictly linked to these choices; more than a reasoned choice, captology declares mainly an aim, a list of desiderata to motivate the user in an effective way. Captology evaluation can be faced both a priori, as an aim in the solution construction, and *a posteriori*, in the evaluation of the effects produced by the solution use.

Horizontal Grinding of Asphalt Roads – Environmental Implications based on Life Cycle Assessment

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Abstract

Out of all the energy consumed within the transport sector in Sweden, about 71% is derived from road traffic, and since fossil fuels are mainly used, the greenhouse gas emissions are substantial. Road surface properties are an important factor influencing rolling resistance and thereby fuel consumption and greenhouse gas emissions as well. Apart from the relation to greenhouse gas, the road surface's interaction with tires also creates substantial wear of both tires and pavement, giving rise to air pollution with unfavourable health effects on the population. Particulate air pollution has, due to mitigation efforts and favourable meteorology, been reduced in many Swedish cities. Still, the concentration limit values set by the European Union are exceeded a number of times each year. Recently, horizontal grinding of asphalt pavements has been tested to achieve a more even road surface in order to attain a reduction in air pollution, and to reduce fuel consumption of passing vehicles through lower rolling resistance. The idea is that by grinding away some of the roughness on the road surface, which is not needed for safety reasons, the lifetime of both roads and tires could be prolonged and the potential environmental impacts decreased. This grinding technique has already been proven to achieve such effects on cement concrete floors in industry halls. By applying a life cycle perspective with a time span of 40 years, potential environmental impacts are calculated for with the intention of investigating whether horizontal grinding of asphalt roads reduces theses impacts. This with regards to emissions of carbon dioxide, nitrogen oxide and particulate matter has been addressed. It is found that one of the factors that significantly affect the roads potential environmental impacts is the amount of reconstructions of the surface course and that the amount of reconstructions correlate to the amount of different grindings, where double grinding every fourth year is preferable. Nevertheless, with regards to the cases and scenarios set for this study, it is revealed that horizontal grinding of asphalt roads today do not decrease the potential environmental impacts. In order to potentially achieve that, it requires more research e.g. in order to improve the grinding technique and make it more efficient and how to prolong the time between need of re-grinding.

Keywords: Environmental effects, Transportation, Emissions, Particulate matter

Introduction

As of today, about a quarter out of Sweden's energy consumption originates from the transport sector. Out of all the energy consumed within the sector, about 71 % derives from road traffic (The Swedish Energy Agency 2015), and since fossil fuels are mainly used, the greenhouse gas emissions are substantial. Recently, horizontal grinding of asphalt pavements has been tested to achieve a more even road surface in order to attain both a reduction in road noise as well as to reduce fuel consumption of passing vehicles. These tests were carried out in a project called Via Futura. The project aims to investigate the potentials of these grindings, in terms of reduced emissions and noise in addition to the possibilities to implement on Swedish roads.

Life Cycle Assessments (LCA) is a technique for addressing the potential environmental impacts throughout the life cycle for a product, service or activity, including all phases from extraction of raw material to end-of-life treatment (ISO 14 040:2006). The development with LCA methodology has been strong and LCA is today broadly applied in practice (Finnveden, Hauschild et al. 2009). LCA has already been recognized by a number of industries as an effective approach to measure and compare potential environmental impacts, which also applies for the road industry (Bird, Clarke et al. 2004, Huang, Bird et al. 2009, Ortiz, Castells et al. 2009). Huang, Bird et al. (2009) expresses that an LCA methodology for pavements can be further calibrated as a decision support tool for sustainable construction in the road industry.

This paper presents an LCA carried out within the Via Futura project with the aim of gaining an insight to how different frequencies of horizontal grinding could improve a Swedish roads potential environmental impact throughout its entire life span.

Method

The LCA methodology applied for this assessment is provided by the ISO 14040 family consisting of two documents the, namely ISO 14040 and 14044, developed by ISO in 2006. The first document describes principles and framework while the second provides for the technical requirements (ISO 14 040:2006 , ISO 14 044:2006). When performing an LCA in accordance to the ISO 14040 family four major steps are to be followed in the study. These are; goal and scope definition, life cycle inventory (LCI), life cycle impact assessment (LCIA) and interpretation. Each of these steps in conducting an LCA is described further on as they are performed.

Asphalt pavements are constructed in layers, firstly a foundation, followed by a sub-base, a base course and lastly a surface course. The surface course can be made of, for instance, either concrete or asphalt (Stripple 2001). In this comparative LCA, an asphalt surface course is assessed, omitting the remaining pavement layers. Stone Mastic Asphalt with 16 mm maximum aggregate size (SMA16) is the most commonly used asphalt pavement on Swedish national and regional highways and on motorways (Sandberg and Mioduszewski 2015). A Swedish regional road with a surface course consisting of SMA16 is therefore chosen for this assessment.

Information and life cycle data needed for the study has been collected through meetings, interviews and literature studies. Meetings within the project collaboration has set the basis of the study by, for instance, defining the roads geometry and thereby resulting in the functional unit. The interviews have been made with people well versed in the field of interest where assumptions were in need to be drawn, this in order to achieve as highly qualified assumptions as possible. In order to set this paper in perspective and to retrieve case specific data, literature studies have been carried out, this mainly to enable the calculation for the construction of an asphalt road.

To calculate for the potential environmental impacts the modelling and computation platform SimaPro is used. For modelling of materials and processes, the database Ecoinvent is applied and calculations are performed using the ReCiPé Midpoint (Hierarchic) method to reach the requested emissions of carbon dioxide (CO2) equivalents, nitrogen oxides (NOX) and particulate matter with grain size smaller than 10 micrometres (PM10).

Goal and Scope

The goal and scope definition is of central importance to an LCA since it not only defines the purpose of performing the study but also more specific aspects such as functional unit, system boundaries and allocations (Klöpffer 1997, Baumann and Tillman 2004).

This attributional LCA aims at retrieving information on whether or not, and how much, horizontal grinding of asphalt roads potentially could improve a road's environmental impacts. Different frequencies of grinding (never, yearly, every two, three and four years) of the surface course of the road are to be compared in order to uncover the most favourable.

Definition of the functional unit (FU) in LCA of pavements as a whole lacks consensus, which is a downside to LCA of pavements (Vidal, Moliner et al. 2013). This is, according to Santero, Masanet et al. (2010), due to the fact that pavement structure is profoundly influenced by environmental conditions and traffic as well as other details specific to each individual project. The functional unit is therefore here defined by the road geometry, its service life and the level of traffic. The road addressed is regional road 636 located between Vikingstad and Sjögestad in Sweden. The surface course is constructed with SMA16 and is 30 mm thick. The road is a two-lane road with two-way traffic, is approximately 7.5 meters wide and a distance of 1 km is assessed. The speed limit is 80 km/h and the Average Annual Daily Traffic (AADT) amounts to 4,670 vehicles, where 6.2 % are heavy.

This stretch of road is estimated to have a service life span of approximately 8 years when no grinding is applied, meaning that every 8 years the surface course of the road is needed to be removed due to wear and new asphalt is paved. With grindings the life span may increase before it is in need of reconstruction, therefore a total time span of 40 years is applied to the study, since this is the most commonly used economic calculation period by The Swedish Transport Administration (The Swedish Energy Agency 2015). This even though a road normally does not have a final end, it is usually built and then used year after year.

System Description and Boundaries

Santero, Masanet et al. (2010) identifies five distinct phases of the pavement life cycle in their review of current research, namely material production, construction, use, maintenance and end-of-life. Inspired by this, herein the phases taken into account in the assessment are shown illustratively in Figure 1 and they are Use, Reconstruction and Waste management. Transports will be addressed directly in the phases where they occur, namely Use and Reconstruction. Marked grey in the figure are phases that to some extent are left out of this assessment and this is further explained throughout this paper.

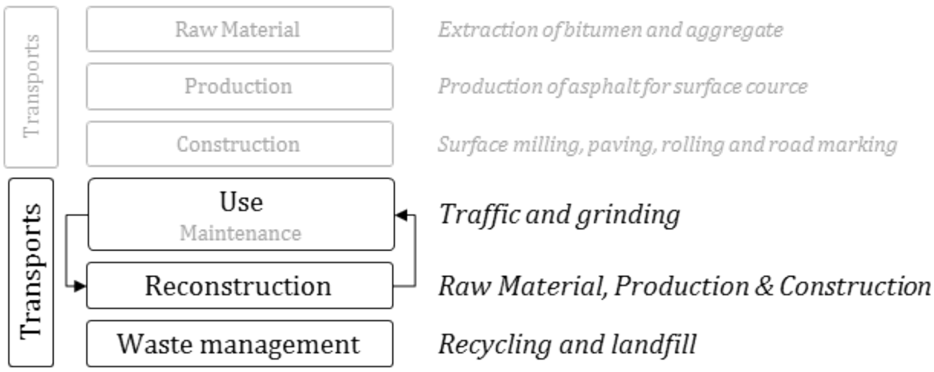

Figure 9. Phases of the roads life cycle. Arrows mark the circular relationship between Use and Reconstruction.

Due to the comparativeness of the assessment the first three life cycle phases Raw material, Production and Construction along with Transports within and in between them are left out – with regards to the entire road structure. These phases are though to some extent covered during the Reconstruction phase where old surface course is replaced with new, since that is the layer which is to be renewed in terms of road repairs. The phases are also only addressed in the sense that they together represent the shifted environmental burden when prolonging the roads life span, namely the Use phase.

Use involves both impacts from traffic and the focus of this assessment: the grinding. The traffic consists of an AADT of 4,670 vehicles, 6.2 % heavy, of which their fuel consumption is accounted for. Measurements in previous testing have shown that the fuel consumption decreases when the road is horizontally ground (Sandberg and Mioduszewski 2015) and these figures are to be calculated with. Grinding is performed by HTC's 2500 iX and the frequencies are applied by either every 1, 2, 3 or 4 years to find the most optimal alternative. The null alternative would be to not grind, which is to be compared to. Five fictitious cases are therefore assessed, see **Table 18** for details regarding the cases. The life span depends on the allowed thickness of the surface course, which is 1.5 times the aggregate size, 16 mm, amounting to 24 mm. Depending on the cases, different grinding depths and frequencies as well as different life spans are accounted for. When the road is grinded for the first time the depth of the grinding is approximately 1.5 mm (double grinding) and this depth is also applied again at the earliest every three years if no single grindings are performed in between, since this is when the fuel consumption reduction is assumed to have subsided. All other grindings has a depth of approximately 0.75 mm (single grinding).

Table 18. Specifications regarding the five cases. The cases numbers refer to their amount of years between grindings, apart from case 0 where no grindings are applied.

	Case					
	0	**1**	**2**	**3**	**4**	**Unit**
Time frame	40	40	40	40	40	Years
Life span	8	9	15	12	15	Years
Single grindings	0	6	6	0	0	pcs./life span
Double grindings	0	1	1	4	4	pcs./life span
Reconstructions	5	4.44	2.67	3.33	2.67	times

Processes such as plowing, sweeping, salting, traffic lights and reinforced road markings are contained within maintenance. They are all together excluded from the assessment due to the comparativeness, meaning that they are assumed to be the same regardless of different frequencies in grinding.

Reconstruction is when a road normally is in need of a new surface course and is therefore herein an amalgamation of the three first phases, as mentioned earlier. The worn out surface course is removed by milling, new surface course is paved and rolled and road markings are reinforced.

Regarding Waste management (WM), assumed is that 90 % of the asphalt dust created from grinding can be recycled as aggregate in asphalt production. The remaining 10 % are assumed to go to landfill. In the case of when reconstruction though occurs, all asphalt residues from milling is to be recycled into new asphalt (Johansson 2015).

The assessment is limited to the geographical boundary of Sweden. All energy and production values are therefore derived from Swedish figures alone, apart from the industrial diamonds contained in the grinding tools, which in this study mainly are manufactured in China.

Data Collection

Data for the assessment is gathered from a couple of different sources. Regarding the raw material and the construction of the surface course, data is mainly retrieved from Stripple (2001). Data for the grinding has been obtained directly from HTC and all assumptions needed have been performed by qualified persons well versed within the area concerned. Calculations of potential environmental effectsare completed with the Ecoinvent® database and the ReCiPe Midpoint (H) method through the LCA software application and computation platform SimaPro®.

Environmental Effects Addressed

The choices of effects are based on the aim of the project Via Futura. Emissions of carbon dioxide, nitrogen oxides and particulate matter (PM10) are for that reason to be analysed in this LCA and are calculated for through Ecoinvent® and ReCiPe.

Uncertainties

Swedish average electricity consumption, which herein is retrieved in 2001 (Stripple 2001), is used for the data in the life cycle phase Reconstruction. As of today, this average consumption could possibly be a different value and could thus affect the results in some way. This somewhat applies to the machinery used in the 2001 inventory as well. Since then, with the rapid development of technology in mind, the effectiveness can have increased and fuel consumptions reduced.

For the traffic included in the study only their fuel consumption is accounted for, leaving other environmental impacts due to traffic outside of the study. It could though be of interest to see what reductions in noise and emissions due to wear that would appear, since previous studies has found grinding to have a positive impact on them both (Sandberg and Mioduszewski 2015).

Furthermore, when calculating for the grinder and sweeper, account is only taken to the size of the motor and the fuel . Further factors can impact the performance, such as weight, grinding and sweeping widths and wear.

Road markings are usually reinforced every four years (Carlson 2015) and even though they are not to be grounded upon they might have to endure wear out of the ordinary. This may lead to further reinforcements of road markings, but is not accounted for in this study. The assembly and exchange of worn down grinding segments requires a small amount of electricity, this is though not included since the figures are viewed upon as insignificant in comparison. However, the amount of tool exchanges could in some sense of course affect the final results.

Environmental impact categories not addressed within the scope of the study can be of great interest for other projects, there will though be no inclusion of such categories. All assumptions are documented throughout the paper in order to achieve as high transparency as possible.

Life Cycle Inventory

The life cycle inventory (LCI) is the second step in conducting an LCA. This is where all in- and outflows are gathered in each of the life cycle phases, energy as well as material fluxes (ISO 14 040:2006). To get an easy overview of the data compiled for this assessment the phases are dealt with separately and schematically illustrated in **Figure 10**. Note that Material, Production and Reconstruction within the Reconstruction phase only addresses the surface course of the asphalt pavement. The complete LCI, containing all values and calculations, is to be found in the Excel file attached.

Use

The use phase represents the main focus of this study as this is the phase which is aimed at prolonging in order to shift the environmental burdens from reconstructions. Within the use phase, both actual use, i.e. the traffic running on the road, and the grinding taking place under variable frequencies are taken into account.

AADT for regional road 636 is 4,670 where 6.2 % are heavy vehicles and the rest light, passenger cars. Tests have previously shown that fuel consumption decrease by 3 % during the first year when the pavement is horizontally ground, throughout the second year it is still down by 1 % and in the third year the reduction is gone, for double grinding (Sandberg 2015). For single grinding two thirds of the decrease from double grinding is reached. Note that only the fuel consumption from the vehicle is to be accounted for in this study, excluding other impacts such as noise and emissions due to wear.

Heavy vehicles in Sweden do, to 99.9 % (HBEFA 2014), run on conventional diesel, hence an approximation of 100 % is assumed in this assessment. Distribution between petrol, gas/petrol, E85/petrol and diesel for personal cars in Sweden is 47.5, 0.5, 14.1 and 37.9 % respectively (HBEFA 2014). Fuel consumption along with CO2, NOX and PM10 emissions for the separate vehicles are provided for in **Table 19**. In Table 20 the emissions for the separate vehicles are provided for in relation to each of the different fuel reductions can be found.

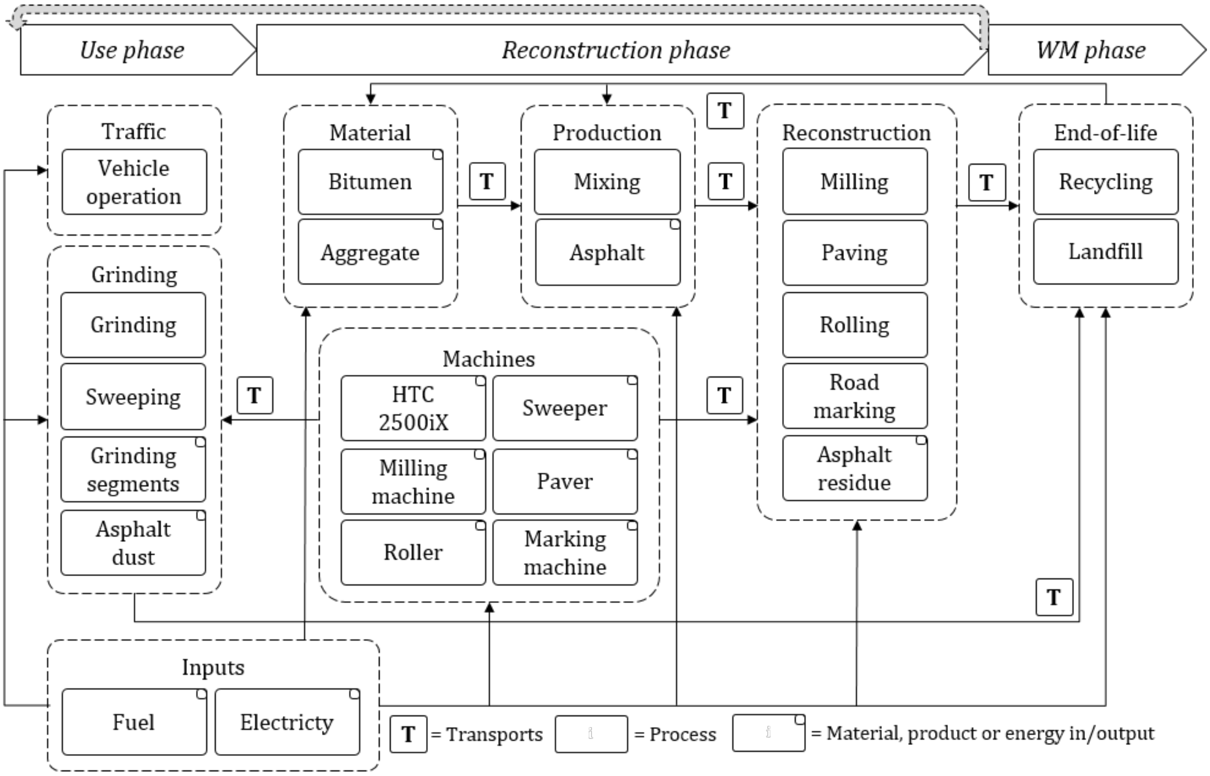

Figure 10. Flow chart for the included life cycle phases. Dotted grey arrow represents the circulation between the two phases *Use* and *Reconstruction*

Table 19. Specifications for vehicles, values per car in 80 km/h. Average fuel consumption (AFC) as well as emissions for when road is not ground (HBEFA 2014).

Vehicle	AFC [g/km]	CO_2 [kg/km]	NO_x [kg/km]	PM_{10} [kg/km]
Car - Petrol	47.63	1.50E-01	1.10E-04	1.40E-06
Car - Gas/petrol	42.88	1.17E-01	3.23E-05	9.00E-07
Car - E85/petrol	47.18	2.23E-02	3.21E-05	9.00E-07
Car - Diesel	40.29	1.27E-01	3.12E-04	6.40E-06
Truck - Diesel	238.74	7.52E-01	3.07E-03	6.09E-05

Table 20. Emissions per year for each of the different vehicle types and the grade of fuel reduction.

Vehicle	Reduction [%]	CO_2 [kg]	NO_x [kg]	PM_{10} [kg]

Car - Petrol	0.00	3.12E+02	2.29E-01	2.91E-03
	0.67	3.10E+02	2.28E-01	2.89E-03
	1.00	3.09E+02	2.27E-01	2.88E-03
	2.00	3.06E+02	2.25E-01	2.85E-03
	3.00	3.03E+02	2.22E-01	2.83E-03
Car - Gas/petrol	0.00	2.57E+00	7.07E-04	1.97E-05
	0.67	2.55E+00	7.03E-04	1.96E-05
	1.00	2.54E+00	7.00E-04	1.95E-05
	2.00	2.52E+00	6.93E-04	1.93E-05
	3.00	2.49E+00	6.86E-04	1.91E-05
Car - E85/petrol	0.00	1.38E+01	1.98E-02	5.56E-04
	0.67	1.37E+01	1.97E-02	5.52E-04
	1.00	1.36E+01	1.96E-02	5.50E-04
	2.00	1.35E+01	1.94E-02	5.45E-04
	3.00	1.34E+01	1.92E-02	5.39E-04
Car - Diesel	0.00	2.11E+02	5.19E-01	1.06E-02
	0.67	2.09E+02	5.15E-01	1.06E-02
	1.00	2.09E+02	5.13E-01	1.05E-02
	2.00	2.06E+02	5.08E-01	1.04E-02
	3.00	2.04E+02	5.03E-01	1.03E-02
Truck - Diesel	0.00	2.18E+02	8.91E-01	1.77E-02
	0.67	2.17E+02	8.85E-01	1.75E-02
	1.00	2.16E+02	8.82E-01	1.75E-02
	2.00	2.14E+02	8.73E-01	1.73E-02
	3.00	2.12E+02	8.65E-01	1.71E-02

The grinder used is HTC 2500iX from HTC Sweden AB and has a capacity of 350 m^2/h and collects about 97 % of the asphalt dust given rise to. To ensure that as much of the dust as possible is taken care of, and extra sweeper is in this study accounted for. The sweeper is fictitious and based on a number of sweepers in the area of Linköping and is assumed to be operating half of the time that the grinder is in use since its capacity is higher. To calculate for the impacts caused by the grinding and sweeping itself, calculations are performed taking energy use from the two machine's engines capacity and fuel into account. Specifications for grinder and sweeper are found in **Table 21**.

Table 21. Specifications for grinder HTC 2500iX and the fictitious sweeper.

	HTC 2500iX	Sweeper	Unit
Weight	6,300	3,500	kg
Engine	117	55	kW
Fuel	Diesel	Diesel	-
Working width	2,400	2,200	mm
Duration (single)	17	8.5	h

Duration (double)	34	17	h

The grinding segments used by the grinder consists of six different materials, namely steel, cobalt, nickel, copper, wolfram and industrial diamonds. The amount of each material is confidential, apart from the holders of the segments which consist of steel alone. 120 of these grinding segments are used at the same time and there lifetime is 9,000 m2. To be calculated for is the extraction and production of the segments needed and the waste management of them as well, where some parts are recycled, but the gains from recycling is placed within the phase of Waste management. The electricity needed to perform the assembly is excluded due to its insignificancy in comparison.

Two materials in the grinding segments are not available in the Ecoinvent database, industrial diamonds and wolfram. The environmental impact of industrial diamonds has in this study been based on that the material is graphite with a yield by weight of 1:1 and an energy use during manufacture of 0.9 kWh/g, based on a previous study made on tools involving industrial diamonds (Larsson, Lindahl et al. 2009). To calculate impact from energy demand, 95 % is based on Chinese electricity production and 5 % Irish. This since 95 % is manufactured in China and that they are shipped from Ireland to Sweden. Data for wolfram is retrieved from the Probas database, which contains process-oriented basic data for environmental management systems (Unweldt Bundesamt 2016).

Transports within Use

The transportations that have been included in this phase are transport of grinding and sweeping machines to and from regional road 636 as well as the empty vehicle which retrieves the collected dust from grinding and drives it to waste management. In Table 22 the inventory for this phase is further defined, clarifying approximated driving distances and truck size.

Table 22. Transports within the use phase. All distances are approximated.

Transport of	Truck size [ton]	Distance [km]
Grinder	3.5-7.5	15[a]
Sweeper	3.5-7.5	15[a]
Asphalt dust, to aggregate production	16-32	10[b]
Asphalt dust, to landfill	16-32	20[c]

a) Approximated distance between road 636 and Linköping

b) From road 636 to aggregate production (Petersson 2015)

c) From road 636 to Gärstadverken (Sandström 2015)

Reconstruction

Reconstruction is represented by the merger of the otherwise normally first three phases of a roads life cycle, namely Raw material, Production and Construction along with their internal transports. The assessed surface course is only to be accounted for and all figures within this phase represent the potential environmental burden which is to be shifted if/when prolonging the use phase. Hereafter, more detailed descriptions of the merged phases are presented.

Raw Materials

The surface course, being SMA16, is a mixture of bitumen and aggregates, with six weight percentages of bitumen. To construct the surface course, 35.1 and 549.9 tons of bitumen and aggregate respectively are needed, giving a total of 585 tons of asphalt. The asphalt density calculated for is 2,600 kg/m3 (Sandberg and Mioduszewski 2015). Emissions and resources needed for the extraction of both bitumen and aggregate is included in the production of asphalt in the following subchapter.

Production

The bitumen is produced from crude oil where the parts not used for asphalt production is used for production of fuel. Transports accounted for occur between the extraction in Venezuela and the refining in Sweden, from the refinery to regional depots and from depots to users, all by tanker boats. Production of crushed aggregates is based on production from rock mass. Transports included are from where the rock is blasted, to a stone breaker where the final product is produced, all other transports are excluded. All electricity consumption is based on Swedish average electricity consumption.

Construction

The processes accounted for are only connected to the surface course since all other road construction is omitted in this assessment. Accounted for are surface milling, paving, rolling and road marking. Surface paving is performed by the asphalt paver DynaPac F12 and rolling by the asphalt compaction machine DynaPac CC 142. Regarding the road markings, the production of thermoplastic material is not included, only the actual operation of equipment for laying road markings.

Life cycle data regarding hot asphalt production as well as all construction steps are retrieved from Stripple (2001) and in Table 23 the life cycle inventory for the entire Reconstruction phase is presented.

Table 23. Life cycle inventory for reconstruction of the surface course, transports excluded. Asphalt production, surface milling, paving, rolling and road marking are presented, per reconstruction.

In/outflow	Unit	Asphalt	Milling	Paving	Rolling	Marking
Bitumen	kg	3.51E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aggregate	kg	5.50E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CO_2	kg	2.01E+04	9.15E-02	1.25E+03	9.09E+02	6.93E+01
NO_X	kg	6.96E+01	8.25E+00	1.13E+01	8.21E+00	4.83E-01
PM_{10}	kg	2.22E+00	3.30E-01	4.50E-01	3.26E-01	2.27E-02

Transports Within Reconstruction

Apart from the transports already included in the LCI for Raw material and Production, other transports within the Reconstruction phase are included as well. The transports that are accounted for are transports of asphalt residue, due to milling, to waste management, of hot asphalt mix to the road for paving and the transports that the machines do. All three transports consist of roundtrips, where the asphalt mix and asphalt residue trips are calculated as one way empty load, one way full. Table 24 presents the distances assumed for the different transports. All vehicles are equipped with a diesel engine as their source of power and the transports are assumed to be performed with equal trucks.

Table 24. Transport distances within the construction phase, one way.

One way trip with	Truck size [ton]	Distance [km]
Asphalt residue, to asphalt production	16-32	10[a]
Hot mix asphalt	16-32	10[a]
Rollers*	7.5-16	15[b]
Paver	16-32	15[b]
Milling machine	16-32	15[b]

* Includes the asphalt team and adhesive equipment as well, but is herein this study excluded (Petersson 2015)

[a] From road 636 to asphalt production (Petersson 2015)

[b] Approximated distance between road 636 and Linköping

Waste Management

For waste management it is assumed that 90 % of the asphalt dust created from grinding can be recycled as aggregate in asphalt production and does therefor substitute parts in aggregate production, the remains are assumed to go to landfills. What on the other hand goes for the asphalt remains from milling when reconstructing is performed is that all is assumed to be recyclable and hence substitutes parts in asphalt production. The shifted environmental burden does therefore contain a gain within this phase. Details on the production of asphalt and aggregate, which is used to calculate for the gains, can be found in **Table 25**.

Table 25. Emissions related to the production of one ton of asphalt and crushed aggregate (Stripple 2001). Note that this crushed aggregate production is part of Asphalt production together with the production of bitumen.

Outflow	Unit	Asphalt production	Aggregate production
CO_2	kg	3.44E+01	1.42E+03
NO_X	kg	1.19E-01	1.23E-01
PM_{10}	kg	3.79E-03	4.77E-01

Concerning the grinding segments, the tools, a great part of the segments are worn off and this is when their life time expires. At that moment, a small share of segment together with the segment holder is what is left. The holder, consisting entirely of steel, is then recycled into steel scrap to be used in other products' life cycles. For this process of recycling steel, only the profits in replacing pig iron with recycled steel scrap is accounted for, hence no manufacturing processes are accounted for in order to use the scrap in new products.

Life Cycle Impact Assessment

The Life Cycle Impact Assessment (LCIA) is defined as the phase aiming at evaluating and understanding the potential environmental impact from the product addressed (Goedkoop, Oele et al. 2013). When all data needed is gathered and complied, ReCiPé is, as mentioned earlier, the method chosen when performing the impact assessment in SimaPro. Processes and materials not to be found within the Ecoinvent database has been calculated for through self-made modelling. Values for NOX and PM10 are retrieved from inventory while CO2 is calculated for through ReCiPé's impact category Climate change, where CO2-equivalents are obtainable.

Table 26 shows for the caused emissions of CO2-equivalents, NOX and PM10 from case 1 to 4 as well as the null alternative; case 0. Complete calculations together with descriptions of selected modelling data are to be found in the Excel file attached.

Table 26. CO_2-equivalent, NO_X and PM_{10} emissions from all four fictitious cases as well as for case 0.

Case	Phase	Sub-phase	Unit	CO_2	NO_X	PM_{10}
0	Use	Grinding	kg	0.00E+00	0.00E+00	0.00E+00
		Tools	kg	0.00E+00	0.00E+00	0.00E+00
		Traffic	kg	3.03E+04	6.64E+01	1.27E+00
		Transports	kg	0.00E+00	0.00E+00	0.00E+00
	Reconstruction	Reconstruction	kg	1.12E+05	4.99E+02	1.71E+01

Case	Phase	Sub-phase	Unit	CO_2	NO_X	PM_{10}
		Transports	kg	1.03E+04	3.14E+01	4.69E+00
	Waste management	Recycling	kg	-7.89E+04	-2.73E+02	-8.69E+00
		Landfill	kg	0.00E+00	0.00E+00	0.00E+00
	Total		**kg**	**7.34E+04**	**3.24E+02**	**1.44E+01**
1	Use	Grinding	kg	5.67E+04	3.01E+02	3.77E+00
		Tools	kg	1.84E+04	6.64E+01	1.91E+01
		Traffic	kg	2.98E+04	6.52E+01	1.25E+00
		Transports	kg	5.78E+03	1.57E+01	1.80E+00
	Reconstruction	Reconstruction	kg	9.93E+04	4.35E+02	1.49E+01
		Transports	kg	8.38E+03	2.56E+01	3.82E+00
	Waste management	Recycling	kg	-7.30E+04	-2.50E+02	-1.02E+01
		Landfill	kg	8.47E+02	4.13E+00	1.14E-01
	Total		**kg**	**1.46E+05**	**6.62E+02**	**3.45E+01**
2	Use	Grinding	kg	2.13E+04	1.13E+02	1.41E+00
		Tools	kg	1.10E+04	3.98E+01	1.14E+01
		Traffic	kg	2.99E+04	6.55E+01	1.25E+00
		Transports	kg	3.47E+03	9.44E+00	1.08E+00
	Reconstruction	Reconstruction	kg	5.96E+04	2.61E+02	8.92E+00
		Transports	kg	4.71E+03	1.44E+01	2.15E+00
	Waste management	Recycling	kg	-3.74E+04	-1.28E+02	-5.42E+00
		Landfill	kg	5.08E+02	2.48E+00	6.84E-02
	Total		**kg**	**9.32E+04**	**3.77E+02**	**2.09E+01**
3	Use	Grinding	kg	3.19E+04	1.69E+02	2.12E+00
		Tools	kg	9.20E+03	3.32E+01	9.54E+00
		Traffic	kg	2.99E+04	6.55E+01	1.25E+00
		Transports	kg	2.79E+03	7.69E+00	9.16E-01
	Reconstruction	Reconstruction	kg	7.45E+04	3.26E+02	1.12E+01
		Transports	kg	6.09E+03	1.86E+01	2.77E+00
	Waste management	Recycling	kg	-5.04E+04	-1.73E+02	-6.64E+00
		Landfill	kg	6.35E+02	3.10E+00	8.55E-02
	Total		**kg**	**1.05E+05**	**4.50E+02**	**2.12E+01**
4	Use	Grinding	kg	1.71E+04	9.01E+01	1.13E+00
		Tools	kg	7.36E+03	2.66E+01	7.63E+00

Case	Phase	Sub-phase	Unit	CO_2	NO_X	PM_{10}
		Traffic	kg	3.00E+04	6.57E+01	1.26E+00
		Transports	kg	2.23E+03	6.16E+00	7.33E-01
	Reconstruction	Reconstruction	kg	5.96E+04	2.61E+02	8.92E+00
		Transports	kg	4.71E+03	1.44E+01	2.15E+00
	Waste management	Recycling	kg	-3.71E+04	-1.27E+02	-4.95E+00
		Landfill	kg	5.08E+02	2.48E+00	6.84E-02
	Total		**kg**	**8.44E+04**	**3.39E+02**	**1.69E+01**

To clarify and display the differences between the cases in relation to each other, **Figure 11** shows for their total emissions of CO2-equivalents, NOX and PM10, values from **Table 26**.

For all impact categories, it is found that case 1, where horizontal grinding is performed every year, is the case giving rise to the most emissions. In opposite, case 0 where no grindings are performed leads to the least emissions. I comparison to case 0, case 1contributes to 99, 104 and 139 % more in total in emissions of CO2-equivalents, NOX and PM10 respectively. Whereas case 4, the grinding case with least environmental impact, still contributes by 15, 5 and 17 % of CO2-equivalents, NOX and PM10 respectively in comparison to case 0. Both case 2 and 4 have lower potential environmental impacts in comparison to case 1, which can be directly connected to that they have the longest life span, namely 15 years, avoiding as much reconstruction as possible.

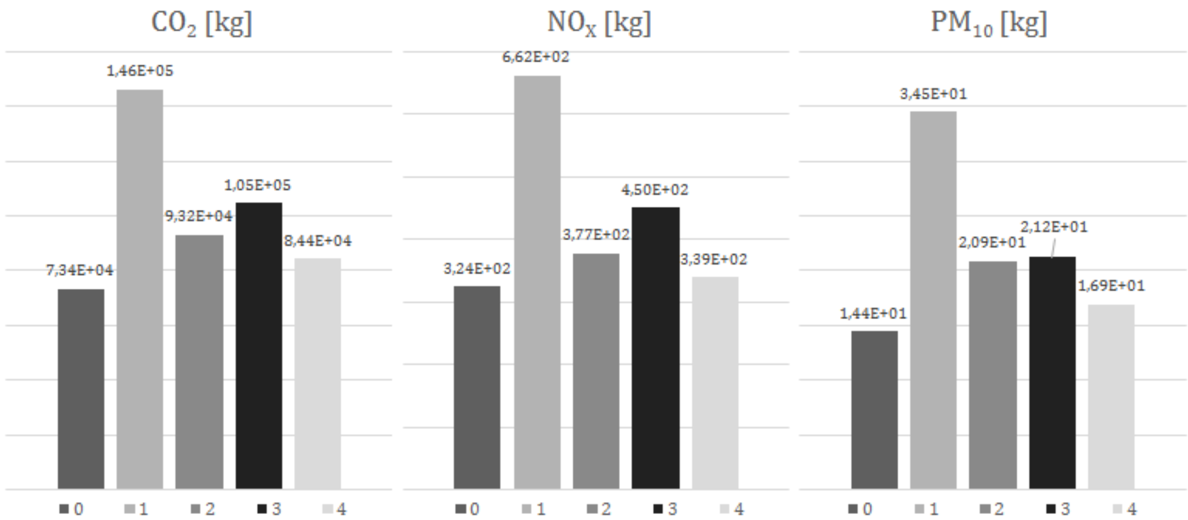

Figure 11. Emissions from each of the four cases, as well as the null alternative: case 0. Cases are identified by their number in the bottom of each bar.

In **Figure 12** the cases are displayed showing the distribution between different life cycle phases and their contribution to the caused emissions. This makes it possible to identify where the largest contributions arise and also to see how high the rate of emissions would have been without the benefits from recycling. Note that traffic together with grinding and tools constitute the Use phase and that all transports are grouped together into one. In the figure it is displayed that reconstruction contributes to a large share in all cases and emission classes. Noticeable is though that for emissions of PM_{10}, the grinding tools stand for the major shares in case 1 to 4.

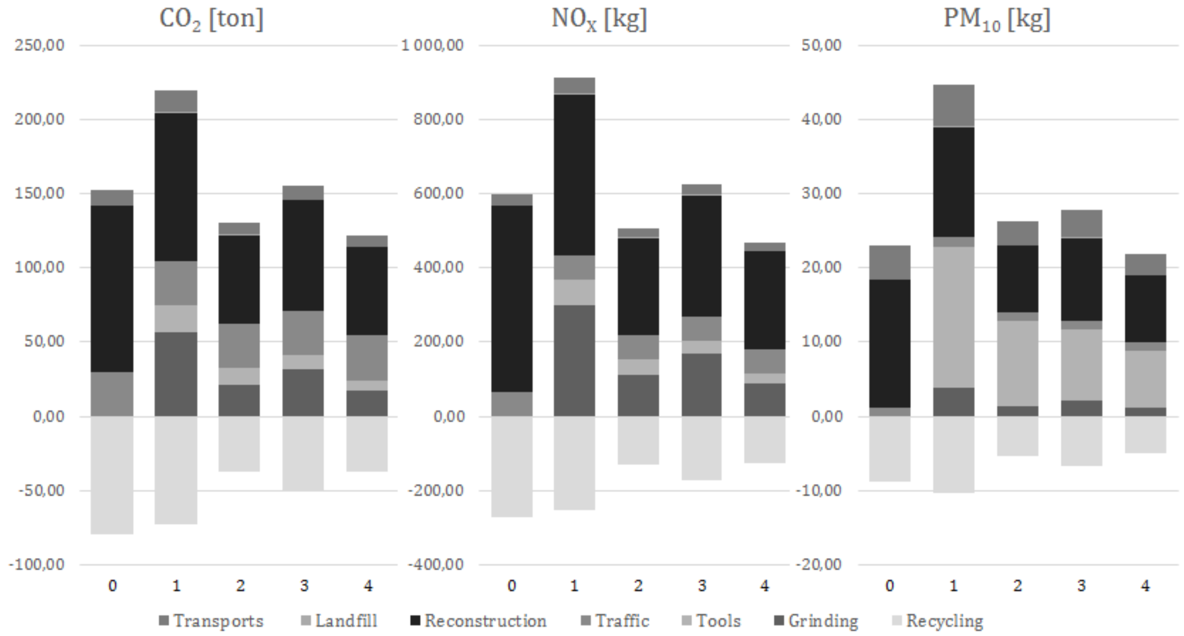

Figure 12. Life cycle phases' contributions within each of the cases. Note that emissions of CO_2 are presented in tons while the others in kilograms.

The recycling consists of three different types of recycling, one from reconstruction where the milled asphalt residue can be reused, one from the worn out grinding tools and lastly from grinding where the asphalt dust can be recycled as aggregate in asphalt production. **Figure 13** illustrates how the amount of recycling is distributed between the three types.

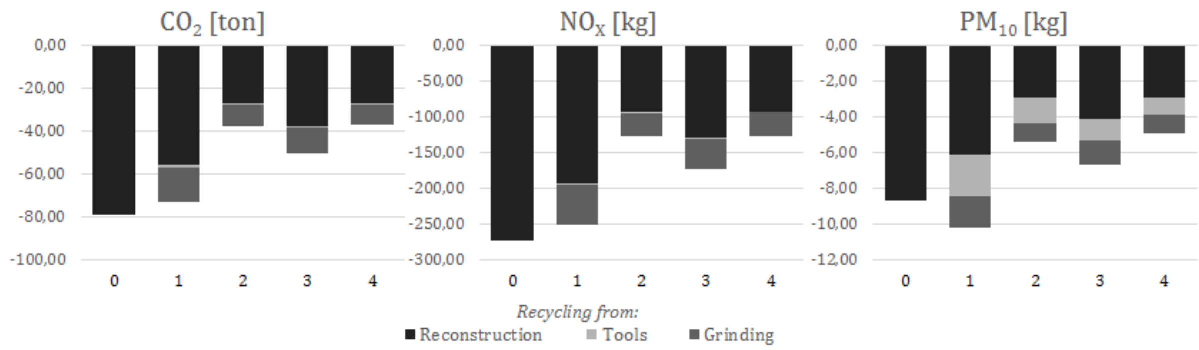

Figure 13. Distribution between recycling from Reconstruction, grinding and the tools, the grinding segments. Note that emissions of CO_2 are presented in tons while the others in kilograms.

Since no grinding is performed in case 0, all recycling origins from within the reconstruction phase. In emissions of both CO2 and NOX the benefits from tool recycling are quite insignificant, asphalt dust collected when grinding stands for about 25 % and reconstruction recycling for the more or less the rest. For emissions of PM10 on the other hand, the recycling of tools has a more significant share, namely about 21 %, which corresponds to the results shown in **Figure 12** where tools proved more significant than in CO2 and NOX. In PM10 case 0 is not the case with the most benefits from recycling, when comparing with CO2 and NOX, which means that steel recycling has valuable influences on the results with regards to the emissions of particles.

If the phases concerned in recycling are assigned their respective benefits, **Figure 14** is conducted, presenting a clearer picture of total environmental impact in relation to the phases in each of the cases. Seen in emissions of CO2 is that reconstruction and traffic contribute quite equally in all cases apart from case 1 where grindings appear rather significantly in comparison to the other cases. Reconstructions do in emissions of NOX contribute to about half of the impact in all cases but case 1 and when it comes to PM10, the grinding tools contribute considerably in comparison to the other phases. To be noted in emissions of PM10 is also that the grinding itself has very small impact on the total.

When comparing the separate phases of the life cycle it is found that the effects on emissions from traffic when grinding are not that significant in either of the addressed emission classes in comparison to case 0, see **Figure 15** for a detailed view. It is the lowest in case 1, thanks to its high frequencies in grinding, so this would of course be favourable for the drivers themselves, saving both money and lowering their emissions to some extent. With regards to the whole life cycle, it is only in emissions of CO2 that traffic stands for a great share, in PM10 it is amongst the minor contributors.

The materials of which the grinding segments consist contribute differently with regards to the different emissions classes. **Table 27** below clarifies for the percentage of which each of the materials stand for, this only for the grinding segments, not for the steel holder. Shown is that two materials clearly stand for the core potential environmental impact, being the industrial diamonds and wolfram.

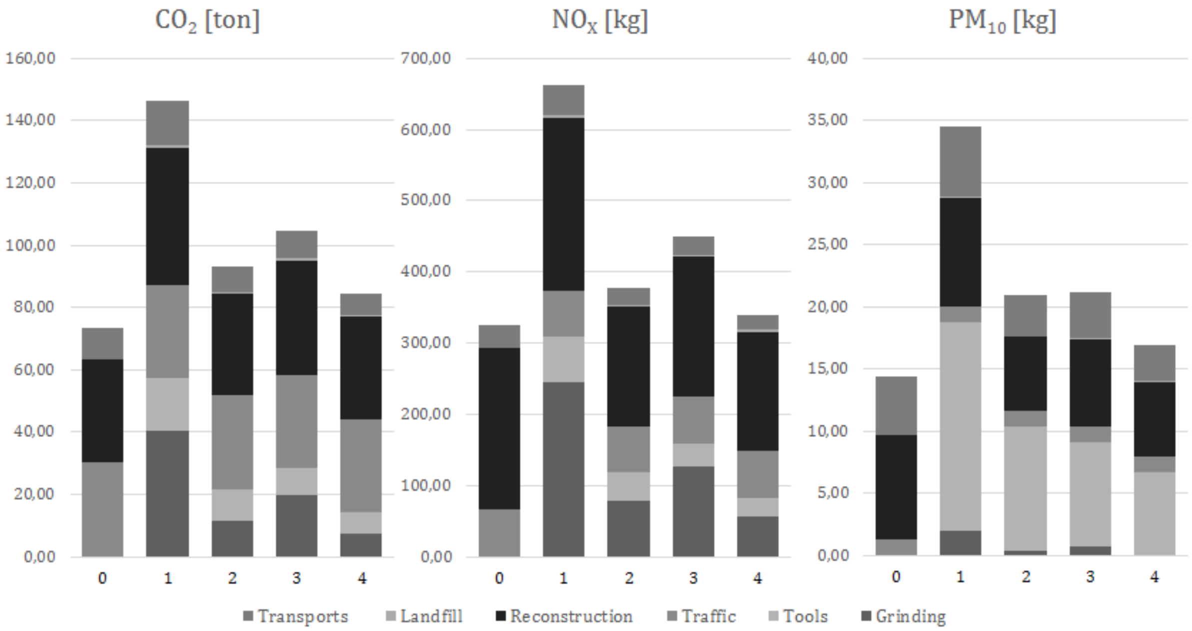

Figure 14. Life cycle phases' contributions within each of the cases where recycling is assigned the phases creating the benfits. Note that emissions of CO_2 are presented in tons while the others in kilograms.

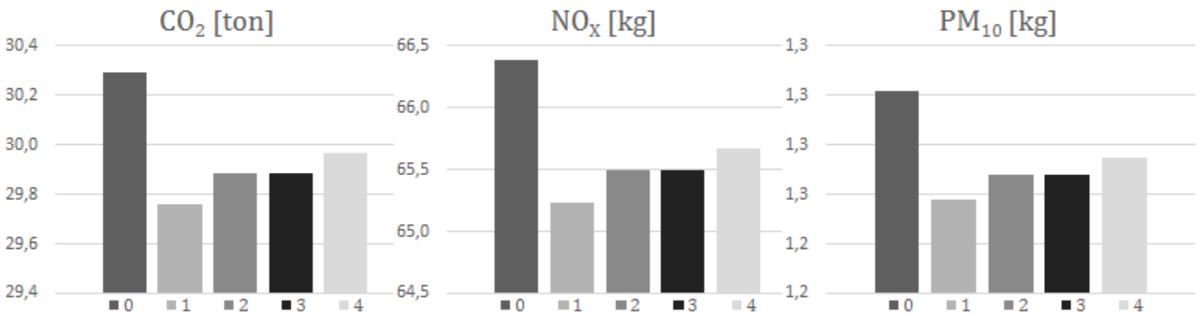

Figure 15. Details on emissions caused by traffic in all cases. Note that emissions of CO_2 are presented in tons while the others in kilograms.

Table 27. Distribution between the materials of which the grinding segment consist of in relation to emissions of CO_2-equivalents, NO_X and PM_{10}, excluding the steel holders.

Material	CO_2	NO_X	PM_{10}

Industrial diamonds	87.37 %	66.75 %	6.40 %
Steel	0.36 %	0.18 %	0.51 %
Cobalt	3.96 %	8.63 %	6.81 %
Nickel	0.93 %	1.24 %	1.04 %
Copper	0.58 %	1.05 %	1.11 %
Wolfram	6.79 %	22.16 %	84.13 %

Sensitivity Analysis

The null alternative, case 0, is an analysis of the conditions today and the other cases are scenarios of what could be, which makes the scenario analyses in a sense sensitivity analyses in themselves. This since almost all factors are altered based on what frequencies in grinding that is assumed for each of the individual cases. Despite this, some sensitivity analyses are still performed in order to verify if there exists any factor in need of special attention, this where some doubt in the modelling is concerned.

Industrial diamonds and wolfram were, as mentioned earlier, the two materials not existing in the Ecoinvent database. They also showed to be the materials who were responsible for the majority of the emissions. If these materials were to have a different environmental impact than accounted for, the results from the study might be different. In the case of industrial diamonds it was assumed that the material is graphite with a yield by weight of 1:1 and that 0.9 kWh/g were needed for production, this based on a previous study from 2009. The yield by weight is in the sensitivity analysis set to be 1.55:1 instead since this is the relation in density between graphite and diamonds, graphite being 2.26 and diamonds being 3.51 g/cm3. The graphite does not give rise to any noticeable differences in environmental impact. If the energy demand also is multiplied by 1.55 the results follow the same rate, this is though not significant on the whole and no significant changes goes for the distribution in impacts from the different materials.

A factor affecting the results quite substantially is the waste management, more specifically the recycling. Assumed in the study is that all remaining asphalt is milled away and recycled when reconstructions occur. Sometimes when reconstructions are made due to wear, the entire surface course is not milled and recycled. Instead it is just milled enough to create an even surface again to pave new asphalt upon. A sensitivity analysis is therefore performed were, for case 0, 50 % of the asphalt is recycled and the other half remains on the road, this based on that the maximum allowed rut depth is 16 mm on a road with a speed limit of 80km/h and an AADT between 4,000 and 8,000 (The Swedish Transport Administration (Trafikverket) 2012). Cases 1 to 4 are reconstructed at the end of their life span due to that they then have reached the minimum thickness allowed for the surface course. Hence, for cases 1 to 4 25 % of the remaining asphalt after grinding is assumed to be recycled, leaving 75 % to stay on the road. **Figure 16** together with **Figure 17** show the results from the analysis, illustrated with the same execution as **Figure 13** and **Figure 14** earlier.

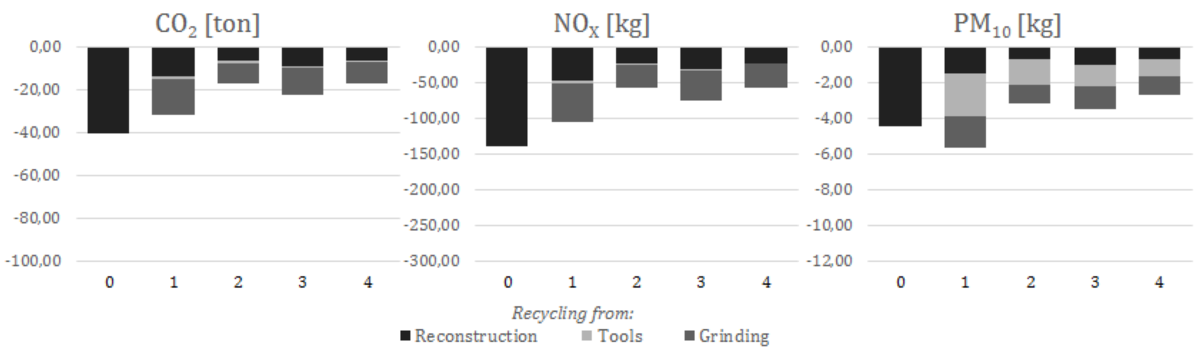

Figure 16. Sensitivity analysis showing how the distribution between reconstrucion, grinding tools and grinding is changed with a different waste management scenario for the asphalt recycling.

When studying **Figure 16** it is clear how much the benefits from recycling in the reconstruction phase has decreased in comparison to **Figure 13**. Seen in **Figure 17** when comparing to **Figure 14** is that the total environmental impact in all cases, all emissions classes, has increased. Likewise, the shares from reconstruction have become larger. With this alternative waste treatment scenario case 0, case 2 and case 4 come very much closer to each other in terms of total environmental impact. In emissions of CO2 and NOX case 4 instead show for the smallest impacts, instead of the previous case 0.

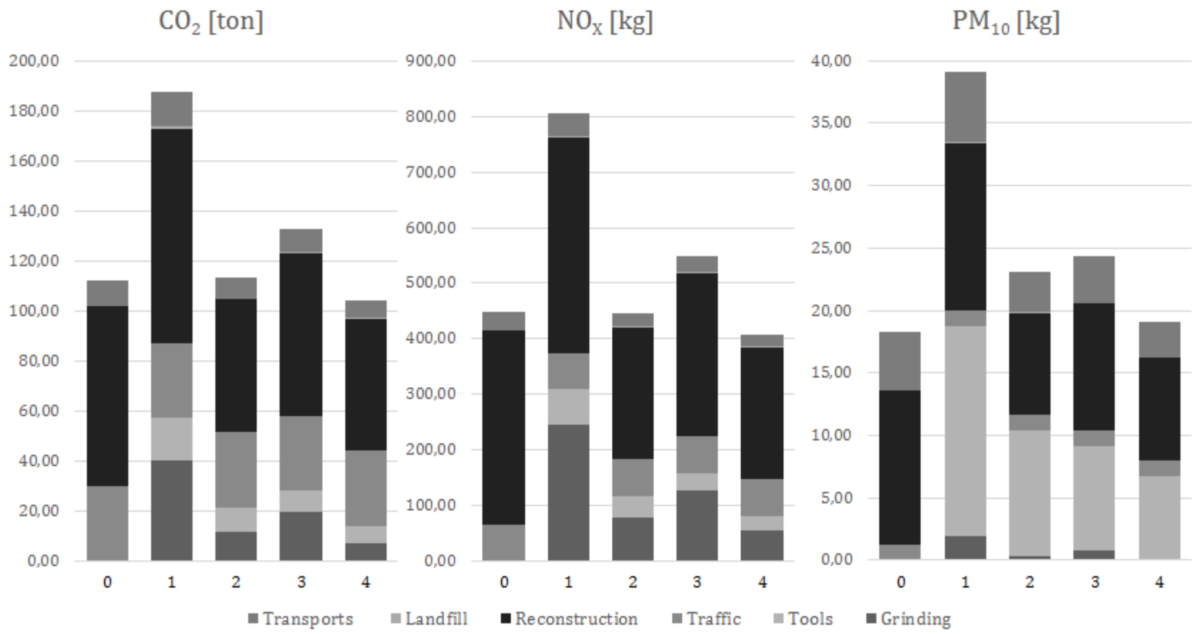

Figure 17. Sensitivity analysis showing how a different waste management scenario for the asphalt recycling affects the final results.

Concluding Discussion and Conclusions

Case 0 is, as mentioned earlier, the case defined as the conditions of today were no grinding of the road is performed. When conducting the four cases to compare with case 0, basis was set with regards to the amount of grindings performed during the surface course's expected life span. These grinding intervals are indeed conducted solely on the grounds of assumptions of what would be realistic, but the effects on passing vehicles has support from previous studies. Conclusions are therefore drawn that the calculated effects on traffic in study is reliable, leaving uncertainties only for the impact that time and wear has on the created fuel reductions from grinding.

Even though traffic in this study showed no major difference in between the cases in comparison to the other phases in the life cycle, a decrease in emissions was still reached. If one has in mind that traffic stands for about a quarter of the Swedish energy use (The Swedish Energy Agency 2015) and that road traffic in 2015 stood for 71 % of that share, then these reductions generated by grinding of asphalt roads may in the larger perspective have great effects.

When it comes to the grinding segments and the materials of which they contain, industrial diamonds and wolfram accounted for the largest share of environmental impact, industrial diamonds in CO2 and NOX and wolfram in PM10. These two materials happen to be the materials which do not exist in the Ecoinvent database and are therefore modelled differently. Concerning wolfram, life cycle data is retrieved from a different database and does for that reason reduce the uncertainty. Industrial diamonds is though calculated for differently but by analysing variations in input values it was shown that the outcomes were not significantly diverse from the initial modelling. Concluded is hence that wolfram and industrial diamonds in deed together account for the largest share of impacts from the grinding tools. However, if the processes surrounding the grinding tools are accurate or not requires more life cycle data to verify, which unfortunately was not available in this project.

It is found that one of the important improvements in environmental impacts is done by prolonging the life span of the surface course and in that way minimizing the amount of reconstructions, which is proved to one of the life cycle phases contributing the most to the total potential environmental impact. Even so, since the data retrieved for modelling the reconstruction phase is from 2001, there does exist an uncertainty in the results that cannot be overlooked. With the rapid technology developments in mind, these figures may be smaller as of today.

In relation to the reconstruction phase being one of the most contributing life cycle phases when it comes to environmental impacts, this study has shown that minimizing the occurrence of reconstructions by extending the life span of the surface course is an efficient way to decrease the total environmental impacts. Case 4, where double grindings are applied every fourth year, does decrease the potential environmental impacts from the road the most, closely followed by case 2 where a double grinding is performed the first time and then single grindings every second year.

With the chosen waste management treatment scenario for the study, none of the fictitious cases do though show for increases in total environmental impacts. However, if the recycling procedures looked more like the one adopted in the sensitivity analysis, case 4 would result in lower potential environmental impacts.

To summerize, with regards to the cases and scenarios set for this study, it is revealed that horizontal grinding of asphalt roads do not decrease the potential environmental impacts today. In order to potentially achieve that, it requires more research e.g. in order to improve the grinding technique and make it more efficient and find out how to prolong the time between need of re-grinding.

Acknowledgements

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Navigating sustainability in Southern India: the Muziris Heritage Site project in Kerala

Jay A. Waronker

Abstract

Dating back many centuries the central region of India's current-day southwestern-most state of Kerala featured a lush and verdant sliver of land intertwined with picturesque and navigable water canals. These canals wound their way through the tropical countryside before opening onto the Arabian Sea. Dating back to ancient times, these waterways were navigated by an assortment of foreign traders – among them the Greeks, Romans, Phoenicians, Persians, Jews, Moors, and Chinese. In this area was a place called Muziris, and it was the landing port for Jews, Christians, Muslims, and a host of other world cultures. It was also the hub of cargo ships and their traders from West Asia, the Mediterranean, and East Africa. Muziris and its environs thrived during ancient and medieval times. It was an economic and cultural center for hundreds of years until the area was affected by a flood in the year 1341. This was followed by the Portuguese colonialists (as a tie to this year's conference venue) who had staked their claim to this part of India and shifted maritime activity from Muziris to Cochin a short distance to the south beginning in the 1520s. In the process, the status and importance of Muziris was greatly demoted. Recently Muziris and its surrounding area became a new beehive of thought and activity showcased as a heritage site and setting for sustainability. The focus of this effort was not exclusively on trade but rather on the region's broader history, architecture, crafts, lifestyle, and living traditions. In 2009/10, an ambitious conservation and sustainability project named the Muziris Heritage Site was announced by various national, state, and local Indian government agencies. This multi-million US dollar project set out to conserve, sustain, enhance, and interpret the cultural significance of the Muziris landscape. It involved not only several secular and religious historic buildings ranging in scale from the relatively grand to more modest, but also markets, town centers, canals, boat jetties, footways, bicycle paths, roads, bridges, and cemeteries. Here sustainability had a triple meaning and context. As an architect, I use it to refer the traditional and time-tested building materials and construction techniques, climatic factors, and religious and secular customs that all shaped Kerala's architecture, and how these variables were faithfully adhered to for the tangible restoration of several local heritage buildings and spaces. These issues are ones that I have long cared for and have personally written about over the years in a variety of academic and popular publications. As an architectural historian, sustainability also refers to how the cultural history of Kerala dating back more than two thousand years has been highlighted and in fact maintained for the long term as a goal of the Muziris Heritage Site project. This was the case not just for the domestic and foreign tourists but, more importantly, through concerted community involvements from the people native to the area. Furthermore, this undertaking will not only restore a series of dilapidated manmade and natural spaces and places but also aid in the economic rejuvenation of the area in a generally sensitive and low-footprint way. After confronting many challenges and delays, the Muziris Heritage Site project will be officially inaugurated in late February 2016. Among the monuments restored as part of the Muziris Heritage Site project were a Portuguese and a Dutch colonial-period fort, a synagogue with a history dating back to the 12th century yet rebuilt various times over the centuries (I served as an Muziris Heritage Site advisor on its complicated restoration), a seminary founded by Portuguese Jesuit missionaries in the 16th century, a masjid – the first mosque built in Kerala, the Palian Palace belonging for centuries to the hereditary prime minister appointed by the rajah of Cochin, some Hindu temples, a few churches, and various private homes. The Muziris Heritage Site project involved the preservation and sustainability of these monuments and historical buildings as well as the restoration or upgrade of old market places, current roadways (no new highways for example), existing natural canals, and bridges – linking them into tourist circuits mostly via water transport but also but footpaths and bicycle trails. The planners of the Muziris Site Project envisioned (perhaps in an overly nostalgic way) that by going on a tour aboard traditional boats and water taxis (or other person-powered modes of transportation) through the area, travelers – whether of the serious type or the

weekend variety -- will have a ride through Kerala's more than two thousand year old history and traditions. Nostalgic or not, the results are set to combine environmentally-responsible and low-impact measures with a component of fun in the context of the verdant, balmy, and breezy Kerala landscape. The Muziris Heritage Site project also included a series of what are described by its planners (who are private design professional contracted by the Kerala government teamed up with government authorities and local experts) as living museums throughout the circuit, including ones devoted to the coir, fishing, spice, and aquatic industries that have been a part of the fabric and fabric of Kerala for centuries if not millennia. More of these museums will showcase the artistic traditions of the regions through bell markers, handloom weavers, and wood workers. Even others will highlight the general history of the state, its diverse religious traditions, and its songs and literature. This paper will reveal the newly-inaugurated Muziris Heritage Site project, a complex multi-year undertaken that I have followed closely and visited regularly as it developed from 2010-2015, as an example of how the science and engineering of sustainability (via an emphasis on such things as local/time-tested building practices, sustainable building materials, ecologically-friendly people-moving and transportation practices, and an overall concern for the environment) can be appropriately if not seamlessly merged with artistic and aesthetic concerns. Here the heritage and distinct architecture of central Kerala has been maintained and left mostly authentic, yet it has been conserved and sometimes repurposed in ways that maintain its distinct sense of place and cultural value within a contemporary digital-age context. These variables will be blended in my paper with an additional focus on local Kerala lifestyle traditions, regional history, and international tourism to tell a story, part successful and part less so, of how sustainability touches on many fields, actions, and traditions. Also, a sustainable project through its planning and implementation can indeed have an enjoyable, recreational, and educational component as well. It is through this combination of factors that the definition and value of sustainability becomes ever more multi-faceted, viable, and accepting.

Track 5e. Circular Economy and Industrial Ecology

Session 5e-01

Session 5e-05

Session 5e-09

Tracing foundations of the Circular Economy for a better understanding of its implementation challenges – A dynamic concept revisited

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Abstract

Over the past few years, the circular economy (CE) has increasingly been promoted as an important means to induce the paradigm shift in resource use required for the transition towards sustainable societies. CE definitions signal that the concept goes beyond resource efficiency approaches as it simultaneously addresses economic effectiveness through its emphasis on maximization of sustainable value creation over the lifecycle of products and services. Scholarly publications on CE are scarce and in non-scientific literature the CE is portrayed essentially as a new concept, accompanied by entirely new business models leading to uncertain implications for business and other stakeholders. This paper argues that such framing of the circular economy fails to uncover its historic foundations in long-established concepts, which form the 'substrata' underlying the contemporary definition. A key aim of this paper is therefore tracing the concept of a CE historically for gaining a better understanding of its interpretation and various forms of implementation over time. The historic analysis of CE development uses scientific papers and edited books for a systematic literature review focusing on the European context and examples from the Netherlands in specific. The Netherlands show a long history of integrated waste management and currently exhibit a frontrunner position in piloting circular business models. The varying meaning of CE over time is likewise derived from a literature study and includes peer-reviewed reports as to capture framings beyond the scientific audience. The analysis reveals theoretical foundations of CE, such as industrial ecology (IE) and shows the diverse political framing of CE precursors during various historic phases. Preliminary findings suggest that previous 'eras of circularity' can be artificially distinguished. Despite using a different terminology some of the preceding concepts are so closely linked with CE conceptually, that the current phase and interpretation of the concept can be considered as 'Circular Economy 3.0'. The CE 3.0 may nonetheless display distinctive features, such as the emphasis on collaboration for closed loop supply chains and service-oriented business models as enablers of high-level value retention. The historic analysis including the framing of CE over time is complemented with an overview on organizational implications following from CE 3.0 implementation. For this purpose, the paper crosses scientific knowledge on supply chain reconfigurations in CE with insights on the waste hierarchy. First findings show that scholarly understanding of the higher reuse options in the hierarchy is limited and definitions differ substantially according to scholarly disciplines publishing on CE wherefore the authors propose a shared conceptualisation of the R-hierarchy and its associated business activities based on a synthesis of the examined literature. An overall conclusion regards the importance of applying a historical perspective to extract lessons learned in previous eras and framings of concepts in order to expose the specific implementation challenges arising when a concept is re-invented, as is the case with the concept of a circular economy.

Keywords: Circular economy, historic review, supply chains, value cascading, waste reuse hierarchy

Co-Processing – Material Recovery of Alternative Fuels in the Cement Industry: A Portuguese Case Study

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Abstract

There is a growing concern about the natural system's capacity in terms of extracting, processing and disposal of resources, especially non-renewables, and its associated impacts. In this context, resource and waste related policies are of fundamental importance in establishing the necessary regulatory, economic and social instruments to mitigate those impacts. The European Union, in particular, established in its Waste Directive that waste management should follow a specific hierarchy, with prevention at the top of the priorities, followed by reuse, recycling, energy recovery and finally end disposal. Member states consequently layout their own policies in order to implement this hierarchy and, furthermore, establish targets associated to resource recovery of specific waste flows; these are especially important for Extended Producer Responsibility (EPR) management entities, like Green Dot, given the tendency towards more progressively ambitious targets in the medium to long term. Therefore, EPR systems must continuously analyze operations within their network, encouraging R&D and technological innovation, thus improving recycling and recovery efficiency. One of the operations that is being scrutinized in terms of its active contribution to recycling is the use of wastes in the cement industry, known as co-processing, which lies at the core of many industrial symbiosis's networks around the world. According to the interpretative guide of the Waste Directive, in terms of clinker production, co-processing combines two recovery operations simultaneously – the energy content of the waste is recovered, substituting fossil fuels, while the mineral fraction is recycled in the matrix of the final product. Despite recognizing this dual result, the EC does not account the mineral fraction of waste recycled in the clinker for recycling targets. Recognizing the need to fulfil increasingly ambitious targets, Portuguese EPR management entities for waste packaging, used tires and end of life vehicles, in cooperation with nationally based cement companies, moved towards implementing a study with the objective of 1) benchmark the regulatory and technical framework associated to co-processing wastes in cement kilns, 2) developing a methodology to readily quantify the recycled materials through co-processing and, 3) quantifying the impacts in the Portuguese recycling targets for specific waste flows, from 2010 to 2013 and with projections up to 2016. The results, presented in this paper, demonstrate that 1) there is no major regulatory or policy obstacle to move towards recognizing the contribution to recycling targets of the co-processing waste materials in cement kilns; 2) co-processing represented 1% to 9% in added contributions to recycling targets between 2010 and 2013, depending on the type of waste; and 3) it could represent up to a 3% added contribution to reuse and recycling preparation targets by 2016.

Keywords: Co-processing; alternative fuels; recycling targets; industrial symbiosis

The role of external agents in collaborative sustainable supply networks in emerging markets

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Abstract

External agents such as consultants and brokers are identified as key elements to moderate collaboration in eco-industrial networks as they facilitate knowledge sharing and trust among member organizations. Their role is considered determined for improvement of network performance. This research explores the role of external agents in a sustainable supply initiative in Colombia based on evaluations of participating firms and analysis of differential performance in terms of environmental and economic benefits. Literature on external agents and sustainable supply collaboration underpin interviews carried out to ten different service providers who participated in a sustainable supply initiative. Performance improvements of 183 suppliers and 17 anchor companies provided empirical information for the evaluation. Outcomes confirm the importance of external agents influencing collaborations with suppliers and between supplier and anchor firms through facilitation of alignment of visions and providing new information. Moreover, external agents with different professional profiles presented homogeneous performance in terms of environmental and economic benefits produced by the various supply networks. The contributions of this research add to literature by identifying the specific role of external agents in collaborative eco-industrial networks such as sustainable supply in an emerging market context with high power distance among suppliers and anchor firms. Likewise, the study confirmed the wide application of the sustainable supply model used in the Colombian initiative, were external agents with different professional profiles contributed to homogeneous economic and environmental benefits.

Keywords: Collaboration, Emerging Market, External Agents, Sustainable Supply

Sustainability-oriented by-products innovation – a case study on lignin valorisation in the Austrian pulp and paper industry

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Abstract

In the coming decades, the current fossil fuel based economy is supposed to shift into a low-carbon bio-based economy due to concerns about climate change and energy security. For this shift, biorefineries will play an essential role for producing bio-based products, materials, fuels and chemicals from biomass. Particularly pulp and paper mills, which already process large quantities of biomass, hold the potential of being transformed into biorefineries, by utilizing by-products that are formed during the pulp production. Next to tall oil, turpentine and resin, lignin is an important by-product, which is separated during the pulp production process. Despite a variety of short to long-term opportunities for lignin valorisation only a small amount of lignin (1-2% - i.e.1 million tons per year worldwide) is currently isolated from pulping liquors and commercially used for the production of a range of special products (see e.g. Gargulak and Lebo 2000; Lora and Glasser 2002; Stewart 2008). This is due to technical challenges such as its structure and its uncertain reactivity as well as due to challenges that are linked to the front-end of innovation process such as uncertainties regarding market potential or environmental performance (Vishtal and Kraslawski 2011). Since current research on lignin valorisation mainly focuses on technical challenges, the particular aim of this paper was to foster the assessment and the optimization of non-technical factors in the front-end of the innovation process for lignin utilization (Bajpai 2013). First, a framework for sustainability oriented front-end innovation of by-products was conceptualized based on a systematic literature review. This framework encompasses a multi-method approach that combines quantitative and qualitative methodologies for assessing optimizing economic (e.g. analysis of market sizes, prices, trends…) and environmental factors (e.g. streamlined or ex-ante LCA…). These methods are grouped into the four different stages idea generation, preliminary assessment, concept and development, inspired by the stage-gate model of Cooper and Kleinschmidt (1988). Second, the multi-method approach of the framework was applied in a case study with lignin-based innovations that are developed in the course of a research project with the Austrian pulp and paper industry. The case study covered the two stages idea generation and preliminary assessment. Thus, in the first step of the case study qualitative and semi-quantitative methods were applied to an initial set of lignin-based innovations. In a second step, quantitative methods (Ex-ante LCA) were used for a selection of lignin based innovations that was supported by the results of first step. The case study confirmed that the proposed multi-method approach allows the identification key factors related to the development and potential adoption of different lignin-based products in the front end of the innovation process. The results of this paper are useful for companies interested in developing integrated biorefinery systems as well as for policy makers in the development of new incentives to promote sustainable biorefinery concepts.

Keywords: By-product synergy, front-end innovation, industrial ecology, lignin valorisation, pulp and paper, LCA,

Drivers and barriers for the implementation of circular business models: a typology

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Abstract

An increasing number of firms is experimenting with circular business models (CBM). These firms aim to make a financial profit by providing valuable products or services to customers while partly or completely closing material loops. There is not one blueprint for a circular business model. Many different options are described in the literature. It is unclear what type of circular business model creates the lowest risks and implementation barriers for firms. In this research we provide a framework with a conceptual typology of CBMs and we investigate the drivers and barriers related to those business models. We conducted 20 in depth interviews with firms that have adopted a CBM. We focused on the organization of their CBM and the drivers and barriers related to this. Based on these interviews, we developed a CBM typology by: (1) Distinguishing the sources where recycled inputs in the production process originate from. This could be their own supply chain or external to their supply chain (business or consumer markets not related to the firm). (2) Distinguishing between re-using an existing waste source or by purposefully collecting discarded products before they become waste. (3) Distinguishing between different mechanisms used by companies to keep materials/products in the loop, e.g., by leasing or by providing return incentives. Furthermore, we analysed the drivers for engaging in a CBM, and barriers that are encountered during the development of the business model. Although the data collection is still ongoing, preliminary results show that the barriers originate mostly from the institutional environment, while the drivers often seem to come from within the firm. Drivers are mostly related to intrinsic motivations of the entrepreneurs and business opportunities that the CBM offers. Examples of institutional barriers are regulation around the use of waste, established companies counteracting CBMs, customer acceptance for products from waste and leased products. We found a connection between the typology of CBMs and the barriers encountered. Firms that use waste in their business models for example often mention the difficulties related to regulation around waste as their main barrier, while companies that try to organize lease models mention customer acceptance and juridical issues related to the contract as the main barriers. In this research we elaborate further on these connections. By shedding light on the types of CBMs and drivers and barriers related to these models, this research contributes to the circular economy literature by coupling the firm perspective to the institutional environment. This will provide insight in the factors, both within as in the context of firms that accelerate or hamper the adoption of circular business models by firms. This research therefore might also provide policy relevant information by identifying factors that can be influenced by policy initiatives.

Keywords: circular business models, drivers, barriers

Circular Economy: An economic and industrial model to achieve the sustainability of society

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Abstract

Since the introduction of capitalism system in the seventeenth century during the industrial revolution, there have been an enormous number of opportunities and challenges for society. The main advantage of the industrial revolution has been the increase in production capacity and the development of new technologies, which improved the standard of living for many people. However, this revolution also brought well-known problems for the environment and the degradation of human health. The impact of those negative effects has become evident during the last century, and the future of humanity depends on the restoration of the planet. In this sense, the concept of the circular economy does not ignore global development needs, but it differs from traditional models by closing the industrial loops through ecologically effective eco-innovations. With the goal of contributing to the resilience of the planet, this study examined the circular economy (CE) definitions, principles, and drivers through a systematic literature review. The study showed that no common understanding of the circular economy (CE) framework has yet been developed. The absence of a common framework affects the circular economy (CE) implementation processes and its restorative purpose. Given this gap in the literature, this study proposes a consensus on the concept, principles, and drivers of CE, all of which are key elements in designing a common framework for triggering CE practice. Although existing concepts of CE diverge, we find that it is a complex and multilevel model which implies economic and physical flows. Environmental and ecological economics have described the economic flows; on the other hand, physical flows have been analyzed by industrial ecology. We propose that the operation of these flows can be guided by the 3R principles (Reduce, reuse and recycle) and six key drivers in order to close the loops. We also investigate the link between eco-innovation and the circular economy within the same framework. The interest emerged from finding in the literature some of the successful experiences that companies have had with CE and the evidence of the development of eco-innovation in those companies' process. Furthermore, the value of the CE framework's design lies in its potential to achieve the regeneration of the environment and the sustainability of society through eco-innovative solutions. In this way, the implementation of a circular economy really could bridge the distance between the economic system and the current environmental challenges and society expectations.

Keywords: Circular economy, eco-innovation, industrial ecology, social prosperity, paradigm.

Introduction

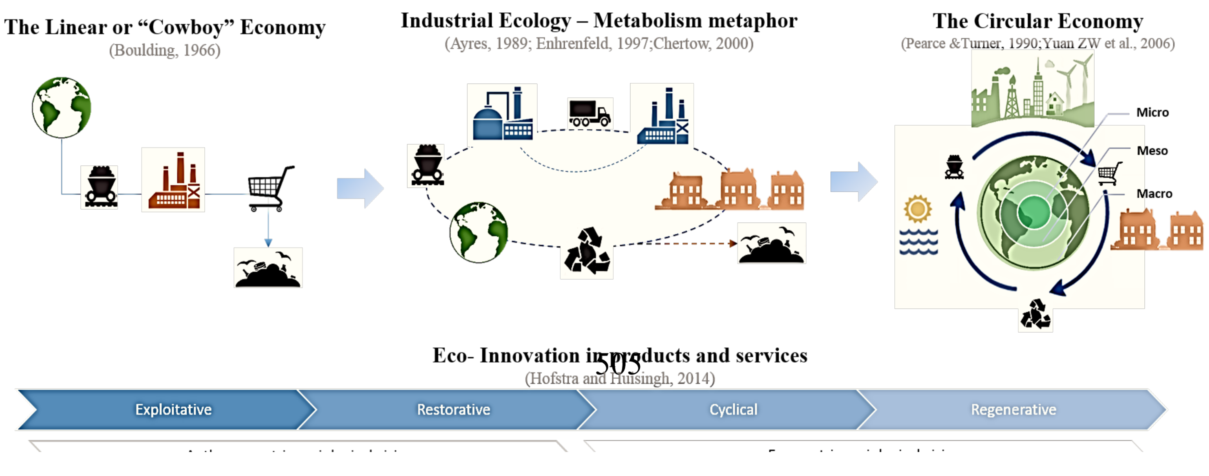
The concept of the circular economy (CE) has been presented by China and the European Union as a solution that will allow countries, firms and consumers live in balance with the natural environment and close the loop of product lifecycle (EU Commission, 2014; Murray et al., 2015). Unfortunately, this solution is an answer to the intense linear economic activity that is depleting the environmental resources of the planet. This environmental chaos, which began with the industrial revolution of the 17th century and has led to the production of more than 10,000 chemical substances as a consequence of the discovery of the structure of the benzene ring in 1865. It means that the Earth has had less than 300 years to assimilate the humanity burden (Wright and Welbourn, 2002). Although the scientific and technological improvements in the past served the purpose of developing economies and societies, the survival of humanity depends on our ability to change the way we approach development (Nicolis and Prigogine, 1989). The problem is not that society progresses; the problem is the way we choose to progress. This idea was highlighted when Gandhi was asked if he would like to achieve the same standard of living for India's people as the British had. He answered: "It took Britain half the resources of the planet to achieve this prosperity. How many planets will a country like India require?"

This environmental awareness started to become evident around 1960, with the publication of "Silent Spring" (Carson et al., 1962). This book revealed the damage that humanity has been doing to the planet because of resource depletion and especially because of the excessive use of toxic substances widely spread, metabolized and bioaccumulated by the natural environment. During the sixties, with a similar purpose, many economists recognized the importance of establishing a coherent relation between the environment and the current economic system. One such economist was Boulding (1966), who formulated the idea of a "spaceman economy". Boulding proposed that Earth could work as a cyclical ecological system, thereby recirculating the limited resources and making them unlimited. Following Boulding's research, Pearce and Turner used the term "circular economy" for the first time in the book *Economics of Natural Resources and the Environment*. Pearce and Turner explained the possible economic flows achieved by closing industrial loops (Pearce and Turner, 1990; Xue et al., 2010). To that end, there have also been various economists who have tried to bridge the distance between the environment and the neoclassical economy with concepts such as the green economy. A green economy is defined by United Nations Environment Programme (UNEP) as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP, 2011). The problem with a green economy is that it is founded on the same exploitative system within a culture of consumption, which has evidently failed.

At the same time, from the field of engineering, awareness of the planet has grown since the seventies. Another milestone in the formulation of the circular economy was the research by Ayres (1969; 1989). Ayres explained that industrial activities can work like a metabolism, where different actors can be integrated through their wastes and resources, which continuously circulate through the resource inventory of the system. The industrial metabolism theory, which encouraged the rise of Industrial Economy (IE), also explains the physical flows and industrial symbiosis implied by a circular system in which loops can be closed, although zero emissions are not possible because of the difficulty of attaining 100 percent efficient waste removal in the environment.

Following these studies, different disciplines and fields of study have combined their efforts to transform the linear system into the circular paradigm. Results can be seen in numerous areas including policy (Murray et al., 2015), in management with alternative business models (Lewandowski, 2016), in design with the "Cradle to Cradle" philosophy (McDonough and Braungart, 2002), and in bio-mimicry with solutions inspired by nature (Hofstra and Huisingh, 2014). Moreover, all of these theories agree that it is in our best interest to question the validity of existing linear systems rather than optimizing them (Wells and Zapata, 2012). Even though we find that studies of CE have taken diverse approaches, all the studies have similar principles.

Nonetheless, this change of paradigm also has involved a sociological change from an anthropocentric to an eco-centric vision, which has impacted the way society develops eco-innovations (Hofstra and Huisingh, 2014) (See Figure 1). Thus, a deep and feasible transformation of the society needs to occur in order to achieve economic, environmental and social prosperity expectations (Huesemann, 2004). In this manner, the circular economy may be an option for



achieving sustainability by involving all the determinants that can change it, in every level of action (Yuan et al., 2006). Currently, the circular economy proposes a restorative and regenerative economic model as a solution for the need to develop an environmental resilience that is coherent with an economic growth tendency. It means a cycle of take/make, use and return/enrich(Ellen MacArthur Foundation, 2013; Park et al., 2010). Take/make refers to the way industries take resources from the environment to transform them into products and services. Consumers or other companies use the product/service, and CE aims to redirect the waste and return it to the environment or industrial process.

Figure 1. Change of paradigm from linear to circular economy

A range of literature reviews related to our research focus along these lines has been published. However, they have mainly focused on specific areas of knowledge, which just partly overlap. They are related to understanding the application of IE at the factory level by taking into account all resource flows (Despeisse et al., 2012), some IE applications (Korhonen et al., 2004), industrial symbiosis dynamics (Boons et al., 2011) and their evolution (Yu et al., 2014). Furthermore, some literature reviews related to circular economy topics and processes are focused on the 3R (Reduce, Reuse, Recycle) taxonomy (Sihvonen and Ritola, 2015), and the value creation throughout the supply chain (Schenkel et al., 2015). Additionally, there are other studies focused on CE performance in a particular region, like the review done by Su et al. (2013), which developed a literature review to assess the design, implementation and effectiveness of China's CE policy and it also provides an empirical analysis in Chinese cities. This country plays a significant role in the literature given that Chinese industrial development has led to a decrease in poverty and the improvement of citizens' standard of living quality of life (Ravallion and Chen, 2007). Nevertheless, the high social and environmental cost they had paid for this "development" is not a secret.

Nevertheless, to the best of our knowledge, we have not identified any study that presents a cohesive concept, principles, and drivers of CE and their relation with eco-innovation. They are key elements for designing a common framework to boost CE implementation and make it a feasible way to achieve a real sustainability of society. This interest led us to propose the following research question: *Does a common CE theoretical framework exist?*

With the purpose of filling this gap in the literature, the aim of this paper is to provide a cohesive circular economy framework and to enhance the role of eco-innovation in CE to achieve environmental regeneration and human sustainability. This consolidation of knowledge opens the path to making progress in an orderly fashion to make the circular economy feasible and to give implementation guidelines for advancing along different levels of action (Yuan et al., 2006). Moreover, this research can help define future research topics, which can contribute to the implementation and spread of the concept as a transversal field of study.

This paper is divided into four sections, of which this Section 1 is introductory. Section 2 describes the research method used to find answers to the research question. Section 3 analyzes the outcomes of our systematic literature review. Finally, Section 4 concludes with a summary of the main research results.

Methods

As previously mentioned, we could not identify any previous systematic review focusing on a definition of circular economy. Consequently, a systematic literature review was conducted to identify CE principles and drivers, with the purpose of consolidating published research on the topic and building a feasible framework for CE implementation. The systematic literature review is a replicable, scientific and transparent method for defining the field of study, and it allows readers to understand the path researchers take to arrive at their findings (Tranfield et al., 2003).

We followed the procedure from Tranfield et al. (2003), which includes three steps: planning, execution and reporting. The purpose of the planning stage is to define the keywords of interest and a protocol for implementing the method. Additionally, in this step, we select an accessible, reliable, and academic database source; for this case we selected Web of Science (WoS). Next, we explain how we executed our search in WoS. Moreover, we applied the protocol to create a database with the articles selected during the execution phase to classify the information. Finally, the reporting stage synthesizes our findings according to the defined gap and it proposes a research agenda for future studies.

Planning

In this step, the research was planned according to the objective defined above, meaning our systematic literature review pursued the identification of a cohesive concept of circular economy and described a general framework for facilitating its application. To that end, the research team identified the terms that were going to be used for selecting academic articles, terms such as “circular economy” and other closely related topics such as "Cradle to Cradle," "industrial ecology" or "industrial metabolism.” Moreover, to guarantee the quality of the review we searched the ISI Web of Science database because it provided us with different levels and categories for searching from an accurate collection of indexed articles (Shepherd and Günter, 2011) and it includes the most highly cited scientists from different fields of study (Hirsch, 2005).

Besides, the data collection was supported by a content analysis, which involves organizing large quantities of text into many fewer content categories (Weber, 1990). Protocol listed in Table 1, which is based on a protocol in Stechemesser and Guenther (2012), was designed to record all the information we were going to find in a systematic way. The items in the first column represent the most relevant aspects of bibliographic data and background based on the content analysis method (Krippendorff, 1989).

Table 1. Review protocol.

Adapted from Stechemesser and Guenther (2012)

Bibliographic data	Description	Example (Peters et al., 2007)
Title	What is the title of the publication?	“China's growing CO(2) emissions - A race between increasing consumption and efficiency gains”
Author	Who is the author of the publication?	Peters, Glen P.; Weber, Christopher L.; Guan, Dabo; Hubacek, Klaus
Journal name	What journal published the paper?	Environmental Science & Technology
Journal Category	How was the journal ranked in 2014?	Q1
	What was the journal's impact factor in 2014?	5,33
Year of Publication	When was the article published?	2007
WOS citations	How many other authors have cited the paper in Web of Science?	185
Google Scholar citations	How many other authors have cited the paper in Google Scholar?	317
Publication background		
Methodology used in the paper	What methods are used to develop the research?	Empirical Analysis
Country	Which country is the subject of the paper?	China
Industry Sector	Which industry sector is the subject of the paper?	Multiple

Execution

As a first step, we focused on searching for the terms mentioned above in article topics or in the title, and there were 1,184 results. Then, we selected the papers most closely related to an economic perspective based on the fact that Circular Economy implies market benefits (Hofstra and Huisingh, 2014). Consequently, the categories selected in WoS were: "Engineering Environmental", "Management", "Economics", "Business" or "Social Sciences Interdisciplinary".

As a result, the search was narrowed to 596 results. After that, the team selected only academic articles, which gave us 174 results. Then, during the review, the team added some other articles from WoS because they were frequently cited by authors due to their importance for the CE framework, even though they did not appear in the initial search. Finally, the review focused more narrowly on 149 academic papers by discounting the ones that did not have any citations, which means they have not yet had much impact on the research community (Mohammadi et al., 2015).

Results and Discussion

This section includes four parts that explain the results of the systematic literature review. The first part describes the results from a descriptive and bibliographical analysis. This is followed by a discussion that includes an analysis of CE definitions, CE principles and drivers, and reflection on how eco-innovation can make CE possible. Finally, we highlight a research agenda for future work.

Descriptive analysis

According to the execution phase explained above, 149 publications are included in this study. The oldest source analyzed was published in 1989 and the most recent one is from 2015 (Figure 2). The majority of the publications are published after 2009, the year in which the Circular Economy Promotion Law went into effect in China (H. Q. Wu et al., 2014). The trend shows that research topics related to CE are becoming more and more important within the research community. Moreover, of the terms that were selected for the initial search, the word that most frequently included in the articles' titles (32 articles) and the keyword tags (30 times) was "China". This result proves the clear influence of this country in CE research and implementation. However, it is possible that the inclusion of CE in the European Union agenda (EU Commission, 2014) caused the peak in the statistics in 2014.

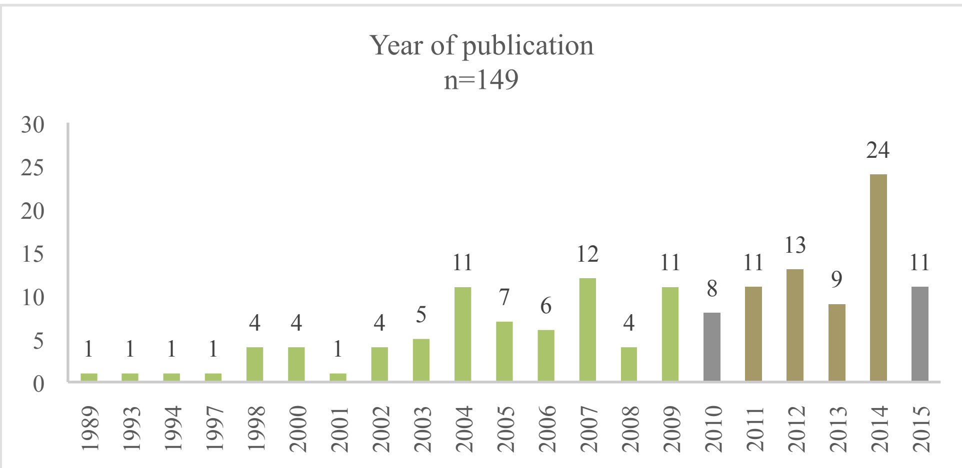


Figure 2. Years of publication

The papers selected showed that the most important journals for topics related to CE and IE (in the sense that the journals published more than one article) are those with a recognized research background in prevention, cleaner production, environmental engineering and management, such as *Journal of Industrial Ecology* and *Journal of Cleaner Production* (Figure 3). Topics related to CE and IE are also present in high impact journals related to waste management and environmental sciences.

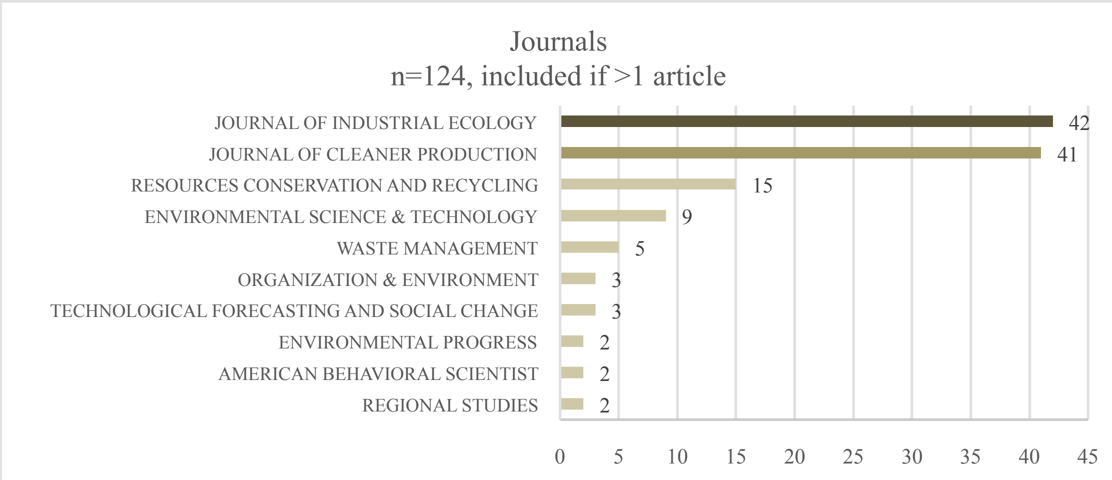


Figure 3. Most important journals

Moreover, the quality of the papers selected was assessed through the WoS impact factor and according to Journal Citation Reports (JCR) categories. Of the 145 articles, 109 articles fall in the Q1 category, which has an impact factor of 3.53 on average. Overall, just 3 of the journals have no ISI-impact factor and 51 publications are rated above the average. The journal *Water Research* has the highest impact factor (5.528).

The bibliographical analysis included a review of the most prolific and cited authors in our set of publications (Table 2). The Table 2 organized the prolific author according their citations in Google Scholar (GS) to complement the results obtained by WoS because the citation counts in GS are considerably higher than either in WOS or in Scopus, in the recent years(Bar-Ilan, 2008).

Table 2. The most prolific authors

Author	Articles in this literature review	Citations in Google Scholar	Citations in Web of Science database
Geng, Y.	13	618	279
Gibbs, D.	3	439	170
Deutz, P.	3	439	170
Hertwich, E.G.	2	376	127
Peters, G.P.	1	317	185
Hubacek, K.	1	317	185
Weber, C.L.	1	317	185
Guan, D.	1	317	185
Braungart, M.	2	301	111
McDonough, W.	2	301	111
Bollinger, L.A.	2	301	61
Ehrenfeld, J.R.	2	278	106

Chertow, M.	4	255	109
Boons, F.	2	252	112
Roberts, B.H.	1	243	76
Zhu, Q.H.	7	241	114
Ehrenfeld, J.	2	237	69
Cohen-Rosenthal, E.	2	224	76
Sarkis, J.	5	210	86

Moreover, Yu et al. (2014) carried out an in-depth review of the research networks based on the analysis of linked concepts such as industrial symbiosis, industrial ecology and circular economy, which coincides with several of the most prolific authors from our review. In the current analysis, Chinese research is still present, the most prolific author being Yong Geng.

Definition of Circular Economy

In our attempt to find a coherent and cohesive definition for the circular economy, the research team carried out a content analysis of CE terms discovered in the literature review. A review of the selected papers showed seven (7) explicit definitions of the circular economy (Table 3), even though there are more than a dozen explicit terms for most developed topics like industrial ecology. All of those CE concepts were defined with words like a model, strategy or policy. We suggest that the circular economy should be understood as a "paradigm shift" social, environmental and economical as the change described Hofstra and Huisingh (2014), based on the fact that CE practices aim to foster a system that takes into account the thermodynamics and ecological rules embedded in a nonlinear and dynamic environment.

The analysis of the explicit definitions of CE shows that they tend to be oriented to in some way to the two sides of the concept, namely the physical and economic flows. The physical flows of matter and energy have been well illustrated by the metaphor of “industrial metabolism,” which was coined by Robert U. Ayres in 1988. According to Geng and Doberstein (2008), this analysis of physical flows explains why industrial ecology has promoted the implementation of CE. In consequence, some explicit definitions expose those two sides. Geng and Doberstein (2008) focused their explanation on the “closed-loop of materials, energy and waste flows”, although they recognize the clear impact on the economic system.

On the other hand, the environmental economic of Pearce and Turner (1990) clearly explained the CE economic flow, where every transformed resource means a flow of capital in the system. The schools of ecological economics and bio-economics have made a significant effort to enhance the issue of sustainability in economic monetary analysis (Korhonen, 2003), where the two paradigms of the economy try to solve the relation between the economy and environment from two different perceptions. While traditional economic anthropocentric models fall short in their ability to solve the global environmental crisis, ecological economics is a transdisciplinary field of study that reaches a balanced relationship between ecosystems, including humanity and the economic system in the long term (Costanza et al., 1991). Thus, the economic flows in the circular economy make sense when they are studied under the lens of ecological economics. In this way, Park et al. (Park et al., 2010) and Ma et al. (2014) highlight the role of CE as a policy and model that aims to cause economic growth in a way that is sustainable and respects nature. Finally, Yuan et al. (2008) and Haas et al. (2015) focus on the strategic value that CE has “by closing economic and ecological loops of resource flows”.

Table 3. Explicit definitions of circular economy

Author	Explicit definition of circular economy

Geng and Doberstein (2008)	"Circular economy is understood to mean the realization of a closed loop of materials flow in the whole economic system," "implying a closed-loop of materials, energy and waste flows."
Yuan et al.(2008)	The concept of circular economy was promoted in China as a new development strategy to alleviate the shortage of resource supply by improving the resource productivity and the eco-efficiency of production and consumption, which will accelerate the economic transformation from economic growth to economic development. The difference of the two modes is that economic growth relies on a continuing increase of resource inputs while economic development relies on the improvement of efficiency (resource productivity and eco-efficiency).
Park et al. (2010)	"The CE policy seeks to integrate economic growth with environmental sustainability, with one element relying on new practices and technological developments, similar to the application of EMT."
Ma et al.(2014)	A circular economy is a mode of economic development that aims to protect the environment and prevent pollution, thereby facilitating sustainable economic development.
Wang et al. (2014)	Circular economy is an important way to protect the environment and resources, and to achieve sustainable development; it can transform a traditional linear growing economy, which depends on resource consumption into an economy that relies on the development of ecological resource circulation.
Haas et al. (2015)	"The circular economy (CE) is a simple, but convincing, strategy, which aims at reducing both input of virgin materials and output of wastes by closing economic and ecological loops of resource flows."
Haas et al. (2015)	In CE, material flows are either made up of biological nutrients designed to re-enter the biosphere, or materials designed to circulate within the economy (reuse and recycling) (GEO5 2012).

After considering the origin and the two sides of CE, we propose the following definition of CE:

The circular economy is a social, environmental, and economic paradigm, whose purpose is to prevent the depletion of resources and regenerate environmental resources through the closed loops of materials and to decrease the loss of energy in the process. The closed loop of materials can be achieved through eco-innovative solutions and products that can be reintroduced in biological and technical cycles. Thus, this circular mechanism makes an economic development model feasible by dealing with the fact that infinite growth is not possible, but social needs will not disappear. This economic model does not reject economic growth, but sets limits on the exploitation of resources; if human societies seek growth, they should be limited to the recirculation of resources and a minimum amount of emissions.

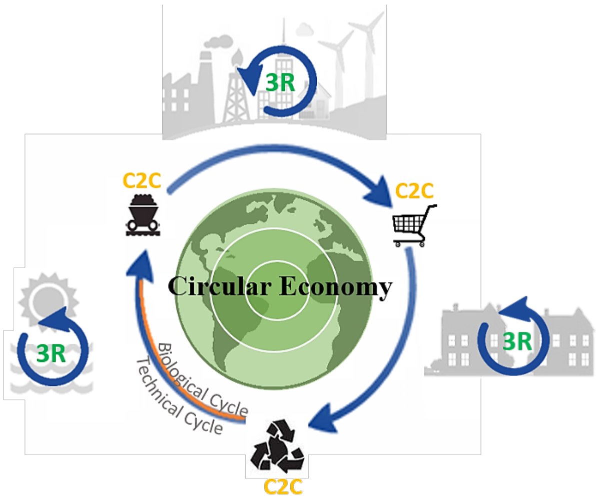
CE Principles and drivers

Regarding CE framework, this section pretends to explore the principles and drivers identified in the systematic literature review. Moreover, this section contributes to align the key elements for triggering CE practice.

Principles

A large number of the articles reviewed describes the principles of a circular economy. However, the most common and frequently mentioned group of principles is the 3Rs (reduce, reuse and recycle) by authors such as H. Wu et al. (2014), Haas et al. (2015) and Yuan et al. (2008). More specifically, Wang et al. (2014) state that "a circular economy based on the 'reduction, reuse, recycle' principle, consisting of the characteristics of low consumption, low emission and high efficiency". On the other hand, there is a significant number of publications which support the CE concept of "Cradle to Cradle tenets" or "C2C" to inform human design (McDonough and Braungart, 2002; van der Wiel et al., 2012): waste equals food, use current solar income, and celebrate diversity.

Both groups of principles configure the CE framework and they can coexist, but they are understood at two different levels and functions. According to Yuan et al. (2008), the 3R principles are clearly transversal in the CE model, meaning that they can be applied throughout the whole cycle of production, consumption and return of resources. However, the C2C tenets work as catalyzers and guidelines to design goods and services which could be reintroduced in the system in the long term as biological or technical resources (Braungart et al., 2007), (See Figure 4). Even products production does not meet all the parameters of measures based on lifecycle assessment



(LCA) (Bjorn and Hauschild, 2013), which they may achieve them in the long term.

Figure 4. Circular economy principles: 3R and C2C

Drivers

The definition and conceptual frameworks for drivers of change are provided by Anastasopoulou et al. (2010). Identifying CE drivers we found that there are numerous studies on drivers of environmental change; they are not necessary in agreement, but the framework most used among researchers is the Driver-Pressure-State-Impact-Response (DPSIR) framework (Anastasopoulou et al., 2010). *Drivers* are the social, demographic and economic developments that lead to the *pressures* on the environment. The *state* of the environment refers to measurable conditions in a defined area, which will cause an *impact* on natural and human systems. The *responses* are the actions implemented by society to deal with the impacts and provide feedback to the drivers. Thus, the literature analysis uncovered the existence of CE drivers: Global resource depletion, consumer behavior, market system, geographical proximity, biomimicry, regulation/policies, energy, and technology (Anastasopoulou et al., 2010).

Following the DPSIR framework, our systematic literature review revealed six main drivers for a circular economy: 1. Innovation and Technology, 2. Interconnection capacity, 3. Global resource depletion, 4. Market system, 5.Regulation and policies, and 6. Consumer behavior (Figure 5).

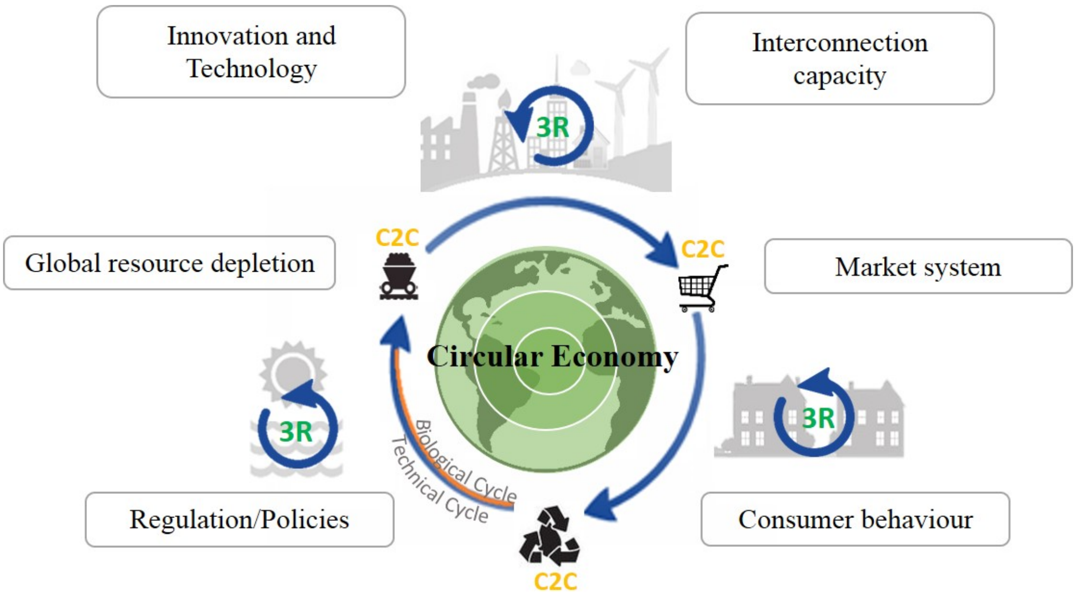


Figure 5. Circular economy principles and drivers

Interconnection Capacity

For this framework, the review shows that interconnection capacity is given by geographical proximity and the affinity to work connected between companies (Kollikkathara et al., 2009; Shi et al., 2010). First, geographic proximity has clearly been a part of successful symbiosis cases such as Kalundborg in Denmark, Campbell Industrial Park in Hawaii, and Guitang Group in China, among others (Chertow and Ehrenfeld, 2012). All of them have taken advantage of a close geographical proximity to compatible partners by sharing resources, reducing transport costs and achieving greater collective benefits (Schiller et al., 2014), which means lower emissions and decreased depletion of resources. Second, empirical studies highlight that spontaneous symbiosis relations appear when organizations share a context and the goal of cooperation (Chertow and Ehrenfeld, 2012). Additionally, the interconnection capacity also helps companies overcome technological challenges and share knowledge to optimize resources and benefits (Zhu et al., 2015).

Technology

Several articles highlight the importance of technologies oriented to a circular economy approach, which allows for the reduction or stabilization of resource demand and the satisfaction of human needs (Ehrenfeld, 2004). To that end, those innovative technologies can be developed at every level of impact; this means inside local businesses, institutions and the region as a whole to effectively close the industrial loops (Deutz and Gibbs, 2008). Then, according to those levels of integration, technological information and technological infrastructure can be exchanged to make progress on industrial ecology initiatives (Braungart et al., 2007; Thomas et al., 2003). Additionally, some empirical cases show that the improvement of technologies and waste management can mitigate the unsustainable use of natural resources (Huang et al., 2014).

Global resource depletion

The continual depletion of resources caused by the growing demand for energy and materials make it evident nature's resilience to let humans "keep growing" (Yuan et al., 2008). Thus, this driver considers the thermodynamic limits of energy consumption (Ehrenfeld, 2000), which have not been measured in the anthropocentric idea of growth. Along those lines, the evident scarcity of resources is changing the concept of "waste". Nowadays, some authors claim that a significant portion of the current waste may be underutilized raw materials (Allen, 1993) or potential circular materials in industries (Braungart et al., 2007; Gibbs et al., 2005). What's more, the improvements in design and technology can drive the extension of product life, reducing the demand for raw materials (Bakker et al., 2014).

Consumer behavior

Implementing CE as a system in the long term will depend on consumers' perception of added value (Cohen-Rosenthal, 2000) and their social perception of sustainable products. In this aspect, the growing social awareness of product components and their chemical origin (Matus et al., 2012) give rise to environmental consumer behavior. In addition, the emerging environmental training programs in schools and universities (Finlayson et al., 2014; Gao et al., 2006; Geng et al., 2009) drive an increase in people's interest in the value of nature, its resources and the way societies manage them (Matus et al., 2012). Nonetheless, the constant changes in fashion and customer taste must be managed by firms with CE strategies such as reverse logistics for waste management (van der Wiel et al., 2012) and the design of products which can return through biological or technical cycles (McDonough et al., 2003).

Market system

The success of the CE in the market is closely related to the options that companies would have to change in order to turn their business into sustainable, competitive and profitable models (Yang et al., 2014). In our review we found multiple business models that are compatible with the CE, even though they are still in their infancy. These include models such as recycle and remanufacturing (Geyer and Jackson, 2004; Ongondo et al., 2013; Zhang et al., 2011), new business through a circular canvas (Lewandowski, 2016), the decrease of ownership and an increase in renting services (Bakker et al., 2014), and dematerialization (Ehrenfeld, 2000; Yang et al., 2014), among others.

In addition, the integration capacity driver plays and important role in market success, because firms that form symbiotic relations also change the way they do business and move to an environmental management approach (Cohen-Rosenthal, 2000; Geyer and Jackson, 2004).

Regulation and policies

This driver is directly related to all of the drivers explained above because it acts from the macro level scale of action. Regulation and policies may influence and motivate consumers' and suppliers' environmental practices by supporting the elimination of significant political CE barriers (Geng and Doberstein, 2008; Zhu et al., 2015). Moreover, the study by Xue et al. (2010) shows that this driver's focus could be influenced by the awareness of government officials, who tend to lead economic aspects instead of the promotion of public awareness and financial support for CE implementation in firms.

Eco-innovation to make CE possible

The systematic literature review used to design this framework supports the fact that human perception of nature is the crucial element needed to change the social and economic systems that continuously affect the ecosystem. Consequently, switching from an anthropocentric to an eco-centric perspective is the key to achieving real sustainability, where humans use nature as inspiration to solve societal and environmental needs (Cohen-Rosenthal, 2000; Hofstra and Huisingh, 2014).

We suggest that this change of paradigm that is configured in the circular economy is visible through eco-innovations, which are the tangible results of the CE system. This conclusion is based on the fact that eco-innovations are nature-based processes, techniques, practices, systems and products developed to solve the needs of humans and nature within a balanced framework (Hofstra and Huisingh, 2014). Moreover, this study has found that numerous empirical studies with both circular economy and industrial ecology approaches are cyclical and regenerative eco-innovations.

Table 4. Circular economy and industrial ecology empirical examples

Author	Article	Country of analysis	Sector
Yang and Feng (2008)	Case study of industrial symbiosis: Nanning Sugar Co., Ltd. in China	China	Sugar
Geng et al.(2010)	Regional initiatives on promoting cleaner production in China: a case of Liaoning	China	Government
Linton et al. (2002)	Supply planning for industrial ecology and remanufacturing under uncertainty: a numerical study of leaded-waste recovery from television disposal	US	Household electrical appliances
Hu et al.(2011)	Ecological utilization of leather tannery waste with circular economy model	China	Tannery
Rossi et al.(2006)	Design for the next generation incorporating cradle-to-cradle design into Herman Miller products	US	Furniture
Gao et al.(2009)	Life cycle assessment of primary magnesium production using the Pidgeon process in China	China	Chemistry and engineering
Verhoef et al. (2006)	Industrial ecology and waste infrastructure development: A roadmap for the Dutch waste management system	Netherlands	Waste infrastructures
Boehme et al.(2009)	Collaborative Problem Solving Using an Industrial Ecology Approach	US	Government
Reyes-Bozo et al. (2014)	Greening Chilean copper mining operations through industrial ecology strategies	Chile	Mining-minerals
Usapein and Chavalparit (2014)	Development of sustainable waste management toward zero landfill waste for the petrochemical industry in Thailand using a comprehensive 3R methodology: A case study	Thailand	Chemistry and engineering
Bakker et al. (2014)	Products that go round: exploring product life extension through design	Multiple	Household electric appliances

These eco-innovation cases encourage the feasibility of the CE because they proved that they benefit the economy, society and the environment. In this way, CE could be configured into a system that can achieve real sustainable development from an eco-centric perspective and the implementation of innovative solutions.

Conclusions

The first objective of this paper was to identify a common CE theoretical framework following a systematic literature review. The most important points of agreement from the review were the regenerative posture and eco-centric perspective of the CE concept. Besides, several CE definitions and principles were found, but they diverge frequently. From the literature review it is clear that differences do exist between the definitions of circular economy, e.g. '...a new development strategy...", "…policy...', '...mode of economic development...' and '…way to protect the environment and resources…' (Table 3).

From there we proposed a coherent and convergent concept of CE to take advantage of previous studies. This renewed concept brings with it the opportunity to continue CE research in an organized way. Furthermore, we suggest a way to understand CE principles and we propose six key CE drivers to guide implementation: 1. Innovation and Technology, 2. Interconnection capacity, 3. Global resource depletion, 4. Market system, 5. Regulation and policies, and 6. Consumer behavior.

To meet our goal of giving advice about how to make the CE a real practice, we highlighted the role of eco-innovation. Based on the examples of CE implementation in different sectors and countries, we believe that eco-innovation study from an eco-centric perspective must be a clear objective for CE feasibility and success.

Finally, future studies should explain in greater depth how the CE principles and drivers can push CE implementation in different fields of study and new business models. We also plan to prove the usefulness of this framework in a future empirical analysis of CE implementation in SMEs through the "Ecopyme" research project, which is sponsored by the Spanish government.

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Rethinking waste management practices in Latin America: A case study in inclusive recycling

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Abstract

A new conflict that needs to be addressed by the international sustainable development research community is the responsibility over the waste management and the contested ownership over wasted resources. In Latin America and the Caribe (LAC), 4 million waste pickers earn their livelihood by being a part of the recyclables supply chain. Informal waste pickers are responsible, in some cases, for the collection of the 90% of the recycled materials in their countries; however, in LAC they are mostly still perceived as a social problem, without getting the recognition for the environmental, social and economic benefits of their work. Under this context, it is gaining importance the so-called "inclusive recycling" movement, that defends the effective inclusion of the informal waste pickers within the recycling value chain. Simultaneously, policies based on the extended producer responsibility (EPR) concept are increasingly being discussed in the region to deal with waste. The "Paso Cierto" Platform, developed with funding from the Regional Initiative for Inclusive Recycling (IRR), is a pilot project that links the accumulated knowledge about the implementation of inclusive recycling projects in different countries of LAC, with the new approaches needed to integrate REP strategies. The major aim of the current research is to further analyse those links to propose the development of future waste management models that effectively include informal waste pickers at the same time that making the manufacturer of a product responsible for the entire life cycle of the product. To do so, the research methodology is based in an in-depth case study focused on the "Paso Cierto" Platform. At the moment interviews and data analysis are ongoing, but some pivotal findings can already be presented: i) Both, inclusive recycling programs and Extended Producer Responsibility strategies need to be integrated into the municipal solid waste program and should not be treated as a separate program; ii) The relationship between waste pickers, manufacturers and the municipality needs to be based on professional relations. "Paternalistic" approaches are not constructive, but rather maintain the processes that create dependency; and iii) To increase efficiency, the new waste management models need to be decentralized and adapted to the local conditions. The main conclusion, so far, is that empowering informal waste pickers enables social inclusion at the same time that many social, environmental, and economic gains for the municipality from the collection and separation of recyclables. Further steps of the research will present new model to guarantee this inclusion at the same time that the Extended Producer Responsibility.

Keywords: Waste Management; Inclusive Recycling; Knowledge Management; Extended Producer Responsibility; Latin America

Recycling Standards in Malaysia: How ready is Malaysian Recycling Industry for Global Market?

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Abstract

Malaysia recycling industry is considered as a new industry. The industry took off in 1990, and its growth at a slow pace. The waste recycling industry and recycled product at the early stages of development, was not a priority industry. The industry does not have full support from other industry especially from the financial service industry. Moreover the government agencies are not clear how to support the industry. However when the agenda to implement Sustainable Development in Malaysia took place in 2002 with the establishment of the National Environment Policy and later the Green Technology Policy in 2009, the recycling industry become one of the key industry to support the implementation of these two policies. There are many challenges which need to be address for the recycling industry and recycled product in Malaysia. One of the aspect is the recycling standards. Hence this study analyzed the importance of the recycling standards for Malaysian recycling industry, the development of the recycling standards in Malaysia and how the industry will comply with global recycling standards. The study was conducted by using secondary data obtained from government agencies, recycling industry and other research institution. The governance structure and system as well as the legislation related to recycling standards were analyzed. Trends analysis of recycling product in Malaysia and development of recycling standards were also analyzed. Several developed country recycling standards were analyzed and how it affect recycling industry in Malaysia. A survey was conducted to get view from the industry and analysis was conducted to determine key factors which influence how Malaysian recycling industry able to penetrate the global market. The findings of the analysis also illustrate the readiness of Malaysian recycling industry for global market. The need for the recycling standards in Malaysia is important, as it become one of the tool to ensure that the industry will not pollute the environment and become of the important economic activity to achieve Sustainable Development. Moreover the recycling standards development in Malaysia helps to prepare the local recycling industry to penetrate and comply with global market standards.

Keywords: Recycling, standards, governance, industry, waste

1. Introduction

Waste recycling industry has become an important industry. It is part of the initiative to achieve sustainable development, especially for cities and industrial areas. In reference to Sustainable Development Goals (SDGs) initiative, the industry is fit in for goal no, 11 and 12. The industries also able to help in achieving SDGs no 1 and 9. The role of this industry for the goal Number 12, Ensure sustainable consumption and production patterns; could be look at how this industry promote sustainable consumption and production. The technology, resources, system and mechanism setup will make the waste recycling industry as one of the main economic activities to achieve this goal. In reference to the goals number 11, Make cities and human settlements inclusive, safe, resilient and sustainable; the industries focus on providing support for urban metabolism. This will ensure waste manage in a sustainable manner, ensure enough resources for city processes which includes waste to energy, resources for industry and support creation of wealth for cities. While for the goals number 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. Waste recycling industry help to ensure efficient use of resources especially the non-renewable resources. The industry will provide alternative resources in replacement of natural resources to ensure industry and economic growth. Innovation from recycling industry to use waste as resources. The important of this industry will also help to achieve the goal number 1, End poverty in all its forms everywhere. Waste recycling industry able to provide new job opportunity and help to reduce poverty. This has been done in many countries and the industry help the poor especially in the developing countries to generate income directly or indirectly (David et. al., 2006, Gutberlet, 2008, Gutberlet, 2010).

However this industry require a support system to ensure its sustainability and its relevancy in providing economic opportunities. Hence one of the key aspects is to establish a standards for waste recycling industry where it will help the industry to be a clean industry, ensure economic viability and help to promotes sustainable development. The standards will help industries to comply with the need for effective legislation and to ensure that the recycling industry is not polluting while protecting the environment. Standards play an important role for industry development. Standards are critical for international trade because incongruent standards can be barriers to trade or giving some organizations advantages in certain areas of the world. Standards provide clear identifiable references that are recognized internationally and encourage fair competition in free-market economies. Standards facilitate trade through enhanced product quality and reliability, greater interoperability and compatibility, greater ease of maintenance and reduced costs. Standards for waste recycling industry should be dynamics and follow technological development and demand trends. The availability of waste recycling industry standards is important to facilitate the increasing demand of alternative resources generated from waste recycling. In reference to Malaysian industry, it will help the local industry to market their product to international markets. Also will ensure that the waste recycling products and processes comply with domestic and international market standards and legislation requirements.

This paper analyses the importance of the waste recycling standards in Malaysia and how they should be a key tool to ensure that the waste recycling industry will not pollute the environment and become of the important economic activity to achieve Sustainable Development. The study also discusses how the recycling standards development in Malaysia helps to prepare the local recycling industry to penetrate and comply with global market standards.

2. Methods

The study was conducted using document search and survey approaches. These two approaches is suitable for a study which seek to establish an understanding of a subject matter through individual perception, knowledge and understanding of how a phenomenon happen (Mason, 2002). Therefore the study was conducted by using secondary data obtained from government agencies, recycling industry and other research institution. The governance structure and system as well as the legislation related to recycling standards were analyzed using government agencies documents. Focus of the analyses was on the drivers such as policies and government initiatives which help to promote the waste recycling industry in Malaysia. Trends analysis of recycling product in Malaysia and development of recycling standards were also analyzed. The standards establishment process was analyzed to understand how it was established and who the key stakeholders in the process. Several developed country recycling standards were analyzed and how it affect recycling industry in Malaysia. A survey involving 32 respondents from the recycling industry was conducted. The survey help to understand the key issues in waste recycling industry and their views on recycling industry as well as the role of standards for the industry. Data obtain from survey was analysed using the qualitative approach. The qualitative approached was used as this help to understand the views and meaning of certain aspect which relate to the questions of the study (Marshall, 1996). In addition analysis also was conducted to determine key factors which influence how Malaysian recycling industry able to penetrate the global market. Which determine the readiness of Malaysian waste recycling industry trough implementation of the Malaysian waste recycling standards.

3. Results

3.1 Recycling Industry in Malaysia

The importance of waste recycling industry was recognized by the Government of Malaysia since the early 1990s. Through the Ministry of the Science, Technology and the Environment (the ministry was change to the Ministry of Science, Technology and Innovation), the Ministry of Natural Resources and the Environment and the Ministry of Housing and Local Government, waste recycling has been identified as an important environmental and economic activity. Awareness and education programs on waste recycling have been implemented with targeted audience of many levels of stakeholders, which include schools, businesses, industries and the community. Industrial waste recycling for the past decade has been identified as an emerging economic activity. Recycling of industrial solid wastes, such as plastic, steel, paper and glass has become an important support industry. This is in line with the increasing demand for limited natural resource, hence waste recycling provides alternative resources and reduces dependency on natural resource such as oil for plastic.

Several initiatives and program were implemented by Malaysian government agencies to promote the waste recycling industry. Table 1, listed the main initiatives or program which have been found to be important.

Table 1: Initiative and Program for promoting waste recycling industry in Malaysia

Initiative and Program	Ministry or Agency	Year
Promotion Environmental Management System (EMS).	Ministry of Science, Technology and the Environment (MOSTE), Standards and Industrial Research Institute of Malaysia (SIRIM), and the Department of Environment (DoE), Malaysia	1995
Promotion of cleaner production	Ministry of Science, Technology and the Environment (MOSTE), Standards and Industrial Research Institute of Malaysia (SIRIM), and the Department of Environment (DoE), Malaysia	1995
Promotion of waste minimization and recycling	Ministry of Housing and Local Government (MHLG), The Department of Local Government (DLG), Standards and Industrial Research Institute of Malaysia (SIRIM Berhad), and the Department of Environment (DoE), Malaysia	1995
Promotion of schedule waste recovery	Ministry of Natural Resources and the Environment (NRE), Department of Environment (DoE), Malaysia, Ministry of International Trade and Industry (MITI), Department of Environment (DoE), Malaysia and SIRIM Berhad.	2005

Promotion and enforcement of domestic waste recycling	MHLG, The Department of Solid Waste and Management (DSWM), Solid Waste Corporation (SWCorp) PPSPN, DoE, SIRIM Berhad.	2007
Biofuel Promotion	Ministry of Energy, Green Technology and Water (MEGTW).	2007
Green Technology and Green Economy	Ministry of Energy, Green Technology and Water (MEGTW).	2009
Economic Transformation Program (ETP).	The Prime Ministers' Department Malaysia	2009
Low Carbon City Framework -	Ministry of Energy, Green Technology and Water (MEGTW).	2011

The Malaysian government established the Department of National Solid Waste Management (DNSWM) in 2007, to ensure effective and sustainability in managing solid waste which includes industrial solid waste. DNSWM role was to implement the National Strategic Plan for Solid Waste Management (2005) and the National Solid Waste Management Policy (2006). The policy implementation was supported by legislative tool, the Solid Waste and Public Cleansing Management Act 2007. DNSWM will implement sustainable waste management based on waste management hierarchy which prioritize waste reduction through 3R, intermediate treatment and final disposal as well as emphasis on environmental protection and public health (Abdul Nasir, 2007).

There are two main types of waste currently collected and recycled in Malaysia. The first is a solid waste which are non-hazardous. These type of waste includes paper, plastics, glass, aluminum and ferrous and nonferrous metals have been the most commonly separated waste materials, (Nasir et.al., 2000). These waste are generated by household and industry. The solid waste generation is estimated at 16,200 tonnes per day in 2001 to 19,100 tonnes in 2005 or an average of 0.8 kilogram per capita per day (Malaysia, 2006). However in 2012 the solid waste generation in Malaysia has increased to 33,000 tonnes per day. However Solid waste recycling rate in Malaysia has increased from less than 2% before year 1992 to 5% in year 2002, and then increased to 10.5% in year 2014 (Nasir et.al., 2000, Zeeda and Keng, 2013,). Although the rate of solid waste recycling in Malaysia increased at a slow rate from 1992 to 2014, the government has set a target to achieve 22% by year 2020. Meanwhile Nasir et. al. (1998) found that industries in Malaysia contributed 30% of solid wastes. It was estimated that the industrial solid wastes generation has increased from 7,721.58 ton/day in 1994 to 11,519.24 ton/day in 2005 (Fariz, 2009). It is estimated that 70% of the total industrial solid wastes generated were recovered. Study conducted shows that the amount of industrial solid wastes recovered in 1994 was 5,405.1 ton/day and increased to 8,063.47 ton/day in 2005 (Fariz, 2009).

The second types of waste are hazardous waste, which generated mostly by the industry. However there are large amount of hazardous waste generated by household, which have a recycling values. These waste are mainly the electrical and electronic equipment (EEE) waste or commonly known as E-waste. The hazardous waste recovery for recycling in Malaysia shows a non-specific pattern of performance, however the amount actually increased from year 2000 to 2013 (Figure 1). A similar pattern also shown for E-waste recovery, where the amount of E-waste recovered increased from 2006 to 2012 (Figure 2). The trends of solid waste and hazardous waste generation which were found increasing annually and providing an opportunity for waste recycling industry to grow in the future. Especially where the recycling rate is still below target of 22%. It will require a full commitment and an efficient system to achieve the target in less than five years.

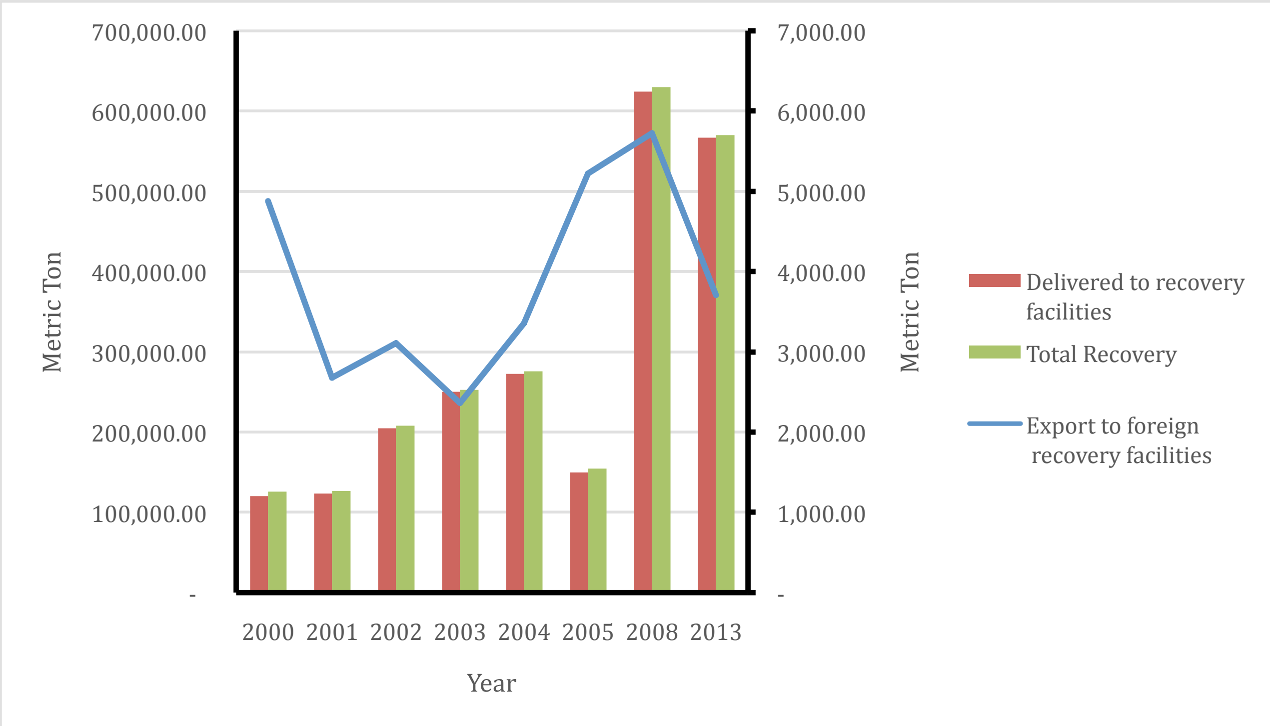

Figure 1: Hazardous waste recovery from year 2000 to 2013 by the Malaysian industry.

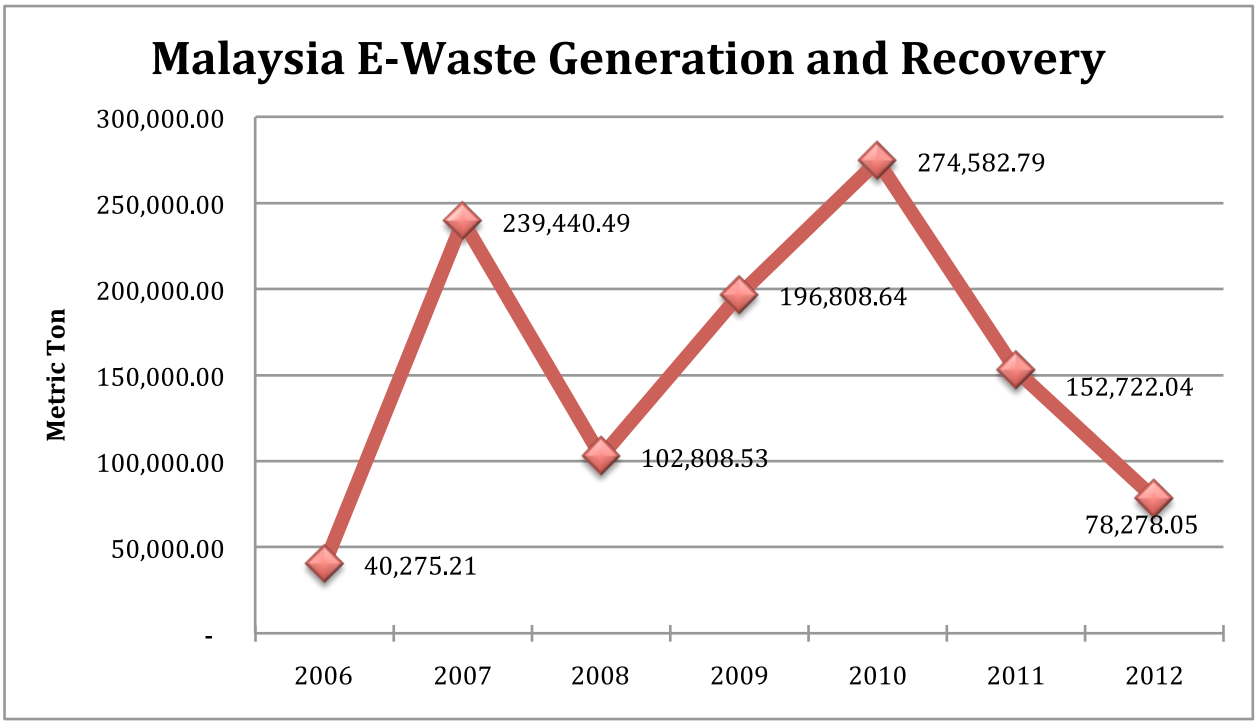

Figure 2: E-waste Generation and Recovery in Malaysia 2006 -2012

3.2 Role of Standards for Recycling Industry

Making waste recycling industry into a mainstream economic activities in Malaysia is a challenges as it require many factors to be considered. And standards play an important role to support and promote the waste recycling industry as to ensure that the industry able to be one of the important industry help to provide economic and social benefit other than its environmental priority. Standards can come in to ensure that the quality of waste recycling processes done by the industry help to comply to the regulations especially in regards to environmental and health requirements. Standards also help to ensure that the quality of products are compliance to regulation and meet the requirements of domestic and international market. The standards also will help the waste recycling industry to become an efficient and clean industry. However to achieve this, there are certain factors needed to be in place before the standards for waste recycling industry be able to perform its task and be effective.

It is important that the governance of the standards come from the government policies or strategic plans. Lead agency for the governance is key, hence it should come from the ministry which able to ensure the application and compliance of the standards as well as the development and enhancement of the standards help the industry. The nature of waste recycling industry standards will involve many stakeholder, mainly from government agencies, business, industry and non-governmental organization which concern about the industry. This is due to the standards should oversee on all aspect of the industry and follow the flow of the waste from collection to producing recyclable materials or products. Thus the structure of institutions must be clear especially for the function of each stakeholders to ensure effective system and higher values for the industry.

The role of stakeholders in development and enhancement of the waste recycling standards should also determine type of standards needed for the waste recycling industry. As mention above where standards should oversee the flow of waste in recycling industry, there are many factors must be taken into consideration in developing and enhancement of the standards. The first factors are to focus on manufacturing of the recycled materials and products. The manufacturing and recycling process standards develop should emphasize on the flow of waste and materials, hence there is a need to inculcate life cycle thinking in manufacturing and recycling process. This is important as to ensure that recyclable products are produce as what it is supposed to be. In this process the standards for emission of recycling process, will be part of the system.

The standards help industry to design and refine the processing, manufacturing and delivery of their product. In addition to this if the industry implement life cycle assessment in its manufacturing process, the standards for transportation of recycling materials will become one of the standards especially for recycled materials with elements of toxic and hazardous materials. The type of the standards in the manufacturing process will help in determine the recyclable product standards especially for compliance to eco-label scheme.

The other factors is the flexibility of the standards, where it is able to be reviewed or enhanced. Since there is a need for a mandatory and voluntary based situation, standards need to development to meet the demand according to situation. The standards could be arranges in different level for voluntary or mandatory requirements. Where the low level standards is for voluntary participation, while the high level standards is for mandatory participation. This is important as the industry player will have different level of acceptance and capability to comply with the standards.

Standards should help to facilitate the industry. Especially for quality requirements, legislation and guidelines compliance, market infiltration and trade compliance (OECD, 2007). In addition standards will help in obtaining financial support. The standards scheme also could be link with the financial system, where financial institution able to support the industry for specific funding requirements or insurance scheme. In addition the governance system will provide support where it help industry and its recycled product to penetrate the domestic and international market. Hence the standards should support the industry in trade matter as well, especially in reference to compliance to foreign legislation and guidelines. Thus this allow the standards system to be synchronize or streamlining the Malaysian standards with other country standards. This initiative will help the industry to prepare itself in making appearance of its product in the international markets.

3.3 Development of Standards for Sustainable Industrial Waste Recycling Industry in Malaysia

The need for waste recycling standards has become critical as the industry expands in Malaysia. The industries and businesses as well as the enforcement agencies require standards to ensure effective performance, responsibility, sustainability of industries and environmental protection. In developing such standards, the process needed must be addressed. Malaysian standards development and establishment process is discuss as follows.

The recycling contractors in Malaysia are licensed by SWCorp and local government for solid waste. While for the hazardous waste, contractors were licensed by DoE. There are a total of 1,183 solid wastes contractors in Malaysia as of 2014. They also conduct waste recovery for recycling. Table 2 show the number of solid waste contractors according to the type of waste collected. As of 2004, 55 industrial solid wastes recyclers were licensed by the Ministry of Housing and Local Government Malaysia. Industrial solid wastes recovery increased from 5,405.1 ton/day in 1994 to 8,063.47 ton/day in 2005 (Fariz, 2009).

Table 2: Number of Licensed Contractor for Solid Wastes in Malaysia 2014

Domestic	Industry	Construction
479	334	370

Source: SWCorp, 2015

However for the hazardous waste, there are 796 licensed contractor for waste collection in 2013. There are 122 recyclers were licensed by the Department of Environment Malaysia to recover the hazardous wastes. As for E-waste, there are 155 E-waste recovery facilities in Malaysia with the total capacity to handle more than 24,000 metric ton of E-waste per month. Out of that number, 135 facilities are conducting partial recovery. With most of them are small and medium size operators engaged in physical or manual segregation of E-wastes for further processing. As the other 20 are full recovery facilities which can process the E-wastes to recover the precious metals.(DoE, 2012). Approximately 45.75% of hazardous wastes have been recovered from the total wastes generation from 2000 to 2005. Thus increasing trend of wastes recovery observed, from 35% in 2000 to 58% in 2004. Between 2000 to 2005, 1.12 million metric tons of industrial hazardous waste have been recovered (DoE (2001, 2003, 2006)).

The demand for waste handling prioritizing recycling increases as the waste generation increased. This is in line with government policies and critical issues of land space for landfilling. Waste recycling must be the main activities for waste management. As the recycling industry grow, the needs for standards which follow through all aspect of waste recycling should be in place. In response to the environmental requirements, Malaysia has established the Eco-Label scheme in 2005. SIRIM Malaysia Bhd is the agency responsible in developing and enforcing eco-label. Eco-label plays an important role towards establishment of waste recycling or materials standards in Malaysia. The scheme helps to provide important criteria for recycling of waste in Malaysia. The four eco-labelling criteria identified (on the product, packaging or letterhead) are as follows:

- Environmentally degradable and non-toxic plastic packaging material
- Hazardous metal-free electrical and electronic equipment
- Biodegradable cleaning agents
- Recycled paper

Source: SIRIM (2009)

These four criteria claimed on 18 type of products listed as follows:

- Environmentally degradable & non-toxic plastic packaging material
- Hazardous metal-free electrical & electronic equipment component & parts
- Biodegradable cleaning agents
- Recycled paper
- Biofibre composite construction material
- Food-grade lubricants
- Floor mat
- Fabric care product
- Tableware from biomass
- Adhesives
- Water-based adhesives
- Paper-based packaging products
- Organic fertiliser
- Recycled rubber products
- Shampoo
- Shower liquid products
- Solid body soap products
- Recycled plastic products

Source: SIRIM (2009)

All of these products with eco-label promote recycling or have information that the products are recyclable after use. However it did not provide any specific standards on how to recycle and what are the quality or values of the recyclable materials from the products.

Specific standards for waste recycling industry in Malaysia are not available and standards for recyclable material and recycled products are not well addressed in the waste minimization plan or strategy in Malaysia. Compliance of standards for recyclable materials only found for export requirements, and industry adheres to import country standards. With the increasing number of recyclers and materials being recycles the need for waste recycling industry standards are urgently needed. This will guarantee the quality of recyclable materials as demand by consumers, whether for domestic or international market.

4. Discussion

4.1 Implementation of Recycling Industry Standards in Malaysia

Availability of standards for waste recycling industry in Malaysia will help to ensure the sustainability of the industry in the future. However, prior to the development of standards there are many factors that need to be addressed. First, Malaysia needs to have common definition of recyclable materials and intermediate products. The definition is critical as this will ensure effective and acceptable standards for waste recycling industry in the country. In implementing standards, legislative support must also be in place. The existing legislative structure need to be enhanced to include waste recycling industry needs. The recycling industry requires general and specific waste recycling guidelines. Data from technical information of wastes characteristics need to be developed. This database is important to support waste recycling standards maintenance and enhancement. Therefore, valuation or assessment tools of standards for recyclable goods or intermediate products must be identified. The standards also need to be supported by technology development and innovation to understand the processes involve in waste recycling. This should include the handling and transportation of recyclable goods or intermediate products as well as possible impact to the environment and human health. Currently, there are 21 standards that have been established for the recycling industry in Malaysia (Table 3).

Flexibility of standards must be in place. Standards should not start as mandatory, hence voluntary must be the first action to be introduced to the waste recycling industry. It is difficult to make mandatory new standards which are not familiar to the recycling industry in Malaysia. Voluntary process must be supported with awareness and education process to ensure that all key stakeholders in waste recycling industry understand and able to accept the use of the standards. However, as the situation improves and when there is an increasing acceptance and capability of stakeholders, the standards could be enforced as mandatory. Standards for recyclable materials and intermediate products must focus on quality and adhere to specification demanded by industry. The manufacturing and recycling process guidelines will ensure key recycling players to achieve this condition.

Table 3: Malaysian Standards (MS) for Recycling Industry

	MS Number	**Title**
1	MS ISO 22628:2009	Road vehicles – Recyclability and recoverability – Calculation method (ISO 22628:2002, IDT)
2	MS 2080:2008	Ecolabeling criteria for recycled paper
3	MS 1904:2006	Specification for polyethylene plastics moulding and extrusion materials from recycled post-consumer (HDPE) sources.
4	MS 1388 : 1995	Specification for high slag blast furnace cement.
5	MS 1389 : 1995	Specification for Portland blast furnace cement.

6	MS 1387 : 1995	Specification for ground granulated blast furnace slag for use with Portland cement.
7	MS ISO 3037:2008	Corrugated fibreboard – Determination of edgewise crush resistance (unwaxed edge method) (ISO 3037:2007, IDT)
8	MS ISO 3034:2007	Corrugated fibreboard – Determination of thickness (ISO 3034:1975, IDT)
9	MS 1912:2006	Wood-based panels - Fibreboards - – Specification.
10	MS 1786:2005	Woodbased panels – Fibreboard, particleboard and oriented strand board – Terminology (ISO 17064:2004, MOD)
11	MS ISO 13820:2004	Paper, board and corrugated fibreboard – Description and calibration of compression – Testing equipment.
12	MS 398:1976 (CONFIRMED:2004)	Specification for corrugated fibreboard boxes.
13	MS ISO 186:2003	Paper and board – Sampling to determine average quality (ISO 186:2002, IDT)
14	MS ISO 535 : 2001	Paper and board – Determination of water absorptiveness – Cobb method
15	MS 1226 : PART 1 : 1991	Pulverized-fuel ash part 1: Specification for pulverized-fuel ash for use as cementitious component in structural concrete.
16	MS 1494:2000	Specification for billets for hot rolled non-alloyed steel bars and rods
17	MS 1495:2000	Specification for blooms for hot rolled non-alloyed structural steel sections
18	MS 224:2005	Retreaded pneumatic rubber tyres for cars and commercial vehicles – Specification
19	MS 571 : 1991	Specification for ingot tin
20	MS 18:1971	Specification for toilet tissue paper
21	MS ISO 15270:2008	Plastics – Guidelines for the recovery and recycling of plastic waste (ISO 15270:2008, IDT)
22	MS EN 933-11:2011	TESTS FOR GEOMETRICAL PROPERTIES OF AGGREGATES - PART 11 : CLASSIFICATION TEST FOR THE CONSTITUENTS OF COARSE RECYCLED AGGREGATE
23	MS EN 1097-1:2011	TESTS FOR MECHANICAL AND PHYSICAL PROPERTIES OF AGGREGATES - PART 1: DETERMINATION OF THE RESISTANCE TO WEAR (MICRO-DEVAL)
24	MS 1478:2008	PLASTICS - LOW-DENSITY POLYETHYLENE FILMS FOR GENERAL USE AND PACKAGING APPLICATIONS - SPECIFICATION (FIRST REVISION)

25	MS EN 1744-5:2011	TESTS FOR CHEMICAL PROPERTIES OF AGGREGATES - PART 5: DETERMINATION OF ACID SOLUBLE CHLORIDE SALTS
26	MS EN 1744-6:2011	TESTS FOR CHEMICAL PROPERTIES OF AGGREGATES - PART 6: DETERMINATION OF THE INFLUENCE OF RECYCLED AGGREGATE EXTRACT ON THE INITIAL SETTING TIME OF CEMENT
27	MS 1904:2006	SPECIFICATION FOR POLYETHYLENE PLASTICS MOULDING AND EXTRUSION MATERIALS FROM RECYCLED POST-CONSUMER (HDPE) SOURCES
28	MS 2080:2008	ECO-LABELLING CRITERIA FOR RECYCLED PAPER
29	MS 2280:2010	AGGREGATES FOR MORTAR - SPECIFICATION
30	MS 2454:2012	ECO-LABELLING CRITERIA FOR PAPER BASED PACKAGING PRODUCTS
31	MS EN 12620:2010	AGGREGATES FOR CONCRETE (SECOND REVISION)
32	MS EN 12620:2010, AMD. 1:2012	AGGREGATES FOR CONCRETE (SECOND REVISION)
33	MS ISO 22628:2009	ROAD VEHICLES - RECYCLABILITY AND RECOVERABILITY - CALCULATION METHOD (ISO 22628:2002, IDT)
34	MS ISO 22754:2009	PULP AND PAPER - DETERMINATION OF THE EFFECTIVE RESIDUAL INK CONCENTRATION (ERIC NUMBER) BY INFRARED REFLECTANCE MEASUREMENT (ISO 22754:2008, IDT)

Source: SIRIM, 2016.

Inculcating the life cycle thinking in manufacturing and recycling process helps to ensure good quality and minimized impact to the environment. Hence, standards for emission or exposure of materials process need not to be established as long as the recycling process complies with the existing country environmental standards. As for the movement of the recyclable materials and intermediate products, the standards for transportation of recycling materials which might be considered as how the roles of standards should engage in each process of waste recycling industry in Malaysia. The recycling recovery guidelines and standards determine type of waste suitable for specific purpose. This guidelines and standards must be supported with separation at source methods. As for the recycling process and activity, guidelines and standards must be in place to ensure that the recycling process toxic or hazardous materials, must comply with the Basel convention procedures. Figure 3 illustrate the activity of easte recycling industry which will have impact to the human health and environment as well as at which stages guidelines and standards for emission and exposure should be in place. The quality standards are critical as to ensure that the recyclable materials meet the requirements needed by the consumers. Transporting recyclable materials which are considered as hazardous require specific transportation standards. This is important since most of the recyclable materials are products for export and import. The standards which monitored the waste recycling industry play important role to ensure that the recyclable materials comply with legal requirements of imported country.

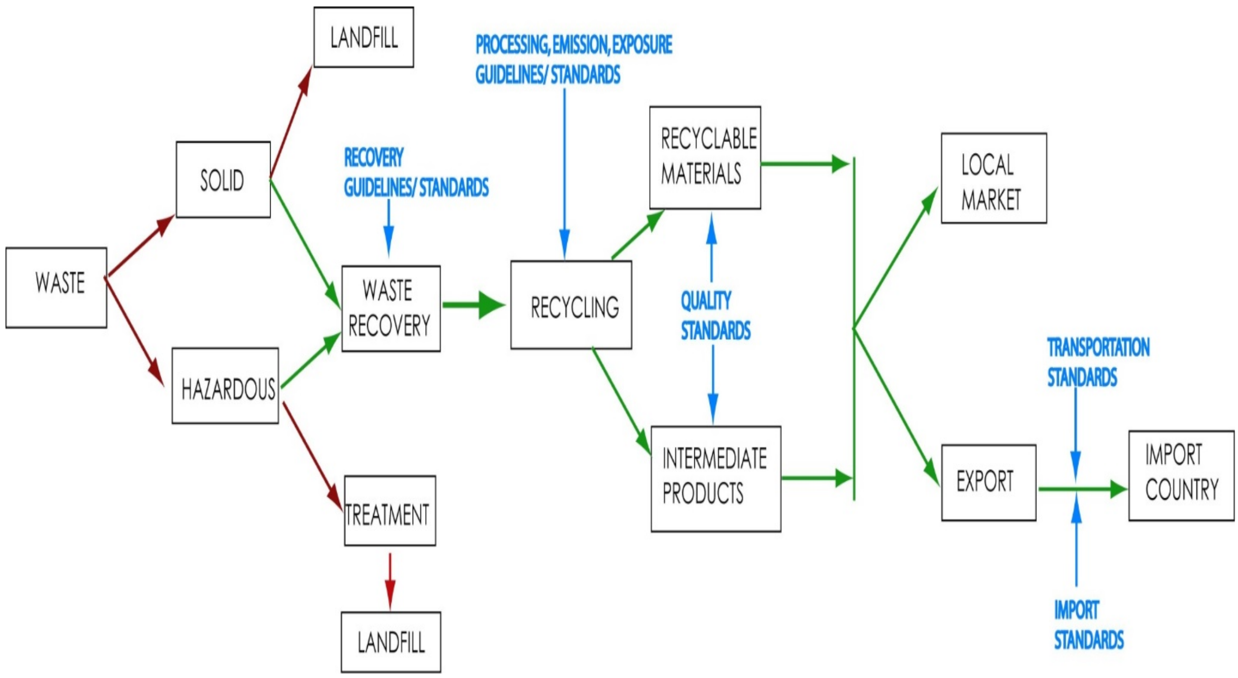

Figure 3: Role of Standards in Waste Recycling Industry in Malaysia

Source: Fariz, (2010).

4.2 Are Malaysian Recycling Standards Help Industry ready for International Market?

The real question is are Malaysian waste recycling industry ready to use recycling standards as a tools to enhanced their capacity and ensure their sustainability. There is a need to understand what their responds are and asses how they will applied the recycling standards. The current status of waste recycling industry in Malaysia illustrated that most of the licensed contractor focus on collection of recyclable materials and sell raw materials. Only small number of industries focus on producing recyclable products using recyclable materials from Malaysian recycling industry. Hence majority of the industry involved in raw recyclable materials production and some do export.

One of findings from the survey shows that most of the waste recycling industry in Malaysia, do agree that recycling standards are important and will help them to produce better quality products and help them to market their products into local and international markets. In addition it will help them to comply with related legislation and guidelines set by the government as well as to comply with import country trade legislation requirement. They also suggested that the available standards need to be expanded to cover many types of wastes, recyclable materials and products. In general the Malaysian recycling industry are ready to comply with international standards requirement, but at the current level of practice, will only comply for raw materials. Most of them are not ready for recyclable products.

There are issues which contributed to this responds and condition. The Use of standards in Malaysia is still voluntary for waste recycling industry. However for the industries who exported their products, the industry will make it compulsory to comply with standards set by the importing country. Many small waste recycling industries still practice a low level type of operations, where quantity is the main focus rather than quality. Moreover some of them still using low costs technology which were found contributed to certain level of pollution to the environment. The understanding of recycling related standards in reference to its application and implementation will incur additional cost for industry operation. Hence these requirement will be difficult for small industry to apply. The waste recycling industry mainly the small industry have difficulty to obtain financial support especially to prepare or enhance their capacity towards standards compliance. The financial and insurance institutions still have different view of the small and medium industry, and unable to provide financial or insurance as they are not convinced of the ability and capacity of the industry (United States Environmental Agency 1996; Xiaolan Zheng et al 2013). Moreover there is no specific monitoring system in place in Malaysia to assess compliance of standard by the waste recycling industry. Mechanisms for continue monitoring for industries who have complied for the specific standards are not available. Hence this will affect trade aspect of the recycling products, especially for the requirements of quality assurance, compliance of legislation and guidelines of the importing country. There are other factors which may have direct impact for readiness of the industry, and this includes training program, skill human resources, space for expansion and trade assistant from the relevant agencies. Thus these factors contributed to many waste recycling industry did not agree to suggestion in making recycling standards compliance as compulsory for domestic market.

In addition to aspect of Malaysian waste industry existing capacity and issues highlighted above. There are also concern about Malaysian waste recycling standards acceptance by other countries. The concern includes compliances of Malaysian recycling standards with the international or other countries standards. For example each Asian country will have different law and legal enforcement capacity and efficiency, hence show different scenario for each country in Asia. This includes difference aspect of guidelines and standards. Such capacity and differences could be seen through how these countries manage the trade and shipment issues. Since these recyclable waste fall under the purview of international agreements such as Basel Convention, compliance and enforcement of related international convention, also show different level of compliance by Asian countries.

The need in harmonising standards for Asian region waste recycling industry to ensure industry sustainability is important. The rapid growth of export and import of waste as raw materials for recycling and secondary products especially within the ASIAN region is significant for economic activities. However a common and accepted waste recycling standards is not available. This will become a hindrance for sustainability of waste recycling industry especially for ASIAN region. The current scenario shows that, most of the ASIAN countries have established and developed standards for its waste recycling industry serving its domestic market (Fariz, 2010; Kojima and Michida, 2013). The trends also illustrated that each country has prioritized different type of recyclable products or material in their waste recycling standards. Nevertheless there are a common recyclable products or material, but the standards are different. This due to their domestic industry and market demand and requirements. Since each country have different legal requirements and system for compliance of standards, as well as different standards requirements and characteristics, this is a block for harmonization. To ensure sustainability of waste recycling industry in ASIAN region there is a need to harmonize different country standard. It is not an easy task but the possibility is there. The existing infrastructure such as the policy, legislation, institutional, market and technological input has been established in most ASIAN countries.

There is a need to determine the best mechanism and approach for harmonization. The harmonization mechanism and process will also help in tackling issues on trade policy and regulatory differences between countries in Asia for waste recycling industry in this region. The policies and regulations will either help to facilitate recycling or become a hindrance. There are different levels of policy and legislative setups and enforcement. Developed countries' policies and legislation are more stringent than those in developing countries, and this is related to the fact that demand for lesser quality recyclable waste and materials is high in developing countries. Developed countries demand high-quality recyclable waste and materials, especially South Korea and Japan which prioritize the import of high-quality scrap metal (Kojima and Michida, 2013).
Changes of policy or legislation in one country may affect the trade flow of recyclable

materials. The current platform available for the task is through ASEAN Free Trade Agreement (AFTA) mechanism and process. ASIAN governments will play an important role to ensure the harmonization process take place with technical input from the industry and business. Governments will play the role as a facilitator and enforcer to ensure the level of playing fields, prepare important infrastructure and promote sustainable market. Establishing ASIAN standards harmonization mechanism allows an easy synchronization and compliance between ASIAN countries' own standards can help the country's waste recycling industry to produce good quality recyclable products and material as well as to penetrate the international market.

5. Conclusions

For the waste recycling industry, there are important drivers or factors which play important role in establishing and implementing standards. A standard requires stakeholders and institutional support. The governments of a country, the main implementer and enforcer of standards need important inputs from industries, business sectors, financial institutions and consumers. Legislation must also be established along with standard to ensure effective applications and compliance. Standards should be developed in line with technological development, thus it requires human resources for many important activities especially for enforcement and technology development for standards enhancement. This is important and thus, technology development for product should be handled immediately and competitiveness of products technology should not be slowed down by lack of standards. Compliance for standards must be supported not only by the government and its legislative role, but other support system must be also be in place. This support system must come from industry and business entity which will ensure trade and market suitability in applying the standards. Financing and insurance scheme should also be developed and be established to facilitate standards compliance by industry and business. These drivers or factors should be integrated to ensure that the standards for waste recycling industry are able to deal with the increasing demand of recycled materials for industry in many parts of the world. Hence, many countries especially the developed countries have established their own waste recycling standards (Kojima and Michida, 2013). With these standards in place it will help the local waste recycling industry such as in Malaysia to able producing high quality products and comply with international legislation and guidelines. Thus help to ensure sustainability of the waste recycling industry while promoting sustainable development. The study also finds that the Malaysian recycling industry is still at early stages but are ready to become key player in producing raw recyclable materials especially within the Asian region and the world.

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Stimulating circular economies through intermediation - A case study of textile pilot project of the Dutch Ministry of Defense

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Abstract

The role of public procurement provides a unique opportunity to the transition towards a more circular economy by stimulating European growth through innovation; however, the relationship between public procurers and suppliers are still not fully understood. This research discusses a pilot project led by the Dutch Ministry of Defense which gauged the potential for suppliers to incorporate post-consumer recycled content in textiles, through extensive knowledge gathering and consultation. Seventeen in-depth interviews were conducted with people directly involved in the pilot, including sustainability advisors, procurement staff, technical specialists, category managers, and firms across the textile supply chain. The interviews helped to capture aspects of these interactions, including their nature and frequency, drivers for change, barriers to change, facilitators, and suggestions for improvement. The findings show that dialogue for the pilot fostered new relationships and motivations for firms to work together toward circularity. Some of the key benefits of the pilot project included increasing awareness of sustainability possibilities and creating communication channels across textile supply chains. The pilot was a critical first step toward creating circularity by providing an initial market for textiles from recycled material. This research shows that a transition towards a more circular economy can provide transparency between the parties, as well as improving environmental performance.

Keywords: circular economies, public procurement, collaboration, intermediation, innovation

Toward a more integrated and holistic assessment framework for life cycle modelling – life cycle sustainability unified analysis

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Abstract

There is an ongoing call to develop disjointed life cycle studies into what is now known as Life Cycle Sustainability Assessment (LCSA). However, existing frameworks do not adequately consider the role of stakeholders in the assessment process, rebound effects, holistic ways of addressing data uncertainty and how the concept of vulnerability and resilience can be applied to life cycle modeling. Life Cycle Sustainability Unified Analysis (LiCSUA) was proposed to address these four issues, while unifying two widely used LCSA frameworks. Based on control theory, psychological and sociological theories, and quantitative approaches to describe risks in decision-making, a mathematical model was also created to link the vulnerability of a life cycle system to stakeholders' sense of vulnerability, rebound effects, system resilience, interdependence among life cycle stages, and the adaptive capacity of the system. Finally, proposal to operationalize this new framework was given.

Keywords: life cycle sustainability assessment, rebound effects, stakeholder engagement, vulnerability, resilience

1. Introduction

It is widely agreed in the international life cycle study community that life cycle thinking has reached an important milestone. With the advent of the Sustainable Development Goals, there is a need to keep life cycle thinking more abreast with sustainable development concept. The next stage of development in life cycle thinking is life cycle sustainability assessment (LCSA). That is, life cycle-based methodologies must assess the sustainability of the chosen life cycle system. There are presently two widely used frameworks for LCSA. The first defines LCSA as a summation of the processes of life cycle assessment (LCA), life cycle costing (LCC) and social life cycle assessment (SLCA) (Klöpffer and Renner, 2007); it is termed herein as "sumLCSA". While it addresses the three dimensions of sustainability – economy, society and environment – it neither integrates across these dimensions nor addresses the interlinkage among environmental, economic and social indicators.

These problems are partially resolved by the second framework – life cycle sustainability analysis (LCSAy) (Guinée, 2014); however, LCSAy has its own weaknesses. Specifically, it implies that LCA, LCC and SLCA can only be applied to the product level and not at the industry and economy levels (at which industrial ecology tools such as economic input-output analysis and material flow analysis are more appropriate. However, the flow of materials into the various life cycle stages can occur across different scales (product, industry and economy); in other words, this "scale-straddling" nature is inherent in many products' life cycles. Separately, Sala et al. (2013) opined that future sustainability assessment method should contribute to proposing new insights on uncertainty analysis, engage stakeholders throughout the sustainability assessment process, integrate rebound effects (RE)) into assessment, and describe the vulnerability, resilience and adaptive capacity of a system assessed in a holistic manner. In its current form, LCSAy is unable to address these four points.

Hence, the objective of this work is to propose a new LCSA framework that unify the key features of sumLCSA and LCSAy, as well as embody the four qualities mentioned above.

2. Literature review

2.1 Incorporating risk-based uncertainty analysis and rebound effects in LCSA

LCA, LCC and SLCA results, even when uncertainties are considered, are risk neutral in nature; that is, life cycle studies typically do not consider how the risk aversion mentality or behavior of decision makers influence how uncertainties in the life cycle modeling results are used and finally lead to their decisions. Furthermore, the conventional approach of uncertainty analysis used in life cycle modeling, which is based on Monte Carlo analysis, requires large numbers of repetitions of simulations to accurately approximate the outcome distribution. Also, the characterization of the probability distribution of the input data depends heavily on subjective choice of this distribution, which is usually assumed to be either normal or lognormal. When the exact distribution of the uncertain input data is unknown, new methods are necessary.

Although incorporation of REs into life cycle modeling is a relatively new research topic, recent efforts set the foundation for further exploration on how integrate REs into LCSA in general. Takase et al. (2005) assessed RE with respect to multiple environmental indicators and highlighted the need to assess trade-offs among these indicators, thus underlining the importance of relating interlinkages (among the three dimensions of sustainability) to REs. More recently, Vivanco and van der Voet (2014) identified four types of REs that are relevant to industrial ecology; they are the direct, indirect, structural and transformational effects.

2.2 Stakeholder engagement based on psychological and sociological information

Conventionally, stakeholders' role in LCA is limited to providing input or feedback for the determination of weighting factors in the impact assessment stage. Thabrew et al. (2009) were among the first researchers to show that stakeholders can perform a larger role in LCA by engaging them in all life cycle stages, in order to understand the likely impacts that these processes may have on them. The Corporate Sustainable-development Responsibility (CS^dR) system proposed by Kua (2010(a)) is another version of such deep engagement methods applied to corporate supply chain. However, what is lacking in these earlier approaches is an understanding of the identified stakeholders from a psychological and sociological perspective, and applying this understanding to engage them throughout the product life cycle under study. There is another reason why knowing the psychology of stakeholders is important – allowing us understand their risk aversion, which in turn enables us to understand how they may respond to uncertain data (or life cycle modeling results obtained from uncertain data).

2.3 Describing the vulnerability and resilience of a life cycle system

Life cycle modeling almost never, or seldom, evaluate the resilience and vulnerability of the system under study. The resilience of a system can be defined as "the magnitude of disturbance [or shock] that can be absorbed before [it] changes to a radically different state as well as the capacity to self-organize and the capacity or adaptation to emerging circumstances" (Adger, 2006, page 269). A similar concept is the vulnerability of a system, which depends on three key factors – its sensitivity, exposure and adaptive capacity. Satterfield et al. (2004) found that the way individuals consider their vulnerability will affect the way the groups in which they exist view the groups' collective vulnerability. Although the relationships among vulnerability, resilience and adaptive capacity in the context of climate change have been widely discussed in the literature (for example, Fellman, 2012), the integration of these concepts within life cycle modeling have not been addressed.

All in all, this review inspires the following research questions, which are in sync with our abovementioned research objective:

- What is the relation among the vulnerability, adaptive capacity and resilience of the life cycle system under study (with respect to the three dimensions of sustainability)?
- How can stakeholders be identified? How can identified stakeholders be understood from a psychological and sociological angle, including their risk aversion and sense of vulnerability in decision-making with uncertain data?
- How can a life cycle system's vulnerability be determined by various REs?
- How can the eventual impacts felt by a life cycle system, due to an external shock, be determined by those factors mentioned in the questions above?

3. Concept of Life Cycle Sustainability Unified Analysis (LiCSUA)

3.1 The key concepts

The key concepts underlying the proposed framework of LiCSUA are summarized in figure 1. The three dimension circles form its theoretical foundation. Within each circle, there is either single- or multi-dimensional (crosslinking) indicators that are appropriate to the chosen context of the problem under study (for example, a country or a specific problem related to global warming). Crosslinking indicators are indicated by the intersections of these circles.

Within each circle, there are "consequences", which are defined as changes made to certain single- or multi-dimensional indicators. If a consequence occurred in a dimension that is different from the one in which changes were made originally, it is called an inter-dimensional consequence (examples have been provided by Kua and Kamath (2014), and Kua and Maghimai (2015)); otherwise, it is an intra-dimensional consequence. Four kinds of inter-dimensional consequences were identified – environmental-economic (shown in area A in figure 1), social-economic (area B), social-environmental (area C), and social-environmental-economic (area D) consequences. Earlier applications of this concept were seen in the Clean Development Mechanism of the Kyoto Protocol (Kua (2010) and Gunawansa and Kua (2011)). In this scope, direct and indirect REs can be seen as special cases of intra- and inter-dimensional consequences respectively.

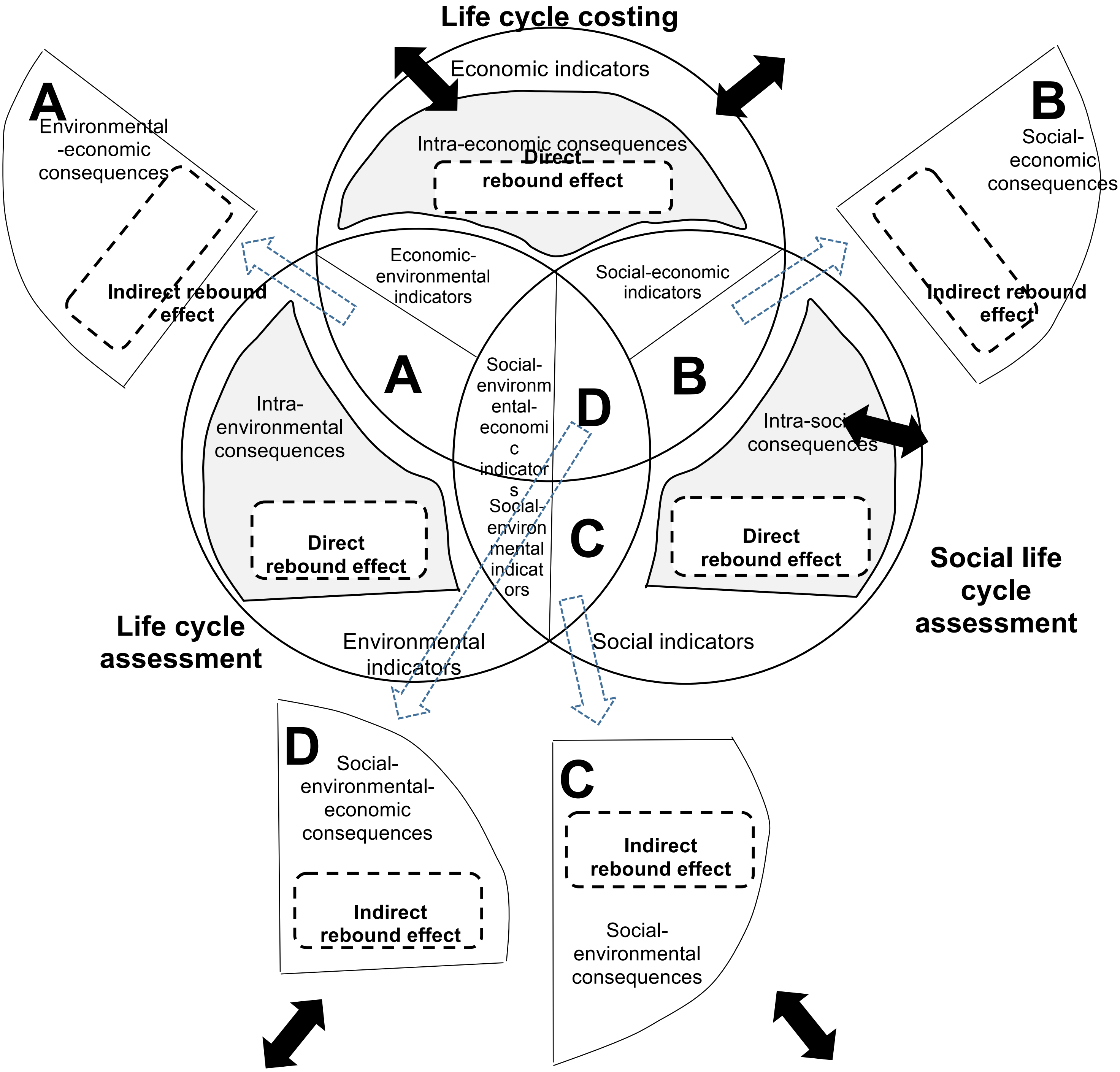
Life cycle costing
Economic indicators
Intra-economic consequences
Direct rebound effect
A
Environmental -economic consequences
Indirect rebound effect
B
Social-economic consequences
Indirect rebound effect
Economic-environmental indicators
Social-economic indicators
A
B
D
C
Social-environmental-economic indicators
Social-environmental indicators
Intra-environmental consequences
Direct rebound effect
Intra-social consequences
Direct rebound effect
Life cycle assessment
Environmental indicators
Social indicators
Social life cycle assessment
D
Social-environmental-economic consequences
Indirect rebound effect
C
Indirect rebound effect
Social-environmental consequences

Figure 1. Central concept diagram of Life Cycle Sustainability Unified Analysis (LiCSUA) framework. The details of areas A, B, C and D are shown in the respective blown up inserts.

An example of negative intra-dimensional (environmental) consequence is that switching to hydroelectricity to mitigate greenhouse gas emissions may lead to decrease in biodiversity due to flooding of forests. A direct RE occurs when the notion of availability of such "cleaner" electricity from hydropower sources encourages consumers to use more electricity.

An example of inter-dimensional (economic-environmental) consequence is how severance tax imposed on wood (economic) reduces the demand for it and help promote the use of wood-plastic composites (WPC, which is made of recycled plastic and waste/recycled wood), thus conserving virgin wood (environmental). An indirect RE occurs when the above tax is successful in creating a sizable market for WPC (economic) such that local manufacturers are under pressure to supply wood fibers and may turn to virgin wood as feedstock instead of waste/recycled wood (environmentally negative).

3.2 Unifying sumLCSA and LCSAy

In this section, I showed how LiCSUA embodies both sumLCSA and LCSAy, thus unifying both frameworks.

The overall concept of sumLCSA can be illustrated by the *non-overlapping* parts of figure 1 – that is, the separate social, environmental or economic indicators, and their respective consequences and direct REs. In addition, LiCSUA also takes into account how these separated indicators can change with time. For example, one many be interested to analyze the life cycle benefits of replacing wood with WPC. The number of jobs in industry may be treated as an economic indicator. An effort to downsize the local wood industry and develop the WPC industry may unintentionally result in a number of displaced workers from the wood industry to "spill over" to the WPC industry. This shows that jobs in these two industries are linked, and that policymakers must evaluate the success of their policies based on the number (and quality) of jobs in both industries. That is, the economic indicator of "wood industry jobs" has now "transitioned" into one having intra-dimensional consequences, linking both wood industry and WPC industry. Symbolically, the size of the non-overlapping part of the economic LCC circle in figure 1 shrinks, whereas the area of "intra-economic consequence" expands.

Besides, one needs to consider how this change may trigger other non-economic consequences (for example, any increase in social welfare needs for displaced wood workers, including job counseling, which is a kind of social indicator). Similar "transitioning" possibilities could be considered for the other two dimensions, as indicated by the double-headed black arrows on the borders of the circles in figure 1. In short, while sumLCSA is useful in spotting any changes in the relations among indicators within a certain dimension, LiCSUA provides additional insight into how these changes may be linked with changes in the other dimensions, through crosslinking indicators and/or indirect REs.

As mentioned above, the "scale-straddling" nature of life cycle modeling is intrinsic to flows into and out of the life cycle stages of some products; hence, it is technically possible to expand LCSA to a level beyond the product level. Cross-level material/substance flows can also occur, for example waste wood flowing from the processing stage to the WPC life cycle system. Since wood/timber can also be used for the paper and pulp industry (not shown in figure 1), the processing stage resides at the economy (and not product) level. Usually, the forests from which the timber is obtained is situated within the same country (as the country in which the WPC is used) but the diesel required for transportation is a commodity traded cross national borders, which can be accounted for using methodologies such as economic input-output analysis (EIOA).

More importantly, LiCSUA shows that accounting for this "scale-straddling" nature of life cycle modeling can provide important insight on the emergence of inter-dimensional consequences and REs. For example, in LCC, we may consider flows of money alongside material/energy flows across different geo-economic boundaries. When a severance tax is imposed on the harvesting of timber, the cost of wood will increase. This may force the timber corporations to sell its waste wood to the WPC industry at a higher price (a consequence). Depending on the increase in the price, manufacturers of WPCs may face a dilemma – to increase the prices of their products or resorting to using virgin wood from uncertified forests (which will have a net negative impact on forest sustainability – an environmental-economic indirect RE). Appropriate modeling methodologies, including general equilibrium models based on profit maximization of firms and net cost minimization of consumers (in the use phase), can be applied in this case.

Finally, one of the key challenges of integrating SLCA with LCC and LCA is the fact that the functional units of SLCA may be incompatible with those of LCA and LCC (Guinée, 2014). Specifically, while it is possible to attribute cost and environmental impacts of a product to its functional unit (for example, mass or volume), it may not be logical to attribute workers' welfare or cultural preservation to that same functional unit. LiCSUA can contribute by providing an alternate definition of SLCA. For example, one may want to evaluate the life cycle impact due to a reduction of logging in local forests (raw material acquisition stage) using severance tax. However, the decline of forest areas before the introduction of this tax might have already forced younger forest dwellers into neighboring towns, who might even have ironically found jobs in the logging or timber processing industry; this occurred in Sarawak, Malaysia (Forest Monitor, 2015). Therefore, restricting logging with this tax may unintentionally force these laborers out of their jobs (indicated by the checkered arrows in figure 1), thus resulting in negative social impacts. This is a type of social-economic-environmental indirect RE and may be considered as an indicator of SLCA. In short, by defining SLCA indicators as *social responses* to changes in the inventories or impacts in LCA and LCC, LiCSUA readily integrates SLCA with LCA and LCC.

In conclusion, this section shows how LiCSUA embodies the key concepts of sumLCSA and LCSAy, and provides a framework for further developing these concepts.

3.3 Facilitating stakeholder involvement

As pointed out by Sala et al. (2013), both sumLCSA and LCSAy are not specific enough on stakeholder engagement. To effectively engage stakeholders, they have first to be identified (Mitchell and Wood, 1997; Donaldson, 1999). Kua's IFSIUER (Integrated Framework for Stakeholder Identification, Understanding, Engagement and Role Management) (Kua, 2016(a)) framework proposed the use of life cycle stages as the basis for identifying important stakeholders, and then involve them by chronologically understanding, engaging and managing their roles. Building on this idea, LiCSUA proposed that inter-dimensional consequences and REs involving the social dimension provide the contexts to identify these stakeholders in a product's life cycle (as shown in figure 2). For example, in the above example of price hike of wood wastes, increased demand for foreign wood wastes may trigger more small and medium-sized freight companies to enter the market and provide more options for cross border transportation; these companies may now play a bigger role in the WPC industry. Furthermore, stakeholders can play the traditional role of providing suggestions for the weighting factors in LCA and LCC (shown as the dotted arrows in figure 2). Since stakeholders' perception of vulnerability determines the overall vulnerability of the life cycle stage in which they operate, understanding their degree of risk aversion is crucial for estimating how each makes decision with uncertain information.

Kua (2016(a)) found that various aspects of the Theory of Planned Behavior and other psychological and sociological theories suggest that a stakeholder can be understood by examining his/her RICCOW – Responsibility, Incentive, Capacity, Capability, Opportunity and Willingness – to take certain decisions. That is, stakeholders are understood from the decisions that he/she chooses or otherwise (Gurauskienė, 2008; Saphores, Ogunseitan, Shapiro, 2012; Dwivedy and Mittal, 2013; Kua and Wong, 2012; Van Beukering and van den Bergh, 2006; Kua and Ashford, 2004; Wang et al., 2011; He and Kua, 2012). Based on this understanding, different engagement methods, such as those policies based on soft operational research proposed by Vidal (2005) or coherently integrated sustainability concept (Kua, 2007), can be applied to change

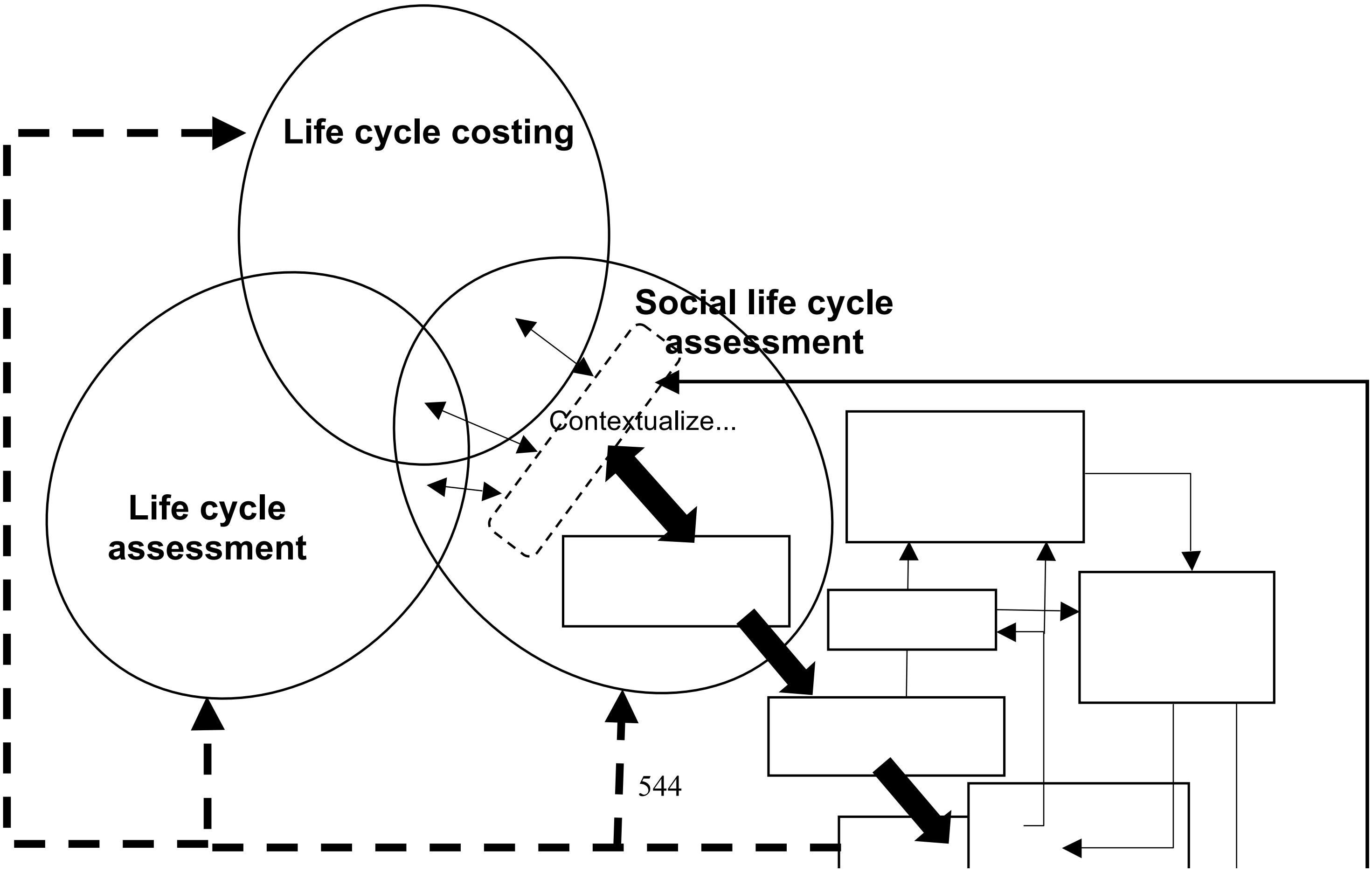

Figure 2. Framework for stakeholder involvement in life cycle sustainability unified analysis (integrated with Kua's model (2016(a); 2016(b))). Inter-dimensional consequences and rebound effects that involves the social dimension (thin double-headed arrows) sets the context to identify relevant stakeholders, who will be understood, engaged and managed with the help of policies and other strategies. Understanding stakeholders' RICCOW, sense of vulnerability and risk aversion helps design of strategies that can possibly change their RICCOW (and even their original vulnerability and risk aversion) and effectively manage their roles in the life cycle. By engaging stakeholders, some of the original consequences or rebound effects can be modified. The dashed arrows indicate that stakeholders can still play their traditional roles of providing suggestions for indicators (including crosslinking indicators) and weighting factors to life cycle assessment, life cycle costing and social life cycle assessment.

behavior, manage their roles throughout the involvement process, or address the related inter-dimensional consequences and REs. For example, the government may resolve the above boycott by the WPC manufacturers by agreeing to provide financial incentive (I) (grants or subsidies) to affected companies. The government may also aim to provide them with adequate capacity (C), capability (C) and opportunity (O) to change their decision (for example, by holding focus group discussions to share information); if necessary, the government will also appeal to their sense of corporate and community responsibility (R) to consumers to persuade them to abort the boycott. Knowing the risk aversion of these companies enables the government to decide the nature of financial assistance and other related aid packages, so that companies' risk can be mitigated. In fact, from this involvement process, the government understands how vulnerable the WPC supply chain is to price changes in the wood industry, thus linking knowledge on risk aversion to RICCOW factors and system vulnerability.

In summary, LiCSUA provides a good platform for stakeholders to be involved with policy strategies that are designed based on understanding them from an integrated psychological and sociological (RICCOW) perspective (including their risk aversion).

4. Quantitative description LiCSUA

Traditionally in LCA, the impact on a product's life cycle is caused by the inputs into and/or outputs from each life cycle stage. In LiCSUA, impacts caused by these flows may also be due to rebound effects (direct and indirect), the resilience of each life cycle stage and interdependence between life cycle stages, and the adaptive capacity of the life cycle system. Each of these components is described in the following sections.

4.1 Multi-dimensional sustainability indicators and crosslinking indicators

To create a mathematical representation of this concept, one can denote the abovementioned crosslinking indicator as x_{ij} (which is associated with two dimensions denoted by indices "*i*" and "*j*"); it can be affected by an influencing indicator x_{k}, where "k" represents the dimension of the influencing indicator; influencing indicator is defined as the indicator that is originally being changed. This phenomenon of x_{ij} being affected by the influencing indicator is called *coupling*, and an indicator that shows such coupling phenomenon is denoted as $x_{ij,k}$. The change in $x_{i,j}$ – either with respect to time *t* or the influencing indicator – is called a *consequence*. The values of indices "*i*", "*j*" and "k" can take on "1" (environment dimension), "2" (social dimension) or "3" (economic dimension).

For example, in assessing the life cycle impact caused by increasing waste recycling, "k" can be set as "1" if it relates to an aim to reduce the quantity of wastes sent to landfills and incineration plants; the influencing indicator (x_k) is waste quantity. As a result of this policy, behavior may be developed or changed, thus leading to more waste sorting by household residents, leading to more recycling and less virgin materials being used. One can thus consider this behavior as having both environmental and social dimensions and it can be denoted as x_{21}. Putting "2" in front of "1" implies that an improvement in behavior *leads* to environmental improvement. Similarly, we can define another variable x_{12}, which describes improvement in public health due to a reduction in incineration of wastes; "1" being in front of "2" implies that reduction in wastes *leads* to improvement in health.

4.2 Consequences and Rebound Effects

Using the above example, the applied intervention (with the aim to reduce x_1) will cause x_{21} to change after some time t_1. One can assume that a feedback occurred at t_2, at which the waste quantity may decrease and/or policymakers may observe a change in waste-sorting behavior and increase the intensity of the policies to aim for more waste reduction (that is, more reduction in x_1). Using control theory, one may express this feedback mechanism in more general terms and define a change function $\left(c\left(x_{ij,k}\right)\right)$ that is triggered by the change in x_{ij}, caused by x_k. As a result of the change function, the original value of x_k changes from $x_{k;t_2}$ to $x_{k;t_3}$ at time t$_3$. If a simple linear relationship between $x_{ij,k;t_1}$ and $x_{k;t_2}$ is assumed, after the Nth loop of feedback, the change in $x_{ij,k}$ between the start of the first and Nth loops can be expressed as

$$x_{ij,k;t_{3N+1}} - x_{ij,k;t_1} = a'\left(x_{k;t_{3N}} - x_{k;t_0}\right) \tag{1}$$

in which *a'* is a constant. The change of in x_{ij} with respect to change in x_k can be expressed as (Kua, 2016(b))

$$\sum_{l=1}^{L}\left(\frac{dx_{ij}}{dx_k}\right)_l = \sum_{l=1}^{L}\lim_{\Delta x_k \to 0}\left(\frac{\Delta x_{ij}}{\Delta x_k}\right)_l = \sum_{l=1}^{L}\left(\lim_{\alpha' \to 0, \beta' \to 0, \gamma' \to 0}\left\{\left(x_{ij;t_{3N+1}} - x_{ij;t_1}\right)\Big/\gamma\right\}\right)_l \tag{2}$$

where

$$Y = \sum_{m=1; i\neq j}^{N} \left[x_{(i,j,k;t)_{2m}} \left\{ \sum_{p=1}^{(P_{indirect})_m} (\gamma'_p \alpha'_p) \right\} \right] + \sum_{m=1; i=j}^{N} \left[x_{(i,j,k;t)_{2m}} \left\{ \sum_{p=1}^{(P_{direct})_m} (\gamma'_p \alpha'_p) \right\} \right]$$

(3)

The dimensionality of the term $(\gamma'_p \alpha'_p)$is that of $(x_k / x_{i,j,k})$. $(P_{indirect})_m$ and $(P_{direct})_m$ are the mth indirect and direct REs respectively. There are altogether P_{Total} REs, of which $\sum_{m=1}^{N}(P_{indirect})_m$ are indirect REs and $\sum_{m=1}^{N}[(P_{indirect})_m + (P_{direct})_m] = P_{total}$. The parameters $\alpha'_p, \beta'_p, \gamma'_p$, and ε'_p are related to various stages of the feedback process.

4.3 Resilience, vulnerability and adaptation capacity of a life cycle system

In classical LCA, LCC and SLCA, the resilience and vulnerability of life cycle systems with respect to impacts is not discussed. After a shock is applied, it is assumed that the value of x_{ij} decreases by an amount Δx_{ij}, and the system requires a certain of time to "absorb" the impact due to this shock and subsequently recover from it (to the original state, at least). Put more specifically, the impact due to this shock can be felt by every life cycle stages and the interdependence between these stages will have a bearing on the net impact felt by the entire life cycle system. Hence, one can define the impact (with respect to time, *t*) as (Kua, 2016(b))

$$\frac{\partial(x_{ij})_{total}}{\partial t} = \sum_{l=1}^{L} \frac{\partial(x_{ij})_{system}}{\partial(x_{ij})_l} \cdot \frac{\partial(x_{ij})_l}{\partial t}$$
$$= \sum_{l=1}^{L-1} \frac{\partial(x_{ij})_{system}}{\partial(x_{ij})_l} \cdot \left[\frac{\partial(x_{ij})_l}{\partial(x_{ij})_{l-1}} \cdot \frac{\partial(x_{ij})_{l-1}}{\partial t} + \frac{\partial(x_{ij})_l}{\partial(x_{ij})_{l+1}} \cdot \frac{\partial(x_{ij})_{l+1}}{\partial t} \right]$$

(4)

where $\frac{\partial(x_{ij})_0}{\partial t} = 0$. The terms in the square bracket describe the relationships among the different life cycle stages, whereas the remaining term describes how the average value of the crosslinking indicator of the life cycle system changes with that of each of the *L* life cycle stages. In short, equation 4 describes the resilience of the life cycle system with respect to the resilience of each life cycle stage, and the relationship among these stages.

Applying the concepts of vulnerability proposed by Luers et al (2003), Kua (2016(b)) expressed the actual adaptation of a life cycle system as

$$\Delta(x_{ij})_{adaptation} = f.\ln(y+1) \Rightarrow \frac{\partial(x_{ij})_{adaptation}}{\partial t} = \frac{f}{(y+1)}\left(\frac{\partial y}{\partial t}\right)$$

(5)

where f is a constant and *y* is the dependent variable of the system adaptation capacity. Even though the dependence of the system's adaptation capacity on the variable *y* is meant to simplify the problem, the central idea of the present approach is relevant to more complicated cases in which more variables are involved.

By summing up the abovementioned three separate contributions to total life cycle impact, one derives a mathematical expression for total impact as

$$\frac{\partial(x_{ij})_{total}}{\partial t} = \sum_{i=1}^{L}\left(\lim_{t_{SW}\to t_0}\frac{\alpha\left(x_{kjt_{SW}} - x_{kjt_0}\right)}{t_{SW}-t_0} + \lim_{\Delta t\to 0}\frac{\Delta(x_{ij})_{shock}}{\Delta t} + \frac{f}{(y+1)}\left(\frac{\partial y}{\partial t}\right)\right)_i$$

$$= \sum_{i=1}^{L}\lim_{t_{SW}\to t_0}\left(\frac{\alpha Y}{t_{SW}-t_0}\right)_i + \sum_{i=1}^{L-1}\frac{\partial(x_{ij})_{system}}{\partial(x_{ij})_i}\cdot\left[\frac{\partial(x_{ij})_i}{\partial(x_{ij})_{i-1}}\cdot\frac{\partial(x_{ij})_{i-1}}{\partial t} + \frac{\partial(x_{ij})_i}{\partial(x_{ij})_{i+1}}\cdot\frac{\partial(x_{ij})_{i+1}}{\partial t}\right] + \sum_{i=1}^{L}\left(\frac{f}{(y+1)}\left(\frac{\partial y}{\partial t}\right)\right)_i$$

(6)

Finally, the system's life cycle vulnerability can be defined as

$$\text{Vulnerability} = \sum_{i=1}^{n}\left(\left|\frac{\frac{\partial(x_{ij})_{total}}{\partial t}}{\Delta}\right| \times R \times S\right)_i$$

(7)

where Δ is the difference of the crosslinking indicator from an appropriate threshold value or tipping point, over which the vulnerability of the system will become very high and any changes may even become irreversible. The summation is performed over *n*, implying that the total vulnerability of the system is dependent on the vulnerability of each constituent (including that of stakeholders; this is in accordance with the idea proposed by Satterfield et al. (2004)).

In summary, equation 7 shows how stakeholders' vulnerability, REs, relationships among the life cycle stages and adaptation contribute to the system's vulnerability.

4.4 Risk aversion toward uncertainty in decision-making

Zhao et al. (2016) described how risk aversion of decision-makers can lead to their final decisions to choose among different technological solutions, based on their life cycle performance that is calculated from uncertain data. A summary of the gist of this method is briefly described here.

A flow into a life cycle stage is measured in terms of an uncertain variable, say, x_{k_q}, which is deemed to have different probabilities of assuming different values within certain range. The index *q* implies that we are considering different kinds of influencing indicators – all of which may belong to the same dimension, *k*. A certain life cycle impact can be defined as an affine function of these uncertain variables; that is, $\frac{\partial (x_{ij})_{total}}{\partial t}\left(\omega, \tilde{x}_{k_q}\right) = \omega_0 + \omega' \tilde{x}_{k_q}$. The time rate of change of $(x_{ij})_{total}$ is used as an example. The linearity of the total impacts due to the impact of individual life cycle stages is assumed in this model. This uncertain impact function can be transformed into a single scalar value, called the impact risk value (Ω_η), using the exponential disutility function:

$$\Omega_\eta\left(\frac{\partial (x_{ij})_{total}}{\partial t}\left(\omega, \tilde{x}_{k_q}\right)\right) = \frac{1}{\Omega}\ln\left[\mathbb{E}_F\left\{\exp\left(\Omega\frac{\partial (x_{ij})_{total}}{\partial t}\left(\omega, \tilde{x}_{k_q}\right)\right)\right\}\right]$$
$$= \omega_0 + \frac{1}{\Omega}\sum_{q=1}^{Q}\ln\left[\mathbb{E}_{F_q}\left\{\exp\left(\Omega\left(\omega_q \tilde{x}_{k_q}\right)\right)\right\}\right] \quad (8)$$

This transformation is a technique commonly used in financial mathematics. ℜ is the measure of a decision-maker's level of risk aversion. Equation 8 computes the impact risk value for every value of risk aversion ℜ of a decision-maker, who has to choose among different technology/policy options in a comparative LCA or LCC (each with its particular set of data uncertainties). Examples on how this model can be applied is shown in Zhao et al. (2016). In short, whenever ℜ is known, this model can deduce the technology/policy option that the decision-maker is most likely to favor.

5. Operationalizing LiCSUA and conclusions

Finally, figure 3 summarizes how LiCSUA can be utilized to assess the sustainability of a life cycle system, based on the various concepts and mathematical model described. Specifically, the flowchart outlines the different types of information that has to be obtained in order to apply LiCSUA. In summary, LiCSUA involves an extensive and "deep" stage in which stakeholders are involved; this sets the background for subsequent research analyses and, finally, policy intervention.

In conclusion, LiCSUA was proposed as a framework to unify key features of sumLCSA and LCSAy, as well as further address the four gaps in existing LCSA frameworks. Above all, it shows mathematically how the vulnerability of the life cycle system can be described based on information on the rebound effects, resilience and interdependence of the life cycle stages and adaptation capacity of the system. As life cycle modeling reaches an important milestone, efforts to improve existing LCSA frameworks should be encouraged. LiCSUA represents one of the latest attempts at that mission.

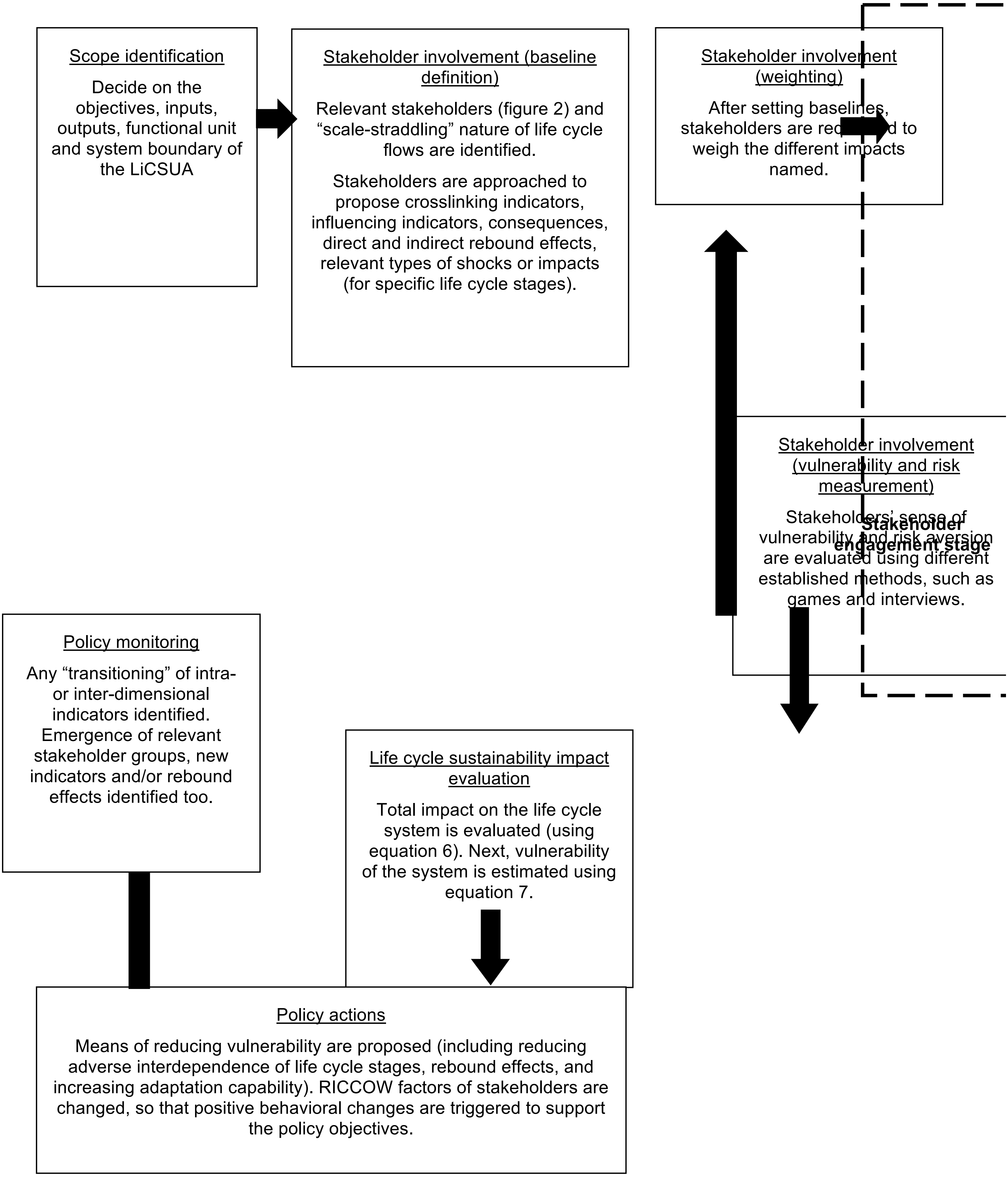
Scope identification
Decide on the objectives, inputs, outputs, functional unit and system boundary of the LiCSUA
Stakeholder involvement (baseline definition)
Relevant stakeholders (figure 2) and "scale-straddling" nature of life cycle flows are identified.
Stakeholders are approached to propose crosslinking indicators, influencing indicators, consequences, direct and indirect rebound effects, relevant types of shocks or impacts (for specific life cycle stages).
Stakeholder involvement (weighting)
After setting baselines, stakeholders are req d to weigh the different impacts named.
Stakeholder involvement (vulnerability and risk measurement)
Stakeholders' sense of vulnerability and risk aversion are evaluated using different established methods, such as games and interviews.
Stakeholder engagement stage
Policy monitoring
Any "transitioning" of intra- or inter-dimensional indicators identified. Emergence of relevant stakeholder groups, new indicators and/or rebound effects identified too.
Life cycle sustainability impact evaluation
Total impact on the life cycle system is evaluated (using equation 6). Next, vulnerability of the system is estimated using equation 7.
Policy actions
Means of reducing vulnerability are proposed (including reducing adverse interdependence of life cycle stages, rebound effects, and increasing adaptation capability). RICCOW factors of stakeholders are changed, so that positive behavioral changes are triggered to support the policy objectives.

Figure 3. Flowchart outlines the stages in applying LiCSUA.

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Tracing property rights in the circular economy: recovery of value in the multilateral stakeholder context of high alkaline wastes

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Abstract

The concept of the circular economy, maximising the efficiency of resource use via inter alia extended product life and the recovery of value from residues, is internationally recognised. Putting this into practice, however, involves significant changes to everyday business practice and regulatory oversight. An under investigated aspect of building a circular economy is the influence of and impact on the rights and responsibilities of the various economic entities through whose literal and metaphorical hands materials circulate. Industrial ecology studies have focused on bilateral relationships between firms, albeit possibly aggregating to extensive networks of firms. Conversely, this study examines stakeholder interests in the recovery of metals from industrial process residues (e.g., steel slag) subject to remediation requirements (to minimise environmental risk), and which in some cases have alternative bulk routes to resource recovery. Building on studies of property rights in the use of common pool resources and environmental protection, this study explores the ramifications of property rights for the recovery of material from privately owned industrial processes residues. We have undertaken a detailed analysis of both EU and UK policies relevant to the on-going management of process residues and governing the management and recovery of value from waste (which these residues are deemed to be by EU law). In addition we have an on-going programme of semi-structured interviews with stakeholders. Our findings indicate that identifying relevant rights and responsibility holders for activities relating to metal recovery is complicated by the complexity of existing inter-firm relationships for remediation and alternative (bulk) routes to material recovery. Changing the resource recovery patterns from these residues would therefore require complex multi-lateral agreements. These findings point to the need for studies of industrial ecology and the circular economy to engage with the principles of property rights (and attendant responsibilities) in order to move beyond relatively simple bilateral arrangements.

Keywords: Circular economy, industrial ecology, property rights, metals, high alkaline wastes

Track 5f. Sustainable Supply Chains and International Trade

Session 5f-03

Session 5f-04

Session 5f-06

A framework between green supply chain management practice and performance of SMEs

Pittawat Ueasangkomsate

Abstract

Green supply chain management is supply chain management that realizes the importance of environment throughout product life cycle including design, purchasing, production, packaging, delivery, logistics and recycling. Green supply chain management applies sustainability concept with practice and technology in order to increase efficiency, to reduce cost and to gain competitive advantage. Currently, products involving with eco-environment are the important attribute that consumers are recognized and interested to the intention to buy. While, small and medium enterprises (SMEs) in Thailand are growing continuously, in 2014, number of Thai SMEs reached nearly at 2.7 million enterprises. They created GDP around 37.4% of total. However, the research between SMEs and environmental concerns introduced SMEs were the key player to generate the environmental problems to the world. Moreover, 60% of CO2 emission came from SMEs in 1998. In addition, SMEs in general has the low engagement to environmental awareness that leads to non-attention of environmental problem. Therefore, the aim of this research is to create the framework of green supply chain management practice and performance of SMEs in Thailand. It will lead to find the relationship between green supply chain management practice and performance of SMEs, and to evaluate the circumstance of green supply chain management practice which might probably impact to performance of SME considerably. From literature reviews, green supply chain in China involved environmental management, eco-design and resource recovery which considered to performance of enterprises with three attributes (environment, economics and operation). The pressure from regulations and issues of environmental management gathered the enterprises to employ green supply chain management. It showed that green supply chain management practices improved performance of enterprise in environment and some part of operation whereas economics did not gain the benefit. Besides, green supply chain could reduce impact of supplier to environment, but competitive advantage of business was not improved. However, another research in the USA revealed developed environmental operation could support economics performance which led to higher output and cost reduction. This research then plans to apply the questionnaires reviewed by experts in related fields to survey the data from SMEs. The target will be collected around 50-100 enterprises from food and agriculture sector in Thailand who has already initiated green supply chain management practices. The study designs to use descriptive statistics, factor analysis and correlation to find the relationship between green supply chain management practices and performance of SMEs. For green supply chain management practices of this study, it consists of five attributes 1) Green purchase 2) Green design (product and packaging) 3) Reverse logistics 4) Regulation and 5) Cooperation among stakeholder. In addition, performance of SMEs involves four attributes 1) Environment 2) Economics 3) Society and 4) Operation. The results could present the benefit of green supply chain management practices to performance of SMEs. It would then enhance the potential of food and agriculture industry in SMEs to get better environment, to cut the problem of environmental pollution and to improve the life quality of residents.

Can we afford Nutella and biodiesel on track for the 2°C target in 2020? The cost of carbon embedded in Indonesian palm oil.

Jan Mizgajski, Florian Wimmer, Rüdiger Schaldach, and Liselotte Schebek

Abstract

Putting a global price on carbon is seen as the most cost-effective and certain way to maintain the emission on the moderate level – commonly referred to as the 2°C target. During the 21st Conference of Parties to UNFCCC in Paris countries have reached a new climate agreement, which is a step forward towards a global carbon pricing system. The new climate framework sends a long-term signal to investors that all countries support the emergence of a global carbon market. It is inevitable that post 2020, a range of inter-linked carbon markets will develop (Lake, 2015). They will certainly incentivise the consumption and production patters, by influencing relative prices of goods and services. One example of the impacted goods might be palm oil and its derivative products. It is because palm oil production contributes to large amounts of CO2 emissions due to triggering land use change. This paper examines what would be the consequences of the global carbon pricing on the cost of Indonesian palm oil and its derivative products. The analysis has been done for the year 2020, which is consistent with entering of the new post-Kyoto climate regime into force. In order to calculate the carbon embedded in Indonesian palm oil, the emission related to oil palm cultivation (including emissions form land use change) and crude palm oil (CPO) processing were taken into account. These activities are typically integrated vertically within a structure of one company, which takes the responsibility over these emissions. Methodical framework of the study relies on model-based scenario analysis, which considers several futures as to the key factors influencing the emission from palm oil production. The data on land use change emissions was generated by running simulations with spatially explicit land use model – LandSHIFT (Schaldach et al., 2011). The emissions from technological processes of palm oil production were obtained from well-to-wheels analysis of biofuels (Edwards et al., 2013). While, the future development of the hypothetical global carbon price, which assumes a consistent realization of the 2°C target, was taken from Angelsen et al. (2014).

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Sustainability in the cocoa industry: why context matters

Amanda Berlan

Abstract

The cocoa industry is widely acknowledged to be in crisis because rising demand in India and China cannot compete with falling production in key origin countries. This has resulted in higher cocoa prices and raises questions about the long-term sustainability of chocolate. This paper looks at the sustainability of the global cocoa trade based on anthropological and mixed methods fieldwork in Ghana and the Dominican Republic to critique some of the initiatives aiming to boost productivity and promote social and economic sustainability in the sector. There has been considerable discussion of the need to address inequalities in the chocolate value chain, to improve producer incomes and to address child labour issues. Certification schemes have expanded exponentially in this area, and Fairtrade International, Organic, Rainforest Alliance/SAN and UTZ Certified are reported to have covered up to 2.7 million hectares of cocoa land globally in 2013 (Lernoud et al 2015). In addition to this, all major chocolate companies have launched ambitious programmes to boost productivity at farm level. However, key challenges remain in the sector: productivity and incomes are still low, there is a lack of younger farmers coming into the sector and gender-based inequalities persist (Berlan and Berges 2013, Barrientos et al 2008). This paper explores the barriers to addressing these issues and why it is necessary to gain a better understanding of the social and environmental context of production. Problematically, many of the initiatives aiming to raise farm productivity rely on top-down approaches and are formulated according to a line of 'best fit' applied to a number of different countries. While some farming practices are of course applicable across a range of countries the specific challenges faced by farmers are not. However, this is not integrated in policy-making which is highly problematic. For example, assumptions are made regarding farmers' ability to hire extra labour to replace child labour based on average annual incomes, which overlooks the seasonality of cocoa incomes and the precarious debt cycle most farmers are trapped in. Similarly, assumptions are made about the farmers' receptivity to agricultural extension services, something which can make investments in this area ineffective. Finally, in order to address some of the barriers to a more sustainable cocoa supply chain, the paper examines why there is a critical distance between the investments and initiatives currently being made and the needs of farming communities and sets forth recommendations for overcoming it.

Keywords: Sustainability, cocoa, chocolate, productivity, private sector initiatives

Developing a research-based strategy for the re-establishment of an industry and its long-term sustainable growth

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Abstract

The Sustainable Cotton Cluster (SCC) was formed in 2015 as a platform to develop the South African cotton industry. The development and implementation of an industry-wide strategy, from cotton farming to market, was identified as key to establishing a sustainable growth path and formed part of the SCC mandate. A transdisciplinary approach, informed by Systems Theory, was applied to the research and strategy development process. The process began with establishing the 'Industry As-Is' using Porter's Diamond Model. The model was populated with the findings and insights from four key pieces of research: 1) a qualitative study that identified critical material issues; 2) a review of 50 international sustainability standards; 3) a life cycle assessment (LCA), using globally relevant sustainability metrics, to quantify impacts at each stage of the value chain; 4) a study that estimated the size of demand and opportunities within the local market. The material issues could be classified under five headings; economics, people, legislation and policing, unethical practices and the environment. The review of standards identified 13 common issues, collectively cited in over 30% of the initiatives. The LCA identified energy use in manufacturing and ecosystem (land and water) issues in agriculture as hotspots, which could be mitigated by diversifying the energy base, increasing yields and intercropping. The demand study identified consumer basics as by far the biggest category, dwarfing demand from government and industry. The 'Industry To-be' picture was globally contextualised and future-proofed through an analysis of global trends and case studies and by testing the strategy against possible futures. A purpose-led strategy, guided by Sinek's Golden Circle, was developed by initially defining the purpose (why), then the mechanisms to achieve this (how), and finally, the actions that are required (what). The purpose of the industry was defined as "A thriving industry that produces textiles and apparel products in a sustainable way". How the industry will go about achieving this is through differentiating from competitors and by becoming competitive. The key differentiators that will set the industry apart from competitors are: 1) proximity and speed to market, 2) sustainability and traceability, and 3) design. Integrated Supply Chains (ISCs) were identified as the mechanism through which the strategy will be executed. A strong foundation will be built through strategic interventions (the what) that specifically aim at strengthening the ISC players in terms of strategy, people, process and technology. Collaboration and sustainability are two key concepts that underpin the strategy. Consensus around 'why' should facilitate industry players and stakeholders working together towards a common goal. The strategy has sustainability at the very core, with a strong focus on long-termism, shared value and risk mitigation. The approach of comprehensive research and robust stakeholder engagement should make for a robust strategy that, if effectively executed, will see South Africa become the sourcing destination of choice for selected sustainable textiles and apparel products. The approach used could be applied to other industries, where a purpose-driven strategy is required to effect sustainable turnaround or growth.

Keywords: Strategy, Sustainability, Cotton, South Africa

1. Introduction

South African history tells the story of a thriving textiles and apparel industry. Not only was the industry capable of meeting the demands of the local market, it contributed extensively to the development of the local economy, supporting countless South Africans through employment across the breadth of the value chain. This changed dramatically following South Africa's re-entry into the global market following the lifting of Apartheid-related sanctions. Much of the support afforded to the industry by the local market was lost to off-shore suppliers, evidenced by the significant increase in volume (231%) and Rand value (674%) of textiles and apparel imports between 1998 and 2015 (the dti, 2016). This shift coincided with a 29% decrease in local production over the same period (Statistics South Africa, 2016). A large number of firms have downsized significantly or closed down operations completely, resulting in the loss of 83 100 jobs across the textiles and apparel industry (Quentec Easydata, 2015). Key skills have been lost in the process, both at strategic and managerial level and at a technical level, further hindering the industry's ability to provide a competitive offering.

The clothing and textile industry is the most labour intensive sector of manufacturing and a key employer (Vlok, 2006), explaining government's continued focus on the industry. It is one of the four sectors earmarked in the Industrial Policy Action Plan (IPAP) (the dti, 2014). Most industry-related actions fall under the Department of Trade and Industry (dti)'s Clothing and Textile Competitiveness Programme (CTCP). The focus is on providing financial assistance to individual operations and the establishment of clusters that involve full value chains, from fibres to retail (the dti, 2011). While these interventions appear to have stabilised the industry and arrested job losses, impacts have largely been confined to individual manufacturers and have not been experienced at an industry-wide level.

It was under the CTCP that the Sustainable Cotton Cluster (SCC), a sub-national cluster was established in 2015 as a platform to develop the South African cotton industry. As the name suggests, the SCC has a strong focus on sustainability and cotton, albeit with dependencies and impacts on the broader Textiles and Apparel sector. Sustainability is holistic, multi-dimensional and encompasses risk mitigation, long-termism and shared value for all (including the environment).

The development and implementation of an industry-wide strategy, from cotton farming to market, was identified as key to positioning the industry on a sustainable growth path. Prior to this, the cotton industry, as well as the broader Textiles and Apparel industry has operated in the absence of a coherent strategy. The consequences include sub-optimal beneficiation of raw materials, industry players that do not work collaboratively and a lack of focused investment from the public and private sector.

In order to develop an effective strategy, capable of turning the industry around, comprehensive research, data analysis and integration were required. The theoretical framework underpinning the research and strategy development process was based on Systems Theory and Transdisciplinarity. The primary rationale of systems thinking is that social problems are invariably connected to and part of a larger set of problems. A system cannot solve its own problems (Dostal, 2005). Transdisciplinarity is a cornerstone of the new discipline of sustainability science, which highlights the need for academic-business collaborations to drive the transition toward sustainability (Orecchini et al, 2012). Starting with this premise, a holistic research approach was adopted. The scope of study incorporated the full value chain, from farm to end-consumer market and considered the macro environment and broader global context. The process needed to consider the past, present and emerging future, drawing on futures thinking and foresight methods.

Systemic problem solving alternates between analysis and synthesis. It accommodates continuous change of the system under investigation, its parts and its environment. It incorporates multiple values and objectives held by various interested parties associated with the system (Dostal, 2005). The research follows a process of extensive stakeholder engagement and consultation, with alternating analysis and synthesis, culminating in a final "As-Is" synthesis using the Porters Diamond Model.

The process included understanding the current context, defining the desired outcomes and then developing a strategy that will result in the industry progressing from its current state (i.e. the "As-Is") to where it wishes to be (i.e. the "To-be"). A robust assessment of the current reality was informed by four key pieces of research; a material issues study, a global sustainability standards review, a life cycle assessment (LCA) on two cotton-based value chains incorporating socio-economic impacts, together with more traditionally-measured environmental impacts, and a demand study that quantified the size of the local market.

The identification of those issues most material to operations would address the prevailing lack of coherent awareness that could hamper the ability to respond in a way that minimises negative impacts and enhances competiveness. An understanding of what the global market considers as 'hotspot issues' for the industry was also important, and achieved through identifying frequently addressed issues by global sustainability standards.

Life Cycle Assessments (LCAs) provide a quantitative assessment of the impacts of a product, service or organisation and a structured framework in which to model the consequences on the natural environment and society. There is very little quantitative data on the impacts of textile and apparel products on the SA environment, society and economy. Environmental LCA has been applied by a number of apparel companies (e.g. Levi Strauss & Co., 2015; NIKE Inc., 2014; Patagonia, 2009; H&M, 2013 and Adidas Group, 2000). These LCAs have been done to not only better understand the environmental impacts of their products and mitigate these, but also to communicate their efforts to consumers. Combining environmental with social LCA is increasingly recognised as necessary to capture the broader dimensions of sustainability (Finkbeiner et al., 2010).

Finally, the demand side of the value chain is a critical component to understanding the current state of the industry and its ability to compete on the global market. Porter's Diamond Model was used to consolidate findings and insights into a single view (Porter, 1990). Porter's model suggests that there are inherent reasons why some industries (and nations) are more competitive than others. The argument is that the national base of an industry provides it with specific factors that will potentially create competitive advantages on a global scale. It includes elements of 'Government' and 'Chance', which act as catalysts or challengers to competitive performance.

With the vision for the SWA industry sitting firmly within a global context, it was necessary for the "To-Be" view to be informed by the global trends that are likely to have the most significant impact and shape the future operating environment. Research included: 1) the identification of global trends and an analysis to understand the impacts at a global, sub-Saharan Africa and South African level, 2) a scenario exercise where the strategy was tested against potential future realities as a means of 'future-proofing', and 3) an analysis of countries with textiles and apparel industries for learnings around how key constraints to competiveness were overcome and what differentiates competitors.

The process used to develop the strategy was guided by Sinek's Golden Circle (Sinek, 2010), defined by "It doesn't matter what you do, it matters Why you do it.". There is mounting evidence to suggest that purpose-led strategies are successful through the rallying behind a common cause (including Bartlett, 1994; Sinek, 2010; Sparkman, 2015; Frisby, 2016). It was upon this premise that a robust stakeholder engagement process was followed, involving consultation with a variety of stakeholders across the value chain.

The robust principles underpinning the strategy development aimed to ensure a sufficiently robust strategy that, if effectively implemented, should result in SA becoming the sourcing destination of choice for selected sustainable textiles and apparel products. This will have a significant impact on the broader textiles and apparel industry, and addressing the unemployment crisis in the country.

2. Methods

2.1. Approach to strategy development

The process followed the sequence of Sinek's Golden Circle (Sinek, 2010), beginning with establishing why the local cotton industry exists, then how it would achieve the vision and finally, what was needed to do this (Figure 1). Each area was developed using stakeholder input, after which consensus was reached by the 'Core Strategy Group' comprised of industry players and a representative from the labour union (South African Clothing and Textiles Workers Union).

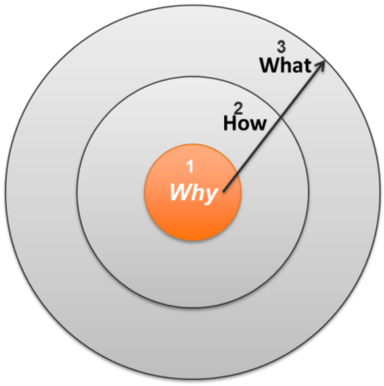


Figure 1: Sinek's Golden Circle describing the approach used to develop the industry strategy.

2.2. Establishing the 'Industry As-Is'

The starting point for strategy development was getting alignment around the current state of the industry. This was informed through comprehensive research around 1) material issues, 2) global sustainability standards, 3) social and environmental life cycle impacts and 4) the demand of the local market; which was consolidated using Porter's Diamond Model. The approach followed in all cases was a combination of desktop research and stakeholder engagement. Consulting with and soliciting input from industry players from across the value chain allowed validation of desktop research, thus increasing its accuracy, robustness and relevance.

2.2.1. Materials issues

The approach commenced with desktop research, which enabled sustainability issues facing the textile and apparel industry to be identified. The information was verified and expanded upon with primary data collected through interviews and workshops with approximately 80 individuals, representing industry players and associations, training providers, government, retail and the investment community. Interviews sought to unpack challenges and opportunities at three levels – individual company, value chain stage and industry. They also sought to identify best practice and lessons learnt.

2.2.2. Sustainability standards review

The process commenced with a comprehensive online search to identify existing sustainability standards as they apply to industry in general and more specifically to agriculture, cotton and textiles and apparel.

Each standard was reviewed in terms of its structure, content, intended users, members and auditing procedures. Additional insights were obtained by reviewing reports comparing sustainability standards. This assessment, coupled with material issues findings, facilitated the standards to be screened according to their relevance and applicability to the local context. A number of specialists in the fields of standards development, implementation and management were also engaged around key considerations concerning standards development.

2.2.3. Life Cycle Sustainability Assessment

The LCSA was conducted as a two-step process. The first step was the selection and development of a relevant set of metrics to capture the sustainability impacts. The approach included a review of existing textile LCA studies and the indicators applied; a review of other SCC research (i.e. material issues and standards review) in order to gain a local and global perspective on sustainability hotspots; and a review of LCA methods and global best practice.

In order to reduce the large number of potential sustainability metrics to a manageable number, particularly on the social impact assessment side, issues were categorised according to industry-wide issues (i.e. such as government corruption, relevant to SA as a whole and likely to be addressed through other channels), those relevant to standards rather than quantitative assessment (i.e. compliance issues, such as Environmental Management System) and those relevant for assessment. Two workshops concluded the process, one with sustainability experts and a second with stakeholders, including industry players across the value chain and civil society, to obtain input and agreement on the set of sustainability metrics against which the value chains would be assessed.

The second step was an LCA that assessed two cotton products, a cotton t-shirt and cotton towel, against the set of metrics developed. This involved the development of the life cycle model (including data collection), life cycle inventory, impact assessment and interpretation of results. The life cycle system boundaries of the two products assessed (Figure 2), included all material inputs (i.e. natural resources and manufactured materials such as fuels, chemicals etc.) and all emissions to the environment (i.e. releases to air, water and land), as well as all products and by-products. The life cycle inventory was constructed using primary data from two specific supply chains. Primary data was collected via questionnaires, followed up with interviews/site visits across the entire supply chain (from cotton farming through to retail). Secondary data (i.e. on electricity, fuels, chemicals etc.) were obtained from the ecoinvent database (Weidema, 2013), customised to the SA context, where applicable.

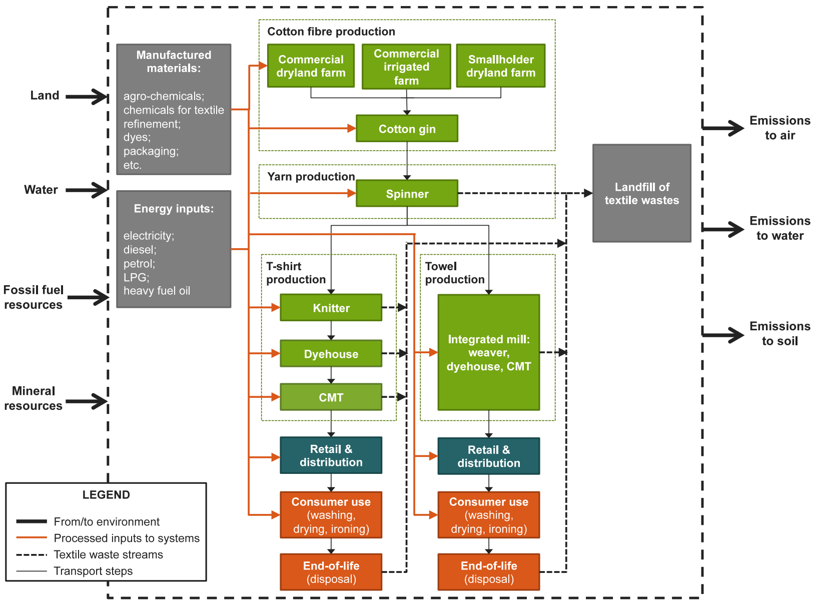


Figure 2: The product system boundary of the life cycle system of a cotton knit t-shirt and woven cotton towel.

In LCA, the inputs and outputs are connected to their corresponding environmental and social impacts. This was done according to the metrics and models selected in the first step of the process. To facilitate analysis and interpretation of results, impacts were grouped into common areas of concern (e.g. human health effects). For the environmental impacts, this was done according to best practice models, whilst on the socio-economic side this was done using constructed scales (e.g. poverty reduction). This allowed a "snapshot" of sustainability impacts across the value chain to be constructed and a visual summary of the strengths and weaknesses of the products with respect to sustainability performance.

2.2.4. Demand quantification

The study aimed to quantify the demand for three key sectors of the SA market, namely Government, Industry/Commercial and Consumer Basics. The study commenced with high-level desktop research, followed by an analysis of detailed customer data and high-level assumption-driven data. It should be noted that had the retail sector been willing to share purchase data (as per the planned approach); the results of the study may have been even more robust. This resulted in the critical inputs required for the Textile Volume Demand Tool (TVDT), developed to inform strategy through updating key macro assumptions, to develop future scenarios and calculate the resulting 'size of prize'.

The estimated demand assumptions for the three key sectors were combined and consolidated into a single set of demand scenarios. This enabled a point of view to be established on the volume or 'size of the prize' by textile type across the targeted sectors, and the highest volume items. In the case of cotton, this was then translated across each stage of the value chain; from end-product through to raw cotton. An estimation of how the current demand opportunity may change, or where potential shifts may lie going forward, was generated by extrapolating the information toward a future (10 year) scenario.

2.2.5. Creating the 'Industry As-Is' picture

Porter's Diamond Model (Porter, 1990) was used as a framework to describe the current state of the industry. The consolidated "As-Is" analysis (Figure 3) formed the basis from which the industry strategy to achieve the "To-Be" objectives was developed.

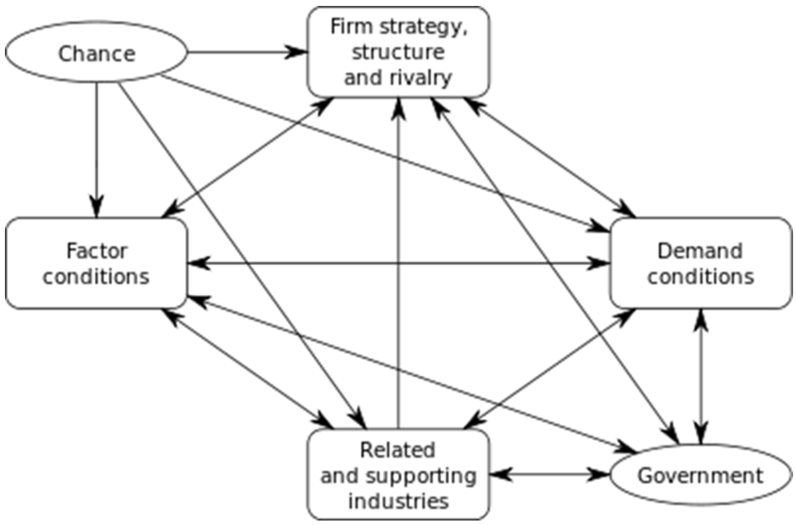


Figure 3: Porter's Diamond Model used to consolidate the 'Industry As-Is'.

The four factors of competiveness were populated using outcomes from the extensive research conducted, including material issues, sustainability hotspots and the demands conditions. Three diamonds were created, according to the value chain stages - fibre production, textile manufacturing and processing (including spinning) and CMT/Design sectors. Government and Chance factors were defined according to their impact on the industry (i.e. not per value chain stage). Government issues were identified through engagement with industry players and other stakeholders, while Chance events were informed by global trends research (see "To-Be" Analysis).

2.3. Establishing the 'Industry To-Be'

The "To-Be" picture was guided by the need to globally-align and future-proof the strategy and achieved through a 1) global trends analysis and scenario planning and 2) a global case study review.

2.3.1. Global trends analysis and scenario planning

A best practice foresight approach was followed (Aguilar, 1967), commencing with a broad scan to identify key global mega-trends.

These trends were explored in the context of the global textiles and apparel industry and analysed in terms of their impact at a global-, Sub-Saharan African (SSA)- and South African-industry level.

The macro trends and local drivers identified were consolidated and then ranked in terms of importance and uncertainty. The top five were used to sketch out a set of plausible scenario logics describing alternative futures that could play out. Finally, these skeleton logics were fleshed out and drawn up into a set of four scenarios.

The implications of the most extreme scenarios on the cotton value chain were then considered, as well as the appropriate strategic responses. This allowed for the strategic plan to be tested and the robustness improved.

2.3.2. Global case study review

The research began with an online search to identify all countries with sizeable textiles and apparel industries. However, in order for meaningful insights to be consolidated, the extensive number was shortlisted to 17, with countries selected on the basis of their developing nation status and/or evidence of a successful turn-around.

A set of Key Performance Areas (KPAs) were selected and the rating factors defined (Table 1). Constructed scales were created for each of the KPAs, which allowed for the scoring of the shortlisted countries. The contributing factors to countries' success were then identified for each respective KPA. Learnings for the local industry were extracted by considering key areas of competitor differentiation, local industry performance, economic and demographic similarity, and the relevance of SA issues.

Table 1: Key Performance Indicators and associated factors against which countries were rated.

Key Performance Area	Factors scored
Value chain capabilities	• Span and strength of local value chain
Market capture	• World market share
Inputs access and cost	• Raw material access and cost • Energy access and cost • Water access and cost • Transport infrastructure access
Labour environment	• Access and cost • Skills and productivity • Labour market flexibility • Labour practice
Governance and govt. support	• Regulation • Protectionism (tariffs) • Trade agreements • Incentives • Access to finance and FDI

3. Results

3.1. The "As-Is" Analysis

3.1.1. Materials issues

The analysis of the data from the desktop and stakeholder engagement led to the identification of five broad issues. The "Big 5" represents the most pressing challenges facing the industry, namely: 1) Economics, 2) People, 3) Legislation and Policing, 4) Power, Fraud and Corruption and 5) Environment (Figure 4).

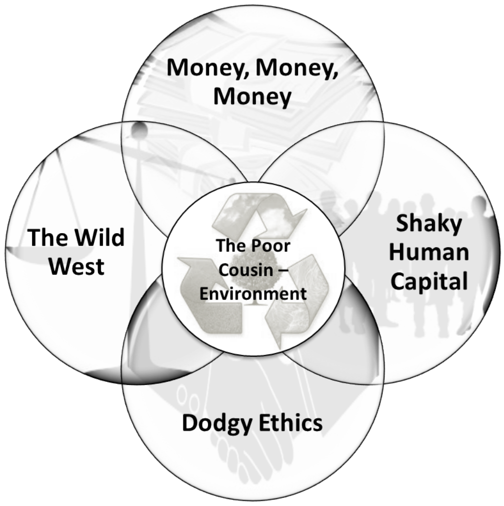


Figure 4: The 'Big 5' material issues affecting the South African Textiles and Apparel Industry.

Economic sustainability emerged as the most pervasive challenge facing the local industry and as such, is the predominant focus. Financial pressures have forced most industry players into a state of survival, preventing them from thinking beyond their current situation. This has driven a silo mentality, resulting in minimal collaborative action to address systemic issues. The significant decrease in the scale of orders emerged as another major constraint to a competitive offering.

The industry's most important asset, people, was found to be in a state of near collapse. An inflexible labour market, a general lack of leadership within the industry, legacy socio-economic challenges and significant skills gaps across the value chain contribute to the diminished competitiveness of the local industry.

Fundamental power and ethical issues were identified as significantly impacting the effective functioning of the industry. Although the most obvious areas relate to corruption (e.g. duties and government tenders), unethical behaviour is prevalent across all sectors. The regulatory environment was found to be complex, incoherent and unsupportive of industry growth. The consequences, both intended and unintended, of proposed legislation tends not to be thoroughly understood prior to implementation.

Environmental issues were not identified as a major concern among industry players, unless there were cost or compliance implications. This reinforced the industry's "survival" mode, with players generally operating within short-term time horizons.

Finally, the research supported the hypothesis that there is no comprehensive and holistic long-term strategy in place. This was identified as one of the greatest challenges facing the industry. The development and implementation of an industry strategy is thus likely to be integral to successful industry re-establishment.

A range of opportunities relating to the Big 5 was identified. The re-establishment of long-term, strategic partnerships between retail buyers and suppliers will be crucial to changing the current economic paradigm defined by a survivor mentality among suppliers. Collaboration between industry, labour and government will be key to overcome the complex challenges relating to people. Resolving some of the key government tender fraud and illegal imports issues will have a significant positive impact on not only cotton, but the broader industry. The legislative and policy frameworks across departments should be aligned in such a way that they create an enabling environment for the industry to prosper. A more stable environment is also needed to allow for planning and investment. Critical to this is the effective implementation and enforcement of legislation, with the identification and prosecution of those contravening it. Finally, a greater degree of awareness and comprehension of key environmental challenges and impacts will be critical to the industry's long-term sustainability.

3.1.2. Sustainability standards review

A number of valuable insights were gleaned from the standards review. The three most important being that a) no single standard exists that is entirely suitable in terms of content (i.e. material issues) and scope (i.e. full value chain); 2) incorporating existing standards into a new standard is common practice and 3) tailoring a global standard to the local context is feasible (e.g. GLOBALG.A.P. to localg.a.p.).

The most relevant standards for the South African environment were identified. The International Labour Organisation (ILO) and United Nations (UN) emerged as the most important conventions/declarations to inform the mandatory requirements of the standard. The most relevant reference tools were the Global Social Compliance Programme (GSCP) (OECD, 2010), an internationally-recognised tool used by Sustainable Agriculture in South Africa (SIZA) and ISO 26000, the Guide to Social Responsibility (ISO, 2010), which has the most comprehensive criteria relating to social sustainability.

Three non-sector specific initiatives emerged as being particularly relevant, namely 'SA8000 Standard for Decent Work', the Ethical Trading Initiative's (ETI) 'Base Code' and the Fair Labour Association's (FLA) 'Code of Conduct and Compliance Benchmarks'. SA8000 (SAI, 2014) has an emphasis on supplier management systems and enjoys universal support. It does however have a 'one size fits all' approach irrespective of firm size. The ETI's Base Code (ETI, 2014) has been applied in a number of local industries and has enjoyed extensive support from apparel retailers. The FLA's Workplace Code of Conduct and Compliance Benchmarks (FLA, 2014) is also highly regarded by the textiles and apparel industry and by standards-developers.

The 'Production Principles and Criteria' of the Better Cotton Initiative (BCI, 2013) was found relevant in terms of content and support by the global retail industry. The SCC is engaging with the BCI to investigate the certification of the SA cotton crop. However, it is only applicable to the cotton farming and ginning sectors. The most relevant standard in terms of broad application across the entire breadth of the value chain is the Sustainable Textiles Production Standard (STeP) (OEKO-TEX, 2016). STeP is a certification scheme specifically developed for the industry, with globally standardised criteria.

Insights from the research highlight that the simpler a standard, the easier it is to drive and action. A set of common principles applying to the entire industry (from farm to finished product), coupled with specific criteria relevant to each stage of the value chain is thus recommended. These value chain-specific requirements should be informed by the material issues research and the LCA. It may also prove beneficial to include levels of requirements – 'Minimum Criteria' that are founded on universally accepted conventions and declarations (such as the ILO ratified issues), as well as 'Best Practice' that aims to improve the sustainability. This will also ensure that small and emerging entities, critical for job creation, are not excluded on the basis of onerous requirements.

Content should cover all sustainability pillars. Beyond issues identified as material to the SA industry, the thirteen most common issues, collectively cited by more than 30% of the 50 initiatives, should also be included, unless found to be entirely irrelevant to the local environment. These are minor protection (child and young workers), freedom of association and collective bargaining, discrimination, occupational health and safety, voluntary employment, environmental management, treatment of workers, compensation and benefits, working hours, business integrity and ethics, chemical management, employment terms and water management. The research also indicated that multi-stakeholder approach is more comprehensive in addressing critical issues.

Auditing was found to be crucial for driving enforcement, measuring improvements and achieving greater credibility. However, there is a need for auditing to be coupled with capacity building and improvement. An appropriately modified version of the auditing system may be necessary for emerging farmers and small businesses, where know-how or capital required to meet requirements may be limited. Brand/retailer transparency with respect to standard-specific compliance of their suppliers was not widespread. The prevailing environment could see the standard tailored for the local industry, involving the entire value chain (farm to end-market) being unique and innovative.

3.1.3. Life Cycle Assessment

Energy use, particularly electricity, dominates the environmental impacts of textile products in SA. This is due to the reliance on coal-based electricity and highlights the need for diversification to alternative, cleaner sources of energy. The impact of woven textile products is worse than knitted products, by nature of the higher energy demand. In terms of carbon intensity, spinning and dyeing are most intensive.

Water, land and ecosystem impacts (e.g. eco-toxicity and excess phosphates) are dominated by farming stage impacts (Figure 5). This supports the findings of other LCA research on textiles and apparel industries conducted in Europe and the USA, in that significant ecosystem impacts occur at the sourcing of the raw materials (e.g. at the cotton fields) (Cotton Incorporated, 2012; Danish EPA, 2007; DEFRA, 2010; JRC, 2014). Many of the impacts associated with farming are unavoidable, particularly those related to land and water use. However, they can be minimised through increasing yields and locating farms away from biodiversity hotspots and water stressed areas. This should be considered when cotton farms are extended to meet the growing demand. Furthermore, intercropping can be used to decrease the overall impact apportioned to the cotton product, with additional benefits such as improved soil quality and a reduction in fertilisers and pesticides, depending on the crop rotations implemented.

The value chains assessed were found to be chemical intensive, from the agro-chemicals required at the cotton farming level, to the conditioning oils, chemicals, detergents and dyes applied in textile manufacturing. After energy use, chemicals (manufacture and use) are responsible for a considerable share of human health and ecosystem impacts (Figure 5). Reducing wastage and investing in more environmentally benign chemicals and dyes is required to mitigate these impacts.

The socio-economic performance across the value chains assessed was found to be varied and company-specific. Although there were a few incidences of long working hours and low wages, labour abuse was not identified as a particular hotspot. Companies across the value chain also showed commitment to operational health and safety.

The industry was found to be a good source of stable employment, contributing to poverty reduction in the local communities in which they operate. The greatest employment-impact is at the CMT level, followed by farming (Figure 5). This confirms the current target sectors for the SCC Incubator Programme aimed at establishing and growing small businesses. Skills development emerged as an area that requires improvement, with the majority of companies assessed showing little or no resources spent on developing their labour force. Another area where the assessed value chains performed poorly was in transformation, likely a consequence of small firm size.

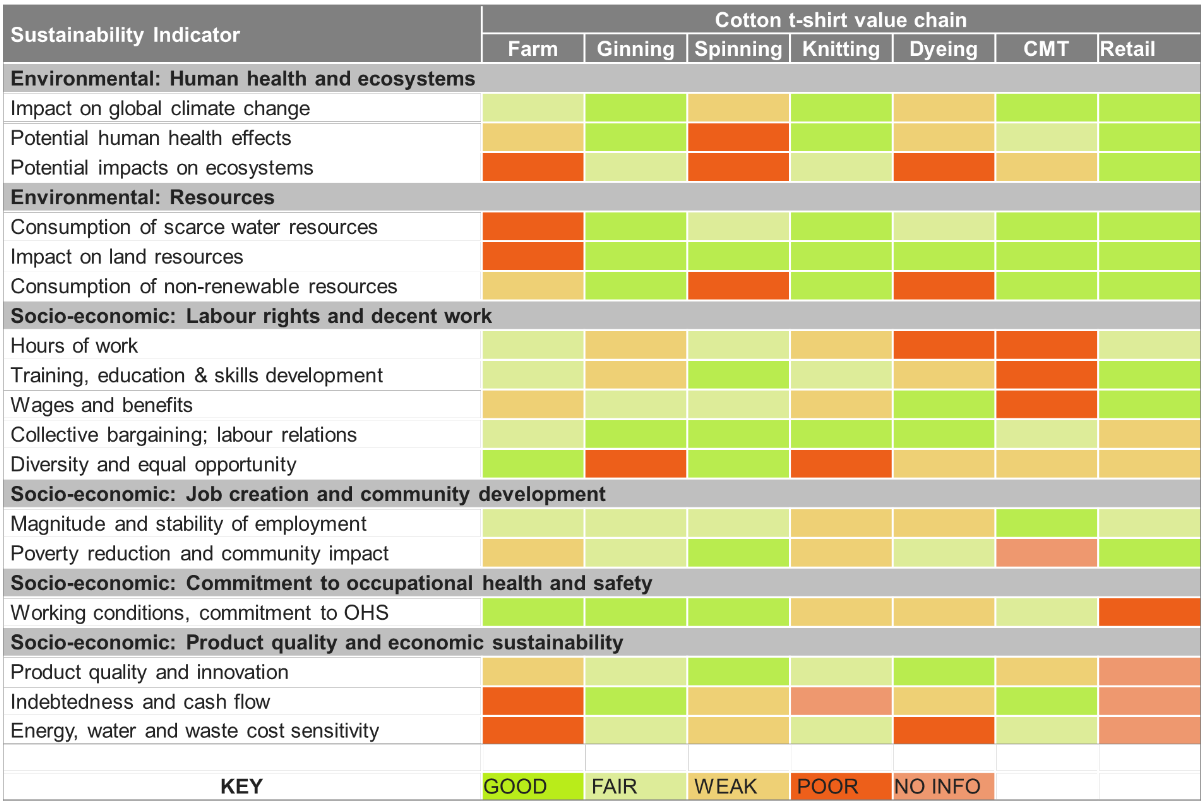
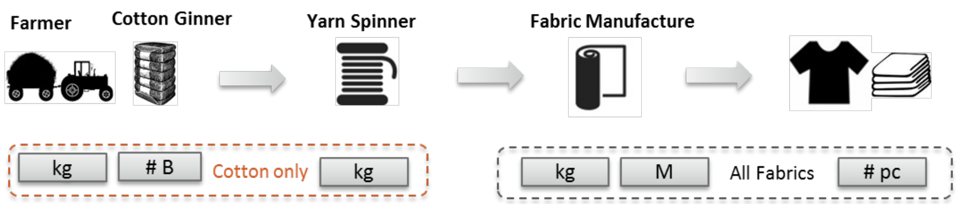


Figure 5: The sustainability indicators along the life cycle of a cotton T-shirt.

3.1.4. Demand study

All previous strategic interventions within the industry have taken a 'push' approach. One of the principles upon which this strategy was developed was that it needed to be demand-led (i.e. a 'pull' approach). The study demonstrated a substantial demand for apparel and homeware textiles by the local market. The estimated demand quantifications, for the three chosen sectors, translated across the value chain are shown in the figure below (Figure 6).



Government	3.3 m	11 637	2.6 m	5 m	16.8 m	12.8 m
Industry	6.7 m	23 570	5.4 m	7.9 m	23.7 m	8.4 m
Consumer Basic	415 m	1.4 m	332 m	529 m	1 787 m	1 264 m
Consolidated	425 m	1.5 m	340.8 m	543.9 m	1 827 m	1 285 m

Figure 6: The demand estimates across the value chain using TDVT.

The TVDT enabled a point of view on the current demand opportunities as they relate to markets, items and fibre. Consumer Basics, at 44 times the item demand (Figure 7a) and 60 times the fabric demand (Figure 7b), dwarfed the demand of the other two markets combined. From this, it is clear that the turn-around of the industry is dependent on the support of this market. Capturing even a small percentage of Consumer Basics would have a significant impact on the industry. The other two markets still represent an opportunity to stabilise certain parts of industry, through their contribution to the scale and consistency of orders.

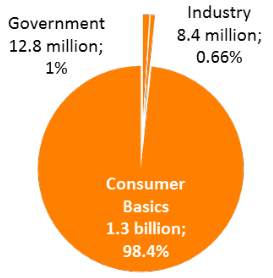


Figure 8a: Demand for items (quantity)

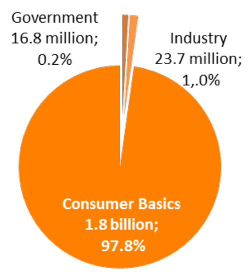


Figure 8b: Demand for fabric (metres)

T-shirts emerged as the item associated with greatest demand in terms of number of items and fabric. It was also associated with one of the highest cotton contents of all items analysed. Other high volume items were shirts and jeans, which together with T-shirts constitute 37% of total fabric demand (Figure 8).

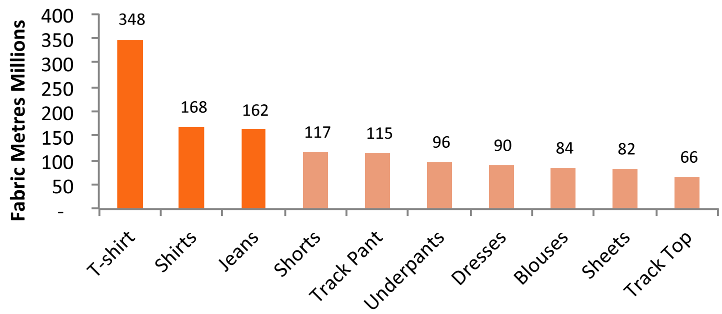


Figure 8: Fabric demand across the highest volume items.

Although some items are unique to certain markets, a number of items were found to overlap (Table 2). Pursuing these items may have the greatest benefits for the industry through improved economies of scale and price competiveness, as well as reduced risk of reliance on only certain markets.

Table 2: Comparison of the highest ranked inventory items by fabric across sectors.

	Government	**Industry**	**Consumer Basics**
1	**Trousers**	Overalls	**T-shirt**
2	***Shirts***	***Shirts***	***Shirts***
3	**T-shirt**	**Trousers**	Jeans
4	**Sheets**	Jackets	Shorts
5	Blouses	**Sheets**	Track Pants

Cotton emerged as the fibre in greatest demand, with just under 60% of the total fabric demand. This is in line with international norms (ITMF, 2013) and is promising when one considers the far-reaching impacts of a thriving cotton industry on the broader textiles and apparel industry.

3.1.5. The 'Industry As-Is'

The relevant information pertaining to value chain stages was used to populate the four factors of competiveness in Porter's Diamond Model. This resulted in three "diamonds", namely fibre production, textile manufacturing and CMT/Design (see Figure 9 for one such example). Although relatively unique from one other, some common features included financial pressure, majority of inputs and technology are imported, ageing infrastructure and the unattractiveness of the industry to youth.

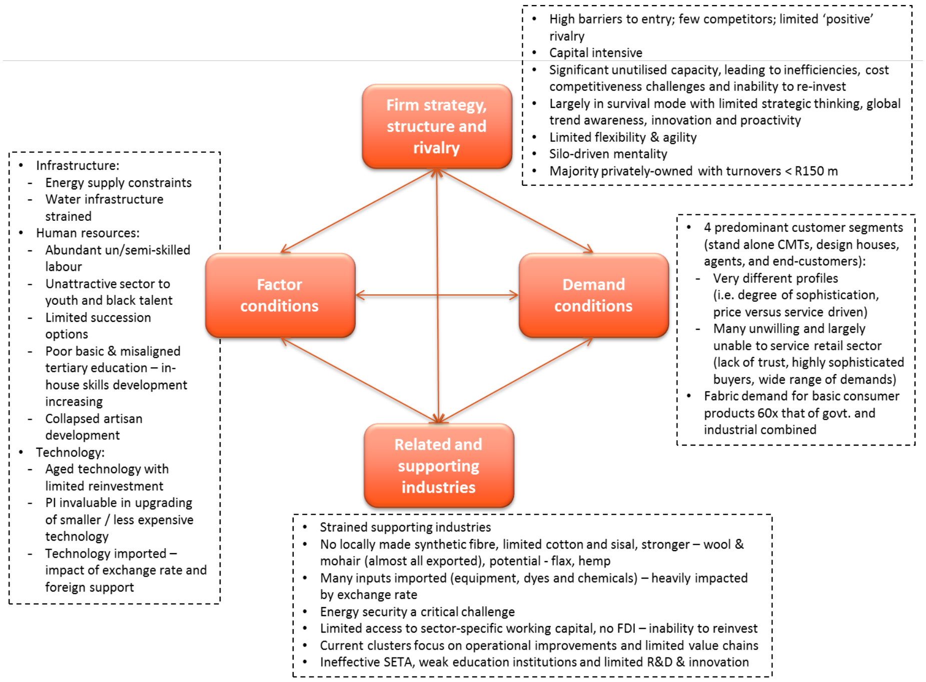


Figure 9: The Textile Manufacture example of the 'Industry As-Is'.

Seven key government-related areas were identified as affecting the industry, namely: policy; legislation, regulation and policing; trade and tariffs; incentives; financial support; labour and capability and capacity. The majority of these act as challengers to the industry, rather than catalysts. Key impacts include the difficulty of planning in the face of changing policy, incentives and trade protection that is not strategically aligned to the industry's needs and inadequate government resources to effectively support the industry.

Six key chance-related issues were identified, namely: natural/environment; economics, politics, society; changes to supply landscape; change to market landscape; technology advances and consumers. The most important insight was the presence of both threats and opportunities in the emerging future.

These concise summaries enabled stakeholders to reach consensus on the starting point from which the strategy would be executed.

3.2. The "To-Be" Analysis

3.2.1. Global trends

Seven global mega-trends were identified from the research; namely demographic shifts, redistribution of economic power, transformation of geo-political landscape, accelerating ICT growth (particularly in SSA), consumer empowerment (particularly the shift from natural to man-made fibre), scarcity in the midst of plenty, advances in automation, robotics and nano-technology.
Three sub-trends were further identified and analysed to assess their impact.

Off-shore migration of labour intensive operations, such as garment manufacturing, has played a key role in the development of many emerging economies, contributing to the redistribution of economic power. East Africa is now beginning to establish itself as a region for outsourced labour-intensive manufacturing. Rather than seeing countries in this region as a competitive threat, SA should seek out collaborative opportunities and develop regional supply chains with emerging industries in SSA.

The global textile and apparel market is expected to almost double over the next 20 years (Wazir Management Consultants, 2015). The rising wealth in developing countries, coupled with demographic shifts, population growth, economic development and rapid urbanisation, translates into new consumer markets for the local industry to pursue.

Transformation in the geo-political space is also expected with new alliances and partnerships emerging across the globe. SA needs to more effectively leverage the African Growth and Opportunity Act (AGOA) for access to the US markets and explore leveraging its BRICs membership (Brazil, Russia, India, China and South Africa) to improve trade agreements and position SA as a gateway into SSA.

Accelerating growth in information and communication technology (ICT) is the single biggest driver of social and economic transformation (The World Bank Group, 2012). Continued disruption and innovation can be expected across all industries. The local industry needs to improve the adoption of ICT to innovate and develop new business models across the value chain. Global connectivity and social media is also driving greater consumer empowerment. The more demanding, sophisticated consumer market is associated with increasing expectations. Two consumer trends that stand out as potential drivers of change at both retail and supply chain level are the demand for customisation and sustainability. Close proximity and Quick Response (QR) could facilitate meeting the demand for customised products. The demand for sustainability may provide the drive and urgency to develop long-term partnerships with suppliers and improved transparency across the value chain.

Demand for energy, water and food resources is expected to escalate. This demand, coupled with climate change, is placing significant pressure on the planet (Friis, 2013). Textile and apparel is seen as a heavily polluting industry and as a result, is coming under increasing pressure to adopt more sustainable operating standards and develop sustainable supply chains. Investment in the industry to drive future growth needs to be done against a sustainable blueprint.

There are significant advances in manufacturing processing and fabric engineering associated with developments in automation and nanotechnology. This is likely to see current production methods shift away from labour-intensive processes, with significant implications for job creation. However, advances can also be leveraged as a way of improving productivity, rather than as substituting manual labour. It also has the potential to attract youth to what is largely considered as a ‘sunset industry’.

3.2.2. Global case study review

The global case study research afforded many learnings to apply in the implementation of the strategy, including the role of proximity and speed to market. However, the greatest insight was the conclusion that while some pockets of ‘sustainability excellence’ do exist, the analysis suggests that there is no country currently ‘owning’ this space. This research therefore played a critical role in identifying key differentiators for the local industry.

3.2.3. Scenario planning

Four scenarios were developed; namely 1) High tech consciousness, 2) Doomsday, 3) Head in the sand and 4) Collaborative growth. Two of these scenarios, ‘Doomsday’ and ‘Collaborative growth’ were used to inform and test the strategy. The parameters considered within the scenarios were climate change, policy and governance, technology, economic growth and consumer demand.

The Doomsday scenario is a worst case scenario and the strategy was developed in order to ensure the industry remained resilient in the face of this scenario. The key insight was the necessity to avoid the requirement for extensive government protection and support.

The Collaborative Growth scenario is encouraging and is a preferred future. This scenario highlighted the importance of collaborative partnerships across the value chain and appropriate use of novel technologies to enable sustainable growth throughout the sector.

3.3. Strategy development

Following Sinek's approach, the purpose of the industry (the 'why') was agreed upon through robust stakeholder engagement in the form of multiple workshops with representatives from across the industry. This was defined as "A thriving industry that produces cotton textile and apparel products in a sustainable way". Following on from the purpose, a vision statement for the industry was established. The 'stretch goal' for the industry to work towards has been defined as "South Africa is the country of choice for sourcing selected sustainable cotton textile and apparel products".

'How' the industry will go about achieving the vision was defined as the key differentiators that will set the local industry apart from its competitors, as well as the way in which the strategy will executed. The key differentiators were defined as 1) Proximity and speed to market, 2) Sustainability and traceability, and 3) Design. These are key for risk mitigation and long-term success of the industry. Integrated Supply Chain Programmes (ISCPs) have been identified as the way in which the strategy will be implemented. ISCPs will be set up for high volume products that the industry is already capable of producing but where additional scale will enable future competitiveness. Supply chains will be re-engineered and strengthened in terms of strategy, people, processes and technology with the aim of building a strong foundation off which to grow the industry.

Finally, strategic interventions needed for the vision to be realised (the 'what') were categorised into seven strategic focus areas: Market growth, Finance and funding, People, Transformation, Industry structure, Production best practice and sustainability and Policy and Compliance. Strategic initiatives were consequently prioritised and placed on a roadmap that is divided into short- (2 years), medium- (7 years) and long-term (10 years) (Figure 10).

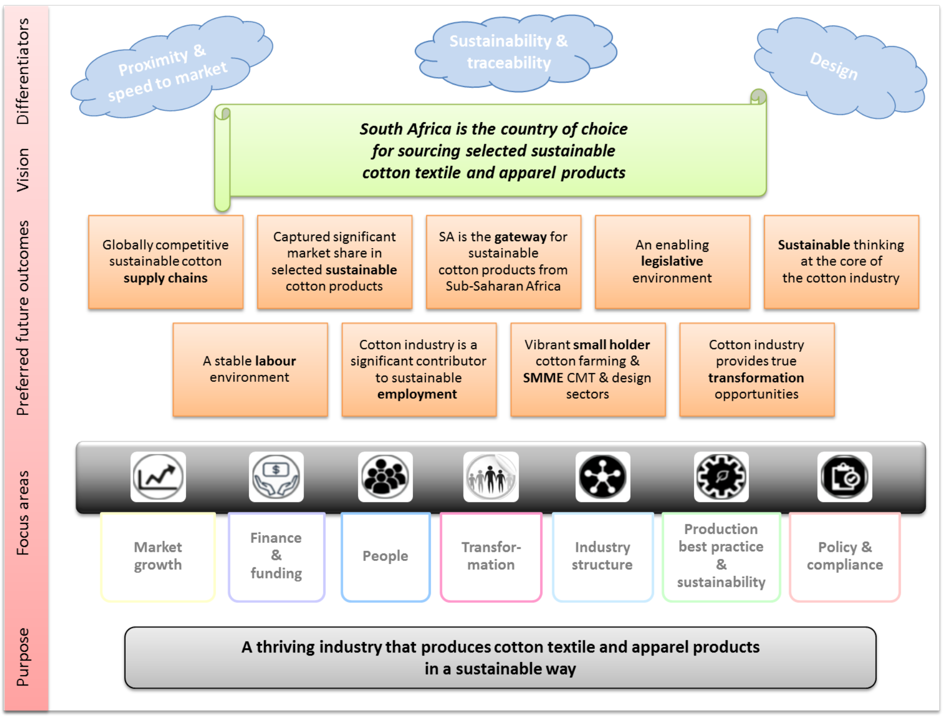


Figure 10: The resulting cotton industry strategy one-pager

4. Conclusions

The SA textiles and apparel industry is in a state of distress, having suffered a sustained period of decline and job losses. Research was conducted to form the basis of a holistic, sector-wide strategy to put the industry onto a sustainable growth path. The strategy needs to address elements of economic, social, environmental and governance.

The “As Is” research indicated that economic and social issues currently represent the greatest challenges to sustainability, with environmental issues only considered relevant when they impact on the others.

The LCA identified energy consumption during manufacturing and ecosystem (land and water) effects in agriculture as the major hotspots. In the short term these can be addressed by improving efficiencies, with the interventions being used to embed environmental sustainability thinking into the operations. The longer term strategy identified smart design and appropriate technologies as key to improving sustainability and creating competitive differentiators. These differentiators can be enhanced by the development of a sustainability standard, as no country currently owns this space.

The process extended the classic sustainability science approach by integrating established business development principles to devise a strategy that focuses on the economic and social pillars in the short term, to stabilise the industry and draws on more environmentally relevant aspects (standards, traceability, design) as drivers to differentiate SA products in the medium term.

Effective implementation of the strategy should enable the South African cotton industry to realise its vision of becoming the country of choice for sourcing selected sustainable cotton textile and apparel products. The approach used is not industry-specific and could be applied to other industries, where a purpose-driven strategy is required to effect a turnaround or enhance sustainable growth.

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The True Cost of Carbon: Integrating Input Side and Output Side Carbon Accounting

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Abstract

Economic sectors in most European countries are heavily dependent on the use of fossil inputs, either as fuel or as raw material. Carbon costs represent constraints for economic sectors both on the input side, through their purchase of carbon-based raw materials, and on the output side, through purchasing emission allowances for greenhouse gas. The input side has been neglected so far in input-output studies. For example, fuel and carbon taxes (representing input side policies) have a life quite separate from GHG policies. The accumulation of carbon inputs, similar to that of carbon emission, can also be detected on the input side. Downstream industries that use carbon-intensive intermediate products and services in their production could also be highly impacted by increases in carbon-related input costs. Carbon costs may have an impact on the market prices of products made by carbon-dependent economic sectors The aim of this paper is to provide an estimate of the total private costs of carbon use at sector level. The proposed model is based on an environmentally-extended input-output analysis, as proposed by Bicknell (1998), Feng (2009) and Lenzen (2012). We propose a method of integrating input side and output side carbon accounting wherein an approximation is made of total embodied carbon costs. The analyses will be supported by statistical analysis for different European countries, based on data drawn from Eurostat. Monetary input output tables are combined with physical data on fossil inputs (coal, oil, natural gas) as well as greenhouse gas emissions as outputs. Both fuel and non-fuel usage of fossil inputs are considered. Sample calculations are carried out for three European countries, namely the Netherlands, Hungary and the Czech Republic, but can be replicated for any other country, too. Findings reveal that the cost of embodied carbon-related inputs dominate the costs of embodied carbon emissions in the total carbon costs of economic sectors. That is, emitting greenhouse gases is still inexpensive compared to the purchasing cost of fossil fuels or raw materials. The results illustrate the problem of potential conflicts between energy policy and climate policy: falling energy input prices, making fossil inputs cheaper, may offset the policy impact of more stringent carbon emission policy that is intended to make them more expensive. The effectiveness of climate policy largely depends on the total cost of carbon inputs and outputs. Integrated accounting allows for the planning of better harmonized climate-energy policies and better forecasting of their prospective effects on carbon emissions. Calculating embodied carbon emission may also reveal the impact of international trade, that is how much carbon emission is shifted to emerging countries by importing intermediate inputs and final goods from there.

Strategic public action facing the expansion of voluntary sustainability standards: implications for sustainability of global value chains in Brazil and Malaysia

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Abstract

The emergence and rapid spread of voluntary sustainability standards are transforming the boundaries between the public and private regulation, particularly regarding tropical agribusiness value chains. Following agricultural deregulation and international trade liberalization in the late 1980s, agribusiness value-chains regulations through new governance arrangements rely on the “retreat of the State” rhetoric. However, although the growing influence of non-state actors in world politics looks obvious, States are far from being sidelined. The development of voluntary sustainability standards contributes further to a change of the role of the state, instead of their retreat. This contribution aims at characterizing these transformations of the public action resulting from voluntary sustainability standards, through case studies conducted in two countries: Brazil and Malaysia. To do this, surveys have been conducted on two value chains in Brazil (sugarcane and beef) and one value-chain (palm-oil) in Malaysia. The results show firstly that voluntary sustainability standards are far from operating alone. Instead, in various cases, their effectiveness depends on a strong public action, as shown by the success of the fight against deforestation in the Brazilian Amazon. Furthermore, our work shows that the emergence of private standards implies a deep transformation of public action. In Brazil, for instance, new technologies of government have been set. By conditioning access to credit on sustainability goals and putting pressure on retailers and manufacturers, the Brazilian government has forced the cattle industry to self-organize in order to set-up sustainability standards that will make them "politically acceptable" on the global markets. However, these standards do not target family agriculture or the informal sectors, for which the social and environmental issues remain significant. In Malaysia, however, many public actors have expressed resistance facing the changes brought about by the development of voluntary sustainability standards. These private standards have been considered by the government as barriers to free trade and a threat to the sovereignty of the State. Public action is then reflected in attempts at re-appropriation of private standards through the creation of national standards, in order to compete or circumvent transnational private standards. These transformations of public action reveal differentiated strategies of states to maintain a certain level of control on the regulation of industrial sectors that are increasingly constrained by private form of transnational environmental governance.

Keywords: voluntary sustainability standards, private governance, public action

Striving for Better Work and Better Businesses via upgrading in the South African Fruit Industry

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Abstract

The extent and reach of global production networks has grown considerably in recent decades leading to widespread economic and social transformation. However, the character of this transformation merits critical interrogation. Whilst there is ample evidence of economic value being added through upgrading, social dimensions have often been neglected leading to a 'decent work deficit' (Capturing the Gains; Nelson et al 2013) in many supply networks. It is within this challenging context that the establishment of the SIZA (Sustainability Initiative South Africa) programme is particularly interesting. SIZA was borne out of a multi-stakeholder project led by the South African fruit industry seeking to overcome social audit overload among local producers. Instead of undergoing multiple audits linked to different retailer requirements, producers are subject to a SIZA inspection which follows an internationally recognised, but locally driven, audit protocol. Capacity building amongst industry players, owners, managers and workers is a core element of SIZA's remit which links directly with the objective of moving 'beyond audit compliance'. In this sense SIZA represents a demonstrable endeavour to achieve value chain upgrading intertwining economic and social objectives. This paper will present findings from ongoing research which is investigating the linkages between ethical compliance and business performance on a sample of South African fruit farms which are actively involved in the SIZA programme. The research specifically focuses upon the dimensions of upgrading that are occurring on the farms. Two major strands will be examined here: Firstly, what forms of social upgrading are most evident? And more specifically, to what extent is meaningful worker empowerment evident as a dimension of social upgrading? Furthermore, are mature systems of industrial relations delivering poverty impact and reaching vulnerable people? Does this lead to positive impacts for workers and businesses? The paper argues that the ways in which farmworkers are drawn into the process is instrumental in facilitating upgrading and draws upon Hedberg's (2013) assertion that it is vital to 'view workers as active participants with networked and topological power rather than as passive victims in a hierarchical power structure'. Secondly, there is a need to develop more nuanced understandings of the actual and potential linkages between economic and social upgrading. Studies have tended to focus upon the impacts that economic upgrading can have on working conditions. Indeed, there is a paucity of robust, replicable work which systematically links ethical upgrading with improved commercial performance by suppliers. This paper asks how social upgrading via ethical trade can interact with economic processes to add greater financial value, thus making a distinctive contribution to debates concerning the business-case for voluntary sustainability initiatives.

Keywords: better work, ethical trade, economic upgrading, social upgrading, South Africa

Private governance beyond compliance? Re-evaluating voluntary standards and exploring alternatives in governing sustainable trade

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Abstract

The last two decades have witnessed a strong emergence of private sector-led governance of sustainable trade, mainly via voluntary standards. Initiated by NGOs and front-runner companies, these private standards were originally set up to fill the governance gap left by insufficient government regulation and enforcement. The number and scope of these private standards has expanded substantially during the past years, covering a broad and diverse range of products, supply chains, and markets. Coinciding with their numeric expansion, a thematic fragmentation of standards has occurred. They all have carved their own 'private governance niche' by focusing on different sustainability issues that relate to various environmental, social, and/or fairness aspects of international trade. Following their emergence, our understanding on the functioning of private standards as a governance tool to spur sustainable trade has enhanced. Clearly, standards have raised private sector and consumer awareness on pressing sustainability issues associated with global production and trade. Furthermore, they have been instrumental in addressing these issues by focusing on the underlying market failures and creating incentives –often targeted at developing country producers at the bottom end of global value chains- to tackle these. At the same time, there is a growing realisation that a genuine sustainable market transformation may require a multi-stakeholder governance constellation that exceeds the supply chain focus and compliance reach of most private standards. Such a new governance model calls for a redefined division of roles and responsibilities between private sector, public sector and civil society. In an effort to gain insights into the shaping of this new governance model, this explorative paper will start by re-evaluating the performance of private standards as a governance tool. To what extent and how do they contribute to sustainable global trade? Which benefits do they generate, to whom and where? What are their strengths and shortcomings, from a governance perspective? The insights into these questions will serve as the basis for a discussion on the governance structure that is needed to achieve a circular and fair global economy, by moving from its current state of self-governance to a more holistic and collaborative multi-stakeholder approach. What are the roles and responsibilities of companies, government and NGOs in this new governance set-up? Will voluntary standards still have a role to play, and if so, what will this role entail? In order to find answers to the abovementioned questions, this paper will contribute insights via desk research, enriched with practical insights and field experiences of the authors on private standards and alternative governance structures, focusing on SMEs in developing countries. Various cases of sustainable trade governance constellations will be discussed to illustrate how and to what extent these constellations may serve as alternatives to -or enrichments of- the private self-governance via standards that is currently dominating international trade.

Keywords: voluntary standards, sustainability, governance, developing countries, SMEs

Sustainable supply chain practices in private sector — drivers and barriers

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Abstract

Purpose: Sustainable supply chain management has emerged as an important organizational philosophy to reduce environmental and social risks, as the role of businesses in contemporary society is changing. Companies have increasingly recognized the need to pursue not only economic but also environmental goals and social goals. Many companies' actions are under pressure from a number of stakeholders, among others customers, media, governments and investors to implement sustainable practices. There is a limited body of research into what drives companies to become aware of their environmental and social responsibility, what drives some to develop policies, to act on these policies and change their practices to become more environmentally and socially responsible. The literature suggests, from the perspective of the focal/buying firm, a number of drivers for organizations to engage in sustainable activities related to the management of the supply chain based on pressure and incentives from external and internal factors, also suggests a wide set of barriers and challenges for the organizations involved for incorporating environmental and social considerations in supply chain practices. This paper aims to explore sustainable supply management subjects in companies that have been recognized as leaders in their sectors in Portugal, and investigate what internal and external drivers and barriers influence and affect the implementation of sustainable practices on the supply chain. Design/methodology/approach: The study builds on the data collected from interviews with eight Portuguese companies, through twenty two semi-structured interviews with CEOs, purchasers and environmental/safety practitioners, and secondary data collection from reports and websites. Sectors included glass, automotive, drink, wood based panels, furniture and cork. Findings: Encouragingly, across the organizations, more drivers than barriers to sustainable practices are identified. Organizations seem to be more influenced by internal rather than external drivers. The barriers to environmental supply chain management experienced by organizations tend to be also more internal and external. While the key finding, namely ethical principles, values of the organization and culture are the number one driver, the main barrier identified was the workers resistance to change. Research limitations/implications: The drivers and barriers could be further explored through a survey of firms from different sectors. Originality/value: The paper contributes to identify and understanding the main drivers and barriers that are behind the implementation of sustainable supply chain management practices by companies. The paper draws useful lessons to practitioners seeking to implement sustainable supply chain management practices.

Keywords: Sustainable supply chain management practices; Drivers; Barriers; Case studies; Portugal.

A paradigm shift in sustainability governance? The emergence of sustainable landscape initiatives

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Abstract

During the last two decades, multinational business and international NGOs from the North have initiated global roundtables, standards and certification programs to promote sustainable cropping in the South. In recent years, new programs and projects have emerged to promote sustainable landscapes, such under different names: sustainable landscape initiatives, area-based approaches, public-private, community-company initiatives, and jurisdictional approaches. The main aim of this paper is provide a critical reflection of the emergence of these new programs and projects in the context of a plurality of regulatory authorities and standards directed at sustainable cropping. Our two main questions are: To what extent do these programs and projects reflect a paradigm shift in sustainability governance? Are sustainable landscape initiatives meant to replace, compete with, or complement "vertical" governance of supply chains? To address these questions, we take the following steps. First, we provide an overview of programs and projects all over the world, offering a general classification of sustainable landscape initiatives. Second, we question why these programs and projects have been initiated and launched. Specifically, we ask whether sustainable landscape initiatives aim to address shortcomings of "vertical" governance of supply chains through global roundtables, standards and certification. Third, we examine the ways in which initiators and supporters have framed problems, solutions and the projects themselves. Our first main finding is that many sustainable landscape initiatives are presented as new technologies, rather than new forms of governance. Our second main finding is that sustainable landscape initiatives are considered as both complementary to and a next generation to global roundtables, standards and certification programs. Our conclusion is that the emergence of sustainable landscape initiatives launched by international development organisations and funded by governments from the North, do not reflect a paradigm shift in sustainability governance. They rather reproduce top-down, technological and procedural approaches characteristic of vertical chain governance. We close by discussing the implications of the lack of attention by sustainable landscape initiatives to their contribution towards increased plurality of state and non-state rights to land and resources, creating confusion and new rivalries in sustainability governance.

Globalization and the sustainable exploitation of scarce groundwater in Peru

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Abstract

Trade in agricultural and food products has increased sharply since the 1980s, but the links and trade-offs between socio-economic benefits and environmental impacts of this trend have hardly been studied. We focus our empirical analysis on the Ica province in Peru, where agricultural export production has led to huge economic growth and employment generation at the expense of unsustainable aquifer depletion. Building on the concept of ecosystem and societal metabolism (MuSIASEM), we build a model of the province including water use, added value generation and employment creation. Absolute and relative differences between crop production for auto-consumption and national markets, and for export markets are assed at different societal levels. Moreover, we analyze the impact of two land use scenarios aiming to reduce total groundwater extraction. Our analysis draws a picture of a system which is highly dependent on the use of natural resources. Export agriculture generates considerably more value added and employment while extracting more than five times more water from the aquifer than local crop production. Our scenarios show that although being more efficient regarding intensive indicators, a reduction of groundwater-irrigated export production is indispensable to secure environmentally sustainable agricultural production in the long run.

Keywords: globalization, groundwater, agricultural trade, sustainability, metabolic analysis, food value chains, Peru

Sustainable Supply Chains in high-quality coffee markets: The Relationship Coffee Model

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Abstract

At least 40% of global coffee production is made according with voluntary sustainability standards, however, increasing price volatility challenges 25 million smallholders that produce 80% of the total supply. In this scenario, there is and alternative for those growers who produce higher qualities and can participate in emerging business model such as the Relationship Coffee Model. RCM promotes a transparent long-term partnership between coffee buyers and smallholders based on product quality. Although not always an explicit goal, the RCM model is thought to indirectly incentivize good and sustainable environmental outcomes. For instance, smallholders have an incentive to adopt shade-grown coffee systems that will produce higher-quality coffee. These systems offer habitat to many resident and migratory birds, which in turn, provide pest control services, reducing input costs and reliance on harmful agrochemicals. Although this model will integrate environmental issues in coffee production with social challenges of community development, the extent to which it realizes positive and sustainable socio-economic, and environmental outcomes remains to be tested. To fill this gap, and following an interdisciplinary collaborative approach, we developed a conceptual framework explaining how geographical, environmental, production and technological factors influence growers' ability to produce high-quality coffees and consequently to participate in RCM. Next, we constructed a database with detailed information from 265 Colombian smallholder growers, including RCM participants and non-participants. For each farm, we collected and analyzed soil samples, applied a comprehensive socio-economic survey, characterized the coffee landscape for biodiversity, and surveyed bird populations. Subsequently, we employed propensity-score matching methods to calculate the conditional probability of RCM participation and to assess outcome differences between RCM participants and non-participants. Our results suggest that RCM participants tend to employ more environmentally friendly resource management practices such as, water-saving techniques, organic fertilizers, increased tree biodiversity, and decreased use of soil-chemical inputs, in comparison to non-participants. In addition, RCM participants have planted higher numbers of Inga trees, which are preferred by bird species, like the Setophaga petechia. This bird specie is critical for the control of coffee borer and was observed only at RCM farms. Our results also suggest that RCM participants have better information about downstream markets and tend to be more optimistic about the future of the coffee business. Surprisingly, we did not find farm gate price differences between the two groups. The reason is that the price premiums received by RCM participants was allocated primarily to training programs and to enhance access to credit. Finally, our results suggest that existing certification schemes (e.g. Fair Trade, Organic) are correlated with the estimated outcomes but do not necessary explain them. Identifying appropriate market-based strategies that integrate environmental sustainability aspects is critical to alleviate rural poverty in developing countries. Sustainability in coffee production is not just about fair-trade practices and production methods that foster environmental protection. It is also about product quality that response to consumer's preferences and it is compatible with better practices. The interactions and impacts highlighted in this research can be applied to other value chains such as cocoa.

Keywords: Sustainable agriculture, high-quality coffee

Managing late modern risks– reflexive responsibility in a textile supply chain

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Abstract

The modern industrial society has transformed the textile sector and altered its risk-profile. Brand-owning companies today seldom own the production process of their textile commodity, but rely on global commodity chains consisting of a myriad of suppliers and sub-suppliers. The global scope of the sector along with the complex and uncertain health- and environmental risks that are associated with textile production put extensive challenges on companies in their effort to manage their chains in a sustainable manner. Moreover, existing governing frameworks on chemicals in textiles are neither globally coordinated nor consistently ambitious, further complicating management efforts. In the void of enclosing legislation, numerous brand-owning companies are assuming corporate responsibility upstream; for example through voluntary CSR-programs, eco-labels, green company standards and restricted substance lists. This paper explores potential possibilities for responsible management of high-risk chemicals in textiles. It uses a qualitative case study approach that centres on a Swedish outdoor company. The concept reflexive responsibility is used to understand and discuss the management practice as well as key challenges encountered in the process. The paper describes the process and illuminates the complexity and balancing acts faced by the brand-owning company. It contributes with an understanding on how important steps towards an organized extended responsibility, embedded within the organization of the outdoor textile company, can be taken. It also addresses the limits of risk management by one, all be it committed, organization.

Keywords: supply chains, CSR, chemicals, risk, reflexivity, responsibility, textiles

Can the Implications of the GHG Protocol's Scope 3 be realized?

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Abstract

The GHG Protocol has become the accepted model for companies to measure and report their greenhouse gas emissions and the CDP was established by large investors to compel MNCs in particular to report their emissions. The Protocol insists that companies assess and publish the emissions of their scope 3 suppliers. The implication is that they should be able to control these emissions. Is that possible given the geography of global value chains/production networks? This paper critically assesses the capacity of MNCs to control the emissions within their global value chains. It reviews the literature in the following areas: 1) what our understanding of lifecycle assessment demonstrates about the comprehensiveness of information available to MNCs; 2) What does the sustainable and the conventional supply chain literature say in regard to power, complexity, product cycles, competition and other issues?; 3) the effectiveness of audits and supplier engagement to extend responsibility through the value chain; 4) the potential to streamline GHG emissions control through the value chain through design for the environment, renewable energy portfolio requirements, etc.; 5) regional governance and capacity building to support MNCs to reduce their GHG burdens; and 6) what MNCs say about their willingness to control scope 3 emissions.

Keywords: GHG Protocol, value chain, sustainable supply chains, design for environment, regional governance

Theme 5 posters

The industrial ecology and the theories of systems, institutional and of the resources dependence: analizing the actors on a technology park

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Abstract

At the same time the interest in sustainable development grows, so does the interest in the challenges it brings. As a possible tool to solve these challenges came the idea of Industrial Ecology (IE), which has as its main perspective nature as a model in the integration of the ecological and industrial systems. It is characterized by scales of action and the most well known of them is Industrial Symbioses (IS), which involves the exchange of materials, products, water, energy, residue, information, experiences and knowledge among organizations. However, is noticed that IE brought new questions and a need for a bigger connection with the social sciences. Usually research started in a more technical field and face difficulties to be implemented and accepted because it wasn't confronted at first with the social and power systems in which organizations are involved in. Opening spaces for studies that take into consideration aspects such as culture, values, organizational politics and power structures and pays attention to these details can reduce the impacts of IE. The challenge is to examine carefully, broaden and integrate this analysis in a transdisciplinary and systemic view directed towards sustainable development. Satisfactory results in face of these impositions involve investments in R&D (research and development), in eco-innovative products and changes in business practices. Thus, this research aimed to analyze the perception of subjects of a technological park on the interactions of Industrial Ecology with the coming together of the Systems, Institutional and Resource Dependency theories. The theoretical reference based on the aforementioned theories made it possible to establish connections with IE and create the categories of analysis. Based on the qualitative approach, on a multidisciplinary perspective and a case study, the Associação Parque Tecnológico of Santa Maria, RS, Brazil was chosen as study subject. Primary and secondary data from documents, meeting notes and observations were used. However, the main data were interviews of 28 members of the technological park. To analyze the data the method of content analysis was used. The results showed that the subjects recognize the need for integrated actions among organizations, yet do not consider that environmental conservation is a socially accepted and well known concept with high impact on business results that can guarantee a company's survival. Generally, relationships are not guided by an institutional context that motivates shared goals aiming to supply critical resources. Decisions made out of habit and in the absence of clarity surrounding the purpose of IE can hinder its performance. Although it is said that there is disposition to abdicate resource control to achieve better and shared results, in practice this was rarely observed. The subjects found that universities and the private and public sector lack insight regarding their responsibilities for developing interactions.

Keywords: Industrial ecology, System theory, Institutional theory, Resource dependency theory, Technological park

1. Introduction

The concept of Industrial Ecology (IE) come to people's attention in the 1980s and 90s (Erkman, 1997). Due to the body of knowledge contemplated within it, it can be understood as a science of sustainability, as it sets out from the metaphor of nature to analyze and optimize the industrial complexes, logistics and consumption, as well as their flows of energy and materials (Jelinski et al., 1992; Erkman, 1997; Cohen-Rosenthal, 2000; Ehrenfeld, 2000; Hoffman, 2003;

Isenmann, 2003; Korhonen, 2004; Costa et al., 2010). According to Deutz (2009, p. 276), IE "includes theory and practice in the implementation of sustainable development."

It is important to point out that IE is characterized by three levels of activity, which range from actions developed within the organization, to inter-organizational relationships, and extend to broader actions that are regional and global in nature (Chertow, 2000). In this study, these scales are denominated, respectively, the micro, meso and macro levels of IE. It can be stated that the Industrial Symbiosis (IS) – the level upon which this study focuses - is the most widespread activity, although it depends on the other two, it is linked to the meso-level as it directly involves the exchange of materials, products, water, energy, waste, information, experience and knowledge between organizations (Posch, 2010; Giurco et al., 2011).

However, Deutz (2009) points out that new perspectives that require greater insights from Social Sciences are emerging in Industrial Ecology. This research aims to investigate the possibility that Institutional Theory (IT) and Resource Dependence Theory (RDT), together with Systems Theory (ST), affect the understanding and development of Industrial Ecology, respectively, with cognitive/values aspects and power/political aspects, and consider IE to be based on systemic principles (Erkman, 1997).

Supporting the research argument proposed in this paper, Chertow (2000) and Sakr et al. (2011) state that it is in environments such as industrial ecoparks (IEP) - in which companies cooperate with each other and with their local communities, sharing various resources and obtaining returns in economic, environmental and human terms (Chertow, 2007) - that the IS principles find the best means of implementation. However, considering that, in Brazil, there are no reports in the literature about this type of facility, the authors of this study sought to identify a project with potential IEP features to serve as the object of analysis for this study.

Because of its current situation, aims, organizational structure, areas and mode of operation, the Associação Parque Tecnológico de Santa Maria (Santa Maria Technopark Association) was chosen as the object of this study. It is located in the municipality of Santa Maria, in the center of Rio Grande do Sul state – Brazil, and notably, among its objectives are the relationship with the government, educational institutions and the business sectors in seeking to promote technological development and innovation (Santa Maria Technopark, 2012).

Despite the absence of an IEP in Brazil, it was considered important to conduct this research in the country, given its emerging economic characteristics (as well as with those of other nations that already have industrial ecoparks) and also its similarity, in terms of social, political, cultural and environmental characteristics to other countries in South America – in which there are few EIP projects.

An additional motive behind the decision to conduct this research was that in studies carried out by Fragomeni (2005), Veiga (2007) and Veiga and Magrini (2009) in Brazil, when investigating industrial ecoparks projects in the State of Rio de Janeiro that had failed to progress, the authors showed that, among the factors that hampered the achievement of their environmental potential and the continuation of those parks can be cited "the lack of continuity, political will, partnership, integration and cooperation between the public and private sectors, community, university and research centers" (Veiga, 2007, p. 192). These elements that constitute social, institutional and power variables, which represent the topics of interest expressed in this research.

It is believed that the three highlighted theories are capable of providing the theoretical support necessary to support the demands required by Industrial Ecology at its meso-level (Industrial Symbiosis), as well as recognizing that the external issues influence organizational performance. In addition, they identify that organizations and the elements integrating their surroundings establish interdependent relations which are, among others, technical, social and political in nature.

One needs to remember that production systems do not solely consist of materials, equipment and energy. They are also made up of people, organizations, institutions and complex natural, cultural and social systems (Allenby, 2000; Hoffman, 2003; Posch, 2010). Thus, the present study argues that the similarities between Systems Theory, Institutional Theory and Resource Dependence

Theory provide significant elements that enhance our understanding of how institutional aspects and power relations affect the Industrial Ecology in a systemic and resource interdependent context. The aim of this article is to analyze the perceptions of the actors in a technological park regarding the interactions of Industrial Ecology with the convergences between Systems Theory, Institutional Theory and Resource Dependence Theory.

2. Methods

The technological park that is the object of this study was founded on October 31, 2008 by 7 institutions (3 universities, 3 business associations and the municipal government) as a private, non-profit entity, with its own legal status. Its organizational structure consists of the General Assembly, Administrative Council/Audit Committee, Board of Directors and Staff.

There are 14 members organizations operating in diverse fields, such as manufacturing power distribution transformers, commercial automation, software development for various applications, information technology (IT) services and consulting, IT and telecom infrastructure management, irrigation management and monitoring services for agribusiness, and digital marketing.

The study was conducted in 2013 and survey participants included the heads of the 7 institutions that founded the SM Technopark together with members of the Administrative Council, the Audit Committee and Board of Directors of the technology park as representatives of the founding institutions. Together these two groups (the heads and their formal representatives) consisting of 16 people, of whom, 14 were interviewed, was denominated the SM Technopark Managers group (M01, M02, M03, ..., M14). In addition, data were collected from the 14 members operating in SM Technopark, denominated the Entrepreneurs (E01, E02, E03, ..., E14) group.

The 28 interviews were conducted using interview scripts (one for the Managers group and another for the Entrepreneurs group) that were built based on the convergences between the three theories with IE, and the development of analytical categories. Furthermore, to enhance the data collection process, document analysis was conducted, meetings were attended and relevant observations were made at the investigated technology park. Content analysis (Bardin, 2004) was used in the analysis of the collected data.

3. Results and Discussion

3.1. Convergences between the three theories with the Industrial Ecology and the analytical categories

The first convergent aspect is in ‘search for survival’. The systems are constantly changing and engaged in exchanges with the environment, involving all the levels and components (subsystems) to ensure their balance and survival (Wood, 1995; Martinelli, 2006; Von Bertalanffy et al., 2008). From the point of view of Institutional Theory, depending on the degree of environmental institutionalization, an organization may survive through legitimacy, even if it is incompetent in its operations. By means of isomorphism, the organization can get the resources it needs (Meyer and Rowan, 1977; Carvalho et al., 2005; Rossetto and Rossetto, 2005; Barbieri et al., 2010). Lopes (2003), when discussing RDT stated that organizational survival is directly related to the ability to obtain and sustain resources. Given that resources in the environment are scarce and essential for organizational survival, there is a need to establish inter-organizational relationships and seek to influence and control environmental conditions (Pfeffer and Salancik, 1978; Rossetto and Rossetto, 2005).

Based on this convergence, the following interactions with the ideas advocated by Industrial Ecology were identified:

i) the occurrence of integrated actions between organizations - directly related to the Industrial Symbiosis, the meso-level of IE (Chertow, 2000; Lima, 2008);

ii) the purpose of mitigating the environmental impact (Boons et al., 2011), given that the preservation of the environment tends to be socially accepted and recognized value (including the legislation - coercive isomorphism);

iii) the possibility of achieving competitive advantage, seeking organizational continuance/survival (Erkman, 1997).

Thus, the first analytical category to be established was denominated 'compliance with the environment', and represents a posture adopted by organizations so that they can adjust to the conditions determined by the environmental context in which they are inserted (Table 1).

The second convergent element between the theories are the 'collective and interdependent environments', i.e., the three approaches share actions within the premise of open systems (Egri and Pinfield, 1998; Von Bertalanffy et al., 2008). Thus, interorganizational relations are highlighted, which, according Balestrin and Vargas (2002), in order to exist means, in practice, the organizations need to have something to trade, among other factors. This exchange can be in the form of information, knowledge, resources and/or inputs. For the authors, interorganizational relations are of necessity (dependence on resources and their scarcity), asymmetry (power of an organization over another), reciprocity (cooperation with common interests and goals), stability (combating uncertainty) and legitimacy (compliance to the institutional environment). Another aspect that accompanies interorganizational relations refers to the intention and the willingness of each of the parties involved to concede something of value in order to receive in return something of value that belongs to the other party (Pfeffer and Salancik, 1978; Zineldin, 2004; Eiriz and Wilson, 2006).

Given that this convergence is associated with the fact that the environments are collective and interdependent, connections can be seen with IE, as there are mutual interests and goals (which give rise to inter-organizational relations) with shared visions (Cohen-Rosenthal, 2000; Isenmann, 2003), in line with the institutional environment, in view of the mutual needs for various scarce/limited resources (Hoffman, 2003).

The second analytical category was identified as 'organizational interdependence', and can be described by the strengthening of interaction due to the mutual need for resources.

The third identified convergence was 'constrained decision-making'. As systems are engaged in constant exchange with the environment and institutional changes are dynamic, people who must decide in organizations have difficulty acting given the interorganizational relationships (Egri and Pinfield, 1998; Bignetti and Paiva, 2002; Teisman and Edelenbos, 2004; Von Bertalanffy et al., 2008). Due to the volume of information available, it is difficult to identify those that deserve to be considered or not. Consequently, decisions are delayed, simply not taken, or even just arise out of habit (Dimaggio and Powell, 1991; Tolbert and Zucker, 1998). Regarding RDT, events and pressure from various external and internal actors hamper the identification and access to critical resources for the organization (Nienhüser, 2008; Davis and Cobb, 2009). Coupled with the fact that the systems have the same purpose and that satisfactory results can be obtained in several ways, uncertainty is increased and the tendency to adopt isomorphic mechanisms.

This convergence is linked to various constraints that affect decision making. Thus, the necessary systemic view of Industrial Ecology, in line with the tripod of sustainable development (Isenmann, 2003), may be compromised by semiconscious decisions, arising from institutional forces (the influence of cultural factors external to the individual and not from within their personality) related to beliefs and values conditioned by social structures (Dimaggio and Powell, 1991; Bastos and Borges-Andrade, 2004). These forces tend to drive those responsible for decision making to act without reflection and without fully understanding (Tolbert and Zucker, 1998) the real sustainable purposes of IE, so limiting any consideration of aspects related to its application - productive, operational, social, cultural, political, power, among others (Hoffman, 2003; Deutz, 2009).

The fourth convergence identified between the three theories can be denominated 'reducing uncertainty'. The systemic approach seeks to minimize this unwanted condition by continuously seeking balance and attempting to adapt to the environment (Wood, 1995; Teisman and Edelenbos, 2004; Martinelli, 2006). It is thought that institutions involve habitually performed actions, which refer to behavior developed by an individual or groups of individuals in order to solve recurring problems, establish expectations, so reducing the risks and uncertainties in the process of social interaction (Berger and Luckmann, 2001; Fachin and Mendonça, 2003). The mimetic isomorphism itself results from the response patterns to uncertainties (Cunha, 2002; Dimaggio and Powell, 2005; Boons et al., 2011). From the point of view of RDT, Nienhüser (2008) states that uncertainty refers to the extent to which future states cannot be accurately anticipated and predicted. The main source of uncertainty is the environment (Pfeffer and Salancik, 1978). The degree of uncertainty will vary according to distribution of critical resources in the environment. Thus, it is clear that interorganizational relationships require skill (Eiriz and Wilson, 2006).

According to Allenby (2000), the degree of uncertainty that characterizes Industrial Ecology and its activity levels is still high. This characterization can be best understood when considering that IE (and hence IS) requires cooperation developed over time (Chertow, 2000; Boons et al., 2011).

The elaboration of this analytical category refers to the decisions made with restrictions and the efforts to reduce the uncertainty. In the discussion presented here, it was decided to address them in unison, given that they are directly linked.

Thus, the third established analytical category was denominated 'ignorance and habit' and represents institutional aspects that influence the identification and use of the ideas defended by IE.

The fifth convergent factor between the three theories under study concerns the conduct of organizational interests. In other words, the managers tend to take decisions on the basis of pre-defined interests. While Systems Theory naturally seeks to analyze the phenomena holistically, considering the organizational interrelations (Wood, 1995; Martinelli, 2006; Von Bertalanffy et al., 2008); Neoinstitutional Theory aims to legitimize the organization through its conformity (formal structure and symbolic purposes, among others) to the beliefs, ways of acting and socially accepted and recognized values (Meyer and Rowan, 1977). In turn, Resource Dependence Theory seeks to maximize power, while minimizing the dependence of an organization in relation to others (Alves Filho et al., 2004; Rossetto and Rossetto, 2005; Ortlieb and Sieben, 2008).

Accordingly, the joint use of the three perspectives in attempting to understand and develop the study of Industrial Ecology is pertinent. According to Nienhüser (2008), if one wishes to understand the power processes, one needs to approach them from the point of view of cognition and social values, because they are socially constructed and interconnected aspects. They are not merely objective and rational elements and, moreover, they are systemically dependent.

Thus, the resulting analytical category was identified as 'readiness to cooperate' and can be described as the willingness of organizations to share resources.

The sixth convergence relates to need for organizations to be alert to external demands. The open systems approach provides that the boundaries between organizations and the environments in which they operate are neither closed nor allow superficial analyzes (Egri and Pinfield, 1998). The complexity of the exchanges between the near and distant components of the organizational system should be considered. Organizations can be said to be evaluated on their efficiency and capacity to adapt to social and political systems. Thus, they seek to pay attention to external threats and the lack of resources, highlighting the use of institutional components in the acquisition of such resources (Dimaggio and Powell, 1991; Fachin and Mendonça, 2003; Rossetto and Rossetto, 2005). Moura et al. (2010, p. 7), referring to the studies involving Resource Dependence Theory, stressed that organizations are faced with a dilemma, "because, on the one hand, adaptation to future demands require skill to change and discretion to act, on the other, the need for stability and security require the creation of inter-organizational structures that control their behavior." That is, organizations need to simultaneously possess sufficient stability to control what is critical for their survival as well as the agility to not be controlled by others - which represents an active relationship with the environment, seeking to manipulate it for their own benefit (Pfeffer and Salancik, 1978; Orssatto and Clegg, 1999).

It is important to make clear that in this text, the possibilities of convergence and divergence between the studied perspectives have not been exhausted, rather the focus has been to present those elements that stood out in the literature.

Industrial Ecology can help meet growing external pressures (United Nations Programme for the Environment, 2013) related to the adoption of actions related to environmental sustainability. According to Allenby (2000), IE can be described as a complex multidisciplinary element, which includes industrial and natural systems beyond the borders of only one organization (Cohen-Rosenthal, 2000). It also provides for the maximum use of natural resources, favoring the emergence of a business ecosystem, in which the knowledge, experience, resources and waste of an organization are shared with the other members of that system (Avila and Paiva, 2006; Posch, 2010). Although, therefore, it demands planning, coordination and the formulation of regional public policies (Lima, 2008; Chertow and Ehrenfeld, 2012; Ashton and Bain, 2012). The corresponding analytical category was denominated 'coordination', and it represents the identification of joint demands, and the role of educational institutions and the public and private sectors in relation to the initiative.

Table 1. Convergences between the theoretical perspectives, their interactions with IE and analytical categories

Convergences	Interaction with IE	Analytical Categories
Search for survival	- integrated actions among organizations -minimizing the environmental impact -source competitive advantage	Compliance with the environment
Collective and interdependent environments	-reciprocity -shared and comprehensive view -limited natural resources	Organizational interdependence
Constrained decision making	-dynamic systemic view of the socio-economic development considering the environment -unclear understanding of the objectives of EI -influence of institutional aspects through social structures	Ignorance and habit
Reducing uncertainty	-the degree of uncertainty that characterizes the IE is still high (Allenby, 2000) -IE requires the long-term, which tends to increase uncertainty -specific requirements for applying IE in different countries -trust in terms of trade is essential	
Previously defined interests	-different and concurrent views on the organizational environment -convergence and guidance of the prospects of sustainable development	Readiness to cooperate
Attention to external demands	-IE is a complex multidisciplinary element that integrates industrial and natural systems beyond the borders of just one organization -requires planning and the formulation of regional policies -helps to meet pressures to adopt actions related to sustainable development	Coordination

3.2. Perceptions of the respondents according to the analytical categories

The perceptions of the surveyed actors in relation to the five developed analytical categories are presented below.

a) Compliance with the environment: the results show the respondents do not identify ecological demands in their businesses. That is, currently, there is no reason to invest organizational resources in the referred aspects, as they do not provide a competitive business differential in the Brazilian domestic market.

The Entrepreneurs were adamant that such demands are reserved for the future, in the medium or long term. So much so that some admit the need to better understand the topic in order to ascertain how their company can work with those aspects. Although, during the interviews, both through in loco observation and the participants' responses, isolated initiatives, restricted mainly to separation and proper disposal of generated waste, were identified.

Perhaps the fact the respondents did not identify environmental demands is related to limited interaction between the companies within the SM Technopark and the universities. These institutions are able to generate and disseminate knowledge capable of bringing about change in society. Added to that, the fact the interorganizational exchanges are primarily related to commercial relationships and not focused on the joint development of new innovative products/services, which suggests wait-and-see and reactive posture before the market.

It should be noted that the Entrepreneurs said that their business sectors are subject to pressures related to environmental issues. Motivated by the specific legislation regarding the type of product produced or the type of business operation, which, in this case, involves considerable consumption of water and energy.

Although the questions were directed to the Entrepreneurs, some Managers also expressed their opinion on the subject. The participants in this group responded that, in general, they do not perceive a demand on the part of Brazilian society in relation to company actions that affect the environment. They claimed that the listed initiatives come about as marketing actions or, compulsorily, in compliance with the law.

This perception of the surveyed Managers confirms the findings of a recent survey carried out in Brazil which showed that the environmental management practices adopted by companies in the country only have a preventive approach, and do not characterize the attempts to establish competitive advantage based on environmentally responsible performance (Jabbour et al., 2012).

It can be seen that the dimensions linked to sustainable development are not perceived as legitimation mechanisms by the actors in this study. The literature shows that the lack of interest on the part of companies with an Industrial Ecology project is the most lethal factor for its development. The active participation of entrepreneurs is, ultimately, the most important aspect for success (Heeres et al., 2004; Sakr et al., 2011). Those involved need to be willing to share not only physical resources, but mainly knowledge and experience.

This result is supported in the research suggesting Industrial Symbiosis receives a significant boost from the economic benefits that entrepreneurs envisage from the market dynamics and legal and social requirements (Costa et al., 2010; Lombardi and Laybourn, 2012).

As discussed in this study, Systems Theory, Institutional Theory and Resource Dependence Theory advocate passive or active compliance in the context of organizations seeking to attain conditions for survival. Locating this finding at the meso-level of Industrial Ecology, it is clear that the actions required for its implementation will be adopted if the decision makers assess it is necessary for organizational perpetuity. That is, the joint analysis of the three theoretical approaches and the contrast with the empirical data support the conclusion that IE projects will be better able to progress and develop when the participants perceive the maintenance and survival of organizations to which they belong depend on such projects.

This discussion may contain one of the reasons that Brazil does not yet have an industrial eco-park (IEP) in operation. When issues of social and environmental unsustainability become dominant sources of concern, then Industrial Ecology practices and the introduction of IEPs will be seen as being important and of value to society and companies (Chertow and Ehrenfeld, 2012).

b) Organizational Interdependence: the coordination of leaders in favor of projects that seek symbiotic and synergistic exchanges need to be effective in the sectors like government, business and education, because they act as the support base of such projects and possess solid institutional characteristics.

Starting with the education sector, the universities are identified by the respondents as agents in the growth of the municipality of Santa Maria more because of their annual budget than by any contribution from academic research. It was mentioned that the universities should produce knowledge that the community can appropriate and use to generate wealth. Moreover, academics tend to devote their studies to subjects unassociated with real problems. The respondents also emphasized that the academic mode of functioning and goals are very different from those of the business environment, which hampers the development of joint research projects and innovation.

From the point of view of companies within the SM Technopark, the study participants said that, in general, they are reactive as their focus is on the present rather than the future. The respondents mentioned government slowness as a significant obstacle to the development of initiatives such as the SM Technopark. In this sense, the documents consulted during this investigation, both institutional (minutes) and those for mass communication, delays due to government agents are recurrent.

The factors are almost identical to those mentioned by Veiga (2007) when he conducted research for his doctoral thesis in industrial ecopark projects in the State of Rio de Janeiro which had failed to make progress. At the time, the author identified “lack of continuity, political will, partnership, integration and cooperation between the public and private sectors, community, university and research centers” (Veiga, 2007, p. 192) as the social, institutional and power elements that impeded the progress of the studied projects.

It becomes clear that in comprehensive interorganizational relationships, consisting of government agencies, business organizations and higher education establishments, social and cultural knowledge pervades the design, planning, implementation and development stages in a continuous process of learning and monitoring of their assimilation by various participants. Thus, the influence the institutional environment through culture, values and beliefs, exerts on the definition of the both shared and particular/specific objectives cannot be ignored.

Therefore, project leaders need to be constantly monitoring what was planned, what has been accomplished and what still needs to be done. Likewise, the responsibilities and commitments assumed by the public agency, educational institutions and business entities require monitoring. More than monitoring, it may be necessary to build a technological, economic, social, cultural, political and environmental context conducive to the characteristics of this type of venture. Thus, in addition to engineers, computer specialists and environmentalists, Industrial Symbiosis projects should also count on the support of anthropologists, sociologists and psychologists. Moving to a new stage of analysis and development of the assumptions related to Industrial Ecology.

c) Ignorance and habit: the responses from the two groups of actors related to the dimensions of sustainable development and IE show them to be concepts that are distant from the day-to-day life of the respondents. With rare exceptions, the respondents stated that the actions related to the topics/themes still sound like mere fashionable terms and plans for the future.

The difficulty is knowing what is wanted regarding the environmental issue, where it is leading, what is being sought. If the intention is to consider it and include it in the company plans, it cannot be something sporadic but rather permanent. It appears the actions need support mechanisms, coordination and management to enable a view of the opportunities in the area. To take advantage of them, it is necessary to be attentive and willing to adjust the way one works, while supported by the appropriate information and knowledge.

However, organizations, being formed from individuals, are not a homogenous set and have differing opinions, leading to several strategic responses to the multiple interactions that companies have with other entities (Vermeulen, 2006). Thus, as was highlighted by some Entrepreneurs, one should start with the integral formation of the human being. Especially since the Industrial Symbiosis is not part of the regular business, and requires significant changes in the prevailing individualistic mental models (Chertow, 2000).

In the view of many Entrepreneurs, there is no lack of adequate management technologies for IE. The lack of change is due to inadequate education and training of the decision-makers with regard their awareness of the importance of sharing and interaction.

The results of this analytical category provide evidence that the organizational decision makers, by acting out of habit, lose, to some degree, their ability to obtain alternative knowledge and innovation. There is a tendency to become relatively inert, while having a sense of satisfaction they are acting properly in the face of the uncertainty surrounding them.

Therefore, routine prevents the preconditions of Industrial Ecology from becoming known and there is no perception of the existence of opportunities for the joint development of innovative products and competitive services from the point of view of social and environmental factors. This represents a cyclical context and complex change.

However, it can be inferred that investment in administrative processes consonant with the ideas advocated by IE, such as the exchange of the experience, knowledge, skills and technologies that each participant actor holds - moving beyond the traditional physical exchanges of tangible resources, is a viable means to establishing symbiotic interorganizational relationships.

Thus, this is another application of the concepts of Industrial Ecology that can generate similarly sustainable results from the environmental point of view. Moreover, one should forget the necessary attention that education needs to be given permanently to such procedures.

d) Readiness to cooperate: the coordinators of Industrial Ecology initiative need pay attention to improving and integrating the production processes by sharing research and development (R & D) and the expertise of each organization. It is also important to develop sustainable products through the exchange of experiences and knowledge during the planning phase of a new product. It is during this phase the definitions that will influence the environmental impact level the product will have throughout its life cycle are determined.

It should be added that the learning derived from sharing the technological knowledge held by each company enhances joint projects in terms of achieving common objectives and outcomes. These aspects are key regarding the environmental responsibility and strategic positioning of organizations.

However, as stated by several respondents, there must be trust between the parties. Winning people's trust is a long-term process and its results tend to take time to appear. Especially when one is dealing with a new topic such as Industrial Ecology, which requires a systemic view because it consists of different areas of knowledge (Gibbs and Deutz, 2007).

In this analytical category, the respondents were seen to perceive that the sense of ownership is intense and difficult to overcome. The transformation of the ideas of Industrial Ecology into concrete action requires that the various actors involved (especially the organizational managers) view that sharing information, knowledge and even control over resources allows them to achieve common goals and increases the intensity of positive results greater than acting individually. Posch (2010) refers to this view as conscious cooperation.

When asked about what it takes to be achieve the conscious cooperation proposed by Posch (2010) among the members of the SM Technopark, the actors highlighted the need for planning, dialogue, knowledge, maturity and especially a change in behavior.

The actors state that achieving the collective good can be considered a traumatic process. Accordingly, for organizations to demonstrate that they are acting through conscious cooperation they need to share power and control of their competitive advantages in favor of mutual future benefits. However, for this sharing to occur it is essential to decrease any possible mental distance characterized by the lack of interest in working together due to the absence of professional and social relations among them (Gibbs and Deutz., 2007, Jensen et al, 2011). Furthermore, we must consider some criteria defined by the survey participants, such as that expressed by this respondent "there has to be a partner bigger than us. I have always tried to make these partnerships, these approaches with those ahead of us. So our parameter was always companies bigger than us" (E05). This statement conveys an initial impression of what this entrepreneur wants, from the beginning, to obtain more benefits in the relationship than his partner. That is, the concession of power may not be equal.

The practice of sharing power depends on a number of factors such as trust, maturity, knowledge, procedures that provide the process legal certainty, dialogue and respect, among others. Finally, they are characteristics that are aggregated to relationships in a long-term context which must be initiated at some point. An alternative might be to have efficient coordination in the inter-organizational cooperation process within Industrial Ecology projects.

e) Coordination: the respondents often expressed the expectation that the SM Technopark would produce a leap development in the businesses, the educational institutions and the city as a whole. Specifically, for universities, the technology park provides the opportunity to retain more of its graduate professionals in the city, establishing a longer lasting link with them. Besides, of course, offering the possibility of expanding academic research in partnership with other members. The Entrepreneurs usually stated they saw the technopark as being capable of adding value to business and facilitating the expansion of operations in the market and the number of clients served.

Another recurring among the respondents was the lack of clarity regarding the responsibilities of the higher education institutions, government and business entities in relation to the Santa Maria Technopark. The universities accredited with the responsibility of fostering academic research, environmental education and disseminating information in partnership with the businesses. The government has an essential role in relation to the preparation, fulfillment, encouragement and enforcement of laws.

The businesses are expected to actively participate with the universities by not only seeking to identify and establish interactions and exchanges, but also generating opportunities for the joint development of innovative and competitive product and services. It is therefore crucial to strengthen the links with the universities.

In these circumstances, the Executive Team of the Santa Maria Technopark plays a key role in the creation of efficient communication platforms to promote the collective understanding of the significance of the project, the establishment of common goals and ensuring the mutual commitment to their achievement. The scope of its actions must extrapolate the municipal limits and reach regulatory agencies, developers and policy makers at regional and national levels as they have the capacity to help overcome obstacles and threats.

The literature often shows that a well-coordinated relationship between universities, government and business is essential to the success of ventures based on the assumptions defended by Industrial Ecology. Therefore, the efforts and strategies need to be aligned between the universities, the government and the private sector in order to favor for the development of SI activities. However, the results depend on a careful monitoring involving frequent review, as well as clear definition of the responsibilities of each of these actors (both for themselves and for the others).

4. Conclusions

From a theoretical point of view, one of its main the contributions provided by this research is to consider three theories, Systems Theory, Institutional Theory and Resource Dependence Theory together in relation to the assumptions defended by Industrial Ecology, emphasizing an analysis in the context of Social Sciences. This choice was made in line with recommendations in the literature suggesting the study of IE would benefit from approaches in this area. Thus, in this study, social/institutional and power/political issues and their possible interactions with EI are examined in an effort to broaden the understanding of what is being investigated.

In terms of managerial practice, studying Industrial Symbiosis in companies that do not operate with physical products (tangible), but rather service organizations is an advance. Thus, an effort was made to go beyond the mere physical application of IS concepts. Moreover, they are enterprises that are, in general, do not directly generate waste related to the production process.

Finally, given the holistic and systemic nature of IE, consideration of the five analytical categories developed in this study may serve as parameters for Industrial Symbiosis projects. In other words, working simultaneously with these categories may contribute towards mapping the weaknesses and strengths a particular project may have. Thus signaling the aspects that will merit more attention from the project coordinators.

Despite efforts to improve this investigation, the following limiting factors were identified: a) because it deals with a specific context and addresses institutional and policy aspects of a particular region, several data from the empirical study cannot be generalized; b) the researcher found it difficult to address issues on Industrial Ecology during the interviews with the surveyed actors. Moreover, the issue of IE is still considered recent and its practices little known in Brazil, and there is no industrial eco-park in the country.

In terms of recommendations for further studies, research into aspects related to business management and interorganizational relationships for the Industrial Ecology would be valuable, in particular involving the meso-level. Last but not least, it was found that in recent years the number of publications in the literature that address academic training in EI has grown. Due to the holistic and multidisciplinary approach to IE adopted in the present study, it is clear there is a need for suitable training in order for IE projects and initiatives to be successfully implemented.

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Trends, Related Topics and Future Directions on Sustainable Innovation

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Abstract

Sustainable development orientation creates value for society and organizations. In the organizational context, the integration of economic, environmental and social objectives generates corporate sustainability, obtained through the adoption of sustainable business strategies. Innovations focused on sustainability are called, in academic papers, as sustainable innovations, environmental innovations, eco-innovations or green innovations. This is an emerging subject whose terms and concepts are still not consolidated. In addition, the literature review indicates the need to identify the different aspects, trends and gaps in research. This systematic literature review aims at contributing to the ongoing discussion on sustainable innovation. The focus is on describing state-of-the-art innovations and the future of studies on this subject. In order to do this, the authors used bibliometric methods to broaden the discussion and provide an overview of the knowledge structure of researches on sustainable innovation. The present research expects to make a theoretical contribution to the development process of the subject, highlighting the following aspects: i) the social dimension of sustainable development has received less attention compared to the economic and environmental dimensions, despite them being theoretically inter-related and elements of the triple bottom line; and ii) the identification of a deep gap of theoretical and practical studies correlating sustainable innovation, organizational culture and strategies for corporate sustainability.

Keywords: Sustainable innovation; Environmental innovation; Corporate sustainability; Systematic literature review.

1. Introduction: sustainable innovation

The idea of innovation applied to environmental issues appeared for the first time in a 1987 report of the UN document Our Common Future coordinated by Gro Harlem Brundtland. It proposed long-term environmental strategies based on the rational use of natural resources through innovation. Since then, it came to be known in different research fields as “eco-innovations”, “environmental innovations”, “sustainable innovations” or “green innovations” (Schiedering et al, 2012; Boons and Lüdeke-Freund, 2013). This type of innovation takes into account Elkington’s (1997) economic, ecological and social aspects of sustainably. Table 1 presents some definitions identified in the literature that use the above terms: (1) - sustainable innovation; (2) - eco-innovation; (3) environmental Innovation and (4) green innovation.

The common thread of the above definitions is that they all recognize the importance of corporations’ role to the development of sustainable societies. The development of strategies and sustainable business models depends on changes in the organizational culture. Thus, the objectives of sustainable development create value for organizations and society. In the context of organizations, the integration of economic, environmental and social objectives created the concept of “corporate sustainability”, which is achieved through the adoption of sustainable business strategies (Baumgartner, 2009).

Table 1. Definitions of Sustainable Innovation.

Source	Definition

Brundtland (1987) (1)	"...the 'common interest' did not necessarily impede growth and expansion though it may have limited the acceptance and diffusion of technical innovations". "...the capacity for technological innovation needs to be greatly enhanced in developing countries so that they can respond more effectively to the challenges of sustainable development...the orientation of technology development must be changed to pay greater attention to environmental factors." "...Hence the procedures and policies that influence these exchanges must stimulate innovation and ensure ready and widespread access to environmentally sound Technologies".
Rennings (2000) (2)	"...the additional attribute of innovations toward sustainability is that they reduce environmental burdens..."
Kemp and Pearson (2007) (2)	"the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives".
Reid and Miedzinski (2008) (2)	"...means the creation of novel and competitively priced goods, processes, systems, services, and procedures that can satisfy human needs and bring quality of life to all people with a life-cycle-wide minimal use of natural resources (material including energy carriers, and surface area) per unit output, and a minimal release of toxic".
Andersen (2008) (2)	"…as innovations which are able to attract green rents on the market. (. . .) the concept is closely related to competitiveness and makes no claim on the "greenness" of various innovations. The focus of eco-innovation research should be on the degree to which environmental issues are becoming integrated into the economic process".
OECD (2009) (2)	"…the creation or implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organisational structures and institu-tional arrangements which – with or without intent – lead to environmental improvements compared to relevant alternatives".
Arundel and Kemp (2009) (2)	"…a new concept of great importance to business and policy makers. It is about innovations with lower environmental impact than relevant alternatives. The innovations may be technological or non-technological (organizational, institutional or marketing-based). Eco-innovations can be motivated by economic or environmental considerations. The former includes objectives to reduce resource, pollution control, or waste management costs, or to sell into the world market for eco-products".
Klemmer, Lehr, and Löbbe (1999) (2)	"Eco-innovations are all measures of relevant actors (firms, politicians, unions, associations, churches, private households) which; develop new ideas, behavior, products and processes, apply or introduce them and; which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets".
Oltra and Saint Jean (2009) (3)	"… as innovations that consist of new or modified processes, practices, systems and products which benefit the environment and so contribute to environmental sustainability".
Driessen and Hillebrand (2002) (4)	"…a rather pragmatic definition', stating that it 'does not have to be developed with the goal of reducing the environmental burden. (...) It does however, yield significant environmental benefits".
Chen, Lai, and Wen (2006) (4)	"…as hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management".

Corporate strategies that are sustainability-oriented promote changes in the organizational culture and aim at corporate sustainability. Changes on the relationship between the organization and its business partners can precede the integration of operations. Geffen and Rothenberg (2000) analysed the case of three North American automobile companies facing growing pressure regarding their painting process. Improvements in their environmental performance were achieved through the partnership with suppliers. The authors conclude that relationship with suppliers (Japanese style or based on the supplier's expertise) encourages and promotes "the introduction of environmental innovations in complex manufacturing processes" (Geffen and Rothenberg, 2000, p. 182). Later on, Baumgartner and Ebner (2010) recognized "collaboration" as a significant aspect of the economic dimension of corporate sustainability. Pujari (2006) analysed the factors that influence the market performance of new environmental products and observed the collaborative relationship between developers of new products and environmental experts, as well as the role of the supplier in the process, obtaining similar results.

The different types of corporate sustainability strategies identified by Baumgartner (2009) Dyllick (2000); Hardtke and Prehn (2001); Schaltegger and Dyllick (2002) and Baumgartner (2005) "describe generic possibilities on how to deal with the challenge of sustainability" (Baumgartner, 2009, p. 103). Such possibilities represent the different types of sustainability -oriented corporations, whose main characteristics are shown in Table 2.

Table 2. Strategies for Corporate Sustainability. Source: Baumgartner (2009) and Baumgartner and Ebner (2011).

Types of Strategy	Segment	Characteristics	Strategic results
Introverted (Risk mitigation strategy)	n/a	• Focus on compliance with legal standards to prevent risks; • Internal actions due to external pressures; • Replacement of materials forced by legislation; • Improvement of working conditions forced by stakeholders.	• non-systematic alignment with the principles of sustainable development;
Extroverted (Legitimation strategy)	Conventional	• Centred in external relations; • Focussed on public acceptance (license to operate and grow); • Stakeholders informed on relevant activities, in order to generate trust; • Low adherence of environmental programmes to sustainability principles	• legitimize the company's activities; • moderate risks and opportunities.
	Transformative	• Interaction with the market in order to change market conditions; • Creation of new market opportunities based on sustainable development using aspects of conservative and visionary strategies.	• High risks and opportunities linked to the company's image; • Loss of confidence and credibility of stakeholders when sustainability principles are mere marketing exercise.

Conservative (Strategy for efficiency)	n/a	• Focus on efficiency: products and services provided with low cost and low consumption of materials and energy; • Emissions and waste prevention; • Efficient production processes generate advantages by reducing environmental impacts; • Alignment with cleaner production processes; • Strongly internally oriented actions and strategies.	• Concurs with principles of sustainability (less material and less energy consumption); Low risk of implementation; • Increased competitiveness promote more efficient and effective production processes.
Visionary (Holistic sustainable strategy)	General	• Business activities are sustainability-centred; • Sustainable development incorporated in corporation's vision and strategy; • Competitive advantages derive from differentiation and innovation.	• Strong sustainable oriented development; Total corporate commitment; • Market acceptance risks higher in a systemic perspective than in the conventional one
	Conventional	• Based on market opportunism; • Sustainability is part of the strategic management, while there are market advantages.	
	Systemic	• Combines elements of conventional visionary strategy with a resource-based view; • Sustainable development deeply rooted in the company's norms.	

The adoption of one of those strategies is directly linked to organizational culture. Organizational cultures tend to change slowly over time and are the result of changes in the business environment, leadership, management, as well as formal and informal socialization processes. For this reason, the literature questions whether it is possible to manage changes in corporate culture. Two perspectives address this issue: a positivist perspective considers culture as a variable that can be managed within organizations; a constructivist approach considers reality as a subjective concept, built by individuals through social interactions, which, in turn, build organizational culture, so that it cannot be managed (Baumgartner, 2009).

A literature review of researches on sustainability by Markard et al. (2012) identified changes in existing practices, technologies being used, business models, value chains, organizational structures, and institutional policies and regulations that require a period of adjustment to the paradigm of sustainability (Markar et al., 2012). Such evidences gave rise to the concept of sustainability transitions, which encompasses the "fundamental and multi-dimensional long-term procedures through which established socio-technical systems switch to more sustainable modes of production and consumption" (Markar et al. , 2012). According to the authors, transition studies favour four frameworks: (i) transition management; (Ii) strategic niche management; (Iii) multi-level perspective on socio-technical transitions, and (iv) technological innovation systems. Changes in organizational culture tend to change slowly over time (Baumgartner, 2009) and so it does those that are critical to the organizational adjustment to the paradigm of sustainability.

In practical terms, corporate sustainability deals with the aspects and issues that have an impact in the companies' operations and business, in themselves, in stakeholders and in the whole society, within an economic, ecological and social sustainable development perspective. Baumgartner and Ebner (2010) study is based on the literature to demonstrate the most relevant aspects these three dimensions. The economic dimensions of sustainability take into account the organizations' economic success and financial results. Their main features are: innovation and technology; collaboration; knowledge management, processes; purchasing practices; sustainability reports. The ecological dimension addresses the environmental impacts of business activities, such as the use of resources; air, water and soil emissions; general and hazardous waste; biodiversity, environmental characteristics of products. The social dimension focusses on corporate responsibility for the results of their activities that would allow them a long-lasting permanency in the market. The author divides the latter's main elements in internal and external: internal elements include corporate governance, motivation and incentives, health and safety and human capital development; external elements encompass ethical behaviour and human rights, non-involvement in controversial activities and corporate citizenship (Baumgartner and Ebner, 2010).

In conclusion, innovations focused on sustainable issues are called, in academic papers, as environmental innovations, sustainable innovations, eco-innovations or green innovations. Being an emerging subject there is no consolidation of concepts and terms used and literature reviews point to the need of identifying the different aspects, trends and gaps in research. This paper aims at contributing to the ongoing discussion on sustainable innovation by carrying out a systematic literature review. The focus is on describing the state- of-the-art and the future directions of studies on sustainable innovation.

2. Methods

In order to reach the objective, we deployed bibliometric methods to deepen and provide an overview of the knowledge structure of the sustainable innovation research.

Specifically, to frame the state of the art of the topic, we employed different bibliometric measures: the publication activity and the co-word analysis (Benavides-Velasco et al., 2013). Indicators of the publication activity allow researchers to deepen the quantitative evolution of literature, by identifying the most representative journals, institutions and countries publishing in the discipline (Benavides-Velasco et al., 2013; Callon et al. 1983), whereas, the co-word analysis of the author-provided keywords allows researchers to frame the conceptual structure of the topic and to obtain insight for future research that could contribute to the advancing, as well as, to the consolidation of this discipline (Benavides-Velasco et al., 2013).

It focuses on co-occurrence frequency of terms (e.g. keywords or subject headings) (Benavides-Velasco et al., 2013; Muñoz-Leiva, et al., 2012; Callon et al., 1983), to identify and disclose the structural and dynamic aspects of scientific research area (Börner et al., 2003; Callon et al. 1991; Cooper, 1982), by discovering linkages among subjects in the field and tracing emerging research areas (Qin He 1999; Bhattacharya & Basu, 1998). As Qin He (1999) stated, the co-word analysis is a powerful technique that offers a significant approach to knowledge discovery.

The ISIWeb of Science was defined as data source due to its reputation of being one of the most important bibliographic databases. In order to set the research domain, we searched for scientific articles using the term "Sustainable Innovation*" OR "Environmental Innovation*" OR "Eco Innovation*" OR "Green Innovation*".

The initial search reveals a total of 1,501 documents, from which we selected according to some conditions: (i) only articles; (ii) only written in English; and (iii) from three specific domains – management, business, and economics. These criteria lead to a corpus of 290 scientific articles, which were submitted to clustering and mapping techniques through Bibexcel and VosViewer (version 1.5.4) software.

The co-occurrence frequency of terms was used to build a map based on network data, in order to identify and disclose the structural and dynamic aspects of the scientific research area. Finally, we created a bibliometric map to show, in a visual way, strong associations and divisions between the several fields of the sustainable innovations stream of research. The map showed 4 different clusters based on the most significant keywords (the higher frequency keywords).

3. Results and Discussion

The following discussion demonstrates, through tables and figures, some publication activities indicators and research domains on the sustainable innovation. They offer some insights to structure the evolution of the literature on the topic.

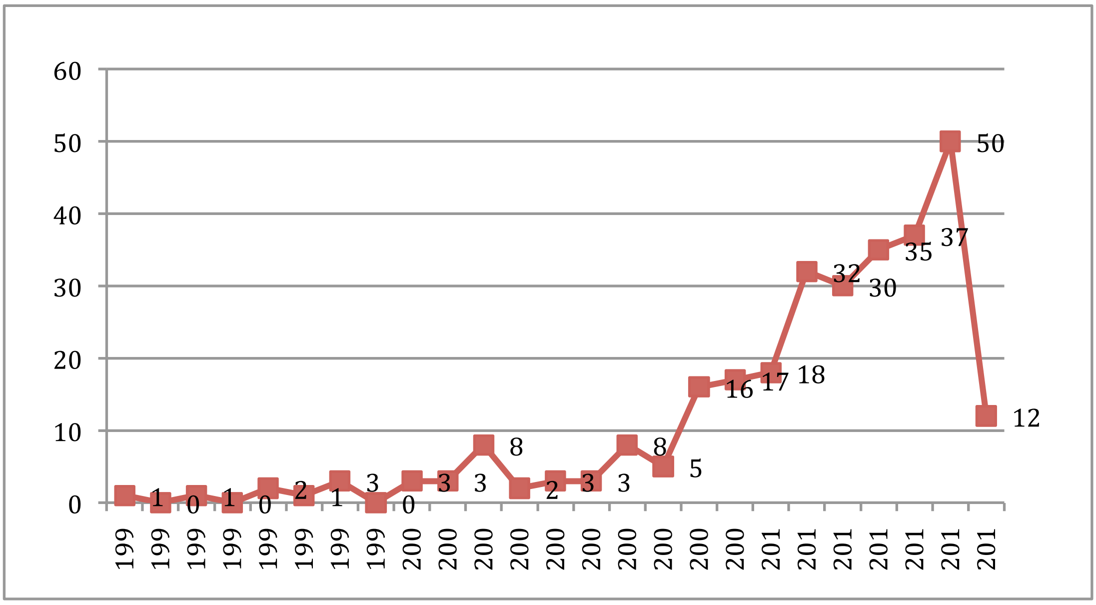

Figure 1. Annual totals of papers on Sustainable Innovation across Management, Business and Economics categorie on Web of Science database (1992-2016 (incomplete)) (Our elaboration).

However first contribuition on sustainable innovation was published in 1992 (according Web of Science database) the increasing number of papers and domains emmerging in the last years allouws to conclude that it constitutes a new stream of research in its evolutinary stage.

The scientific production on sustainable innovation shows an increasing interrest on the topic. Is has been characterized by three waves: the first significant growth rate during the 2008 (220%), the second, durinng the 2012 (77%) and the thrid, since 2015 (35%).

The 290 papers have been published by 93 journals with an average of 3.11 papers per journal. Data reveal a trend to concentrate the academic production: 19.4% of the journals published more than three papers by producing 66.2% of the contribution of the field. Among this, the top ten journals (the most productive) covered 32.4% of the scientific production (Table 3). On the other hand, data show that 23.8% of the journals published 1 or 2 papers on the topic. This analysis reveals a need to spread the field by relating sustainable innovation to new different topics and, consequently, increasing other journals participation.

Table 3. Most cited papers on Sustainable Innovation, according to Web of Science (Our elaboration).

	Authors	Title	Journal	Year	Citations
1	Rennings, K	Redefining innovation - eco-innovation research and the contribution from ecological economics	Ecological Economics	2000	264
2	Brunnermeier, SB; Cohen, MA	Determinants of environmental innovation in US manufacturing industries	Journal Of Environmental Economics And Management	2003	197
3	Schot, J; Geels, FW	Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy	Technology Analysis & Strategic Management	2008	175
4	Lanjouw, JO; Mody, A	Innovation and the international diffusion of environmentally responsive technology	Research Policy	1996	169

5	Geffen, CA; Rothenberg, S	Suppliers and environmental innovation - The automotive paint process	International Journal Of Operations & Production Management	2000	168
6	Horbach, J	Determinants of environmental innovation - New evidence from German panel data sources	Research Policy	2008	144
7	Chen, YS; Lai, SB; Wen, CT	The influence of green innovation performance on corporate advantage in Taiwan	Journal Of Busi-Ness Ethics	2006	138
8	Markard, J; Raven, R; Truffer, B	Sustainability transitions: An emerging field of research and its prospects	Research Policy	2012	117
9	Rehfeld, KM; Rennings, K; Ziegler, A	Integrated product policy and environmental product innova-tions: An empirical analysis	Ecological Economics	2007	106
10	Pujari, D	Eco-innovation and new product development: understanding the influences on market performance	Technovation	2006	98

The analysis of the most cited keywords (Figure 2) show the themes usually related to sustainable innovation, such as, “innovation” itself, “environmental innovation”, eco-innovation”, “sustainability”, among others. The analysis show the high heterogeneity of the research field, as 50.1% of the key-words were cited just one time. This low level of frequencies reveals the wide variety of information and also the novelty characteristic of the sustainable innovation research.

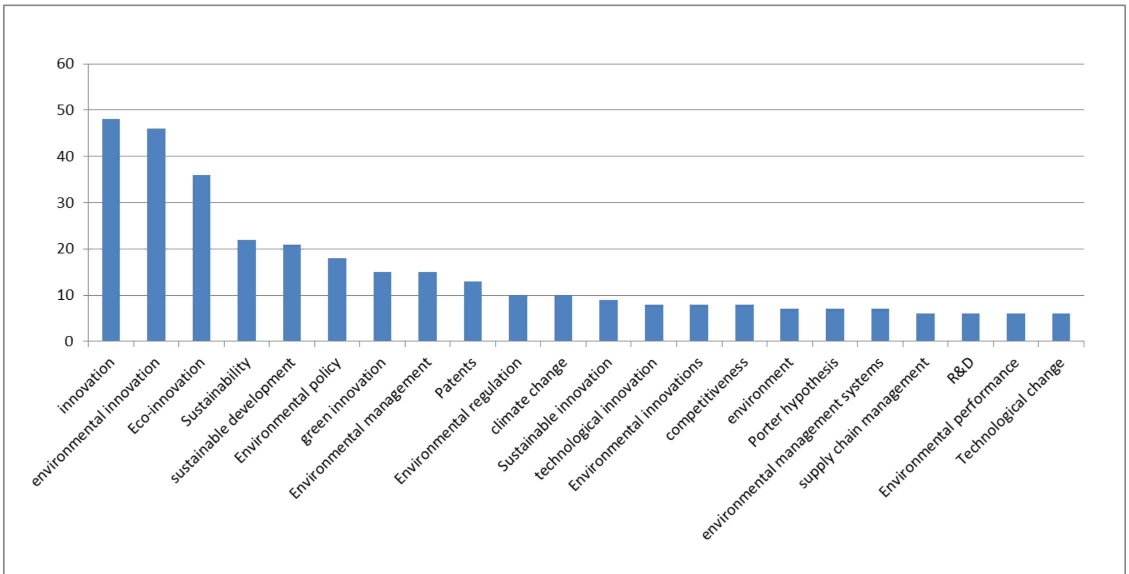

Figure 2. Most cited keywords.

In order to reach the state of the art and identify some research trends, we adopted a visual representation by using both the mapping and clustering techniques. They provide us the keyword co-occurrence network by means of a bibliometric and density maps that show the divisions, associations and main clusters for sustainable innovation field.

The following map (Figure 3) discloses the structural and dynamics aspects of academic research on the topic. In the bibliographic map, each node (theme) is positioned between other nodes to which it is connected by edges. The absolute position of a node on the map is not meaningful, but its relative position is: the closer the nodes in the map, the stronger the relationship between the themes. The size of the color bubble is straight linked to the number of descriptors occurrences; colors are used to indicate different clusters (Callon et al., 1991).

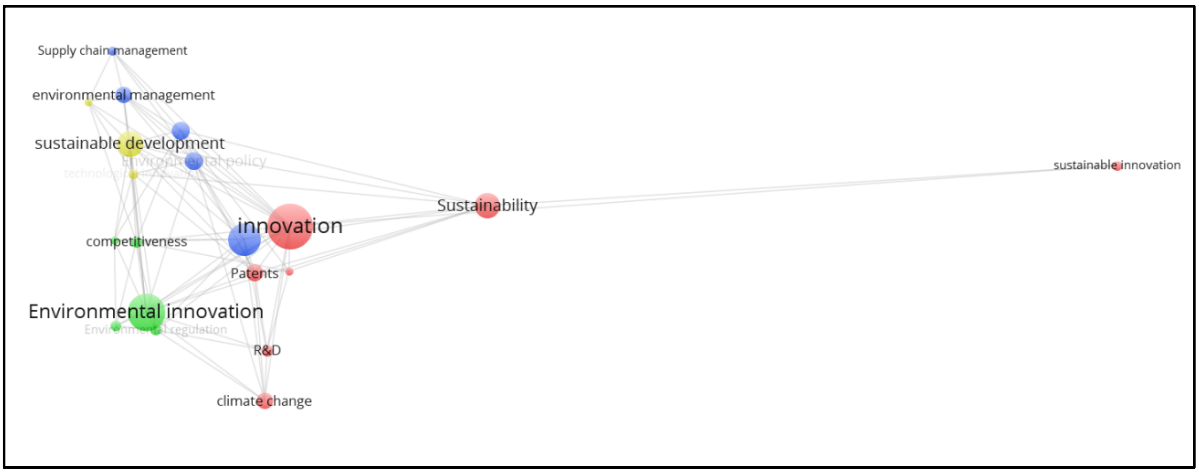

Figure 3. The concept map of Sustainable Innovation (our elaboration).

Associations formed by high frequency keywords generated four clusters whose visual representation is shown in Figure 2.

After analysing the concept map of sustainable innovation, the authors realized that the main issues related to sustainable innovation are divided among the four clusters, which shows that there are still no relatively exclusive thematic areas. Moreover, they observed that the term "sustainable innovation" is far removed from the others: the remaining themes are closer to each other than to the main search subject. This demonstrates that "sustainable innovation" is a new field and still did not establish strong relationship to other related topics. This situation is even more evident in the density map (Figure 4).

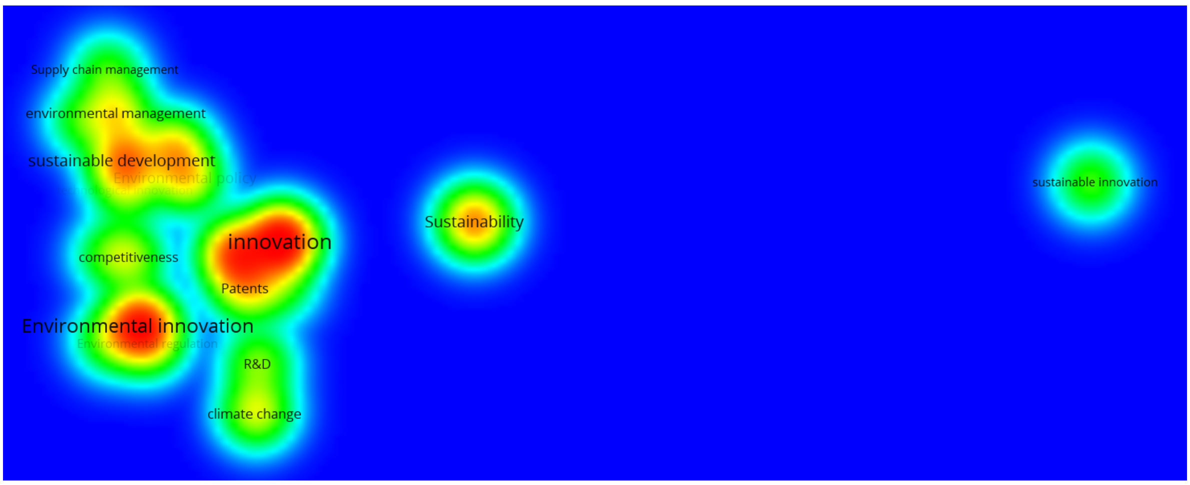

Figure 4. The density map of Sustainable Innovation (our elaboration).

The map shows four clusters: red color indicates more investigated topics and well-established research domains, whereas yellow/green colors identify new and emerging research areas. The density map shows four more important areas: "innovation", "environmental innovation", "sustainable development" and "sustainability".

The analysis allowed the researchers to observe that, taken on their own, terms "sustainab *" and "innovation *" appear as consolidated areas, while "sustainable innovation" appears in under-construction domain. Sustainability is a set of organizational and technological innovations that should be encouraged, because sustainability is the main driver of innovation (Nidumolu; Prahalad; Rangaswami, 2009). Moreover, it is clear that the environmental dimension of triple bottom line is the most represented ("environmental innovation"), which indicates that a more complete interpretation of the tripod is still under construction ("sustainable innovation").

Considering that the limits between subjects have not yet been consolidated, the authors adopted a criterion for identifying the differences between clusters and for naming them: to analyse the abstracts containing at least two keywords (main descriptors) of each cluster and identify which one could differentiate it properly from the others. The clusters identified were: Research & Development (R & D), Environmental regulation, Supply chain management and eco-efficiency. The main descriptors of each cluster are presented in Table 4.

Table 4. The clusters's descriptors (our elaboration).

Cluster	Main descriptors
Research & Design (P&D) (red - 7 items)	Climate change Innovation Patents Performance R & D Sustainability Sustainable innovation
Environmental Regulation (green - 5 items)	Competitiveness Environmental innovation Environmental performance Environmental regulation Porter Hypothesis
Supply Chain Management (blue - 5 items)	Eco-innovation Environmental management Environmental policy Green innovation Supply chain management
Eco-efficiency (yellow - 3 items)	Eco-efficiency Sustainable development Technological innovation

The first cluster differs by the relations of sustainable innovation with Research and Development. Along with "innovation", "patents" and "performance", Research and Development stands out in this group. In fact, the latter is directly related to "technological change which is relevant for eco-innovations research" (Rennings, 2000, p. 328). Eco-efficiency and clean production are obtained through new technologies applied in production processes. The R & D cluster is essentially a set of the company's internal elements connecting research with sustainable innovation.

The second cluster is environmental regulation. Studies demonstrate that when elements related to technology and market do not have enough impact to promote eco-innovations, regulations perform this role: “The demand for drastic reductions of environmental burdens Implies that adaptation within existing technologies is not sufficient. Instead, regulation strategies to effect ‘technology forcing’ and/or ‘technological regime shifts’ are needed” (Rennings, 2000, p. 320). Porter and Van der Linde (1995) state that well-sized environmental legislations can induce the development of eco-innovations in business by reducing costs through a better use of raw materials, reuse and use of alternative materials, as well as reduced packaging. Upon receiving this name, the cluster appears as one of the company’s external elements (environmental regulation) and one of the main drivers for sustainable innovation.

The third cluster highlights the relationship between the company and its supply chain. A company’s supply chain management aims at adopting sustainable practices throughout the product life cycle. Analysing three cases of collaboration with the suppliers Geffen and Rothenberg (2000, p. 166), the authors concluded that “... strong partnerships with suppliers, supported by appropriate incentive systems, were a significant element of successful application of innovative environmental technologies”. Likewise, Pujari’s (2006) survey concludes that an environmental new product development (ENDP) depends on cooperation with suppliers: “there was found to be statistically significant relationships between market performance and several independent factors, such as functional co-ordination, supplier Involvement, market focus and LCA [life cycle assessment] activities” (p 83).

The fourth cluster highlights eco-efficiency as a differentiator. Like in the R & D cluster, eco-efficiency is a company’s internal factor. Sustainability objectives arising from eco-innovations are achieved through eco-efficiency. According to the World Business Council for Sustainable Development (WBCSD) it is a management philosophy that encourages the search for environmental improvements:

> “Eco-efficiency is achieved by the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth´s estimated carrying capacity. In short, it is concerned with creating more value with less impact” (WBCSD, 2000, p. 4).

The present research identified two clusters: one emphasized internal elements and two others, external aspects. Moreover, the “environmental” support of the triple bottom line was the most representative and present in all clusters. It employed terms such as “climate change”, “environmental performance”, “environmental regulation”, “environmental management” and “environmental regulation”.

Except for terms “sustainability”, “sustainable innovation”, “environmental innovation”, “eco-innovation”, “green innovation” and “sustainable development”, whose concepts encompasses economic, environmental and social sustainability, none of the others dealt with the social perspective. The conclusion is that in the areas of knowledge surveyed in database Web of Science - management business and economics - the social dimension of sustainable development has received less attention in comparison with the economic and environmental dimensions, although all of them are, in theory, interrelated.

Concomitantly, there is also a deep gap of theoretical and practical studies correlating social dimension of sustainability, organizational culture and strategies for corporate sustainability. Baumgartner (2011), discussing on the practices of and research on sustainable development concludes that, despite the subject being intensely debated, "real progress of our societies to Become more sustainable is very slow" (Baumgartner, 2011, p. 783). The author exposes its conclusions by stating that “it is questionable if we have made ‘real’ progress towards more sustainable societies. Many sustainability related problems continues to be unsolved or Their impacts have Increased; beside many other problems such as climate change, biodiversity losses, the tremendous amount of poverty and discrimination against women Have Become more severe since 1987 "(Baumgartner, 2011, p. 783). The results of our study confirm the impressions of Baumgartner (2011) on the social perspective of sustainability.

There are but few theoretical and practical studies that connect social dimension of sustainability, organizational culture and strategies for corporate sustainability. Baumgartner (2011) studies practices and research on sustainable development concludes that, despite the intense debate, “real progress of our society to become more sustainable is very slow” (Baumgartner, 2011, p. 783). The author affirms that “it is questionable if we have made "real" progress towards more sustainable societies. Too many sustainability related issues are still unsolved or their impacts have increased; besides, many other problems such as climate change, biodiversity losses, the tremendous amount of poverty and discrimination against women have become more severe since 1987”. The present research confirms Baumgartner’s theories on the social perspective of sustainability.

5. Conclusions

Sustainable development orientation creates value for society and organizations. In the organizational context, the integration of economic, environmental and social objectives generates corporate sustainability concepts obtained through the adoption of sustainable business strategies.

This systematic review was able to identify four main aspects. Firstly, the construction of a network of themes allowed the identification of emerging areas. By analyzing this network, the researchers concluded that sustainable innovation is an emerging subject tied to concepts such as “innovation”, “environmental innovation” and “sustainability”. Moreover, the environmental dimension of the triple bottom line (“environmental innovation”) has received more attention from researchers, indicating that a more complete view of the tripod ("sustainable innovation") is still under construction.

Secondly, the findings show that the social dimension of sustainable development has received less attention compared to the economic and environmental dimensions, although all of them are, in theory, inter-related and constituents of the triple bottom line.

Thirdly, the analysis of the clusters identified two clusters that emphasized internal elements (R & D and eco-efficiency) and two that stressed the external ones (Environmental regulations and Supply Chain Management). Such findings reveal four main research foci that will be broadened in the next steps of the research.

Finally, the authors identified a deep gap in the theoretical and practical studies that connect sustainable innovation, organizational culture and strategies for corporate sustainability. Indeed, corporate strategies that promote changes in organizational culture and lead organizations in search of corporate sustainability are the key elements the commitment to sustainability.

In order to fill such gaps, the next stage of the research, will carry out a thorough analysis of the most cited articles (using content analysis) in order to identify the dimensions, strategies and degrees of maturity of sustainability. Another aspect to consider is a presumed relationship between changes in the organizational culture and the factors related to sustainability transitions, which can be a research object for future studies.

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Industrial symbiosis, the Ecopark Natura analysis: implementation challenges

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Abstract

The cosmetic industry is evaluated at 390.07 billion dollars according to the Allied Market Research in their study "Global Cosmetic Market", in 2015. Growing longevity and issues associated with the environment and greater income availability brought new challenges to the research and development sector and broadened the spectrum of consumers, four-fifths of which are women, and increased expectations for a growing turnover. Global demand for more natural cosmetics of sustainable sources increases the procurement of consumers willing to pay for sustainable technologies, products and processes. In this context, the assumptions of Industrial Ecology (IE) are highlighted. Application of the IE concepts can be a source of competitive advantage, allowing residues to become marketable by-products, due to the need to increase efficiency in the use of energy, materials and the elimination of losses. Among its key features is the integration of the system's components to reduce: a) inputs, b) the generation of pollutants; c) waste outputs, and special application on the inter-organizational level, featuring Industrial Symbiosis (IS). Although medium and long term periods are necessary for the development of IS, its potential to help enterprises interested in optimal performance of corporate environmental sustainability, by entail integrated actions between industries is recognized. Initiatives like those of ecoparks - places in which enterprises cooperate with each other and with the local communities, sharing resources and resulting in economic income, environmental and human development - are where the principles of IS have a better implementation. This paper analyzes the development of an industrial ecopark in Brazil based on a focal company of the cosmetic industry (Natura S/A) as an effort for sustainable development. The main challenges were identified and recommendations were made to contribute to its viability. The authors also describe the ecopark under study and its relation to sustainability values and IE. The main challenges involved are presented by a member of the company administration board and some recommendations are presented by this study as a contribution to the viability of such an ecopark in the Brazilian entrepreneurship governance context based on transferable foreign experiences identified in the bibliography. The following are the more relevant: 1) clear identification of the ecopark´s focal enterprise inputs and outputs; 2) careful analysis of the demands and expectations of any applicant enterprise and its commitment to IE rules, and above all those established by the focal enterprise; 3) the governance system must be transparent and followed by all those in the ecopark; 4) the ecopark must be recognized as a social model and as an example of sustainable development by the community, promoting the exchange of experiences within and without of its physical boundaries. In the final considerations, the authors conclude that the Industrial Ecology process on its three levels of action can be successfully achieved in Brazil.

Keywords: Cosmetics Enterprise; Industrial Ecology; Industrial Symbiosis; Industrial Park; Sustainable Development.

1. Introduction

Progressively, there have been societal concerns for sustainability issues accompanied by their inseparable challenges. In this sense, as an alternative to achieve it, in the 1980s it receives evidence the assumptions of Industrial Ecology (IE) (Erkman, 1997). Even if the concept of IE can be considered recent, given the body of knowledge that surrounds it, can be viewed as a science of sustainability as part of the metaphor of nature to analyze and optimize the industrial complexes, logistics and consumption, as well as your energy flows and materials (Jelinski et al., 1992; Erkman, 1997; Cohen-Rosenthal, 2000; Ehrenfeld, 2000; Hoffman, 2003; Isenmann, 2003; Korhonen, 2004; Costa et al., 2010). Thus, according Deutz (2009, p. 276), IE "includes theory and practice to the implementation of sustainable development."

In 1994, Robert White proposed the definition of Industrial Ecology (Lifset and Graedel, 2002) as the study of the flows of materials and energy in industrial activities and its consumption, its effects on the environment, and economic influences, political, regulatory and social on the use and transformation of resources (White, 1994). Erkman (1997) mentions that the implementation of IE can be a source of competitive advantage, allowing any waste to become marketable by-products, given the need to increase efficiency in the use of energy and materials and the elimination of losses. Thus, it acts as a tool with clear economic, environmental and social properties (Ehrenfeld, 2000). One of the fundamental characteristics of IE is the integration of several components of a system to reduce: a) input means; b) the generation of pollutants; c) waste outputs, and special application in the inter-level (Despeisse et al., 2012).

According to Isenmann (2003), the Law can be understood in general terms through its five characteristics, namely:

i) its fundamental perspective: having nature as a model;
ii) its primary objective: to seek harmony, balance, integration of ecological and industrial systems;
iii) the definition of work: a science of sustainability;
iv) its main objects of work: products, processes, services and waste;
v) its central idea: the search for systems interlacing.

As the manifestation of Chertow (2000), IE has three different levels or performance scales (Figure 01). The first classification refers to activities developed internally to the organization (intra-organizational) and corresponds to actions such as eco-design, pollution prevention and green accounting. At the intermediate level (meso) are initiatives involving inter-organizational relationships such as Industrial Symbiosis, industrial ecoparks (EPI) and analysis of the product life cycle. Finally, at the regional or global level (macro) are the analysis of the flow of materials and energy, as well as policies and development plans.

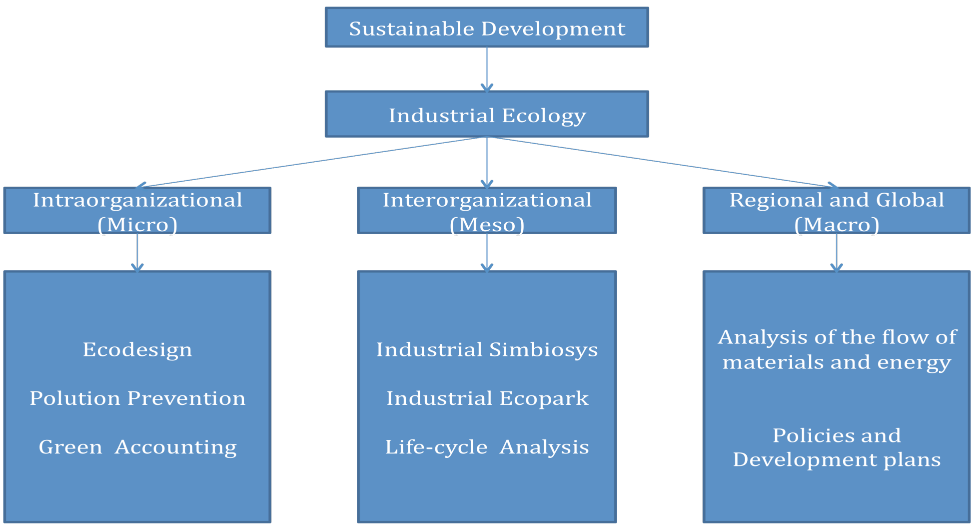

Figure 01. IE performance scales

Source: Adapted from Chertow, 2000, p. 315.

Thus, Turkish et al. (2011) argue that the Industrial Symbiosis (or meso level) may be the most widespread application of IE, whose activity involves not only interorganizational exchanges of materials, products, water, energy and waste. Deserving highlight the exchange of human and technological resources, and its experience and knowledge (Posch, 2010). Also noteworthy is the rise of thematic SI due to the encouragement of non-governmental organizations, state agencies and the private sector to adopt their practices and to increase the number of studies on the subject in an attempt to soften the impact on the environment (Boons et al., 2011).

Although necessary periods of medium and long term for the development of the main scales of Industrial Ecology (Boons et al., 2011), it can be considered a potential with tool to help companies "interested in optimal performance of corporate environmental sustainability for cause actions between industries, requiring regional planning and policy "(Lima, 2008, p. 91).

In turn, Chertow (2000) and Sakr et al. (2011) state that it is in environments such as industrial ecoparks (PPE) - places in which companies cooperate with each other and with their local communities, sharing various resources and getting returns in economic, environmental and human terms (Chertow, 2007) - that the principles of IS are the best means of implementation.

Thus, this study aims to analyze the development of an ecopark in Brazil from a focal company (Natura S/A) of the cosmetic industry. Specifically, it seeks to identify the key challenges and make recommendations to contribute to its viability.

Therefore, this paper is structured in six sections, considering this introduction. The second refers to the description of the cosmetic industry, briefly exposing a context of global and Brazilian context. The third section describes eco-park factors under study and that are related to sustainability. Subsequently, the main challenges involved are presented and, in the fifth section, are presented recommendations to contribute to the viability of the eco-park. Finally, expose the final considerations.

2. Description of the cosmetic industry: global contexts and Brazil

The cosmetics industry at the global level is, according to Allied Market Research (2015) in their study Global Cosmetic Market, 390.07 billion, a fast-growing market. Factors such as increasing longevity, problems associated with through increasingly hostile environment, as well as greater availability of income, bring new challenges to the industry in the research and development chapter as well as broaden the spectrum of consumers, in which four-fifths are women, making also grow turnover. Today the global demand for natural cosmetics and sustainable source increases, recognized and required by traditional consumer markets increasingly concerned and available to pay for technology and source sustainable products and processes.

Of the total volume, Brazil is responsible for 38 Million Reais, according to the Brazilian of Personal Hygiene Industry Association, Perfumery and Cosmetics (ABIHPEC) in your document characterization of the sector; also highlighting a growth of more than nine times from 1996 to 2014, the year that reports the study. This growth factors such as: the extension of consumer classes via a higher disposable income; investment in research and development (R & D) and consequent increase in productivity and; product diversification and increased participation of women in the labor market, and this time the third consumer worldwide of this type of products (ABIHPEC, 2014). According to Euromonitor (2015) Brazil is the first consumer of perfumes and deodorants, the second in hair care products, toiletries, depilatories and sun protection; third in cosmetic products; room in oral hygiene and fifth in skin care products.

The sector's contribution to the trade balance is also relevant, from a deficit position until 2002, when it began to have a surplus (ABIHPEC, 2014). Thus, Natura S/A company in its ecopark installed in the city of Benevides, state of Pará, will operate with those products added, globally represented in 2013, 20.6% of total personal hygiene, perfumery and cosmetics (CT & F) exported by Brazil.

A total of 2,470 Brazilian companies operating in the cosmetics sector, 12 are located in Para state crossed by the Amazon River and possessing high degree of bioprospecting data ecosystems terminating.

3. Description of the factors related to sustainability: social, economic and environmental

Natura ecopark, has a total area of 172 hectares, is located in the municipality of Benevides, in the metropolitan area of Belém, Pará (Figure 02).

Figure 02. Benevides' Geographical position in relation to Para and Brazil

Source: Benevides, 2015.

In a community of about 42,000 in 2007, the company's installation created in 2014, according to the company, 250 direct jobs representing about half a percent of the total city population. There are 2,571 families involved in the production process, through 25 cooperatives contracted as company's suppliers. The qualification and classification of suppliers are ruled by strict regulations, which are based on ISO quality benchmarks, environment, hygiene, health and safety and social responsibility, which requires all entities the full respect for generally accepted rules prevents the contamination of the production lines of the company against products or proceedings not compatible with the values of sustainability (Natura 2015).

From an economic point of view, the company's facility in a location near the raw materials sources, allowed the incorporation of up to more than 30% of assets in the final product without affecting the price, thus improving product's and company's performance and image. On the other hand, the bioprospecting that this new placement allowed, potentiated innovation (Alves et al., 2015) and the addition of new assets in the EKOS line, a line developed exclusively with native species from Amazon, and add at this point 14 new actives, of which stands out the most recent, the Ucuuba (Natura 2015). As the company's expectation that at this stage only engaged in this unit, the production of soaps and oils, will be the full range of installation products, it is expected that the Ecopark receives businesses likely to integrate this effort towards sustainable development, creating that space a productive synergy and productive and commercial interconnection, can be classified as symbiotic.

The sum of the eco-tourism process puts this project at the intersection of three major areas, environment, economy and society, creating extra sources of income for local communities, disseminating knowledge, limiting and monitoring human intervention and saving natural resources.

In the environmental chapter, beyond self imposed strict rules and placed a third party, we are witnessing a bioprospecting process (Santos, 2015) which has cataloged and used new and eligible forest assets, actively contributing to the sustainability of nature as well as the profitability of which depend on actively limiting the depredation of resources beyond the natural renewal fees. At the same time and according to the company, all the ecopark has been designed and integrated technology solutions that advocate its energy sustainability and enhance its independence on external water resources, which can be a competitive advantage for companies that decide to settle in ecopark and follow Natura this sustainable entrepreneurship (Natura 2015).

4. Description of the main challenges in implementing the Natura ecopark

In the development of this section, the authors were based on the specific literature of the subjects under study by consulting research of several researchers (Jelinski et al., 1992; Erkman, 1997; Cohen-Rosenthal 2000; Ehrenfeld, 2000; Chertow, 2000 and 2007; Hoffman, 2003; Isenmann, 2003; Korhonen, 2004; Veiga, 2007; Costa et al., 2010; Posch, 2010; Sakr et al., 2011).

The development of a set of questions that was sent via e-mail in August 2015, Ecopark Partnerships Manager of Natura S/A. Following the results is detailed referring to the description of the main challenges identified in the implementation of sustainability in the cosmetics sector, specifically the implementation of the said company ecopark in the city of Benevides in Pará. In accordance with the factors highlighted by Veiga (2007) to study industrial ecoparks initiatives in the State of Rio de Janeiro who failed to advance in their actions, researched professional pointed out that the main difficulties are linked to the economic and regulatory issues. Moreover, they are present aspects related to access to services and qualified personnel, as well as a network of regional suppliers in approvals.

They were also highlighted by the participants of this significant study: challenges related to governance and condo rules, as well as the balance between attracting companies that meet the objectives of the enterprise (industrial symbiosis, sustainable development, etc.) but no barriers to prevent the entry of most potentially interested companies (searched Manager).

In this regard, he wondered as the representative of Natura assesses a governance model of an ecopark on a guided focal company / anchor, in contrast to a model with shared management. In his response was given emphasis to the fact that the company does not wish to act as leader of the ecopark. The intention is to act in a condominium structure, in which the management of the industrial complex will be independent and shared by all occupants.

This demonstration is in line with the findings of Goldstein et al. (2011) and Choi (2012), which recommend that management elements such as planning, preparing people (training and development) and management processes can interfere with social and environmental performance this type of venture. Superior performance that includes the area of the environment must pervade investments in research and development in eco innovative products and changes in business practices (Lombardi and Laybourn, 2012).

A process of mutual learning and a shared strategic vision of interests and difficulties it is necessary, and these must also be tackled by a comprehensive economic analysis, political, cultural and social development of local and regional variables (Boons and Spekkink, 2012; Lombardi and Laybourn, 2012; Chertow and Ehrenfeld, 2012; Cavalcante, 2012). An important caveat, brought by Chertow (2000), highlights the fact that the principles of Industrial Symbiosis not need to occur in the narrow limits of a so-called environment as PPE. Nor is it enough to designate a site as an ecopark that this is associated with real symbiotic inter-organizational relationships. In fact, the name is irrelevant, given the possible outcomes that the initiative could bring in economic, social and environmental terms. What matters is the coordination team be aware that, to achieve them, there is not (yet) a unique form or shape, and also that the challenges are wrapped in long-term issues, the necessary investments in their legislation and the various associated risks, in line with the social, institutional, political and cultural peculiar to each locality.

When asked about the estimated time for the ecopark Natura reaches its fullness of action, the manager said the following, demonstrating long-time need for awareness so that such initiatives can acquire maturity, "between 20 and 30 years is our estimate, but only have a better view of that period from the next 5 years "(researched Manager). Finally, it was requested to researched to explain how the company seeks to work to establish a culture of cooperation and confidence, able to promote the sharing of knowledge, technology and experience between the various stakeholders (universities, governments, families and other partner companies) with the ecopark. In response, it was stated that this culture has been built in the region since the early 2000s, when the Natura started its activities in the Amazon region. The participant also pointed out that:
were many learnings, with mistakes and successes in this period. I believe that trust and cooperation we got came from a consistency of purpose of what we want in and for the region. In all our dealings with government, suppliers, supply rural communities, consumer public, NGOs, etc. We try to create an environment of innovation and building something positive, with transparency and constant dialogue and present (searched Manager).
Given the above, it appears that the main challenges in implementing the ecopark study should be highlighted (i) the need for a long-term performance, (ii) establish guided partnerships in a culture of endogenous cooperation, knowledge sharing , power, technology, among other factors; (Iii) rely on local stakeholders sensitized, such as governments, unions and businesses; and (iv) increase knowledge and awareness of the aspects related to sustainability.

5. Recommendations to contribute to the viability of the ecopark

The intra-organizational point of view, given the environmental awareness revealed by the company, you can agree that actions tend to be designed and implemented in accordance with what is understood today as sustainable. On the other hand, the concern lies in the full implementation of an ecopark, from an economic cross-organizational initiative, socially and environmentally sustainable.

Thus, the clear identification of the inputs and outputs of the main ecopark unit can be the starting point to establish a grid of selection of business activities to install the ecopark. The insight of this work will influence the success of the initiative, clearly indicating the activities to be included in the project.

In a second phase, they should be considered the space requirements, hand labor, R & D and partner resources to install, since there are resources that are limited. This analysis will include the information provided by the interested company and external contexts and must include the degree of commitment to the principles of Industrial Ecology that already guide Natura procedures, this may avoid future organizational disagreements, for conceptual disparity or draining resources.

Thus, the governance rules should be clear, endorsed and implemented by all members of the ecopark, so that coexistence is regulated and profitable. The investment in the training of cadres and intervention in the community should be continuous and conducted within and outside the premises. So that is able to guarantee interaction between all agents and local business development and cause the Ecopark is recognized as sustained development generator. This thought is expressed by professional researched by stating that: “in Echo Park, we are willing to share our learning and our relationships with companies that will be installed. Since the structure of a chain of raw materials, possibly via relationship with communities of family farmers and gatherers, to the guidance for regulatory processes and sharing symbiosis and business opportunities” (searched Manager).

As Costa et al. (2010) and Lombardi and Laybourn (2012) Industrial Symbiosis receives a significant boost to the economic benefits that entrepreneurs glimpse from the market dynamics and legal and social requirements. Some organizations seek Industrial Symbiosis as a response to regulatory pressure and charges for sustainable development (Chertow, 2007).

Thus, Posch (2010) calls attention to the fact that, a priori, one should not believe that all companies are willing to cooperate for the benefit of environmental and social issues.

However, organizational relationships will occupy your space and give the expected return, as the results of cooperation between organizations are higher than the merely intraorganizational solutions. This is the most basic desire of companies to be profitable and competitive, cooperation for reasons of economic results (Chertow, 2007).

6. Conclusions

The Industrial Ecology processes implementations and its three levels of action can be successful. However, it is essential to understand their interactions and consider cultural and social elements of each region. It is believed that the objectives proposed for this study have been met as it was possible to identify the main challenges and make recommendations to contribute to the viability of an ecopark in the cosmetics sector in Brazil.

As limiting elements of this investigation, we should note the fact that only a professional one company's ecopark in question was interviewed. Thus, it is suggested the development of new investigations considering dimensions of organizational interdependence and contemplating systemic approaches.

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The EMAS downturn: a survey on motivations behind the crisis and enabling measures to stimulate new registrations

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Abstract

The Eco-Management and Audit Scheme (EMAS) is a voluntary Regulation (EC Reg. No. 1221/2009) that defines the European Environmental Management System (EMS). It represent one of the tools through which all kind of organizations can demonstrate their proactive commitment toward the reduction of their environmental impacts. Today the EMAS is undergoing a revision process, in order to fit the scheme to organizations and stakeholders requirements and increase its diffusion. Italy accounts for roughly a third of the 3,000 certified organizations, and especially during the last five years, a growing number of organizations did not renew the certification. This context determined a substantial crisis of EMAS. Thus, the aim of the survey we present is to investigate why a growing number of Italian organizations have dropped out of EMAS, and to figure out which enabling measures would be more effective in order to encourage a re-certification. The target of the questionnaire were the 379 Italian organizations that did not renew their EMAS registration between 2010 and 2015. Costs of EMS implementation and maintenance are the main reason to drop out of EMAS. Conversely, an Increase of permanent bureaucratic and administrative simplifications would be the most appreciated measures for organizations in order to register again with EMAS. This paper for the first time systematically address the phenomenon, contributing to reduce the existing gap in literature, and provides useful input to decision-makers who are ongoing the EMAS revision process.

Keywords: EMAS; Environmental Management Systems; ISO 14001; EMAS crisis; EMAS barriers; EMAS survey

1.Introduction

Over the last decades society concern on environmental issues has constantly grown (Rezaee and Elman, 2000). In order to operate in a global market, firms have to respond to several stakeholders' requirements (Clarkson, 1995; Freeman and Reed, 1983; Freeman, 1984). In this context, Corporate Social Responsibility (CSR) practices become crucial to allow firm to compete and succeed, demonstrating their commitment to stakeholders expectations (Carrol, 1991; McWilliams, 2000; R. Steurer et al., 2005). As a consequence, firms are exploring the possibility of including environmental sustainability in their business operations (Madsen and Ulhøi, 2001; Pomas et al., 2011; Santos-Reyes and Lawlor-Wright, 2001; Sarkis et al., 2010; Stave, 2010). Among voluntary instruments Environmental Management Systems (EMSs) emerged during the 90s (Angell and Klassen, 1999; Gonzales et al., 2008; Neugebauer, 2012; Pomas et al., 2011; Reinhard Steurer et al., 2005). The EMSs allow firms to systematically assess the environmental impact of their operations. To disclose reliability, EMSs should be certified by an independent third party (Berry and Rondinelli, 1998; Chavan, 2005; Reinhard Steurer et al., 2005). Up to date the two main voluntary international standards are the ISO 14001 and the Eco-Management and Audit Scheme (EMAS). The first is an international standard globally recognized issued by the International Organization for Standardization, while EMAS is a European (Regulation (EC) No 1221/2009) (Morrow and Rondinelli, 2002; Neugebauer, 2012; Testa et al., 2014). Both the EMSs schemes assist firms in implementing a formal system to control environmental variables through an environmental policy, program, and practices (Hillary, 2004; Phan and Baird, 2015).

The ISO 14001 is the most widespread and globally recognized EMS standard, adopted in over 170 countries (Heras-Saizarbitoria and Boiral, 2013). Worldwide, roughly 300,000 firms are certified and Europe accounts for over a half of them (ISO, 2014). Its diffusion is homogeneous among sector of activities (Marimon et al., 2011). Since it was issued, the number of certifications has constantly grown, especially in the last years thanks to the contribution of developing countries in the Far East, that consider the standard as a competitive tool, especially for export (To and Lee, 2014).

While numbers of ISO 14001 are constantly increasing, EMAS registration numbers are not growing in the last years. The most recent figures show that in Europe about 2,900 organizations are EMAS registered. Italy and Spain are the leading countries with roughly 1,000 organizations each (European Commission, 2016). In Italy over 17,000 firms are ISO 14001 certified, representing the second country for number of certifications worldwide (Scipioni et al., 2015). Concerning EMAS, in the last years, both at national and European level, there has been a contraction in its diffusion (Heras-Saizarbitoria et al., 2015b; Preziosi et al., 2016b).

Given the crisis of EMAS regulation especially among Italian organizations and due to the forthcoming revision of Regulation by the European institutions, the aim of this paper is to present the main findings of a survey we conducted on Italian organizations that withdrew from EMAS between 2010 and 2015. The survey has been conducted through a questionnaire, developed with the collaboration of ISPRA (The Italian National Institute for Environmental Protection and Research), the Italian competent body for EMAS. The main goal is to figure out motivations behind the decision to abandon EMAS and which enabling measures would be more effective in order to re-encourage organizations to implement it.

We structured the paper as follows. First, the literature review concentrates on the phenomenon of decertification, with specific focus on EMAS. In the next Section we present the case study: the recent phenomenon of escalation of EMAS drops out. Section 4 presents the research questions. Finally, results and discussion are provided.

2. Literature review and research questions

This section briefly summarizes outcomes of scholars that investigated critical aspects of EMSs implementation. Special attention is given to EMAS and previous studies that focused on organizations that decided to drop put of this voluntary scheme have been highlighted. First, the potential relationship between the recent economic crisis and the diffusion of CRS practices among firms is analyzed. Then the main difficulties that firms encounter when implementing an EMS are presented. Finally, works on EMAS drops out motivations are reviewed.

Consequences of the economic crisis on CSR practices

Even if ISO 14001 certification figures keep growing, a contraction of this growth was observed. If between 2007 and 2010 the global growth was 14% yearly, between 2010 and 2013 it decreased to 7% (Heras-Saizarbitoria et al., 2015b). Nevertheless, the European EMAS crisis is more evident, given that in the last years there was no growth, but a slight decrease in the number of registrations (Merli et al., 2016; Preziosi et al., 2016b). One of the first explanation of the reduction of voluntary instruments for sustainability may be connected with the global financial crisis occurred in 2008. Firms in this context may act in a more defensive and conservative way, cutting CSR investments (Cheney and McMillan, 1990; Walley and Whitehead, 1994). However, scholars' findings indicate that there is not confirmed link, neither positive nor negative, between the crisis and the reduction of sustainability practices. In some cases, findings indicates that firms keep investing, in others a generalized reduction of sustainability practices has been observed (Delmas and Pekovic, 2015; Zengin, 2010). Overall, literature on the relationship between economic downturn periods and CSR is not thick and is focused on general CSR, not considering specifically EMSs (Heras-Saizarbitoria et al., 2015b). Heras-Saizarbitoria and Boiral (2013) suggest that the reduction of certifications may be explained by the economic crisis, but there are no specific findings on the topic. In general, the phenomenon of decertification has not been deeply investigated, and just a few papers deal with the specific topic (Heras-Saizarbitoria and Boiral, 2013; Heras-Saizarbitoria et al., 2015b; Merli et al., 2016; Preziosi et al., 2016b). Thus, the next part of literature review will briefly focus on critical aspects of EMSs implementation. Given the scarcity of literature on EMAS, both works dealing with EMAS and ISO 14001 are considered (Tourais and Videira, 2016). Then it focuses on investigations that specifically deal with organizations that did not renew the EMAS registration.

Barriers and constraints to the EMSs implementation

Many authors focused on barriers to EMSs implementation, as the no-achievement of expected positive outcome (Arena et al., 2012; Delmas, 2000; Gonzales et al., 2008; He et al., 2015; Hillary, 2004; Kehbila and Brent, 2009; King et al., 2005; Matouq, 2000a; Moors et al., 2005; Morrow and Rondinelli, 2002; Schylander and Martinuzzi, 2007; Vernon et al., 2009). One of the main constraint faced by firms are the costs of implementation (Babakri et al., 2003; Iraldo et al., 2010; Martin-Pena et al., 2014; Matouq, 2000b; Turk, 2009). Other barriers relate to higher operation complexity (Campos, 2012; Chan and Li, 2001; Darnall et al., 2008; Matouq, 2000a), low commitment of management (Ann et al., 2006; Hillary, 2004; Jenkins, 2006; Martin-Pena et al., 2014; Massoud et al., 2010), and required legislative compliance (Iraldo et al., 2013a, 2005; Schylander and Martinuzzi, 2007; Vernon et al., 2009). Another identified aspect is the lack of market recognition and an insufficient level of regulatory relief, especially concerning EMAS (Daddi et al., 2014; Hillary, 2004; Iraldo et al., 2013a, 2010; Merli et al., 2016). Specific studies on EMAS, mainly identifies as weak aspect of EMAS the low market and consumers recognition (Ahsen et al., 2004; Iraldo et al., 2005; Merli et al., 2014; Vernon et al., 2009) and the preference for the ISO 14001 certification (Dirección General de Calidad y Evaluación Ambiental. Ministerio de Medio Ambiente (Spain), 2006; Iraldo et al., 2013b, 2009; Vernon et al., 2009). Often organizations complained on the low level of regulatory relief linked to EMAS (Ahsen et al., 2004; Dirección General de Calidad y Evaluación Ambiental. Ministerio de Medio Ambiente (Spain), 2006; Iraldo et al., 2005; Meima and Starkey, 2000; Merli et al., 2014; Vernon et al., 2009). Finally, especially small firms signal costs of implementation as a major barrier to EMAS renewal (Dirección General de Calidad y Evaluación Ambiental. Ministerio de Medio Ambiente (Spain), 2006; Hillary, 2004; Iraldo et al., 2013a, 2005; Merli et al., 2016; Molinas and Biserni, 2008; Vernon et al., 2009).

EMAS drops out

The phenomenon of EMAS registrations reduction is recent, thus not many scholars focused on the specific topic. The first work that dealt with lack of success of EMAS among European organizations dates back to 2002. Despite a decade since the enactment of the Regulation, it was noticed that the comparison with ISO 14001 was terribly negative. Authors stressed that the success of EMAS was strongly linked with the regulatory relief for registered companies. According to the Authors, this peculiar characteristic would have lead to a negative future for EMAS (Glachant et al., 2002). Also if narrowed to the Italian context, this findings are confirmed by Daddi et Al. in 2014 and by Preziosi et Al. in 2016. The first paper found out that EMAS is more widespread in activity sectors whose received more regulatory relief (Daddi et al., 2014). Concurrently, Preziosi et Al. found a significant correlation between the implementations of incentives for EMAS and the number of active registrations. In addition, as the number of measures implemented increases, the same happens for the duration of the EMAS registration (Preziosi et al., 2016a). These findings suggest that one of the reason why EMAS drops out are growing is the insufficient regulatory relief that serve as a primary incentive to EMAS registration.

In 2004, an interview with German companies that dropped out of EMAS was conducted. The main reason for not renewing the registration was that EMAS has no appeal on the public, followed by the lack of regulatory relief. In addiction, authors underlined that over a half of the companies were still certified with ISO 14001 (Ahsen et al., 2004). Also in the *Evaluation of EMAS and Eco-label for their Revision* study, organizations that did not renew EMAS were interviewed. Organizations did not renew the registration due to the lack of recognition by the market and other external stakeholders. As in the German case previously mentioned, organizations continued to implement a structured EMS (Iraldo et al., 2005). In 2009, 25 European organizations that dropped out of EMAS were interviewed. Unclear benefits was the first reason to not renew EMAS, than the preference for another EMS and the lack of managerial culture. The main enabling factor to re-encourage registration were customer requirements, reduced regulatory requirements. Surprisingly, support during the implementation and reduced registration fees were not recognized as relevant. This may be explained because interviewed were mainly large private organizations (Vernon et al., 2009). According to the German EMAS evaluation document of 2012, only 6% of respondents declared that would probably or definitely drop out of EMAS. The main characteristics of these organizations is that they attributed low importance to energy efficiency and to the environmental statement, and they do not consider EMAS an advantage for public tenders (Steyrer and Simon, 2012). Unfortunately, today no figures on German organizations that dropped out of EMAS are available. In 2012, a survey from Spanish EMAS organizations revealed that 11% of them would not renew EMAS, while 45% expressed doubts on the future renewal. The Authors found out that the renewal is positively correlated to environmental performances improvements motivations. Conversely, costs are not a significant predictor of organization future behavior toward EMAS. Also in this case, findings confirm that positively perceived public incentives are a strong driver to renew the certification (Heras-Saizarbitoria et al., 2015b). In Italy during 2012 and 2013 EMAS organizations were asked if they intend to renew the certification. From a sample of 500 organizations, over 84% declared that intended to renew EMAS, whilst over 15% were not sure about it. In this case, small and micro sized organizations had the higher rate of abandonment intention (Merli et al., 2016). Considering the Italian data updated to the end of 2015, we can confirm that many of these sceptic organization decided to withdraw EMAS. In fact, in the last years, the rate of EMAS abandonment significantly grew in Italy (Preziosi et al., 2016b) (See Section 2).

3. The EMAS crisis

Italy by the end of 2015 accounted nearly one thousand EMAS registrations. Nevertheless, in the last years the ratio between new registrations and non-renewal of the registration was negative. For the first time in 2012 non-renewals (121) exceeded new registrations (79), determining a negative growth trend. This negative trend was observed also in 2014 and 2015. Between 2010 (year of effective entry into force of EMAS III – Regulation EC 1221/2009) and the end of 2015, 419 organizations dropped out of EMAS, while 420 activated a new registration (Figure 1). Thus, while for ISO 14001 there is a generalized growth, EMAS in the last lustrum substantially remained in a steady state (ISPRA, 2015).

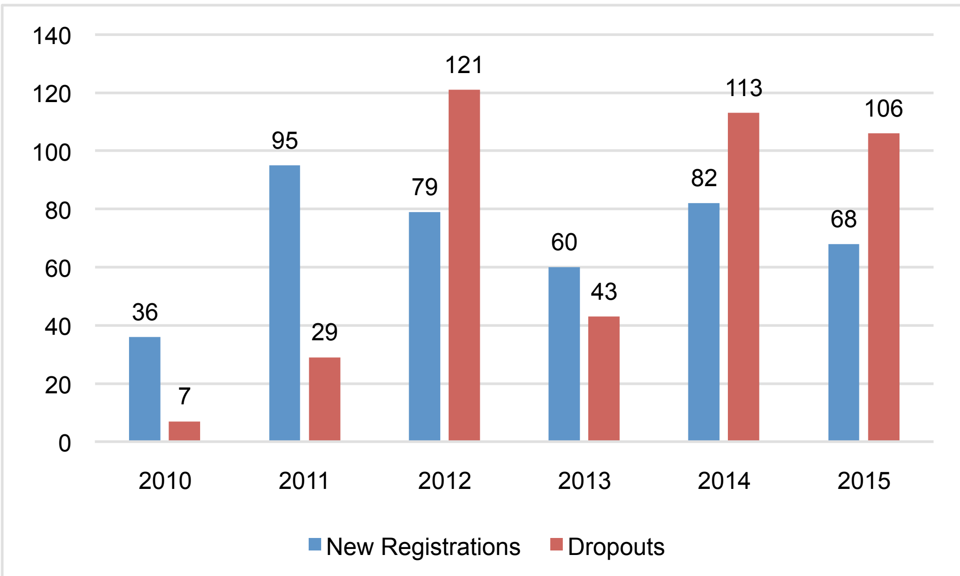

Figure 1. Comparison of new EMAS registrations and non-renewals in Italy. Updated to December 2015. Source: Authors' elaboration based on ISPRA dataset.

While the size of active organizations is well distributed across the four groups, it is evident that the major part of non-renewals relates to small-sized organizations. Small organizations account for

54.18% of non-renewal between 2010 and 2015, while they account for 30.71% in the active registrations group (Figure 2).

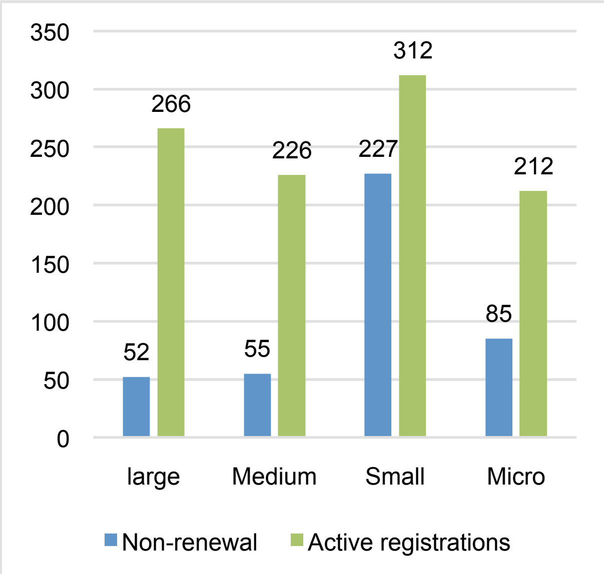

Figure 2. Comparing organizations that did not renew EMAS registration (2010-2015) and active registrations (2015) by size. Source: Authors' elaboration based on ISPRA dataset.

Considering the activity sector using the NACE codes, organizations that did not renew EMAS belongs mainly to the NACE code 84, corresponding to PAs (17.38%). In this case the total is represented by NACE code 81.11, corresponding to Municipalities (European Parliament, 2006). Second and third activity sectors are "Manufacture of food products" (9.79%) and "Electricity, gas, steam and air conditioning supply" (7.64%). Considering active registrations, the most widespread activity sector is "Waste collection, treatment and disposal activities; materials recovery" (22.83%), PA (18.01%), and "Electricity, gas, steam and air conditioning supply" (12.01%) (ISPRA, 2015).

4. Research questions

Given the contest of crisis of the EMAS regulation in Italy, two main questions are arising. First is why organizations decide to drop out of EMAS (RQ1). Then, it is crucial to understand how to stimulate these firms to come back to EMAS (RQ2). Answering this question would create a baseline on which EMAS competent institutions can develop a strategy to re-launch it across Italian and European organizations. Another interesting aspect is to figure out the relationship between motivations toward certification abandonment and the like-hood to come back to certification consequent to the implementation of enabling measures (RQ3).

RQ1: what are the motivations for dropping out of EMAS?

RQ2: which measures would re-encourage organizations to resume the EMAS registration?

RQ3: which drop out motivations are significant predictors of EMAS future re-registration?

5. Methods and data

Given the general context of EMAS recent crisis, to answer research questions we conducted a survey targeted to all Italian organizations that did not renew the EMAS registration between 2010 and 2015. The list of organizations was provided by ISPRA. The database consists of organizations' name, registration number, location, size, NACE code, and mail and telephone contacts. We decided to select organizations since 2010 because it is the year in which the last revision of the scheme (EMAS III) entered effectively into force, and the one in which a strong growth of drops out was firstly observed.

The survey has been built on the main findings of focus groups that took place in February 2015 at ISPRA. The goal was to figure out the critical aspects of EMAS implementation and propose enabling measures to re-launch EMAS considering the forthcoming revision of the regulation. Thus, the items proposed in the questionnaire where based on findings of the focus groups previously conducted (Capra et al., 2015). Questionnaire is composed of three main sections. In the first, the potential motivations of EMAS drop out were listed. In the next section, we placed the potential measures to be implemented in order to re-encourage organizations to resume EMAS in the future. On a Likert scale ranging from 1 to 6, organizations were asked to indicate the level of importance of EMAS drop out motivations and the level of appreciation for the enabling measures proposed. In the scale, 1 corresponds to "not important" and 6 corresponds to "very important". To encourage a definite choice by respondents and reduce answers' uncertainty, the authors decided to have no neutral or mid-point on scale (Garland, 1991). In the last section, general information on the organizations were asked: size, NACE code, location, and years of EMAS registration.

The initial dataset consisted of the 379 Italian organizations that withdrew EMAS between 2010 and June 2015. The questionnaire was submitted by email and then we contacted the organizations by phone. Of the initial population, 40 organizations were excluded because they did not exist anymore at the time of the investigation. Specifically, 18 went bankrupt, 17 were liquidated, and 5 merged with other companies. Thus, the potential respondents dropped to 339 organizations. Of these, we were not able to contact them neither by email and/or telephone 144 organizations. We were able to contact 235 organizations. The respondents were 99. Considering the organizations that we have been able to contact the response rate was 42.13%, while considering all the population under investigation the response rate was 26.12%. Given the context, the initial response rate of 26.12% can be considered as satisfactory. Moreover, this percentage of respondents is consistent with other main survey investigations conducted in the field of Environmental Management System certification (Babakri et al., 2003; De Oliveira et al., 2010; Heras-Saizarbitoria et al., 2015a, 2015b; Martin-Pena et al., 2014; Phan and Baird, 2015; Quazi et al., 2001; Schylander and Martinuzzi, 2007)

6. Results

In this section, the profile of respondents is firstly presented. Then descriptive statistics help to answer RQ1 and RQ2, while RQ3 is assessed through a binomial logistic regression.

Profile of respondents

Of the 99 respondents 54% are small-sized organizations, 21% micro, 16% medium, and 9% large. Thus, the sample well describes the nature of the population under investigation, composed mainly by small organizations. Respondents are located in Northern Italy for their majority (63%), while 21% are in the Centre, and 16% in the South and Islands. Considering the sector of activities, over 36% are PAs, and this is the most represented sector.

RQ1 and RQ2: motivations for dropping out and enabling factors to re-encourage the registration

In order to answer to RQ1 and give a general overview on the reasons why organizations decided to drop out of EMAS, Table 1 illustrates the mean values and the percentage of answers with score equal to 5 and 6 (on the Likert scale ranging from 1 to 6).

Table 1. Descending values of motivation importance for dropping out of EMAS.

Item	Scores 5-6	Mean
Costs of the EMS maintenance	65.70%	4.62
Lack of permanent bureaucratic and administrative simplifications	58.60%	4.37
Lack of exposure due public low knowledge of EMAS	56.60%	4.28

Lack of economic savings	46.50%	3.78
Management choice	42.50%	3.73
Lack of relationships improvement with the competent authorities	36.30%	3.65
Internal difficulties within the organization	30.30%	3.25
Lack of environmental performance improvement	25.20%	3

The main reasons why organizations did not renew EMAS concern the impossibility to sustain cost of its maintenance (mean 4.62), followed by a scarce support offered by public authorities in terms of permanent simplifications (mean 4.37). The third reason is linked with low awareness of EMAS outside the organization, among local stakeholders, customers and citizens. On the other hand, organizations considered EMAS as being effective in improving environmental performances; only 25% of respondents consider the lack of environmental performance improvement as a significant reason to abandon the certification (Table 1).

Once determined the importance of reasons why organizations dropped EMAS, we asked which potential measures would re-encourage the registration in the future. Table 2 shows the mean values and the percentage of answers with score equal to 5 and 6 (on the Likert scale ranging from 1 to 6), in order to figure out which measures and policies would be most effective to re-launch EMAS in the future.

Table 2. Descending values of enabling measures.

Item	Scores 5-6	Mean
Increase permanent bureaucratic and administrative simplifications (e.g. Longer Permits and / or simplifications for obtaining approvals and permits)	72.70%	4.96
Financial facilities (reduction of fees, charges and rates for inspections, controls, environmental preliminary expenses)	71.70%	4.91
Increase in tax benefits for the long term (e.g. Reduction of the Italian Regional Tax on Productive Activity (IRAP), reduction of environmental hygiene tax etc.)	71.70%	4.79
Greater importance of EMAS in obtaining public funding (European, national, regional funding)	70.70%	4.82
Greater importance of EMAS in the public funding mechanisms compared to ISO 14001	65.70%	4.51
Reduction of inspections by the competent authorities	55.60%	4.18
Reduction of costs to obtain EMAS registration	52.50%	4.12
Greater commitment / investment by the government in the promotion of EMAS knowledge to citizens and consumers	47.50%	4.2
Request of the EMAS registration as a requirement by the commercial partners (customers / suppliers)	46.50%	3.79
Greater importance of EMAS in public tenders (GPP) compared to ISO 14001	45.50%	3.7

Of the 10 items proposed, the first three concern the possibility to access to long term simplifications. More specifically, firms claim a higher recognition of EMAS for permanent bureaucratic and administrative simplifications (mean 4.96), financial facilities (mean 4.91), and tax benefits (mean 4.79). In addition, a major recognition to access to public funding would be an efficient measure to stimulate new registrations (mean 4.82). Conversely, organizations have less expectations as regard to the chance to increase EMAS knowledge through promotion (mean 4.2) and as a requirement by the commercial partners (mean 3.79). With respect to ISO 14001 standard, they will EMAS to have greater importance of EMAS in the public funding mechanisms (mean 4.51), but surprisingly not as regard to public tenders (GPP) that received the lower score (mean 3.7) (Table 2).

Comparing Table 1 and Table 2, the most evident outcome is that even if cost is the main reason to abandon EMAS, it is not desired as a major measure to encourage EMAS registration. The same statement is valid for the low visibility of EMAS into the public. Conversely, answers are more coherent as regard to the lack of permanent bureaucratic and administrative simplifications linked to EMAS, considered as the second statement in order of importance both for dropping out motivations and potential EMAS enabling measures.

How drop-out motivations influence organizations' attitude toward a EMAS future re-registration (RQ3)

Organizations were asked to indicate if they would come back to EMAS registration after the implementation of enabling measures and6 5% of the respondents answered positively. RQ3 explores whenever or not the motivations for EMAS abandon influence organizations' attitude toward a future re-registration. Through a binomial logistic regression, we explored if motivations for EMAS abandon are significant predictors of future re-registration.

Table 3. Binary logistic regression. Dependent binary variable is "would you come back to EMAS if the enabling measures are implemented?". Independent variables are motivations for EMAS drop out.

ITEMS	B	Exp(B)
Internal difficulties within the organization	-0.583	0.558*
Costs of the EMS maintenance	-0.071	0.931
Lack of exposure due public low knowledge of EMAS	0.56	1.75**
Lack of permanent bureaucratic and administrative simplifications	0.475	1.608
Lack of relationships improvement with the competent authorities	-0.535	0.585*
Management choice	-0.451	0.637*
Lack of economic savings	0.279	1.322
Lack of environmental performance improvement	-0.469	0.625*
Constant	2.945	19.015
*,** Significance level at 1% and 5%		

Table 3 illustrates the Summary and main results of the model. Considering the Nagelkerke R Square coefficient, the model explains more than 50% of the variance (R2=0.507), the Cox & Snell R Square is 0.369. In the model proposed, four of the predictors are significant, with a confidence level minor than 0.05. While, "Greater importance of EMAS in public tenders (GPP) compared to ISO 14001", has a significance level at 1% and is the only one with an Exp(B) coefficient greater than 1 (Exp(B)=1.75) (Table). It means that if the score of "Greater importance of EMAS in public tenders (GPP) compared to ISO 14001" grows the odds ratio of renewing EMAS is positive. On the other hand, the other significant independent variables have an Exp(B) lower that 1, meaning that growing their value determine a negative odd ratio of renewing EMAS.

7. Discussion

The sample of the investigation well suits the characteristics of the population, composed mainly of small sized organizations. On the other hand, PAs are overrepresented: in our sample represent 36%, while in the population of organizations that did not renew EMAS between 2010 and 2015 represent nearly 18% of the total. Thus, we decided to in-depth the analysis of this peculiar sector.

As regard to the entire sample, among motivations for dropping out of EMAS (RQ1) costs are the most significant. This probably depends by the fact that the population is mainly composed of small organizations, recognized as the most sensible to EMSs implementation costs (Campos, 2012; Hillary, 2004; Iraldo et al., 2010; Kehbila and Brent, 2009). Lack of improvement of environmental performances is considered a relevant motivation for dropping out of EMAS just for one quarter of the interviewed. Considering that one of the main goals of EMAS is to reduce the environmental impact, this can be interpreted as a positive result.

Concerning RQ2 firms claim a mayor recognition of EMAS for permanent bureaucratic and administrative simplification. This type of measure is partly already on going, but is limited especially to larger organizations that receive simplification in terms of duration of the authorization (e.g. firms that have to comply with Directive 2010/74/EC On industrial emissions (integrated pollution prevention and control)). Findings are consistent with previous investigations that pointed out that EMAS is an incentive-based certification (Daddi et al., 2014; Heras-Saizarbitoria et al., 2015b). On the other hand, respondents do not expect EMAS to be an instrument for commercial relationships and to promote into the public the environmental commitment of the organization, as suggested by Vernon et Al. (2009).

While costs are the main motivations for dropping, they are not considered as a primary measure to implement in order to encourage EMAS registration. This may be explained because organizations are willing to pay EMAS related cost provided that incentives and simplifications are put in practice (RQ1-RQ2). This finding is consistent with the European investigation on EMAS conducted in 2009 (Vernon et al., 2009).

Roughly 60% of interviewed stated that would register again their organizations if enabling measures would be implemented. Nevertheless, the like-hood to come back to EMAS is not the same when linked with motivations of the abandonment. In particular, companies that left EMAS for internal reasons have the less odd to rejoin it. On the other hand, a significant positive relationship exists between lack of knowledge of EMAS by the public and possibility to join EMAS if the stakeholders would start to recognize this instrument (RQ3).

8. Conclusion

The paper presented the main findings on an investigation we conducted, in collaboration with ISPRA, the Italian Competent Body for EMAS, to identify reasons for dropping out of the EMAS certification, and to figure out which measure would be more effective in order to re-encourage the registrations. The ratio of the research is twofold. On one hand, the recent increase of EMAS missed renewals, especially in Italy, determined the demand for an in-depth analysis of motivations behind this negative phenomenon. On the other hand, this is a crucial moment for the Regulation, because the EMAS refit process is ongoing. Thus, the output of the investigation would contribute to increase the knowledge of decision-makers on the topic, providing the feedback of organizations that decided to abandon this instrument.

Findings on drops out motivations are representative of both PA and private organizations, and are related to EMAS cost of implementation and maintenance. However, while private organizations expect an increase in tax benefits for the long term in order to come back to EMAS registration, PAs wish a mayor consideration of EMAS to obtain public funding. Generally, it is evident how the decision to not renew EMAS is strongly linked to the size of the organizations. Apart from costs of implementation, the most reasonable explanation is that, while Italian institutions provided regulatory incentives especially for large size organizations, small organizations perceive an insufficient support. In fact, the most required enabling measures indicated by our respondents (over 90% small and medium sized) are linked to bureaucratic simplifications that organizations will to receive. This confirm findings of other investigations previously conducted, indicating that the success of EMAS is connected with the incentives provided by European Member States (D'Alessandro and Masone, 2014; Daddi et al., 2014; Iraldo et al., 2013a; Preziosi et al., 2016a).
The questions that arise is if EMAS is just an incentives-based instrument. Recently Italy

headed in this direction, approving a law (Law n. 221 28/12/2015), which allows organizations with EMAS to reduce the financial guaranteed to access to public tenders. In order to guarantee a bright future to this instrument, European decision-makers will have to question if a robust intervention to allow greater regulatory relief for EMAS is needed. Even if EMAS has not reached a strong success in terms of diffusion, many studies confirmed that is an efficient tool through which companies can reduce their environmental impact, contributing to the ambitious plan for a more sustainable economy (Daddi et al., 2014; Heras-Saizarbitoria et al., 2015b; Merli and Lucchetti, 2010; Merli et al., 2016; Vernon et al., 2009).

The main boundary of the present study is the limitation to the Italian context. Future contribution to better contextualize EMAS strong and weak points could be to compare perspectives from different European Member States. It would support European institutions to refit EMAS on potentially heterogeneous needs of organizations from several European States. Moreover, a specific focus and attention should be given to small organizations that represent over 95% of European firms.

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Fair Trade Image Constructs – A self-fulfilling Prophecy?

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Abstract

Over the past twenty years of the Fair Trade movement, a series of image constructs were created as a means to build the collective imaginary of this ethical trade system. These constructs have been communicated to the final consumer in a way that the values of justice, the definitions of what "development" stands for, as well as the images of the producer organizations, their socio-economic condition and locations, follow a self-fulfilling prophecy in line with an ideal ethical discourse aiming at calling socially conscious consumers in the North for action. This poses two issues: the first one is that the expectations about the Fair Trade may, when translated into socio-environmental certification criteria, not attain the necessary significance to the producers within their context of norms, values and life-styles; and second, the imagined narratives of Fair Trade form a set of preconceived images of the other which have a hold upon the intercultural commercial relations between sellers and buyers in inclusive business processes. This study investigates the influence these preconceived images of the Fair Trade system exert on the international commercial relationship between producer groups from the Global South and their respective buyers in the Global North. For this objective, we applied a scaling of Best-Equal-Worst in the way of doing business for three different fair trade value chains between Brazil and Switzerland. Through this scaling, a value thought of as characteristic of one culture will correspond to a stereotype shared by members of a second group in relation to the first group. This allows identifying, which stereotyped ideas and representations of the other cultures prevail in a given culture. An exploratory study of a qualitative nature with interpretative multiple case-study method has been applied for this study and included 40 semi-structured in-depth interviews with relevant actors along the value chains and in the Fair Trade ecosystem. Key findings indicate a high influence of the image constructs of Fair Trade in international dealings, which are related to the stereotype of the peasant/marginalized producer, the North-South relationship and the concept of fairness. The consumer market and the certification agencies design producer groups' profiles, roles and management models. Integration of the Global South into the normative discourse discourse, as well as a higher awareness of the actors facing the consumer market about the Fair Trade stereotypes, are deemed essential for a successful re-conception of the Fair Trade image constructs. Most of the extant research on values and image-associations in Fair Trade try to map preference elements from the consumer perspective. This study contributes to existing literature by bringing in the perspective of the producer groups and by focusing on how the stereotypes of Fair Trade influence the power play in international commercial relationships.

Keywords: fair trade image constructs, intercultural dialogue, international trade, agricultural cooperatives empowerment, Global South and Global North.

How the Brazilian law handles the greenwashing situation

Carolina Cesetti

Abstract

Nowadays there is a world tendency to prefer products which are produced in a more ecologically way. The "eco-friendly" labels certify products and services that intend to cause less damage to the environment. This change of consciousness is caused by a variety of facts, for instance, natural disasters, climate change and the increase of global population and consumption. In what concerns climate change, the search for adaptation is among all spheres of society and also embraces the attitude of some multinational companies that search for ways to support sustainable production and consumption. This work seeks to explore precisely the social responsibility of enterprises, specifically in Brazil, that claim to follow sustainable production methods; despite their publicity being more convincing than the reality. In these circumstances, this work's objective is to show how a juridical problem may arise from these fake advertisements in Brazil. Could these "sustainable" enterprises be held liable for their fake advertisement? Furthermore, how does the Brazilian government and consumers control the veracity of those statements? We will observe that the misleading advertisement influences the consumers decision to buy a product because of the sustainable information or the type of respectful production it promises. In other words, we will demonstrate that what was meant to be a honorable reason of acquisition becomes actually just a strategy of marketing to attract more consumers who, on the other side, have few capacity to inform themselves about the veracity of those informations stated in the companies' website or in a simple package or tag. This work gives examples and illustrates how Brazilian law treats companies that do these types of publicity by studying a real case judged in the Federal Regional Court of Brazil that condemned the enterprise Monsanto for a fake advertisement about transgenic seeds. We will see how the Brazilian code for consumers law deals with this kind of situation. The general idea of this work is therefore to show that not only governments have a role to play to develop and promote sustainable markets by stimulating and informing its citizens ways to concretize a better protection and respect of the three aspects of sustainability but also that enterprises have a role and need to be ready to respond in justice for their sustainable advertisements.

Keywords: Sustainability, "eco-friendly" products, misleading advertisement, social responsibility of enterprises, Brazilian Law.

A strategy for the sustainability of the University of Aveiro's campi

Miranda, A.I., Martins, F., Fonseca, C., Pinho, R., Bernardes, C., Vicente, R., Martins, N., Costa, J., Vieira, R., Dias, N., Agostinho, J., Ferreira, P., C. Borrego

Abstract

Forty two years after its foundation, in 1973, the University of Aveiro (UA) keeps developing and promoting the construction of the future and an academic community where sustainability is one main driver. A evolving sustainable campus is inherent to its mission of: creating knowledge and expanding access to knowledge through research, education and cooperation in benefit of people and society; undertaking the project of global development of the individual; being active in the construction of a European research and education community; and promoting a model of regional development based on innovation and scientific and technological knowledge. In this scope, and based on the university's experience, a Mission Group for the Sustainable Development was created by the Rector, in 2014, with the main objectives of promoting actions, internal and externally, which contribute to sustainable development, and disseminating research and good-practices. This group is composed by 11 staff members from different departments, ranging from science and engineering to education and design. The purpose is to integrate several backgrounds and perspectives of sustainable development and consequently involving a whole academic community. Besides the organic and functional units represented in the Mission Group other academic units and groups have been involved in the process (e.g. the Students Union, the Social Services, and Technological Platforms). Currently, with about 15000 students attending undergraduate and postgraduate programmes, a total area of 921,500 m^2 and 65 buildings, the UA is spread over the Aveiro's district with three *campi*, located in three cities: Aveiro, where the main *campus* is located (*Campus* Santiago), Águeda and Oliveira de Azeméis. The *Campus* Santiago, overlooking the Aveiro lagoon, a prize-winning Campus, renowned for its many buildings designed by re-known Portuguese architects, is considered the first premise and evidence of the sustainable policy of the UA. Taking into consideration the UA characteristics, a strategy for the sustainability of its *campi* was outlined. This strategy, covering the period 2014-2020, is based on four pillars: education, *campi* management, community engagement and research. For each pillar, key-areas and goals for 2020 were established. Along 2015 several activities were performed covering different aspects of the *campi* sustainability, such as education, communication, discussion of limitations and good-practices. Considering the importance of involving every actor throughout the campus in the Sustainability target, incoming students were invited to exploit the sustainability of the Campus and of the city. This action has successfully enrolled 1100 students and will be repeated in the forthcoming September. We expect this action to generate spillovers in the student community and in the short run all students will be familiarized with the topic. Moreover, the plan for 2016 aims at actively involving the Departments, the Community, the Governance and all University stakeholders pursuing specific actions to consolidate the importance of all in building a sustainable Institution in several dimensions. This paper will present the strategy and action plan for the sustainable development of the UA and describe the activities developed during 2015 and their impact, as well as foreseen activities for 2016.

Keywords: sustainable university, strategy and action, education, communication

An urban river front at risk of flooding: A case study in sustainability

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Abstract

Fishing communities integrated in urban areas settled at river fronts are often times exposed to flooding due to monsoons and the increasing of the water level. As a solution to this problem, buildings usually are built on stilts, with a few variations depending on the materials available on site. The traditions of the inhabitants dictate the empirical rules governing the construction and maintenance of such buildings. The project presented in this paper proposes a house module designed according to a sustainable, environmental and economic point of view, in order to respond to the inhabitants needs, combining the knowledge of past generations on a demand to ensure the preservation of the future. The case study of the present work takes place on the waterfront of the River Bassac, on the city of Chau Doc, Vietnam. The proposal is designed with different levels of social intervention in mind; it's inspired on family values and sense of community, typical of the Vietnamese culture, and takes form in a house module, developed according to the locals needs, but also spanning to the level of neighbourhood and community, respecting the Vietnamese way of life. The main construction material is Bamboo, typical in the Vietnamese landscapes, easily handled by locals, making the house largely sustainable, with relatively low cost, allowing the inhabitants to engage in its construction and maintenance. Other sustainable achievements through architectural design are the use of a rainwater collector, which supply the needs of water for sanitary and kitchen needs. Another achievement is a waste water reservoir, solving the sewage problem. The river water pollution is due to untreated sewage, which is a serious pollution problem, creating health problems. The main goal of this project is to ensure that architecture can respond to the needs of a sustainable lifestyle, through a basic construction, suiting the needs of the inhabitants using materials from the surrounding areas, conforming to tradition, and achievable to ordinary citizens, thus guarantying a good quality of life and improving the sense of community.

Keywords: Sustainability; Architecture on stilts; Urban flood; Low-cost house; Regional culture

1. Introduction

The sustainable reaction for the present and future climate scenario, begins on the design principles, based on the knowledge for a sustainable, energy efficient and climate responsive buildings, known as Vernacular Architecture. As Singh et al. refer (2009), vernacular architecture based on bioclimatic concepts was developed and used throughout the centuries by many civilizations across the world. This type of construction is characterized by the direct relation to human needs, keeping in mind the economic, politic and cultural values, based on the study of past local generations (Oliver 2006). Due to the global warming, caused by constant increasing of the pollution levels, architecture is often exposed to degradation caused by the climate changes, such as, occurrence of long rain periods off season, tropical weather, storms, and other phenomenon. It´s urgent to find a solution trough architecture based on past generation building methods to show the maximum adaptability to the local implantation, to its context, climatic characteristics and resources, through the application of materials available locally and indigenous skills.

As Ghaffarian Hoseini et al. (2014) refer the contemporary residential design has been promoted in cities without concerns of the essence of vernacular houses and is often poorly linked to traditions and values of each region. The divergence between the interior spaces and the spatial demands of local inhabitants may result in unsatisfied users with their living environment. However, it is known that vernacular buildings across the globe provide instructive examples of sustainable solutions to building problems (Rashid and Ara 2015). Representing a way of living and a use of the territory of the local communities (Fernandes and Mateus 2011). Natural harmony between people, house and local environment is frequently cited in the research studies, with focus on the idea that vernacular architecture that always respected nature (Jayasudha et al. 2014), therefore, vernacular architectural features as well as ideas of heritage, sense of place and belonging presented during the present study.

Vernacular solutions, such as material and structural sensibility, minimalism, modularity, adaptability, as well as tactile and temporality or fluidity, are still modern (Rashid and Ara 2015). Other positive aspects of this type of architecture is low price and maintenance, affordable for every inhabitant; a great solution for poor countries like Vietnam, where the building price is the main factor that guaranties a quality of life. Bamboo, typical of Vietnam's landscapes, is one of the main building materials, offering a solution for architecture in Asia, used for generations, mainly for domestic propose, where its qualities and characteristics are adequate for this type of subtropical climate. This material combined with a solar passive architecture, allows the buildings to achieve thermal comfort and the possibility of decreasing the dependence on fossil energy as much as possible, a major principle of a sustainable Architecture.

This research is aimed at exploring the generic principles in Vernacular Architecture taking form in the design of sustainable house modules, a case of study on the fisherman communities, located on the Bassac River front, Chau Doc, Vietnam (Figures 1 and 2).

Figure 1. Chau Doc location.

Figure 2. Aerial view of Chau Doc

2. The contextual and the dwellings of Chau Doc

Chau Doc is a traditional city, which dates back to the 3rd century, located on the south of Vietnam, one of the most problematic flooding areas. It is characterized by its subtropical climate, known for the long periods of rain during the winter season and dry periods on the summer season. Architecture should be given the responsibility to respond to the inhabitants needs of this atypical climate. Chau Doc is recognized its culture and religion, where the traditional houses and building techniques have a representative style whose influence is seen in all the vernacular examples, mainly taking form in houses build on stilts (Figure 3), as a solution for the occurrences of floods. This type of traditional house is located on the margin of the Bassac River, where the study was conducted in one of the selected problematic areas, and resulting in the development of a modular house solution, based on the principles of traditional architecture and building techniques, where Bamboo is one of the oldest and representative construction material.

Figure 3. Chau Doc traditional house built in the margins of the Bassac River.

2.1 Analysis of the dwellings

One of the ways to develop a sustainable house is to strive to effective and purposeful changes while taking advantage of the local implantation conditions and qualities, such as the natural ventilation (Lane et al. 2008) (Wahab and Ismail 2014) and solar radiation, providing an ecologic solution that guarantees human comfort indoors. It is important to understand that climate has a direct influence on the settlement; its building form and design. According to the case at hand, Vietnam is a country known for its warm humid climate (subtropical) where the temperature varies is from 27,5 C to 35 C in the summer and from 19 C to 27 C in the winter, with a relative humidity ranging from 45% to 65%. Besides the atypical climate, Chau Doc also represents atypical differences in urban planning, growing into an irregular grid due to the non-planned sudden growth of the city. On one side on the layout plan we have the residences that are set within a narrow plot, abutting the short edge, influenced by the Occidental building techniques and materials. On the other side, located on the margin of the Bassac river are located the fisherman communities, traditional typical Vietnamese houses, characterized by its poverty and lack of conditions, exposed to high levels of destruction due to the increase of the water levels, reaching about eight meters high on the raining season and three meters high during the dry periods. The exposure of the buildings surface to direct solar radiation is reduced to a minimum, where there is no control on indoor temperature throughout the seasons, due to the materials being inadequate for this type of climate, lowering the inhabitant's quality of life.

2.2 Description of the selected sample

The study takes place on the communities located on one of the most damaged areas of the South of Vietnam, Chau Doc, located on the margin of the Bassac river, place of residency of fisherman families with six to eight members per house. The main orientation from the river is North-South, facing the Northern direction. The houses are a gable roofed two levels structure with a simple open plan, organized into a non-planned urban landscape with raised in platforms supported on stilts with six to seven meters high, inferior to the river's water levels on the raining season, often exposed to degradation on the first level.

Traditional houses are organized in two levels. On the floor plan are located the public areas, main entrance, a small kitchen with a fire stove, living and dining rooms, organized on an open space adapted to receive guests and other family members. On the first level, a more private space are the bedrooms. There is no sewage and plumbing features and only in some cases is possible to have a rudimentary bathroom. Traditional houses are built based on past generation's knowledge and techniques, keeping tradition. The materials applied, such as industrial waste and cheap materials, are inappropriate for this type of climate, increasing the discomfort and lowering the inhabitant's quality of life along the year.

3. Project Description

The proposed dwellings are adapted to specific social and cultural contexts, based on past generation's expressions of a reality slowly elaborated during centuries, executed with local techniques and means, expressing precise functions and satisfying social, cultural and economic needs. For the project were very important the interviews with three Vietnamese, that gave a first person impression about the main problems and needs of their families; one of the interviewers have family on the fisherman communities. The local builders and residents try to guarantee a solution for the climatic constraints, while constructing with only locally available resources. In the Vietnamese Architecture, harmony with nature and sense of community are important design elements (Rashid and Ara 2015). The main objective is the improvement of life conditions by designing an adequate space where inhabitants could have their own personalized environment. This facilitates viewing the dwellings as a micro-cosmos and also the adaptation of passive energy techniques such as the use of natural local ventilation to regulate indoors temperature, were it's possible to say that Vernacular Architecture sets an example of sustainability on a design form (Heal, Paradise, and Forster 2006).

One of the pillars of Vernacular Architecture is by understanding the underlying culture, way to guarantee that is possible to respond to the inhabitant's on a physical and emotional level. Keeping that in mind, it was taken into account the importance of Vietnamese Religion summarized in three main founder peoples: Cham, Khmer, Kinh, which one with a different religion (Buddhism, Islam and Daoism, respectively)in a design inspiration based on the symbol of longevity; creating a body, a mind and its spiritual union (Figure 4). On the house module, the staircase that connects the dock with the rest, is the main element, a metaphor of a core centre that connects the different levels, such as the symbol of inspiration connecting the three people. Based on past generations, the modules are organized according to a metric rule, inspired on the culture and tradition of Japanese houses, pillar of the Vietnamese culture, where the space in the dwellings are minimum, an open and flexible space typology.

The main characteristic of this proposal is the stilts that support the raised house platform; the house foundation is built with local wood pillars with 9m high, which offers a solution to protect the house from the water raising levels, reaching as much as 8m high during the raining season, and also allowing to maintain the locals culture and quotidian activities through the design of leisure areas located on different levels along the stilts (Figure 8).

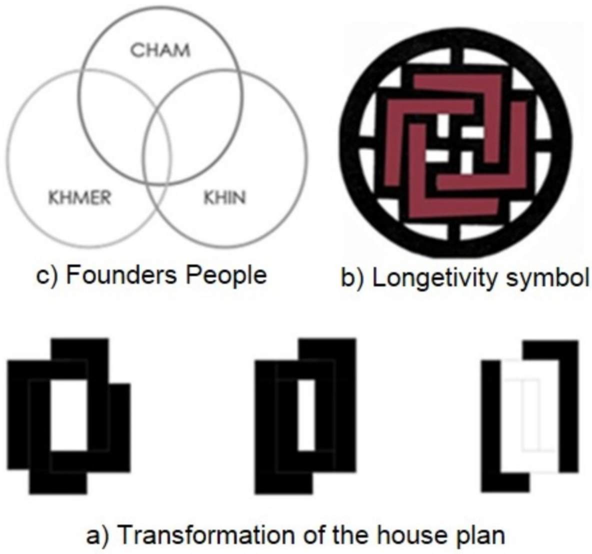

Figure 4. Conceptualization of the design module.

The house is designed to guarantee a correct adaptation on the Implantation site, keeping the actual houses dimensions, a rectangular form with 8 m x 12 m = 96 m2. The quality of spaces depend upon its flexibility and purpose, the way in which they were organized and the quality of natural light and ventilation (Figure 5) inside. There are no rigid divisions or demarcation inside the house, with spaces flowing into the other. A consequence of this flexibility of spaces allows to have different activities in the same space at different periods of time. There must be a perfect balance between the human beings and the environment; therefore it is possible to live in harmony with nature, where structures evolve over time to reflect the environmental, cultural and historical context in which they exist. The thermal regulation is possible due to façade openings, designed based on subtropical climate characteristics, sliding panels on the façade allows to control the amount of sun heat and gattered. Also to pay tribute to the past generation Vietnamese Architecture, the house module is projected with two floors. The public area are located on the floor plan. The main entrance is from the access road having southern orientation, and the secondary entrance is through the stair case that connects the boat dock and leisure platforms. A simple Kitchen, with a wood oven and storage area, bathroom, dining room and living room, all divided with sliding panels (Figure 6). On the second level, a more private and flexible open space, designed for sleeping areas, organized by the futons (Figure 7). The house module was designed based on local building techniques and available resources (Figure 9) where there is no machinery available, only the local inhabitant's skills are available to anyone in the community can participate on its construction.

Figure 5. Ventilation study, Summer and Winter season.

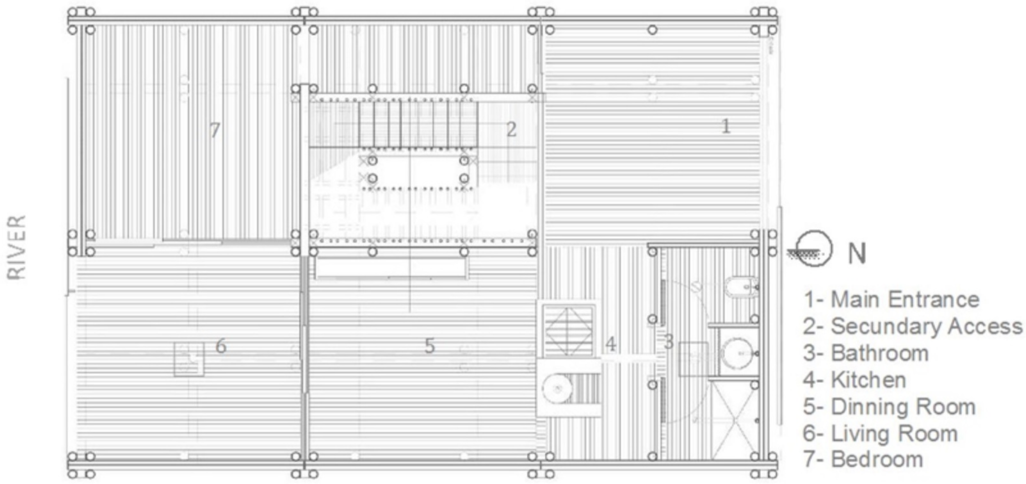

Figure 6. Floor plan typology.

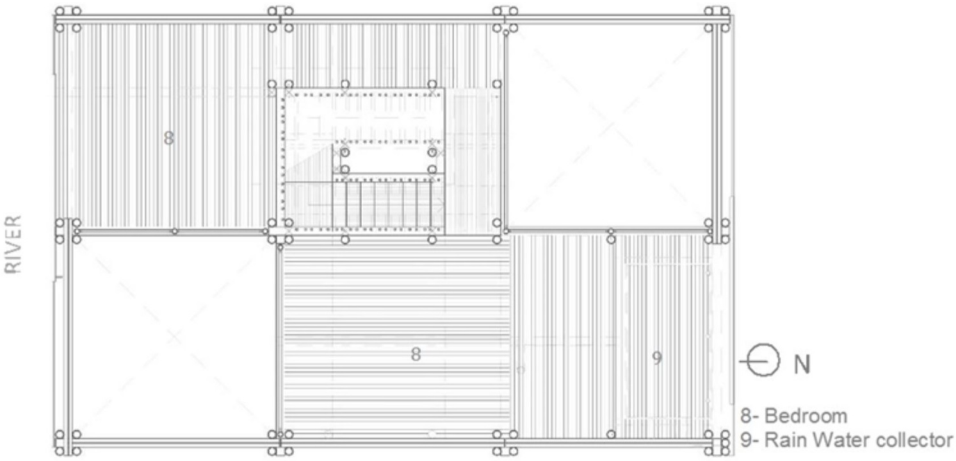

Figure 7. First level plan typology.

3.1. Water supply and sewage system

Other sustainable achievement trough architecture design is the use of a rainwater collector, which supply the needs of water for sanitary and kitchen activities, inexistent at the present time. The design objective is also to guarantee a self-sufficient house, where there's no electricity supply by power lines or generators. As so water flows by natural gravity through the placement of the rainwater collector on the first floor, above the bathroom and kitchen, covered with bamboo, maintaining a material harmony. During the dry periods, there is a possibility to fill the reservoir with water from the public wells located near the dwellings. The collector dimensions were based on expected consumption per day of water used by eight inhabitant's activities, which assumed 20 l per person per day, resulting in dimensions of 2,70 m x 1,50 m, a volume of 1,2 m3, guaranteeing a balance of the structure.

Another achievement was the waste water reservoir, having the same dimensions of the rainwater collector, designed to be easily handled by any inhabitant of the house through a system that floats along the pillars, accompanying the tide solving the sewage problems (Figure 8). Designed on a floating structure of bamboo, like a raft system, possibly made by recycled oil tanks, guaranteeing service access at any period of the year, following the river raising level, where the discharge is easily executed by boat. The pipe feeding the collector is flexible 30 cm diameter, possible to extend and reduce the size.

Figure 8. Waste water sewage reservoir.

3.2. Materials

Bamboo was chosen for the structure, sliding panels, furniture and roof of all modular housing. This is typical of Vietnamese landscapes. Bamboo has good capability to absorb energy. It's reliable, eco-friendly and a sustainable renewable local material. It gives the necessary sense of beauty, tradition, with a unique connection to nature DeKay (2011). It's tactile and visual sensory rich. For the foundation pillars, were applied wood from the surrounding forest (called SIndora Tonkinesis), which is adequate for long periods under water. Waste water and rainwater collector plumbing are made with stainless steel.

3.3 Building components

The structure has a variety of thickness and construction techniques. The outer walls are built with two layers of bamboo, with 15 cm diameter, a layer of thermal isolation of 0,04m, an waterproofing layer with 0,02 m. This provides an excellent thermal insulation properties to the structure. The inside doors are sliding panels, built with bamboo with 0,01 m x 3 m, fixed with ropes and nails sliding on stainless steel rails. The roof is made of bamboo rafters and battens, covered with two to three layers of bamboo tiles. The sloping roof is one of the major climate responsible elements of vernacular settings, where the height ridges of 5m, which acts as a major isolation providing a good air flow inside. All floors and stairs are built with bamboo fixed to the structure. Doors and windows are the only openings of the proposed dwellings located only on the Northern and Southern facades, an adaptation at the implantation site surroundings.

The front and back door alignment eases the wind flow from the exterior to the interior, guaranteeing a thermal regulation. On the roof was placed a small opening to the air in the upper part of the house, to open during the dry season. Planning and design of buildings on river margins are a challenge task due to the difficult terrain, combining with adverse climatic conditions. In response to this harsh development conditions, numerous vernacular practices and styles have evolved with local materials and indigenous techniques to fulfill inhabitant's needs, causing a minimal damage to the environment. The house module was designed to have low maintenance, strength of materials and building components, adaptable to the skills of local craftsman who are used to work with traditional materials and techniques.The building system is based on:

Step 1: Ground coverage, a small footprint and dimensions adequate to guarantee an adaptation to the implantation site. Build the direct foundation pillars with 1,5 m underground, making the foundation with local stone and a combination of mud, raising up 9 meters to the houses platform, elevating above the water raising levels.

Step 2: Building the stilts, beams and post system with local forest wood, with a combination of bamboo on the platforms placed along the pillars.

Step 3: Construction of a double slab Bamboo structure in between the lower level and the house module.

Step 4: Introduction of the staircase that connects the house with the lower platforms and boat pier, on level -3.

Step 5: Construction of the walls and floors, built sliced bamboo placed in two layers, plastered and isolated on the center with an isulation material with 4 cm and an waterproofing protection.

Step 6: Introduction of a sloped roof, where it's imperative that bamboo roofs are treated to extend their longevity. A boric acid/ borax solution is used to preclude fungus and insect infestation. Vernacular Architecture has a large variety of techniques that have been developed along the years to create roof support systems. This module includes a prefabricated triangular truss system comprising units of eight meters long built In Bamboo. These trusses can be carried by only four people, and only deflect 2 1/2 centimeters along their entire length, posteriorly the frames are then covered with bamboo boards, lath and plaster to create a waterproof roof.

4. Building with Bamboo

4.1. Bamboo history

Bamboo is a great material, recently discovered strong as steel and concrete, cheap, easy to work with, is light weighted in comparing to wood, concrete, or steel, and it has a huge strength to weight ratio advantage due to the hollowness of its cylinder shape. It's widely accepted as an example of a sustainable material, a never-ending source, when compared with plain wood, one does not need to wait for 75 years to get a crop; it's possible to make it grow on the dwellings. As a building material it could be used both in the structure and as a finish material, the canes are beautiful when exposed, traditionally used on Vernacular Architecture in structures mainly on subtropical climates like Vietnam (Dunkelberg, 1992).

4.2 Bamboo structural characteristics

Known as a strong material in both tension and compression, where the strength increases as it gets older, reaching the perfect conditions for construction at three years of age. Easy to cut, handle, repair, reposition and maintain, without the need of any machinery. It is suitable for all type of structures and constructions of vernacular architecture; it's non-polluting and could be applied in combination with other types of construction materials, such as reinforcing materials foundations.

All of the Bamboo cane is used and recycled back into the earth as a fertilizer, it has a circular form and hollow sections which make a light building material, transport and store, saving time at the construction process (Dunkelberg, 1992). On each of its nodes, Bamboo has a dividing transverse wall that preserves the strength and allows blending thus preventing rupturing when bent, has a superior earthquake resistance, it is adequate for this subtropical climate with a constant occurrence of natural phenomenon, such as earthquake. The composition of the fibber in the Bamboo walls allows it to be cut lengthwise or cross cut in pieces of any length, using just a simple manual tool like the machete. The natural surface of Bamboo is smooth, clean, attractive, and colourful, doesn't need to be painted, scraped or polished, in spite of being a structural element, Bamboo can be applied on floors, walls, water pipes, drainage and furniture. Nature made it almost perfect.

4.3 Bamboo building techniques

In standard Bamboo construction, joints are difficult to make, were the structure is formed with flaps incising the Bamboo radially. The soft inside of each "flap" is cut away, wich allows to bend easily (Dunkelberg, 1992). These flaps are then bent over a cone with a threaded rod sticking out of the tip, this external cone protects against insect entry. This results in an end which can easily be attached to a central hub. One of the biggest problem that affects the adoption of Bamboo architecture in those areas, is due to vernacular history and the perception that it is considered "poor people's" housing. In Vietnam, the highest castes use stone to build, the middle castes, wood, and only the lowest castes use bamboo, there is a need to introduce Bamboo in recent constructions becoming a sustainable building material of choice.

4.4 Bamboo treatment

To guarantee a resistance has a building material, Bamboo canes need to be submitted to vernacular treatments such as the soaking method, where it'is submerged in water for about six weeks, increasing its durability; it is a safe and low cost solution, though is not a 100% effective, on the other hand is time consuming causing a delay of the construction period and the transportation could be difficult. Other method more effective and environmentally friendly, which guarantees a preservation of the Bamboo canes for 75 years, a combination of borax and boric acid. This salt is used as an insecticide and fungicide, effective against fungi and algae; has an infinite shelf life and is not affected by temperature. Bamboo can be impregnated, submerged or sprayed with this chemical. The natural durability of this material is very low and depends on species, climatic conditions and type of use, so it's necessary to carry out reliable preservation of every Bamboo pole, guaranteeing a safe, ecologic and sustainable treatment (Satish et al., 1994).

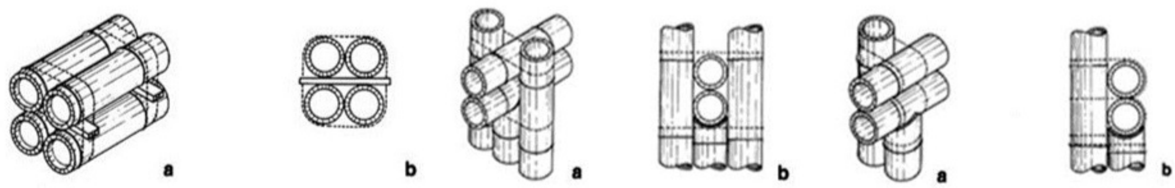

Figure 9. Bamboo building techniques

5. Conclusion

The present study reveals that the identified dwellings are directly responsive to climatic conditions and to the cultural and social needs of their inhabitant's. Chau Doc's river margin is often exposed to degradation due to the water raising levels and the occurrence of long periods of rain. Among the years the locals tried to solve a myriad of problem based on the available knowledge, from which resulted a general landscape full of houses supported on stilt platforms, poorly built, and with lack of general conditions. According to the vision vehicular in the paper, it's urgent to design a solution, based on Vernacular and sustainable knowledge, exploring the spatial design, flexibility and energy efficient of guaranteeing a do-it-yourself construction and affordable to locals. Based on the study and analysis of subtropical architecture, the proposed modular house displays openings on the façade allowing the regulation of indoor temperature, both in summer and in winter. Other aspect of great importance was the need to build a simple bathroom and a sewage and water systems, non-existent at the present time, lowing the pollution levels of the Bassac River.

Bamboo is the main material of the modular house, typical of past generation's constructions and generations to come. It's applied on the walls, floors and platforms, due to its flexibility, low price and handling with. It's a perfect, sustainable, material for this type of climates. The buffer spaces, circulation, entrance and stilt platforms, allows a gradual and smooth transition of movement from exterior to interior, at the same time encouraging and facilitating interaction among people, which leads to a strengthening of societal bonding, increasing the sense of community. The designed indoor spaces accommodate multiple activities at various time periods; no space is left unused for more than one hour in a day due to the design of flexible spaces encouraging family interaction.

Summarizing, it's possible to say that Vernacular Architecture principles aren't based on copying past generation's knowledge, but to show a better understanding of the local implantation needs, its traditions and culture, connecting the building design and form. We can assume that vernacular settlements have evolved in a way to respond to the climate conditions, through building techniques and through the use of proper materials easily employed by the inhabitants, where the spatial flexibility and the climate conscious design enhances the quality aspects of each individual space, guaranteeing the appropriate thermal comfort inside of the house module.

Acknowledgements

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Design for local development: an approach based on autochthonous materials and traditional manufacturing methods

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Abstract

Paper presents amount results of PhD research about the implications of choosing native materials and traditional manufacture methods for design of local products. Consequently, it is expected adding value to local resources and its origin. The aim is to develop strategies for local product innovation by identifying and exploring native materials and traditional manufacturing methods. The major motivation for the research is the abundance of materials resource in Brazil and specific methods of manufacture developed by several communities around different regions of this country. However, the lack of articulation among producer community, companies, development policies in association with a poor projectual speech implies reduced use of local resources and, consequently, results in losses of opportunity to add value to local resources and developing local economy.

Keywords: Materials selection and design, local products, manufacturing methods, promotion of resources of the territory

1. Introduction

Discuss and propose strategies for adding value to local materials and techniques is very important for practitioners and researchers that work in the area of product design. Many opportunities for local development, especially in megabiodiverse contexts as Brazil, can be identified by means of searching and selecting original materials and techniques. This paper is part of a PhD research in progress that aims to contribute to understanding the role of autochthonous materials and traditional manufacturing methods in design of local products.

Due globalization, it is possible to list three general characteristics of current systems of production: (1) Standardization of products (universal design); (2) Profit generation; (3) Lack of bond to territories; (4) Exploitation of resources and cheap work force.

According Santos (1999), for those territories that economy is emerging, this reality is devastating: large companies have no responsibilities with social or environment aspects; they just obtain profits until it attends.

In this context, it was addressed following questions:

How to add value to local resources and its origin by using materials resource to design of local products?

What are the relevant aspects of materials and manufacturing methods selection for design?

Brazil is an immense country and owns vast natural resources. Moreover, ancestry communities developed a lot of traditional manufacture methods. However, current situation about local products in this context is:

- Traditional manufacturing methods are not registered, and it exist seriously risk of they disappear;

- Rarely, companies using mass production explore traditional manufacturing methods and natural materials. Frequently, it is done by craft and results in low quality products;
- Emotional aspects of materials and manufacturing methods are not exploited;
- Profits generated by massive production do not stay in territories;
- Design education ignores this found of source.

Then, we found on autochthonous materials and traditional manufacture methods an alternative to improve and add value to local product. And it was addressed more one question:

What is the role of autochthonous materials and traditional manufacture methods in this process?

This paper presents amount findings of PhD research about the implications of choosing native materials and traditional manufacture methods for design of local products. PhD research goal is offer a syllabus for design education based on strategies for selection and application of autochthonous materials and traditional manufacture methods. It is expected that findings contribute to local product innovation and, consequently, promotion of resources of territory.

2. Methods

Relevant information is being collected by a qualitative approach through several research tools such as literature review, case studies analyses, exploratory interviews and exploratory studies with design students and designers. Findings will generate a model that should be tested in a workshop with design students. For validation of findings and model, a group of experts within the correlated areas will be invited to evaluate it.

Exploring autochthonous materials and traditional manufacturing methods: implications

This investigation studies three main implications of exploring autochthonous materials and traditional manufacturing methods for design of local products:

First one intends to understand what aspects are important to designers when they select materials and manufacturing methods to shape their projects. Decision making about material and manufacturing methods are influenced by a lot of factor: technical features, company needs or esthetical requirements. In most cases, technical and costs reasons are determinative. However, for design field, other characteristics are as important as them. In 1986, professor Ezio Manzini presented the book “The material of invention” about materials and manufacturing processes like a “horizon of possibilities” for designers. Author explained technical features should not be principal criterion to select a material against an increasing number of new materials. Then, he realized reflections about cultural aspects of materials and it effects at users perception of products.

From then on, lots researches investigate the role of sensorial, emotional and perception aspects of material and manufacturing methods. These aspects are called by experts “intangible meanings” since they are subjective. (Jee and Kang, 2001; Sapuan, 2001; Ashby and Johnson, 2002, 2003; Ljungberg and Edwards, 2003; Hodgson and Harper, 2004; Rognoli and Levi, 2004; Lefteri, 2005; Conran, 2005; Zuo, 2005; van Kesteren, 2008; Karana, 2009).

Intangible aspects of materials are relevant to this research and the proposed model because it is concerned with factor of local recognition. Recognition of territory is an essential factor for adds value to its resources. Starting by “materials evoke meanings and elicit emotions” (Karana, 2009), we investigated if some material or manufacturing method employed in local products evokes emotions in users.

Then, second implication of this research appraises if this approach really make any sense to final users. It was used two kinds of surveys: Survey 1 and Survey 2.

Survey 1 - We made use of a survey based upon online questionnaires, answered by 100 people (50 Portuguese and 50 Brazilian). They should indicate products or brands made by materials or manufacturing methods they judge related to a place. It was mentioned products made by: Murano glass from Murano in Italy; Portuguese filigree from Gondomar in Portugal; Portuguese filigree from Viana do Castelo in Portugal; golden grass from Jalapão Brasil; cork from Alentejo/Portugal; Portuguese ceramic from Portugal; black clay from Molelos/Portugal; Persia Carpet from ancient Persia; tile from Portugal; among others. Figure 1 presents a board with results.

Figure 1. Products cited by interviewed users

Survey 2 – On this experiment, we presented 4 different products to a group of 15 students from Faculty of Architecture of University of Lisbon. Then, they were invited to answer a multiple questionnaire about their interaction with objects. We selected four objects based in the following criteria: they are part of a collection or a brand that only uses that material or manufacturing method; they were made to represent a place; various geographic localization. Subsequently, objects selected were: (1) a purse in cork designed by Portuguese brand Pelcor; (2) a pendant (jewellery) in golden grass designed by Crafters Association of pontealtense golden grass from Brazil; (3) a pendant (jewellery) in Murano glass designed by Italian brand Venezia; (4) a box with Portuguese tiles designed by Portuguese brand Sá Nogueira azulejaria. Figure 2 displays experiment realization.

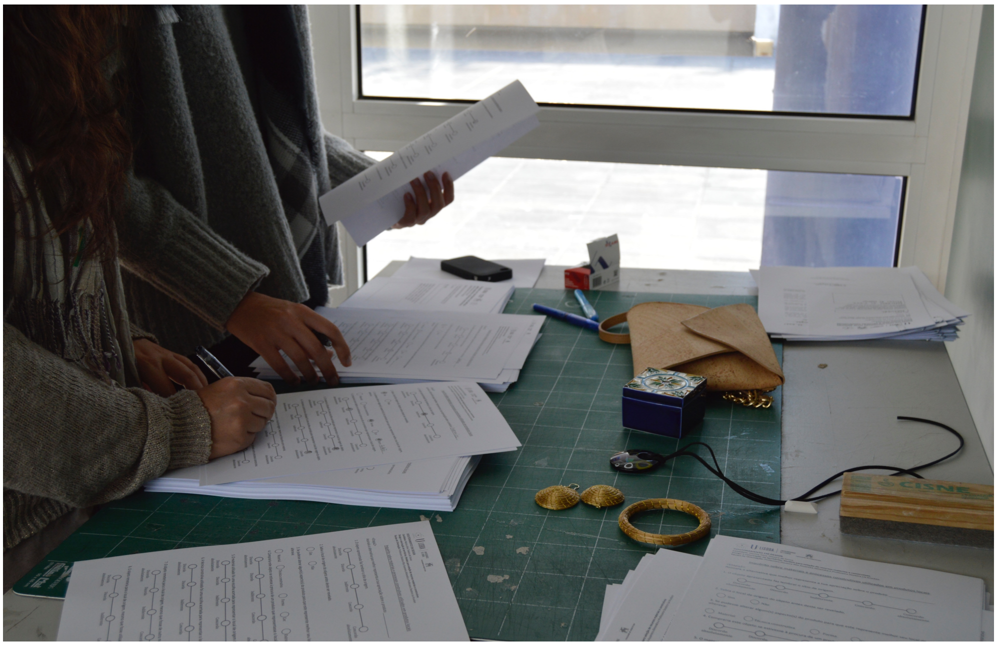

Figure 2. Experiment in course

Third implication, finally, evaluate effects of this approach to territories based on economy, people and environment.

Currently, productive systems are based on accumulation of property, profit generation and territorial expansion. According Braungart and McDounough (2013), in this economic context, "gross products" are designed. They are attractive, accessible, obey regulations, their performance is sufficient and they attend market expectation. Although, these products partially satisfy some clients and companies, usually, they do not attend environment, health or territory economic aspects.

Brazilian philosopher Milton Santos (2001) defends that large companies explore natural resources and local labour from territories without social or ethical responsibilities about their development. It only consists in an extractives phase of production system.

Cultural practices become poor by extractive production systems because in this situation people are limited in their activities: they only do repetitive actions in programed journey. Moreover, people do not maintain residence in origin place searching better opportunities.

A solution proposed by Manzini (2015) is the collaborative work between designers and productive community. In this way, community has an active participation not only with manual work but also with intellectual work to promote what author calls "social innovation".

Beyond economic and social injuries, Schumacher (1979) defends that the concentration of economic supremacy and massive production had been also injuring environment. Braungart and McDounough (2013) advert that large industrial systems discharge amount toxic waste on air, soil and water; causes intoxication to people and natural systems; produce dangerous materials; produces unless waste; buries materials.

Then, a model to design of local products by using autochthonous materials and traditional manufacturing methods is satisfactory because it is possible to establish a renovation role to these resources.

3. Results and discussion

Based on amount findings, we listed positive and negative points of introducing proposed model in Brazil.

Positives:

Brazil has a large and varied number of natural resources; Brazil has a large and varied number of mineral resources; Traditional manufacturing methods in Brazil are varied, creative and original; Even though design is a recent activity, it is increasing in Brazil.

Negatives:

Most of people in Brazil do not give value to handmade items; This subject is not including on design education curricula; Design is a recent activity, and then most of people do not kwon about it. It is included most of companies; Traditional manufacturing methods are not registered.

It is necessary to underline several factors declared thorough paper; they consist in the convergence to a major challenge:

- In general, designers only learn basic information about materials and manufacturing methods.
- It is important to designer kwon how to explore materials and manufacturing methods.
- Techniques aspects are as relevant as those intangible aspects.
- Autochthonous materials have some meanings for people. They recognize it and do associations to places.
- The same occur in relation to traditional manufacturing methods.
- Using autochthonous materials and traditional manufacturing methods results in more gain to territory.
- It outcomes in more intellectual involvement of produced community. Designers can learn with specialized manpower, in addiction manpower can participate and become design process more complete.
- Using autochthonous materials and traditional manufacturing methods consists in an environmental solution.
- It is necessary to establish solid design policies.
- It is necessary to assembly design strategies that include users, produced communities, production system and sustainability.

4. Conclusion

Starting point of this research is to offer a syllabus for design education based on strategies for selection and application of autochthonous materials and traditional manufacture methods. It is important to underline our proposal is to present more one alternative that should not be overlooked. Data declared through paper presents a context as a challenge to design and our approach consists in alternate to solution. Thus, we are not proposing an inflexible system.

Consequently, it is necessary the deep understanding of: role of autochthonous materials and traditional manufacturing methods in design of local products; users appreciation of them; design process and materials selection field; implications of Brazilian context. All data are being collected by qualitative approach.

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Thermal and physical characterization of composite vegetal fibers/animal dung for sustainable briquettes

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Abstract

Currently most of the world's energy production is based on the use of fossil fuels (oil and natural gas). However, mainly due to environmental issues (global warming and greenhouse gas emissions), the use of oil in thermal power generation has been replaced by alternative forms of energy (solar, geothermal, wind, wood briquettes, etc.) with less environmental impact. In this study we propose the development of composite materials made from natural fibers from exotic plants, such as the conteira (*Hedychium gardnerianum*), and animal dung, for the production of briquettes. Conteira, a plant of the Himalayas, was introduced in the Azores (archipelago located in the North Atlantic) as an ornamental, but has quickly become invasive and is currently a serious threat of the local biodiversity. It is considered the worst invasive Azores since it grows very easily and has no predators, which facilitates the full use of large amounts of these plants in the processing of endogenous products. On the other hand, there is huge potential of raw material (leaves, stems, branches, etc.) resulting from the cleaning of forests, available for processing of new materials at present being wasted. A large percentage of this raw material comes from constituents of invasive plants, particularly conteira. Thus, the manufacture of composite briquettes made from forest biomass and animal dung coming from the agricultural holdings (cows and horses), abundant in the archipelago region, which mainly lives of the primary sector of the economy, is a valuable alternative to traditional fuels solid. The use of biomass for energy production reduces emissions of gases responsible for the greenhouse effect, reducing the emission of chemical compounds such as nitrogen oxides (NOx) or volatile organic compounds and other greenhouse gases (eg CO_2 and CO), which makes these composites potential forms of heating cleaner. The sustainability of this product is immediately noticeable as the necessary raw material comes from waste generated by agricultural industries (dung) and the forest itself, making the product cheaper. Energy recovery of biomass will reduce the import of oil products in archipelagic regions and is conducive to job creation and economic development. Thermal analysis such as thermogravimetry (TG/DTG, mass change *vs*. temperature) and differential thermal analysis (DTA, heat flux *vs*. temperature) were used to evaluate the stability and thermal decomposition of the composites as a function of weight loss when subjected to heating. The physical characteristics of composites, such as surface area, density, pore volume and pore size distribution were determined by nitrogen adsorption at 77 K and mercury porosimetry. The internal structure and the surface morphology were determined by scanning electron microscopy (SEM). The results of the analysis of Higher Calorific Value (HCV) performed on composites indicated the value of 18.79 MJ / kg. The developed of such composites are an inexpensive and eco-friendly alternative compared to the traditional solid fuel.

Keywords: Composites; Briquettes; Hedychium gardnerianum; Animal dung; Sustainable energy.

Ten Propositions for Urban Timber: Developing Guidelines for the Multi-Story Timber City

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Abstract

Much hope is associated with wood in the context of civilization's impact on the environment. This also creates new concerns. Multi-story timber buildings (MSTBs for short) are a new concept that has been gaining significance in recent years. The technology is still developing but it is already visible, that if a shift towards a sustainable economy should occur, the building industry has a part to play. Replacing a share of steel and concrete with timber could be its crucial contribution. MSTBs currently get built to stick out rather than to blend in. In order to fulfil the hopes associated with them, they must become generic. The aim of this research is to improve the practice of design of MSTBs through the development of a design tool - a guideline set, applicable in the early stages of the design phase, when the potential influence is at its peak. The guidelines result from the review of the current state of the art in MSTBs. They address three MSTB types - basic units of dense neighbourhoods: the infill, the block and the superstructure - catering to a vision of a dense timber city. The development of guidelines follows a long-standing tradition of navigating complexity. Le Corbusier's five principles of modern architecture are an exemplary instrument of transformation of design practice. In following research stages the guidelines are refined in collaboration with the Scandinavian practitioners of MSTB. In a series of interviews they reorganize and contribute to the guideline set. In a further stage students test the guidelines in action within the framework of diploma course at AHO. The students use the tool to design three types of MSTBs. Results of the exercise are then assessed to again refine the guideline set. A discussion emerges and further research options open up.

Keywords: solid timber, multi-story timber buildings, timber city, urban infill, scandinavian architecture

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