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Supply chain management on the crossroad to sustainability: a blessing or a curse?

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Abstract The implications of environmental sustainability and social responsibility transcend the actual ownership of the particular product; up-stream the supply chain to consider behaviour of suppliers, and down-stream to consider the impact of the product-in-use, and ultimately, its disposal. These concerns are frequently conceptualised as an extension to current theoretical approaches and practices in supply chain management (SCM). This paper raises the question of how SCM is actually addressing these issues. In particular, it is argued that SCM can be seen as amongst the causes of the problem rather than a viable solution. To clarify this challenge, three generic strategies are developed as a response: (1) enhancing the use of current SCM approaches, (2) aligning SCM with social and environmental concerns and (3) rejecting SCM in its current fashion to address environmental and social concerns and suggesting a replacement strategy.

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1 Starting point of considerations and problem statement

Supply chain management (SCM) has had a substantial impact as a facilitator of globalisation of the world economy. It seems, however, that the society pays a high price for the economic advantages of globalisation in terms of environmental shortcomings, which are today summarised by terms such as 'global warming', 'climate change' or 'carbon footprint'. Issues conceptualised under the umbrella of corporate social responsibility (CSR) have become common in many mission statements and annual reports from multinational corporations. CSR relates to transparency in financial reporting, sustainability reporting, and opportunities for stakeholder dialogue. A closely related concept is *sustainability*, which Elkington [15] (p. 20) defines as "the principle of ensuring that our actions today do not limit the range of economic, social and environmental options open to future generations" and called this principle the triple bottom line approach. The economic, social and environmental dimensions are also recognised as "three pillars of sustainability" [29, p. 1688].

The reactions to this development include the consideration of these issues in the design and operation of global supply chains. This has been synthesized by research into topics such as reverse logistics, closed-loop supply chains, and sustainable supply chain management. A common denominator here is that environmental and social issues will not only affect the individual company but also the managed network of suppliers, producers, distributors and

customers; i.e. the supply chain will be influenced. Elkington [15] anticipated the importance of a triple benefit integrating economy, ecology and people at the supply chain level, as companies "will increasingly be forced to pass the pressure on their supply chains". This move is still a challenging task as Seuring and Müller [55] make out in their study on sustainable SCM.

The attempt to conceptualise sustainability as a part of supply chain design, operations and performance is often depicted as an extension to current theoretical approaches and practices in SCM. But although, for example, logistics becomes 'reverse', the operations (e.g. movement of products that are returned) do have implications for, e.g. the carbon footprint. Instead of calling for more focus on attributes of the supply chain as solution—such as integration, performance, collaboration and centralization—we ought to take a step back and explore the intersection of SCM and sustainability. In doing so, we have taken notice of Ghoshal's [22] critical view on management theories who states: "Our theories and ideas have done much to strengthen the management practices that we are all now so loudly condemning". On the basis of this, this paper seeks to address the following question: How can sustainability be integrated in the SCM approach—is sustainability coherent, complementary or contradictory to the traditional SCM approach? Derived from this are three propositions suggesting multiple and perhaps fragmented ways in which SCM addresses the sustainable agenda. This prompts a more fundamental but also sensitive issue; is SCM amongst the causes of the problem rather than a viable solution? This paper includes a discussion on the meaning of sustainability when it comes to SCM as well as a suggestion of how to incorporate sustainability into the SCM concept. The character of this paper is conceptual and based on a literature review and secondary data analysis of illustrative case examples.

After presenting the general notion of sustainability, the paper presents a topical review of how sustainability is discussed from an SCM point of view. Afterwards, three possible generic strategies are presented which show how SCM and sustainability can converge. These conversion strategies refer to enhancing, aligning and replacing. The paper ends with a discussion on the managerial and research implications of sustainable SCM.

2 The notion of sustainability

The basic idea of sustainability was initially presented in the field of agriculture in 1713, when the Saxon miner Captain Hanns von Carlowitz requested a sustainable, continuous and enduring utilization of forest resources [11]. The technical and scientific progress in the field of agriculture, e.g. the use of more effective fertiliser or machines, have in particular reduced sustainable thinking, as modern technology has secured the long-term existence of the agricultures' organisation [23]. In 1962, Silent Spring, a book written by Carson [7], spurred the ecological discussion in the Western Hemisphere by documenting the detrimental effects of pesticides on the environment.

In 1972, the Club of Rome presented its first report "Limits to growth", which has been the starting point for a discussion of a sustainable development of the society. The methodology behind this report has been the Systems Dynamics approach [18] and the authors conclude that "….it is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future" [41].

The Brundlandt-report, [6] 'Our common future', can be seen as an extension of these ideas. The main outcome of the report showed the consequences of present economic behaviour and suggested change in business activities. Business should provide a sustainable development or sustainability, which is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. Sustainability puts economic, social and environmental elements together and, "like it or not, the responsibility for ensuring a sustainable world falls largely on the shoulders of the world's enterprises, the economic engines of the future" [13].

Disciplines like marketing have incorporated these thoughts and presented subject-specific concepts such as eco-marketing, social marketing or society-based marketing [2, 35, 42]. Management theory introduced the business case sustainability for strategic management [14], and the corporate responsibility has recently been recognised as a major driving force for the competitive strategy of companies [47, 60].

The Stern Review on the Economics of the Climate Change [58] gave a wake-up call for logistics and SCM. This report primarily discussed the effect of climate change and global warming on the world economy widely and largely and showed that agriculture, industrial production and transport together account for 40% of the total emission of greenhouse gases in the world. These three sectors are vital elements of a supply chain which "encompasses all activities associated with the flow and transformation of goods from the raw materials stage (extraction) through to the end user, as well as the associated information flows" [26]. The Stern report then proposes action plans on multilateral frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC) or the Kyoto Protocol and it also shows that the climate change mitigation raises the classic problem of the provision of a

global public good where an international management of common resources is required in order to avoid free riding.

Taking these developments into account, supply chain managers are requested to deal with the consequences of climate change, ecological issues, polluted air/water, children labour, physical/psychological working conditions and more—but are the traditional frameworks of logistics and SCM providing them with the necessary guidelines?

3 A topical review of sustainability in SCM

A systematic search and review of literature within SCM and logistics has already been conducted recently [9, 36, 55, 57] Besides logistics, these reviews do even include references to operations management and purchasing. This section provides a topical review of concepts within SCM that are associated with sustainability. We summarise these discussions under the term "sustainable supply chain management" (SSCM) [9] and elaborate on the following concepts as the constituent components of SSCM: reverse supply chains, green SCM, triple bottom line, product stewardship, CSR in supply chains and carbon footprints in supply chains. We start this review by the notion of sustainability.

3.1 Sustainability in logistics and SCM

3.1.1 Reverse logistics and closed-loop supply chain

Reverse logistics is defined by Rogers and Tibben-Lembke [52] "the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal". The closed-loop supply chain is a wider concept, and includes, besides reverse logistics, the return product process of acquisition, test, sort and disposition, including distribution and marketing [25].

Closed-loops consist of two supply chains: a forward and a reverse chain, whereby the recovered product either re-enters the primary forward chain or is shunted to a secondary market. Examples of closed-loop supply chains are Xerox-Europe [25], Kodak's Single-Use Cameras [25], IBM's spare parts [17], Caterpillar's remanufacturing of diesel engines [71] and the European Recycling Platform founded in 2002 by Braun, Electrolux, HP, and Sony [65].

However, the return flow does not always go back to the origin, as noted by Bernon and Cullen [3]. In many cases, collective schemes assume the responsibility of collecting and disposing the returned products. Reverse logistics is also a new, growing business area for TPL providers [37]. Brodin and Flygansvær [5] have empirically identified three types of coordinators within the EEE-industry: The dominant coordinator (closed-loop supply chains), the implicit coordinator (a recycling specialist of an open reverse logistics system), and the mediating coordinator (e.g. a TPL provider).

Stock et al. [59] argue that effective product returns strategies and programmes can enhance the competitive advantage. Similarly, Johnson [32] states that "product returns have long been a necessary evil, but top companies today are managing their reverse supply chains as a source of value". Jayaraman and Luo [30] look at reverse logistics from a resource-based view of the firm, and claim that procedures, policies, and processes related to the firm's reverse logistics are embedded in the operational routines of value-chain activities. Therefore, reverse logistics belongs to the firm's distinctive capabilities that are difficult to imitate, transfer or substitute [43, 52, 53].

The variations in timing, quality, and quantity of product returns make it difficult to forecast requirements and allocate resources to return systems on other than an ad hoc basis. Only a few companies have a formalised information system and standard operating procedures for handling returns. An important problem is related to the fact that products returned by end-users are often unpacked, without barcodes or other product identifications. When the products are returned to consolidation or return centres, it is a time-consuming task to identify the product and re-labelling it with a barcode.

Time-to-remarket is essential for time-sensitive returns, e.g. clothes, books, mobile phones, and electronic equipment. Blackburn et al. [4] use the term "preponement" as a strategy to make the reverse supply chain responsive by reducing time delays and promote early collection, sorting, disposition, and disassembly rather than late (postponement) process and product differentiation.

Cannibalization is a problem for companies, which take back used products or new products returned from the end-customer to be returned to the market. In some cases the products are repacked and returned to the primary market at the same price. In other cases, the products are sold on a secondary market, e.g. via a broker or an electronic auction (e-bay.com, lauritz.com, amazon.com).While performance measurements can be routine in the case of forward flows of products in the supply chain, return flows are rarely measured in a systematic way. However, it is also important to set up performance measures for the reverse supply chain, e.g., time from consumer complaint to replacement of new product/repaired defect product at the customer premise, time to pay-back the customer, quantity and quality of returns, causes of returns, costs involved in returns, etc. The responsibility of the reverse supply chain

is often fragmented among different actors, and as a result, no one takes overall responsibility. This often results in sub-optimization and inefficient solutions.

3.1.2 Triple bottom line

The triple bottom line by Elkington or Dyllick and Hockerts consists of the following three parts [14–16]:

1. *Economy/profit*: The economic dimension does not refer only to profitability. At any time, economically sustainable companies deliver cash flows that are sufficient to maintain liquidity and offer a constant, above-average return to the shareholders.
2. *Ecology/planet*: In the past, the environmental dimension has had the largest impact on sustainable development, as an eco-system represents the ultimate profit line. Dyllick and Hockerts define an ecologically sustainable company as a company that uses natural resources that are consumed at a rate below natural reproduction or at a rate below the developments of substitutes. Ecologically sustainable companies do not cause emissions that harm the environment, but are companies where managers limit the use of any type of resources as necessary and minimise any waste as much as possible. From a company point of view, it might also be clear, that the input into the companies' production systems are often natural resources, the output is not only a final product but also pollution and other forms of waste. An ecologically sustainable company can be characterised as a company that has incorporated ecological considerations in its daily operations as well as in its strategic planning.
3. *Equity/people*: The 'people' dimension could best be characterised as the company's social responsibility. The social dimension refers to a growth strategy without decreased job quality and it reflects internal as well as external effects. According to Dyllick and Hockerts, socially sustainable companies increase the human capital of individual partners as well as advancing the societal capital of their communities, in which they operate [32]. These actions are in accordance with the company's value system [67, 69].

The consideration of the 3P (Profit, Planet, People) within the SCM concept will lead to SSCM that can be defined as follows: Collaboration among supply chain members within all activities, that concern the delivery of environmentally and socially responsible products and services to the end customer, as well as attaining acceptable profit and information in the supply chain [50]. A sustainable supply chain as outlined in Table 1 includes the inter-organisational dimension as well as the value-added perspective, social and environmental issues.

3.1.3 Product stewardship

Product stewardship is a product-centred approach to environmental protection. Product stewardship recognises that product manufacturers must take on responsibilities to reduce the ecological footprint of their products. By rethinking products and relationships with their supply chain partners and end-users, some manufacturers can reduce costs, promote product and market innovation, and reduce the environmental impact of their products. Reducing use of toxic ingredients, reducing energy consumption and material waste, designing for reuse and recyclability, and developing take-back programs are some of the opportunities to become better environmental stewards of their products.

One example is the US-based Interface Carpets, a world leader in modular carpets, which has been committed to becoming an environmentally sustainable company since 1994. Interface's sustainability efforts fall into three categories: waste minimization, engineering changes, and product and process changes. Thus, Interface has implemented a closed-loop supply chain by leasing carpets, maintaining them, taking them back again, and reusing them as raw materials for new carpets and fabrics. Furthermore, Interface has designed a system of eco-metrics that allow them to measure the inputs and the waste outputs per unit of finished product, so they can track their progress and see, which areas to prioritise in the future [68].

Another example is Apple, which is trying to eliminate all toxic chemicals from their new products. In 2006, Apple became the first computer company to eliminate cathode-ray tubes (CRT). A CRT contains about 1.4 kg of lead. The third-generation LCD-based iMac contains less than 1 g of lead. Since 2006 all Apple products worldwide have been compliant with EU's RoHS Directive (Restrictions of Hazardous Substances in Electronics). In 2005 Apple recycled 10% of the weight of their electronic waste. The target for 2010 is 30% [64].

3.1.4 Green supply chain management

Srivastava [57] defines Green supply chain management as "integrating environmental thinking into SCM, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life". According to this definition green SCM essentially means that all activities related to the total supply chain should take into account environmental considerations as well as the more traditional economic considerations. Green SCM focuses on two of the three Ps in the triple bottom line, namely profit and planet, while people issues are normally not included in this concept.

Table 1 A sustainable supply chain

Supply chain stages	Triple bottom line dimensions		
	Environment/planet	Equity/people	Economy/profit
Supply of raw materials and components	Supplier evaluation and selection based on environmental profile, e.g. ISO 14000 Consolidation of shipments Sharing of information Use of eco-efficient transport modes Reuse of transport packaging materials Cooperation with suppliers to reduce environmental impacts	Supplier evaluation and selection based on social profile Training and education of logistics employees Ensuring codes of conduct at suppliers, e.g. safe working conditions, no child labour, and no abuse of union rights	Transport savings Costs of supplier evaluation and monitoring Costs of internal and external audits of suppliers' compliance with codes of conduct Improved quality of products Reduced risk of damage to brand
Production	Elimination of waste and overuse of resources in the production process Environmentally friendly packaging Green design and manufacturing Eco-efficient production, e.g. waste from one company becomes input to another Replace hazardous materials and processes Recycling materials from used products	Automation of physical heavy work Minimization of specialised, repeating work Prevention of work accidents Warehouse layout, that minimise picking distances In-service training of employees Improved staff recruitment and retention Job rotation and job enrichment	Improved working conditions may increase productivity Savings through resource minimization Economical gains through new product development Costs of certification, documentation and reporting
Distribution and reverse logistics	Choice of environmentally friendly distribution channels Choice of environmentally friendly types of transport Substitute information technology for physical transport Design effective return systems Reuse packaging materials	Reduced traffic congestion Education in energy saving driving Automation of loading and unloading Respecting driving and resting time rules	Savings due to consolidation of shipments to customers Savings due to increased capacity utilization of transport modes Higher prices for eco-friendly products Savings through increased reuse of materials and components

Adapted from [50, 57]

Preuss [48] suggests five steps to achieving a greener supply chain. First, the buying company should focus on the products to be purchased and require its suppliers to comply with recognised international codes of conduct. Second, the buying company should be concerned about the manufacturing processes used by the supply chain, e.g. by requiring accreditation to an environmental standard such as ISO 14001. Third, the buying company should include environmental criteria in its assessment of suppliers. Fourth, supply management should be involved in internal environmental protection initiatives, e.g. design for environmental programs or establishing environmental management systems. Finally, supply chain managers should be responsible for some downstream activities, such as product recovery, recycling and environmentally friendly disposal of end-of-life products.

The ISO 14000 initiative was launched in 1993 and can be differentiated into two groups: evaluation of the management and evaluation and analysis of the products and processes. The management evaluation includes the introduction of an ecological management system, the assessment of the ecological performance and an eco-audit. The product assessment includes the ecological aspects of product norms, eco-labelling and life-cycle-assessment. A number of different standards apply within these areas, e.g. ISO 14001, 14004, 19011, 14015, 14031, ISO guide 64, 14020, 14021, 14040 and 14042 (www.iso.com). However, companies are not obliged to introduce the ISO standards; this is one of the main reasons ISO 14000 is yet to be widely implemented [69].

3.1.5 CSR in supply chains

CSR is based on the idea that a company may be held socially and ethically responsible for a large range of stakeholders such as customers, employees, governments,

NGOs, investors, local communities, unions, and media [34, 61].

As the nature of many business relations is changing from companies manufacturing goods within vertically integrated facilities in national operations to companies engaging in supply chains and contract-based manufacturing across national borders, the concept of CSR is likewise transforming. CSR is no longer the individual company's domain; increasingly, it encompasses the entire supply chain. In other words, multinational companies are not only expected to behave in a socially responsible way inside the company. They are also held responsible for environmental and labour practices of their global trading partners such as suppliers, third party logistics providers, and intermediaries over which they have no ownership [31, 39, 51].

Applications of CSR to the supply chain have not a long history. According to Murphy and Poist [44] the logistics discipline appears to have been more of a laggard with respect to social responsibility considerations. However, ethical considerations are increasingly becoming important to the logistics discipline since contemporary logistics and SCM emphasise strategic outsourcing, buyer–supplier relationships, and information sharing.

The calls for CSR in supply chains should particularly be seen in light of the fact that a large part of global trade is conducted through systems of governance which link firms together in various sourcing and contracting arrangements [20, 56]. The term 'governance' implies that some key actors in the supply chain—often large multinational corporations—take responsibility for the inter-firm division of labour and specific participants' capacity to upgrade their activities [21]. Thus, they are able to control production over large distances without exercising ownership [31].

Gereffi [20, 21] argues that these key actors are typically located in developed countries and include not only multinational manufacturers, but also large retailers and brand-name firms. The power held by these corporations stem from their market power and control over key resources needed in the supply chains, of which they are part. Given their power, these actors play a significant role in specifying what should be produced, how and by whom [20]. The corporations might also provide technical support to their suppliers to enable them to achieve the required performance.

The pressure exerted on multinational companies comes from both internal and external stakeholders, who show an increasing concern for the environmental and social conditions at offshore production locations, particularly in developing countries [1, 33, 39, 61, 62]. This concern is largely a result of an escalation of multi-media communication technology, which makes it more difficult for companies to hide their own or their suppliers' unethical practices. The escalating flow of information across national and cultural borders has given rise to stories about multinational companies' irresponsible practices, such as violation of union rights, use of child labour, dangerous working conditions, race and gender discrimination, etc. Well-known examples from the media are Nike, Gap, H&M, Wal-Mart, and Mattel [19].

By now, many multinational companies have responded to the pressure and expectations from stakeholders by defining, developing and implementing systems and procedures to ensure that their suppliers comply with social and environmental standards. Although firms choose their own approach to systematising the CSR efforts in supply chains, many studies reveal that the most visible element in the approach of large multinational companies is the application of corporate codes of conduct. The number of codes of conduct has grown spectacularly since the early 1990s [28, 31, 61, 62]. Levi Strauss & Co.'s [70] code of conduct labelled "Global Sourcing and Operating Guidelines" from 1991 was the first of its kind in the international apparel industry.

In short, a code of conduct is a document stating a number of social and environmental standards and principles that a firm's suppliers are expected to fulfil [31, 40, 54]. Codes of conduct are increasingly introduced in contracts between a buyer company and its suppliers [61]. They are typically based on the values with which the individual firm wishes to be associated, and its principles are often derived from local legislation and international conventions, standards, and principles, such as UN's Global Compact, the Global Sullivan Principles, Social Accountability 8000, ISO 14001, Global Reporting Initiative, and the ILO Declaration on Fundamental Principles and Rights at Work. In many large multinational companies, the codes are accompanied by elaborate managerial systems for formulating, enforcing and revising the standards outlined in the codes of conduct. However, empirical evidence has shown that many multinational corporations have struggled with the issue of how to implement their codes of conduct in their global supply chains [38]. Recognising this, the ILO has performed an in-depth study of the management systems and processes used to implement Codes of Conduct in the sports footwear, apparel and retail sectors [40].

Several empirical studies have been conducted to investigate how firms work with CSR-related issues in their supply chains [10, 61]. Most of these studies are not confined to only large multinational corporations, but also include small- and medium-sized enterprises (SMEs). Carter and Jennings [9] examined the impact of purchasing social responsibility on supplier performance, and ways of overcoming barriers. Maloni and Brown [39] developed a comprehensive framework of supply chain CSR in the food industry. Mamic [40] presented a summary of an in-depth

study embarked upon by ILO of the management systems and processes used to implement codes of conduct in the sports footwear, apparel and retail sectors. Welford examined the written CSR policies of companies in 15 countries in Europe, North America and Asia [61]. Pedersen and Andersen [46] analyse how the interest of the actors in the supply chain can be aligned with the terms of the codes. IKEA is used as a "best case" example to illustrate how codes of conduct can be effectively managed in the supply chain.

However, despite many companies' efforts to engage in CSR-related activities in their supply chains, there is often a gap between the expressed ethical standards and the actual conditions in the supplier company. In other words, we might argue that so far only a limited number of multinational corporations "walk the talk" of CSR in their global supply chains [12, 51].

3.1.6 Carbon footprints in the supply chain

The European Commission has recently announced that member states are to reduce their emissions of greenhouse gases by at least 20% before 2020 as compared to 1990 levels, the reduction possibly reaching 30% if other industrialised countries, such as USA, China and India, commit themselves to a similar effort in connection with the coming climate conference in Copenhagen in 2009. This decision has an impact for all European Union member states as well as all included stakeholder groups such as globally organised companies, that have off-shored a lot of their production capacities to low-cost countries and have set up long-linked inter-modal transport chains in order to serve their markets.

An initial step towards the reduction of greenhouse gas emissions has been the introduction of the carbon footprint as a measure, which is "the total amount of carbon dioxide (CO_2) and other greenhouse gases emitted over the entire lifecycle of a product or service" [21]. The carbon footprint is typically measured in tons of CO_2 and it can be used to understand the relative amount of damage, which a product or service causes to the environment [24].

Large UK-based retailing companies such as Tesco, Marks & Spencer, Boots, and Sainsbury have already started to label some of their products with carbon footprint related information. Brand-owners, such as Walkers (snack food), Innocent Drinks (fruit smoothies) and Botanics (shampoos) have measured their products' carbon impact and committed themselves to reduce the carbon footprint of their products. The British and Austrian governments are considering mandatory carbon footprint information labelling on all products. Another example is Timberland, manufacturer of the ikonic walking shoes, which has committed to becoming a carbon neutral enterprise by 2010 by using more renewable energy, incorporating more recycled and renewable materials, generating less waste, manufacturing with fewer chemicals, and planting more trees [68]. The Danish–Swedish dairy giant Arla Foods has decided to reduce their global CO_2 emissions from food production, transport and packaging by 25% before 2020. When the British Standard for CO_2 emission is accepted, Arla Foods will start to affix a CO_2 label on their products in large UK retail stores [63].

4 How does SCM address the sustainable agenda?

4.1 Evaluation of the theoretical findings

The evaluation as shown in Table 2 is based on the authors' interpretation of the literature reviews and experiences from previous research in this topic. This reveals that the level of discussing of sustainability in SCM literature is rather sobering. There is a lack of consensus and coherence in the literature as regards definitions, scope and strategic importance of the concepts. Reverse logistics, for example, is often considered as an operational/tactical approach to dealing with the return flows of goods, while CSR and Triple Bottom Line do not only encompass

Table 2 Extent to which current activities in supply chain research addresses the sustainable agenda

Stage in supply chain: streams of SCM research	Design	Sourcing	Production	Distribution	Consumption/Use	Disposal
Reverse logistics	◖	○	◖	◖	●	●
Triple bottom line	○	◖	●	●	◖	◖
Product stewardship	●	◖	◖	◖	●	●
Green SCM	●	●	●	●	◖	◖
Corporate social responsibility	○	●	◖	◖	●	◖
Carbon footprint in supply chains	○	◖	●	●	◖	◖

○: Very limited if any consideration

●: Comprehensively addressed

◖: Partially or only more recently considered

supply chain activities, but also all business processes at the corporate level. Product Stewardship is a product-centreed approach related to environmental protection while Green SCM includes all supply chain activities and takes into account both environmental considerations and more traditional economic considerations. Carbon Footprint focuses on the emission of greenhouse gases during the entire lifecycle of a product or service, but excludes other environmental and social issues. The identified gaps reflect the focal areas of the different streams of SCM research (Table 2).

It remains clear, that although the sustainable agenda has taken off within SCM, it has originated within different streams of research. Of the six streams of research discussed above, only one is unique to SCM, namely reverse logistics. The other five have emerged elsewhere, but been brought into the context of SCM.

4.2 How could SCM deal with sustainability? A proposition of three approaches

The intersection of SCM and sustainability can be understood by three different approaches:

- An *integrated strategy*, where sustainability is fully consistent with SCM
- An *alignment strategy*, where sustainability is complementary to the traditional SCM focus on costs and service
- A *replacement strategy*, where the traditional SCM concept is replaced by an alternative approach to cope with the environmental and social aspects.

It should be noted that the nature of the argument amongst these three options varies. First, the degree to which *SCM is expected to change* increases gradually. Second, whilst the first two assume that current *SCM theories and practice are part of the solution*, the third is of a more radical nature and implies that *SCM is actually amongst the root causes of the problems* of the sustainable agenda.

4.2.1 An integrated sustainability strategy for SCM

This is the approach taken in the research streams: reverse logistics, product stewardship and green SCM. Therefore, sustainability is just another characteristic added to the SCM concept. The use of current theory and practice should be enhanced to address and solve the sustainable agenda. On the supply side, suppliers are chosen, developed and monitored based on their compliance with international codes of conduct, and this provides sufficient comfort to industrial buyers, who want to know about the origin of raw material and components [39, 40]. The products are designed for the environment by eliminating hazardous or harmful materials and making recycling and disposal easy [57]; the current systems and solutions can already cope with these circumstances.

The production process is organised to reduce waste of materials, emission of gases and polluted water, and minimise the consumption of non-renewable energy resources. Transportation and distribution is organised to minimise total mileage, maximise capacity utilization by consolidation of shipments, and to use environmentally friendly transport modes when possible; this is seen as coherent with the logic of efficient distribution systems. The reverse logistics system is organised to maximise the value creation of the returned products, whether it is end-of-life products that are recycled or remanufactured or it is commercial returns, which are taken back to the market as soon as possible [30].

An integrated strategy is thus a strategy where the focus has changed to include not only the traditional costs and service considerations, but also the social and environmental impacts. Thus, the responsibility of greening the supply rests on everyone in the supply chain; from design of products, supply of materials and components, through production processes and delivery to the customers, and finally the return recycling processes [27]. The measurement of supply chain efficiency—such as costs, dependability, quality, reliability and speed—can be captured with measures of environmental and social impacts.

By integrating social and environmental objectives and performance criteria into the strategic and operational decisions in their supply chains, the firms can make the appropriate balance between costs, service and environmental and social impacts.

4.2.2 An alignment sustainability strategy for SCM

Following an alignment strategy, economic, social and environmental concerns will be balanced against each other. They are considered as complementary, meaning that they all have to be taken into account simultaneously, when companies are making important decisions regarding the design or operations of their products and supply chains. The triple-bottom line approach is an example of an alignment strategy [15], and trade-offs between these three dimensions are made to meet the desired output of a particular process.

The same is true for CSR [39]. The main difference between an aligned strategy and an integrated strategy is that the overall objective in the integrated strategy is to increase value creation to customers. If the customers ask for environmental and social concerns these are integrated in the planning, design and operations decisions. If not, the company will comply with existing laws and regulations.

An aligned SCM strategy puts equal weight on profit, people and planet, irrespective of the customers' requirements. Social and environmental issues are part of the company's mission statement and the company accounts for all three aspects in its annual reports. On some occasions, measures such as speed and reliability must be replaced by, e.g. 'energy use', 'material use', carbon footprint' and 'waste/landfill'. An aligned strategy focuses on co-operation and competence building in the entire supply chain. It is not enough to claim and control that the suppliers comply with the focal company's codes of conduct. It is also necessary to co-operate with the suppliers and help them to improve the working and environment conditions.

4.2.3 A replacement sustainability strategy for SCM

It could be argued that the full implementation of the idea of SCM is contradictory to sustainability. If, for example, an agile supply chain design can increase the responsiveness to meet customer requirements, this may happen at the cost of resources (inventories, warehouses) and CO_2 emissions (e.g. by use of airfreight from China to Europe instead of container transport).

The main objective of SCM is to maximise customer value in the most effective and efficient ways possible. In order to survive in the global competition, companies extend their supply chains to further distant locations in order to reap the benefits of differences in labour costs and take advantage of efficient transportation networks. Outsourcing and off-shoring to the Far East, South America and Eastern Europe has increased dramatically during the last decade. This shift has increased the distance between production and consumption considerably with negative results on the use of non-renewable energy resources and emission of greenhouse gases. From this perspective, the success of the extended enterprise is positive for the revenues of the companies, but negative for the environment.

Therefore, a call for a paradigm shift is needed. Instead of continuing to squeeze every penny out of the total costs of products, firms have to reconsider, *how* and *where* they produce their products, and customers have to reconsider their decision criteria for buying the products and the way they dispose them after use. A possible way to change the traditional SCM approach could be to measure the carbon footprint of the product throughout the supply chain over the product's lifecycle, including the disposal and recycling [24]. A label on the product indicating the total amount of CO_2 per unit will tell the customer how green the supply chain of the product has been.

However, calculating the carbon footprint of a product through the supply chain is not an easy task. First, a global standard for measuring carbon footprint is still lacking. Second, carbon footprint is only one aspect of the environmental impacts of a product. Other aspects are related to water waste, air pollution, energy use, use of raw materials, etc. Third, the implication of focusing on the carbon footprint may be a major change in the design of the global supply chain in terms of location of production, choice of distribution channel and transport mode, selection of suppliers, etc.

One possible consequence might be a local-to-local approach instead of the current global-to-local approach. This is actually taking place in various countries; take for example the 'farmers markets' in the UK that are now competing with supermarkets. Local markets squares in towns and cities around UK regularly (weekly or every fortnight) arrange a sales outlet for local farmers and food producers. Such community efforts focus heavily on the sustainable agenda.

First, the food must be *produced locally*, i.e. challenging the distance and volume of global supply chains. Second, *packaging is at a minimum,* where the extensive use of packaging is also due to long distances, dispersed responsibilities and complex liability in the global supply chain. Third, products are *fresh* and preferably *organically* grown, i.e. challenging the artificial maturation process during long-distance transport in refrigerated ships and trucks. This is seen as complementary to local shops, and to the business prosperity of the local community; farmers and producers must operate within a 30–50 mile radius from the market outlet [67]. Should global supply chains now turn local as regards other products? Pearce identifies thereby how difficult it is—from a consumer's perspective—to act in an 'environmental-correct' manner. He calls some of the re-localization strategies also patriotism-strategies and shows that in some cases it is better to buy green beans from Kenia instead from England as most of the CO_2-emissions stem not from transport but from the production process [45].

5 Learnings and implications

5.1 Conclusions

There is no doubt that social and environmental issues are becoming more important on the business agenda. The clear signals of global warming and the devastating effects on climate and life on earth cannot be denied anymore. The international society will, in the future, take dramatic precautions against emission of greenhouse gases and other environmentally damaging actions. Companies have to revisit their supply chain strategies in the light of environmental concerns.

In order to answer the research question, the relevant literature was screened, a topical review developed, and

theoretical findings on how the literature discusses the issue at hand was assessed. Based on these findings three different strategies for dealing with sustainability from a supply chain perspective were proposed: an integrated strategy, an alignment strategy, and a replacement strategy. This means that sustainability will either be a vivid part of SCM, an add-on to SCM or a complete re-definition of SCM.

Reverse logistics, green SCM and product stewardship is related to the integrated strategy. Triple bottom line and CSR are mainly related to the alignment strategy, and finally the carbon footprint is related to the replacement strategy. Still, the literature discusses the topics from a micro-point of view, but not from a macro-point of view. It may be possible that sustainability may be an external factor impacting the design of supply chains and their operations. It is then likely that a contingency approach is the most prosperous way, assuming that there are differences between industries, products, and countries as regards to the most appropriate way to handle sustainability in a supply chain. Further research is therefore necessary to determine the contextual factors for a sustainable supply chain strategy.

We were also able to show that there is no single understanding of sustainability. It is a multi-facetted term, which can include many layers ranging from operative reverse logistics to strategic sustainability on a corporate level (CSR). From a SCM point of view, we identified a certain gap in the sustainability discussion, which refers to the network dimension of SCM. Sustainability in all facets is typically discussed from the single company, but not from a chain perspective. However, recent discussions show that sustainable cooperation can positively affect the total supply chain [49].

5.2 Managerial and research implications

There are several drivers for companies to 'go sustainable'. First, international regulations force companies to at least comply with the new environmental standards set forward in terms of limits of toxins in the products (RoHS directive), restrictions on air and water pollution from production, producer's responsibility for environmentally friendly disposal of end-of-life products (WEEE directive), etc. Second, consumers are more concerned about the carbon footprint of products, especially food products, and of social and environmental impacts of production in developing countries. Third, "sustaining" the supply chain can reduce the operating costs and create value to the products. Fourth, shareholders and investors are demanding that companies are socially responsible, because bad press can damage share prices.

These drivers put a pressure on companies to explore new business models to improve the sustainability of operations across the supply chain. The complex interaction between economic concerns and social and environmental issues have to be considered. Sustainability moves beyond current practice. Companies, legislators and researchers have to address new issues, policies and approaches to meet this challenge.

SSCM includes organisations' activities upstream as well as downstream in the supply chain. An increased focus on sustainability leads to new ways of collaboration with suppliers, customers and intermediaries in the supply chain, including environmental audits, technical and training assistance to critical suppliers, industrial agreements of codes of conduct, etc. Kovács demonstrates in a cross-industrial study of 16 Finnish trans-national corporations that supply chains can be seen as mediators of industry regulation across industry and regional boundaries [36].

Environmental issues should be integrated in all parts of corporate life, including supplier auditing and assessing, product design, manufacturing, distribution, and end-of-life disposal. Handfield et al. [27] emphasise the importance of environmental goals that are specific and measurable. Each product/process should have its own set of environmental goals, depending on its potential impact on the environment. SSCM must consider the entire lifecycle of the product through the supply chain. Cradle-to-cradle analyses must be performed to calculate the total costs from raw materials to final disposal.

The relationship between the concept SSCM and economic performance is not well documented either in research or in practice. In other words, "Does it pay to be sustainable? Research has yielded mixed findings regarding the impact of CSR on firm performance. Carter [8] suggests that a possible explanation for these mixed findings is that this relationship is likely mediated by one or more key variables. He introduces organisational learning as such a mediating variable.

The current global financial and economic crisis raises the question whether companies can afford to maintain their commitment to sustainability. When companies are facing tough times through decreasing demand and lower prices on their products and services, social and environmental issues in the supply chain appear to be an attractive area for cutting costs. However, an alternative approach is to align sustainability efforts with cost-saving efforts. An example is Wal-Mart, which recently announced tougher measures to improve social and environmental standards in factories supplying the large American retail company, including factory's gas emissions, wastewater discharges, and toxic and hazardous waste. The agreement will be phased in, beginning with suppliers in China in January 2009 and expand to other suppliers worldwide by 2011 according to a company statement [66]. An international

standard for measuring carbon footprint in supply chains is still lacking. However, until a standard has been agreed upon, pilot studies and experiments must be developed to test the appropriateness of various methods. There is a general international acceptance of UN's Global Compact, but there is disagreement about the most suitable auditing process to make sure that the codes of conduct are respected. There are EU directives for e-waste, end-of-life vehicles, packaging materials, tyres, batteries, etc., but the implementation of these directives takes place in different ways and at different speeds across Europe.

Future research in SCM should address these issues and encompass a variety of approaches including case studies, surveys, simulation studies, model development, and experiments. It is a big challenge for the logistics and SCM research community to analyse and present alternative solutions for the development of sustainable supply chains.

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