Abstract:
We introduce an approach to investigate structural change on supply chains. We put forward a methodology to generate scenarios based on stakeholders’ views. In addition, we illustrate how the approach can be implemented with a major project on the sustainability of the UK clothing and textile retail supply chain. We discuss the economic, social and environmental impact of one of the pilot scenarios, i.e. leasing of clothing.

Introduction

During the last thirty-five years, we have witnessed an increased awareness of sustainability issues in industry, including waste management policies and clean production, or closed-loop systems and the integration of social responsibility in corporate values (Hollender, 2004). One can commonly find in the business world one, or more, of the following strategies (see Russell and Allwood, 2007): to use less, e.g. material or energy; substitution, e.g. non-toxic for toxic materials; clean –up the outputs, and turn outputs into inputs, by means of several recovery options (see De Brito and Dekker, 2004 for a typology on recovery options). To achieve the previous may involve re-organizing the supply chain at several levels, putting in place efficient reverse logistics systems to take-back products and materials, or developing a broader culture of design, i.e. going beyond immediate functionality bearing in mind the recovery phase. Though demanding, the greening of supply chains and the aforementioned eco-efficient strategies have most of the times led to incremental changes rather than effective transition towards sustainable supply chains in practice. There are many reasons for this: e.g. the great number of parties involved and insufficient tools to support decision makers in assessing in advance transition towards sustainability estimating potential impacts.

In this paper, we propose a research design to consider structural shifts in practice and a methodology to guide the decision-process, and to evaluate its impact. Next section describes the proposed research design and the following two sections illustrate how the proposed methodology has been implemented in a project on the sustainability of the UK textile and clothing supply chain. We then wrap-up with the main points of this paper.

A methodology towards sustainable supply chains

Up to now there have been to incremental changes towards sustainability rather than effective transition towards sustainable supply chains in practice. This indicates that, if the system is in transition, it is only at the pre-developmental stage and it can still collapse (Rotmans, 2003).

In order to identify a potential transition, it is crucial to be aware of, on the one hand the trends and needs of the sector and to be aware of the influence of the external environment. Furthermore, and as put by Van der Brugge and de Haan (2005), there is a need to make
explicit different perspectives and to integrate them. We therefore suggest a methodology based on stakeholders' views (trends, breakthroughs and context). Different stakeholders will look upon the aforementioned issues from a different perspective. To gather the group opinion and to guarantee some degree of convergence, the methodology makes use of a Delphi study. The aggregated group view is in this methodology an input to build scenarios on a potential structural change, which then can be assessed with respect to sustainability. Next, we explain and fundament each of the steps in more detail, starting with the identification of the stakeholders to include in the study.

**Stakeholder mapping**

Involving stakeholders (in this case are those who can affect or are affected by the way the supply chains currently work and by any potential change) facilitates the generation of better solutions (see Adams, 1986 and De Bono, 1985 on techniques for problem solving). Even strong apologists of shareholder theory, agree that stakeholders influence business practice (see Sundaram and Ikpen 2004). For more on the on-going stakeholder versus shareholder debate, please see also Smith, 2003, and Freeman et al., 2004.

![Figure 1: The Supply chain and its stakeholders.](image-url)
Philips (2003b) identifies two types of stakeholders: normative are the ones that have a legitimate relationship with the supply chain such as e.g. suppliers, versus derivative, the ones that acquire legitimacy such as NGO’s. Other authors also make a dual split on types of stakeholders. For instance, Kaler (2002) identifies claimants with strong, versus weak links to a business, and Newcombe (2003) distinguishes between internal and external stakeholders. It is not uncommon to include suppliers, industry associations, regulatory agencies, customers and employees, or even the environment as stakeholders (see Gupta, 1995; Donaldson and Preston, 1995; Pigé, 2002; Philips, 2003a and Buchholz, 2004). Thus, to select the respondents, one can first proceed to mapping the supply chain and its broader stakeholders minding the environment, society and business (see Figure 1).

The Delphi approach

Delphi studies can be employed to structure communication among stakeholders. The Delphi study is usually considered a suitable tool to reflect on the future and it has been employed in many fields of research like technology, marketing, supply chain management and so on (see e.g. Boks and Tempelman, 1997; Akkermans et al., 2003, and De Brito, 2004).

Applying the Delphi method basically involves several rounds of questions (and feedbacks) being send to a panel of stakeholders. Individual comments/answers remain anonymous to the group. Through the process, each member of the panel has the chance to refine his/her own answers or comments. Linstone and Turoff (2002) further explain the principles beyond the Delphi method providing examples of applications, and a statistical evaluation of the theoretical response distribution and response errors.

To guarantee quality in information, the questionnaire has to be carefully built to serve the purposes of the study. In this case, the main objective of the Delphi study is to get input on trends and needs of the supply chain, and on the influence that the external environment has on the supply chain. The main forces influencing the sector can be categorised as political, economic, social, technological, legal, environmental, cultural and historical. This tool, referred to as PESTLECH, is commonly accepted as a useful tool to investigate future change given the influence of the external environment. Table 1 summarises the structure and the content of the proposed Delphi questionnaire in this methodology.

Table 1: The structure and content of the Delphi questionnaire.

<table>
<thead>
<tr>
<th>Part I- PAST &amp; PRESENT</th>
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</thead>
<tbody>
<tr>
<td>PESTLECH factors (political, environmental, social, technological, legal and cultural, and historical)</td>
</tr>
<tr>
<td>Part II- FUTURE</td>
</tr>
<tr>
<td>Challenges and tools to deal with them</td>
</tr>
<tr>
<td>Potential positive developments, trends and breakthroughs</td>
</tr>
<tr>
<td>PART III-SPECIFIC ISSUES</td>
</tr>
<tr>
<td>Environmental &amp; Logistics issues in decision-making</td>
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</tbody>
</table>

Given that some of the stakeholders will be supply chain actors with busy agendas, we propose a Delphi study with no more than two-rounds to not risk a low answering rate in subsequent rounds. The first questionnaire can be a set of open questions organized as described in Table 1. For the PESTLECH section, respondents can be asked to list factors influencing the supply chain, which is equivalent to an individual brainstorm session (Rietzhel
et al., 2006). Each individual stakeholder answers freely and anonymously to every question. In the second round, the panel of respondents receives an anonymous feedback-summary of the answers to the first, i.e. there is a pooling of the individual brainstorming sessions. This process guarantees, a priori, a good performance with respect to quantity and quality of ideas, as it is known that pooled individual brainstorming outperforms interactive brainstorming (see e.g. Dugosh and Paulus, 2005). The panel is then asked to rank the pooled-answers according to importance. The top ranking (most important contextual factors influencing the supply chain, and the key trends and breakthroughs) will guide the identification of potential structural change.

Figure 2: The proposed methodology.
Identifying potential transition: scenario generation and evaluation

We suggest using the input of stakeholders on the main forces influencing the sector, together with their view on trends and potential breakthroughs to identify potential changes leading to a transition towards sustainable supply chains. For the generation of these scenarios a face-to-face group (of researchers or decision-makers, depending on the setting) is adequate, as there is evidence that in presence of large amount of information (in this case, the Delphi study results), interactive generation of ideas is most appropriate (see McGlynn et al., 2004).

To investigate, advise or decide on which structural change to pursue, the generated scenarios have to be compared with respect to their respective economic, environmental and social impact, which is directly deducted from the definition of sustainability.

The following two sections illustrate how the proposed methodology has been implemented so far to investigate transition towards sustainability in the UK textile and clothing retail supply chain.

Application: the UKTEX research project

UKTEX is a project mainly on the sustainability of the UK textile and clothing retail supply chain. One of deliverables of the project is to present a vision on the future development of the UK textile and clothing sector and how it relates with the sustainability (see Allwood et al., 2006). We illustrate with this project how the methodology proposed in the previous section can be employed to identify scenarios representing structural change for the chain by starting with the stakeholder mapping, followed by the Delphi study, and finally reaching the generation of the scenarios.

Stakeholder mapping

After carrying out interviews with different actors of the supply chain, and visiting trade exhibitions, we have identified the following main stakeholders to provide input for the study:

- Suppliers (fibers, machinery and chemicals)
- Manufacturers (clothing and textiles, including technical textiles)
- Retailers and Fashion Bureaus
- Post-consumer actors (e.g. operating in the second-hand market)
- Service Providers (software, consultants, press, and professional organizations)
- Independent experts (e.g. scholars)

The rationale of the selection was to assemble a set of actors that can provide as a whole a diversity of supply chain points of view plus impartial views. Given that the objective is related with the future of the sector in the UK, we gave priority to actors in the chain located in the UK, or with branches in the UK. Suppliers, and service providers were mostly of organizations with global operations, and independent experts included European and North American experts.
The Delphi study

After contacting about 50 organizations and researchers to participate in the Delphi study, 25 agreed to answer and answered the first Delphi questionnaire (open questions), well distributed among the selected groups of actors. The answers were analyzed, grouped, and fed-back anonymously to 22 panelists for ranking. Three of the panelists were left out in this phase, because they were independent experts on the textile and clothing supply chain but specialized in other countries than the UK. Their answers were very much valuable to expose, in the first-round, the panel as a whole to external points of view, but it would be outside of their competence to rank which issues were most important for the UK. Out of the 22 that received the second-round ranking questionnaire, 18 filled it in.

Table 2: Specific Delphi results for clothing and supply chain serving the UK market.

<table>
<thead>
<tr>
<th>TRENDS</th>
<th>ENVIRONMENTAL MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth of niche/new markets</td>
<td>Resource use (energy, water, chemicals, and raw materials)</td>
</tr>
<tr>
<td>Growth of e-business and e-commerce</td>
<td></td>
</tr>
<tr>
<td>UK design gains importance</td>
<td></td>
</tr>
</tbody>
</table>

Through the Delphi study, we gathered the views of stakeholders on future trends, breakthroughs, technological development and environmental management. It is not the purpose of this paper to report on the complete set of results, as this is the subject of another publication (see Allwood et al., 2006). Table 3.2 gives a flavor of the results by summarizing some of the specific outcome: growth of niche markets, e-business and e-commerce, and of the importance of UK design. At the same time, resource use is one of the most important issues being taken into account in environmental management. Based on the results we have generated a couple of scenarios and have elected one or two to run as pilot studies. Leasing a percentage of the clothing consumption could be one of the niche markets emerging in the future. It could be combined with e-commerce, through online leasing shops, which could actually be specialized in UK design. This also goes along with the environmental management practices in this supply chain, as leasing will potentially lead to a reduction in resource use. Next we discuss this pilot-scenario, i.e. leasing instead of selling as a channel to serve the clothing consumption in the UK.

Leasing vs. Selling clothing: a preliminary discussion

Leasing of clothes is not a new concept. For instance, Professional Expectations leases office, formal and other apparel to pregnant women (see www.maternityleasing.com). Some schools sometimes offer parents the option to lease expensive school uniforms for their kids, instead of buying them. Expensive sport apparel, such as skiwear is also commonly leased. A dominant type of clothes being hired is formalwear. Lease periods can vary from two or three days to weeks or several months, depending if they are going to be used just in one occasion, holiday season, or school/maternity period. Garments are commonly leased several times and dry-cleaned or minor repaired after each lease. In the end of its lease-life, a garment may be sold at a discount price or destroyed. The hire domestic clothing market in the UK is of about 300 million pounds on a year basis (Dunn and Gibbins, 2007). Leasing of apparel or textiles does also occur at the corporate level. Examples are work uniforms or linen hire by the catering industry, hotels and hospitals. For instance, Johnson Service Group, PLC is a
company offering leasing and dry-cleaning services for corporate wear in the UK (see http://www.johnsonplc.com/).

Garments become obsolete for a variety of reasons, as identified by consumers (Crehan, 2005): bored of it, out of fashion, grown out of it, looking shabby/old, worn out, falling apart. When consumers dispose of their garments this does not necessarily mean that garments have reached the end of their useful life. They can still be in good condition and they could be worn again. Thus, the leasing concept could be extended to day-to-day clothes. A major barrier however is consumer’s psychology along two fronts: 1) wearing clothes previously worn by others, and 2) the ownership-desire. On the first, the good news is that there is a market for worn-clothes as charity shops are currently selling donated second-hand clothes. Similarly, thrift, consignment or op-shops are commonly available in the U.S., Canada and Australia, where donators sometimes receive a share of the sale price. The Internet is another market channel, where second-hand clothes sales including design labels have grown in the last years (see www.ebay.com). On the second, there is evidence that for either expensive apparel or special occasions or needs, the sense of ownership can be overcome by the benefits of leasing. In a pilot consumer’s questionnaire, Crehan (2005) found out that besides of formal and sportswear, the consumer is predisposed to lease coats, jackets and skirts, but is less willing to lease casual wear such as jeans and T-shirts. Furthermore, a study of Euromonitor (2004), identifies that 23% of the consumers are fashion-driven or style-leaders. If only one quarter of those overcome the aforementioned barriers for leasing, the market for clothes leasing would surpass the £2 billion a year (based on annual clothing expenditure at £600 average per capita, and a total of 60 million UK inhabitants, see Dunn and Gibbins, 2007).

Table 3. Leasing clothes beyond currently specialised markets: preliminary feasibility analysis

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Risks</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>• less dependency on sales (diversification)</td>
<td>• sales cannibalization damaged image</td>
<td>• market for leasing clothes</td>
</tr>
<tr>
<td>• consumers visit stores more often (dependent of business model)</td>
<td>• (poor quality)</td>
<td>• hygiene</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Opportunities</th>
<th>Facilitators</th>
</tr>
</thead>
<tbody>
<tr>
<td>• consumer psychology (wearing worn apparel and ownership-desire)</td>
<td>• the needs of the fashion-leaders</td>
<td>• producer/retailer responsibility (regulation/legislation)</td>
</tr>
<tr>
<td>• running ‘out of fashion’</td>
<td>• consumer’s predisposition to lease skirts, coats, and jackets</td>
<td>• environmental awareness</td>
</tr>
<tr>
<td></td>
<td>• focus on certain garment types, such as children wear for special occasions (parties, sports, etc.) and fashion accessories</td>
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</table>
facilitated if it would be associated with an exclusive innovative product only available through leasing. The future development of regulation on e.g. producer responsibility in the clothing industry would also stimulate alternatives or extensions to current business models, such as leasing. In France, there is since late 2006 a ‘producer-responsibility’ scheme, where producers and importers of textiles and clothing, shoes and household linen pay a tax that is being used to finance textile processing at the end-of-use. Reuse, a European network of associations and companies with activities in re-use and recycling, is also lobbying for end-of-use producer responsibility for clothing and textiles, at the European level (Reuse, 2005).

The manufacturers and the retailers could vertically share disposal responsibility. Retailers could take the initiative to offer a leasing channel, but eventually garments would have to be disposed, thus collaborative partnerships, not only with manufacturers, but also with post-consumption chain players (land-fillers and recyclers) would likely come in handy. Currently this kind of partnerships exists in UK’s second-hand hand market of clothing. For instance, Salvation Army has a partnership with Kettering Textiles, and Oxfam with Wastesaver (see http://www.kettex.com/ and http://www.oxfam.org.uk/). The collected clothes by these charities that are not suitable for their second-hand shops or that surpass demand are then re-directed for the clothing processors having other type of recovery (e.g. to be sold in secondary markets abroad, or for recycling). Retailers could also liaise with other parties to provide additional services such as dry cleaning and laundry, or to fit leasing within a re-design and remanufacturing environment. Table 4 resumes the required changes in the clothing supply chain.

Table 4: Changes required in the supply chain.

<table>
<thead>
<tr>
<th>Designers/Manufacturers</th>
<th>Distributors and retailers</th>
<th>Consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td>To select more durable fabrics</td>
<td>Establishing a leasing channel Diversification of services (laundry, etc.)</td>
<td>Consumers overcome psychological barriers</td>
</tr>
<tr>
<td>(Responsibility for garment disposal)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ECONOMIC IMPACT**

The leasing charges can be constructed to depend on type of product, based e.g. on the garment’s vulnerability to weariness and on a discount factor, e.g. the number of previous leases. Cleaning or washing costs are not to be ignored. They can be either embedded in the leasing price or reflected in an additional charge, if the customer prefers to benefit from that service instead of doing it herself. A comparison of the operational costs of leasing with those of selling should also be taken into account in the design of the cost model, if same or larger margins are to be ensured. In addition there are the investment costs, which may include re-designing stores. In sum, these are many factors to take into account to design a leasing cost model. Nonetheless there are economic benefits for both the retailer and the consumer, where consumers do not intensely wear the garments during the leasing period (otherwise, they worn out quickly), and where the initial leasing price is not too high (otherwise consumers will prefer to buy). See Crehan, 2005 and Allwood et al., 2006.
ENVIRONMENTAL IMPACT

The environmental impact depends mainly on the effect of leasing on overall consumption. Current clothing consumption in the UK is estimated to be 500,000 tones (Crehan, 2005). Assuming consumption fixed, lease capacity of 10% of current consumption and clothes being leased three times (one time new, two times reused), then sales would decrease to 350,000. Together with the clothing in leasing, this represents a production reduction of 100,000 tones. Based on these values, Crehan (2005) estimates a reduction of more than 7000 terajoule in energy, 20 billion litres of water, 12,000 tones of chemical dyestuffs and 27% reduction in land filled clothing waste.

<table>
<thead>
<tr>
<th></th>
<th>Production</th>
<th>Use (2 more washes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>7,000 (TJ)</td>
<td>- 0.742e-3 (TJ)</td>
</tr>
<tr>
<td>Water</td>
<td>20 billion litters</td>
<td>- 2.2 billion litters</td>
</tr>
<tr>
<td>Chemicals</td>
<td>12,000 tonnes (dyestuffs)</td>
<td>N/a</td>
</tr>
<tr>
<td>Landfill</td>
<td>27% reduction</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Lease of 10% of UK’s consumption for 3 lease cycles: savings during the clothing life cycle (Crehan, 2005).

It is possible that the number of washes increases if both the customer and the retailer wash clothing after the leasing period. Given that in this scenario there are two inter-lease periods, this implies two more washes, with negative impacts for energy and water consumption. This is however a small portion of the savings made during production (see Table 5). However it is possible that the retailer opts for dry cleaning instead of more traditional washing. In this case there is substitution of washing for dry cleaning solvents. Furthermore there might be an increase of transportation, given that leasing may cause customers to go to stores more often. The change in transport also depends whether, or not, the cleaning or washing is carried out in the same site where clothes are leased.

SOCIAL IMPACT

In this scenario, there is a reduction of 100,000 tones of clothing in production, which would likely be within a few categories of clothing. The production countries are mainly developing countries in North Africa, Eastern Europe or in the Far East. Minding that clothing production employs flexible female work, the social impact is likely to be felt most there, special if the leasing-model would become a global phenomenon.

The total decrease in clothing sold would likely imply a percentual decrease of clothing being donated to charities or recyclers by the consumers. This could however be compensated by the retailers, depending on their option regarding the disposal of clothing after the three end-of-lease cycles. The resulting balance is of importance for countries which economy actually depends of the second-hand clothing trade like the Sub-Saharan countries (Baden and Barber, 2005).

To sum up, there is room to develop a leasing business with positive economic and environmental impacts. The social impact at a global level would depend, among others, on the destiny that retailers would give to the clothes at the end of their lease life.
Summary and conclusions

In this paper we introduced a methodology to investigate structural change in supply chains based on stakeholders’ views for future scenarios. The approach roughly follows the following steps: stakeholder mapping and identification of key-stakeholders; building a questionnaire including questions on contextual forces, trends and potential breakthroughs; carrying out a Delphi study; a guided ‘brainstorming’ on the identification of potential change (scenario transition); evaluation of the impacts with respect to sustainability.

We illustrated the methodology with the case of the clothing and textile supply chain serving the UK market and discussed one pilot-scenario, i.e. leasing vs. selling a percentage of the national clothing consumption. We showed, preliminarily, that under certain circumstances, it is possible to develop a leasing business model with positive economic and environmental impacts. The type of social impact at a global level however would depend from many factors, including end-of-lease disposal policies. This served to illustrate the complexity involved in evaluating economic, social and environmental consequences, at a global level.

Given that supply chains operate more and more globally we ought to take into account both global and more regional impacts, when we consider shifts or changes in production and other operations. Thus, there is a need to develop further methodologies, like the one presented in this paper, to support decision makers in assessing transition towards sustainability. On this, and taking into account the global scale of supply chain operations, there is a need to build a dedicated set of sustainability indicators, to measure in this context, local, regional and global impacts.

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