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Addressing Sustainability Issues through Enhanced Supply-Chain Management

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1. Introduction

A search on Google for 'sustainable Supply-Chain Management' (SCM) gives 15 000 000 results. 'Green supply-chain management' has even more. Both topics are addressed in numerous international and national publications. Already in 2001 the Sigma Report from the UK examined the fundamentals of sustainable supply-chain management and the challenges for its further expansion[1]. The UN secretariat explored the issues further in its report on "Industrial Development for the 21st century"[2]. A report by the World Bank discussed the situation of suppliers in developing countries[3]. The UN Global Compact[4] has prepared a 'tool kit' for corporations to facilitate the application of sustainable SCM. Many publications of the World Business Council for Sustainable Development stress the importance of sustainable supply chains in developing forward-looking corporate strategies. Business journals regularly feature articles on SCM and its relationship to corporate social responsibility (CSR).

After a decade of promotion and producing motivational material on sustainable supply chain management, it is now opportune to review the state of its application. And as the sustainability agenda is not standing still we should also discuss how supply chain management links to new thinking behind the concepts of value-chains, life-cycle management, sustainable consumption, and corporate social responsibility. We outline some factors that would assist SCM in contributing to the sustainability agenda. In particular a more holistic framework for sustainable SCM will be needed in future, in the same way that environmental management systems arose to overcome the earlier fragmented approach to solving pollution problems.

Why should SCM consider issues of sustainability? Quite simply because many of the challenges faced by companies have their genesis in the operating practices of sub-contractors and suppliers, whether this relates to chemical content, labour practices, or impact on communities and habitats. And the political agenda has moved on; it is no longer accepted that we blame someone upstream for deficiencies in the products we put on the market, nor for the environmental impacts may they have caused there. By building

[1] http://www.projectsigma.co.uk/RnDStreams/RD_supply_chain_strategy.pdf
[2] http://www.un.org/esa/sustdev/publications/industrial_development/full_report.pdf
[3] http://siteresources.worldbank.org/INTPSD/Resources/CSR/Strengthening_Implementatio.pdf
[4] http://www.unglobalcompact.org/Issues/supply_chain/guidance_material.html.

sustainability criteria into its purchasing practices a company is taking a preventive approach that translates into lower liability risks and greater operating efficiency, and increasingly also into innovative product development.

Many companies have already oriented their future strategic approach around the sustainability agenda. A recent article in the Harvard Business Review[5] included it as one of the 'mega trends' that are here to stay. Supply-chain management exerts its influence over various parts of the life cycle of materials and products. It can thus be a powerful lever to enhance sustainability performance across all services, products and processes in which a company directly or indirectly engages.

For SCM to do this however it has to expand its reach as well as incorporating additional performance parameters. 'Supply-chain' traditionally refers to the sources of raw materials and components coming into the production plant. The more recent and broader concept of 'value chain' includes all points and activities directly related to a company's products, from the extraction of raw materials through to processing, manufacturing, distribution, and sale. Importantly, it includes the consumption phase (of products, materials, services…), and the eventual recovery, recycling and disposal at the end of the product life. Value chain is also a wider notion than the conventional concept of 'life cycle' which is usually employed to communicate to clients and other stakeholders the environmental footprint of a single product. Much discussion on product life-cycles has a technical or political connotation of materials and energy flows, and is not always linked with options of corporate decision-making. The value-chain framework leads to a reconsideration of how supply-chain management can contribute more strongly to the sustainability initiatives being pursued within the company. Fig. 1 below shows the relationship between some of the key concepts.

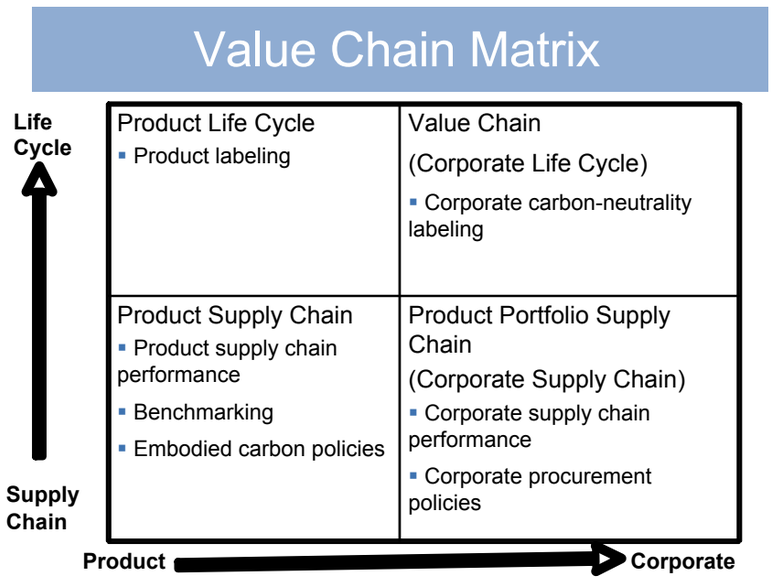

Fig. 1. Value Chain Matrix

In promoting a greening of the supply chain, there remains in some minds the question 'why do it'? We will see that by addressing sustainability issues via supply chain

[5] http://hbr.org/2010/05/the-sustainability-imperative/ar/pr

management it becomes easier for the company to implement its corporate sustainability programme, to reduce potential environmental and social liabilities, and to facilitate future product development and marketing. In short, environmental and social compliance is easier and cheaper where the supply-chain is more closely linked to corporate sustainability policy. There is of course a cost in doing this – it leads to more complex SCM, requires additional training of company and suppliers' staff, more extensive monitoring and tracking, and more time spent in developing closer relationships with suppliers and clients. The experience of most big companies is that the benefits outweigh the costs.

2. Background to sustainability issues

2.1 What is meant by sustainability?

In 1987 the Brundtland Report[6] defined sustainable development as a form of societal progress that satisfies current aspirations while simultaneously protecting the needs of future generations. While our future quality of life depends on an adequate protection of environment and natural resources, sustainable development also considers in equal measure social and economic criteria. Putting this simple concept into practice has occupied the governmental and business communities for over two decades, including negotiations at major international meetings of heads of state[7]. At these venues key partners – including the business sector - were encouraged to reformulate their activities along 'sustainable' lines.

Despite regular references to 'win-win' strategies, optimising simultaneously our environment, social and economic progress requires some compromises, increasingly so as we deal with local issues. Along the way the meaning of 'sustainability' has been defined in a host of different and sometimes incompatible ways, sometimes to a point where it has almost lost its original meaning. In this chapter we will be referring to the key issues identified by various leadership organizations at national and international levels and as included in major global initiatives, agreements and conventions. Thus the United Nations Environment Programme (UNEP) has defined key sustainability challenges concerned with an environmental point of view (Fig. 2). The complete sustainability agenda also includes social and human rights issues. In its outreach to the business sector, the UN Global Compact[8] has defined nine major issues in four categories (human rights, labour rights, environment, anti-corruption) on which it invites a business response from global and national companies.

For industry, preoccupied with costs, profitability and workplace issues the sustainability agenda may seem far removed from immediate concerns. In part this is due to the language used in international fora. A closer look shows that many issues – but hiding under other names – are already serious concerns for managers. Many companies face land-use conflicts over plant location and resource extraction in environments of high conservationism value. Polluted water must be cleaned before it can be used in manufacturing processes (and of course discharged after use). Occupational safety and health requires serious attention everywhere. Companies have been known to go out of business due to chemical contamination they were unable to control. Importantly, environmental management has understood that the company is no longer an isolated entity – actions of upstream suppliers

[6] http://en.wikipedia.org/wiki/Our_Common_Future

[7] http://en.wikipedia.org/wiki/Earth_Summit and http://www.un.org/jsummit/

[8] www.unglobalcompact.org

can also affect regulatory compliance, pollution liability and reputation damage to the company.

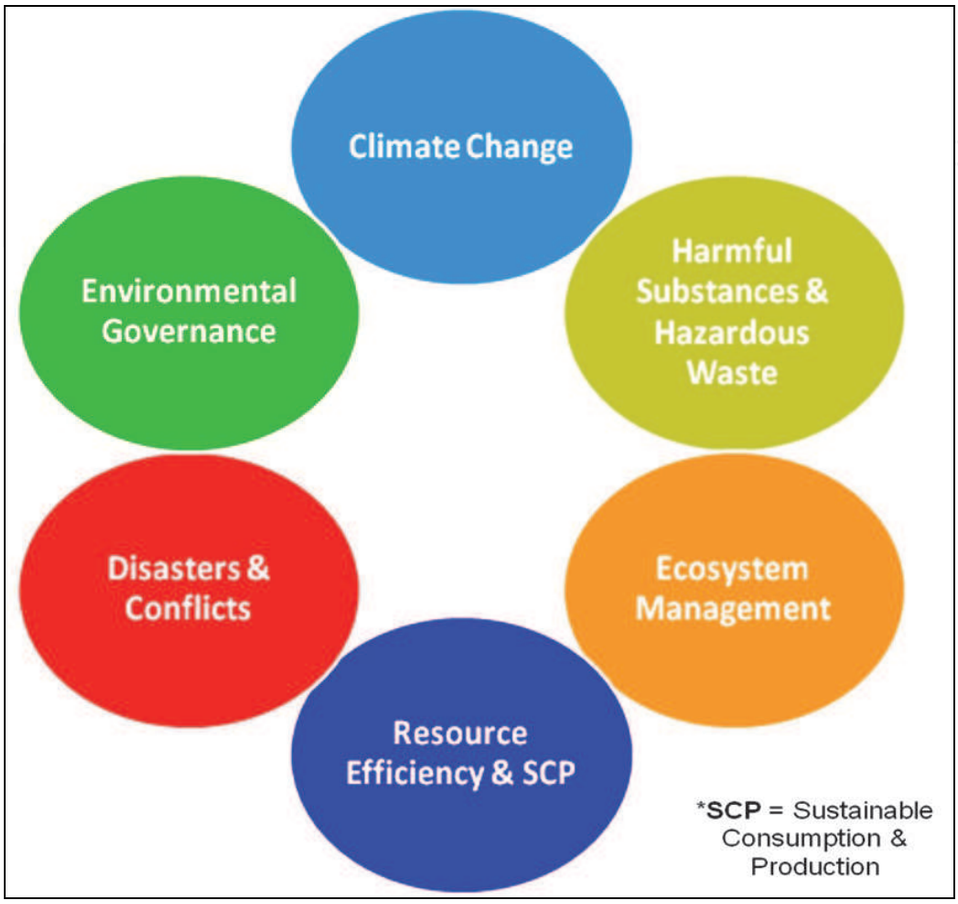

Fig. 2. UNEP's midterm strategic priorities

Addressing impacts after they have been allowed to occur is expensive compared with avoiding them from the outset. Experience has shown that 'upstream, preventive' action is cheaper (and more effective) than crisis control and remediation. Sustainability programmes now almost always embrace the use of management approaches such as cleaner production, pollution prevention, eco-efficiency, green productivity, life cycle management and so on. These approaches all depend on two common factors: (i) preventive action to avoid wastes, pollution and other impacts from being generated in the first place, and (ii) a focus on the entire value chain since many interventions need to occur well before the manufacturing steps (eg in product design, raw material selection, transport, packaging etc). This latter aspect extends to the consumption-side issues of efficiency in use, recycling and of end-of-life disposal.

2.2 What has been the response to the sustainability agenda?

There is an increasing trend in companies to adopt sustainability policies, and to integrate wider social factors into business strategies. "Shared values" was the term used in a recent

publication (Porter, 2011). For instance the Lafarge cement company[9] says "…..we have identified our most significant sustainability issues. Addressing these issues is essential for maintaining our legitimacy to operate. In areas such as emissions control, industrial ecology and recycling, sustainability also helps drive efficiency and competitiveness." When groups of companies are faced with the same problem(s) there have also been attempts to develop sector-wide sustainability codes and principles.

While governments[10] are still grappling with the complexity of transforming preventive, up-stream approaches into regulations (Gunningham et al., 2004), industry - often in partnership with other organisations - has moved ahead to develop and implement management systems and tools and sometimes redefined its product lines. It has found that in the same way that 'add-on' pollution controls are inefficient, so is add-on sustainability management. The best results occur when the entire company and all its procedures embrace the sustainability objectives as set by corporate policy. The mobilisation of the company's production and marketing sections to this end has not always been easy, especially in bigger corporations, but there are enough examples to show how it works. Since both the 'upstream' and the 'value-chain' elements are invoked in such sustainability management it is not difficult to see why further development of traditional supply-chain management is one of the key elements in implementation (Füssler et al., 2004).

Ensuring that all parts of a company pull together in a co-ordinated fashion usually requires a formal management system, commonly of the type ISO 14000[11], most recently accompanied also by ISO 26000 on Corporate Social Responsibility. The (sustainability) objectives and targets that underpin these management systems are either separately enunciated or else encapsulated in CSR statements. Such self-adopted standards may also be influenced by various voluntary industry codes that groups of companies have prepared. While few governments make corporate management systems mandatory, financing institutions and investment bodies increasingly require companies to have in place visible systems for managing sustainability issues. Even between industries the mandating of the use of such systems is becoming common. Large companies often require suppliers and contractors to have certified environmental and other management systems in place at the same level as the parent company.

At the operational level companies (and some governments) use a range of environmental instruments and tools to give effect to their standards. In particular, there is increasing use of assessment procedures such as environment impact assessment, life cycle assessment, chemicals risk assessment, social impact assessment, etc. all of which help an organization to look into the future and predict what sustainability issues and impacts may be attached to a product or process. This assists not only in achieving 'cleaner operations' but also the planning for more sustainable products, services and operations. For example at the level of product conception, the use of Product-Service Systems (PSS), eco-design and eco-labelling is becoming increasingly common. At the manufacturing stage extensive monitoring of supply chains and operations ensures that sustainability principles are efficiently (and

[9] http://www.lafargenorthamerica.com/Lafarge_sustainable_development-Sustainable_report_2009.pdf

[10] http://www.oecd.org/dataoecd/18/39/33947759.pdf

[11] http://www.iso.org/

effectively) applied. Most major companies put in place pollution prevention programmes, energy efficiency, water saving, as well as work-place and public safety initiatives.
Companies may also practise various forms of green purchasing for their raw materials and operational supplies, or engage in types of 'offset' activities by purchasing carbon or other environmental credits. Major distribution chains such as Ikea, Walmart, Tesco and others now have stringent requirements on certain substances that must not be included in products, e.g. chlorine-free for Ikea, low embedded energy for Walmart. Others, especially food retailers (e.g. Tesco in the UK and Monoprix in France), have put emphasis also on ethical and/or locally produced food, as do many individual product brands, of which Max Haavelar (see for more details below) is perhaps the best known. Most major retailers now require that no child or prison labour be used in the supply-chain of the products they offer.
Some go further, for example, in 2000 Carrefour worked with the Fédération Internationale des Droits de l'Homme, a group of more than 100 human rights organizations from around the world, to establish INFAS, a monitoring agency to help Carrefour have a code of conduct for its suppliers. The purpose of the code was to commit the company's suppliers to recognize and respect international standards regarding working conditions set out in various conventions of the International Labour Organisation (ILO) with regard to the abolition of child labour and forced labour, freedom of association and collective bargaining, etc. According to CSR Europe[12] the basic goal was to contribute to the gradual and total elimination of child labour while respecting cultural diversity.
A number of green supply concepts are also employed by governments, either in their own activities or by way of a statutory requirement on operators. Companies are constrained by increasingly tight environmental and safety standards to reduce the level of environmental impact of operations but of their products. Authorities are also involved in various forms of supply-chain management such as green government purchasing, setting targets for recycled material content, and promoting ecologically based products such as organic food. An interesting example is the US government requirement that electronic products must now not only be free of ozone depleting substances (ODS) but that even the manufacture of the products did not involve the use of ODS as for example as solvents. Some countries now ban the use of certain toxic substances such as cadmium or persistent organic pollutants (so-called POPs) in consumer and industrial products, placing the onus on manufacturers to ensure that their suppliers do not incorporate these chemicals.

3. Supply-chain management and the value chain

3.1 Supply-chain management as a management activity

The value-chain spans the entire upstream-downstream progression from raw materials through manufacturing to the final product, including its use and eventual recovery or disposal.
Traditional supply chain management has an important place in this progression. For convenience we can consider the following five basic components of SCM[13]:

1. Plan — Companies need a strategy for managing all the resources needed for their product or service. A big piece of SCM planning is developing metrics to monitor the various aspects of the supply chain.

[12] www.csreurope.org
[13] http://www.cio.com/article/40940/Supply_Chain_Management_Definition_and_Solution

2. Source — Companies must choose suppliers and create metrics for monitoring and improving also the relationships and managing their goods and services inventory.
3. Make — Companies need to schedule the activities necessary for production, testing, packaging and preparation for delivery. This is the most metric-intensive portion of the supply chain—one where companies are able to measure quality levels, production output and worker productivity.
4. Deliver — This is the logistics, to coordinate the receipt of orders, storage, transport and delivery
5. Return — This can be a problematic part of the supply chain for many companies. Planners have to create a responsive network for return of defective and excess products and increasingly, end-of-life products.

In the context of a corporate sustainability objective, 'managing all the resources needed' takes on a new meaning. Suddenly additional criteria become relevant in the choice of materials and suppliers. But it is important to not regard sustainability merely as a constraint or some form of restrictive operating framework for companies. Careful choice of incoming raw materials also improves efficiency, avoids pollution problems and cuts manufacturing costs, as well as reducing subsequent product liability risks. Many sustainability issues give rise to new business opportunities when properly managed, as for example the increased market for organic food, higher efficiency appliances, newer materials and energy technologies. Incorporation of social and environmental issues also makes the company less vulnerable in an uncertain and fast-changing commercial world. Pro-active supply-chain management can help to identify and implement these opportunities in addition to its traditional role of addressing cost and quality.

What is the impact of responsible sourcing, environmental sustainability and the "green" movement on the supply chain? If the technological side of supply chain management was not hard enough, the new corporate social responsibility movement inside 21st century organizations adds another layer of complexity. Broadly defined, CSR initiatives for companies include such strategies as being able to show environmental sustainability (eg. reducing the carbon footprint), responsible sourcing from a wide range of global suppliers, and how "green" an organization is. So how does that affect supply chain management? In order to prove that a company has lowed its carbon emissions, is not dumping hazardous materials into rivers and doesn't buy its materials from suppliers that employ underage workers, company leaders need to be able to gain insight into and track the actions of their suppliers, and their suppliers and their suppliers—all the way down the chain into some good and not-so-good parts of the global economy. This ability also becomes critical when tainted goods need to be identified and found quickly in a supply chain, before the goods spread throughout a country's population[14].

3.2 Green supply-chain management

In the two decades following the Brundtland Report, environmental and social parameters have still often been overlooked in SCM in many industry sectors despite the increasing prominence of corporate social responsibility programmes.

In an attempt to redress this situation a number of initiatives in what can be loosely called "green supply chain management" have sprung up in recent years. The driving force comes

[14]http://www.cio.com/article/40940/Supply_Chain_Management_Definition_and_Solutions?page=5#scm_green

from two different directions. The first is from the environmental movement (including government ministries) as it looks for new instruments to help implement sustainability policies in public life. This constituency stresses the environmental outcomes rather than the business benefits, but the end-result is still a business issue. For example, government legislation on recycled content of products such as paper is deemed to be beneficial for the environment and changes market conditions in favour of companies that can modify their processes to incorporate paper scrap. Governments and environmental groups promote 'green purchasing' as a way of moving the environmental agenda forward, with some successes, but also some limits[15].

The second and possibly now more major force is from business itself. Many companies have found a commercial reason to green their value chains, exposed as they are to regulatory and consumer pressure in environmentally aware societies. This applies especially to retail and consumer distribution chains. Major retailers such as those mentioned above Walmart, Carrefour, Tesco, Ikea, Monoprix and also others are offering customers a choice of 'green' products, and are increasingly applying sustainability criteria to their entire product range. The outcome for their suppliers is a modification not only of the composition of the components of their products (e.g. free of toxic chemicals), but perhaps also to change the type of product completely. This latter factor may well lead to the selection of an entirely different supplier who can better meet both criteria.

According to the New York Times[16], Walmart is now examining the environmental footprint of the products it distributes. While there is a special focus on energy efficiency, other sustainability factors such as water are also considered. The initiative is not directly reflected in the price of the goods, rather Walmart is aiming to gain sustainability respectability with its broad customer base. As it has the purchasing power, it is establishing a de-facto industry standard for others to follow. The company has a sophisticated assessment and identification scheme that informs its purchasing department about selecting appropriate products and suppliers.

IKEA[17] markets low-cost home furnishing products that try to impact on the environment as little as possible and are produced in a socially responsible way. IKEA's Code of Conduct outlines minimum demands on its 1,600 suppliers in connection with social, environmental and work-related conditions. The use of life-cycle thinking ensures that the company is abreast of development trends and at the same time contributes to a sustainable development for IKEA itself and for its suppliers. Supply chain management factors include resource use, sustainable forestry practices and training for employees.

Related to the above is the increasing trend to form consumer groups around green purchasing, green procurement, equitable commerce etc. These initiatives[18] are often not at the same level of sophistication as corporate SCM, but the objectives are similar – the inclusion of sustainability principles in the provision of goods and services. Their reach can be quite large. 'Equitable producer' systems have grown up as a result of these purchasing initiatives. Whatever the configuration of these systems, the conscientious end-user is exerting an influence all the way up the supply-chain to the primary producer via a variety of intermediaries.

[15] http://www.cio.com/article/638219/Retailers_Going_Green_But_Customers_Remain_Apathetic
[16] http://www.nytimes.com/2010/02/26/business/energy-environment/26walmart.html
[17] http://www.lca-center.dk/cms/site.asp?p=4683
[18] http://www.igpn.org/ http://www.fairtrade.org.uk

Max Havelaar[19] coffee intends to guarantee the growers a reasonable share of the profits of end-of-point sale. Criteria are well established, and producers are regularly checked for compliance. While the product does not make claims about other sustainability criteria such as land-use, pesticide use or other environmental damage arising from coffee production, growers are 'encouraged' to take these factors into account. Thus the ultimate purchasers of the coffee can consider themselves as practising a form of green supply-chain management that can actually be better described as "sustainable (or equitable) procurement".

Many of these green purchasing arrangements consider a limited set of issues (often only a single issue). No doubt this simplicity is partly responsible for their success as it is easy to understand. But it also means that other equally important issues may go unaddressed. The major distribution chains are gradually expanding their vision by increasing the number of criteria, nevertheless even in such a highly organised sector the limited extent of the sustainable elements is still evident. For Max Havelaar coffee the sustainable supply-chain focus is on the growers rather than on the subsequent processing, distribution and consumption stages, and the number of criteria taken into account is still limited. Organically grown food, similarly, may subsequently be processed or packaged in environmentally unfriendly ways without affecting its label. The distillation of public sustainability sentiment into a number of popular surrogate issues, each with a simple label like organic food, fair trade, chlorine-free, sustainably harvested timber etc thus satisfies certain market requirements even if it does not always accord with a rigorous sustainability management approach.

Intimately linked to green purchasing is the issue of eco-labelling[20], or sustainability labelling. A number of such schemes are in use around the world, the best known probably being the Blue Angel[21] scheme in Germany. France has recently launched its programme "Affichage environnemental" to allow consumers to learn more about the life-cycle impacts of the products they buy[22]. Independent or governmental frameworks for labelling schemes are regarded as more reliable than allowing individual producers to prepare their own labels without reference to standardised criteria. Their utility of eco-labels depends very much on the selection of criteria, and the way these are assessed. Despite the frequent wish for it, it is generally considered as unrealistic to develop a single ranking number for products when multiple criteria are involved.

Green supply-chains are not limited to consumer goods. They also apply to heavy industry sectors such as construction, chemicals, oil and mining. Many corporations in these industries are sensitive to pressure from shareholders and institutional investors and thus have well-defined sustainability policies. These companies increasingly apply their criteria along the supply-chain to their raw materials suppliers in whatever country of origin. It can be noted that government and privately owned companies are somewhat less influenced by such a movement and provide fewer examples of green SCM than do listed public companies.

For instance the Indian subsidiary of the major cement company Lafarge undertakes sustainability audits of its regional gypsum supplier in Bhutan to ensure that it has a level of sustainability performance acceptable to the parent company in Europe. Labour and safety

[19] www.maxhavelaar.org
[20] http://www.unep.fr/scp/ecolabelling/csd18.htm
[21] http://en.wikipedia.org/wiki/Blue_Angel_(certification)
[22] http://www.developpement-durable.gouv.fr/Consommation-durable,19201.html.

factors were given particular emphasis in addition to the checking of regulatory compliance with environmental standards. From Lafarge's 2009 sustainability report[23]: "In 2009 our global purchases totalled €8.15 billion. We are engaged in a process to ensure that our external sourcing of goods and services properly reflects our sustainability principles. The significant role played by local suppliers in Lafarge's operations enables the Group to have a positive impact on the economies of countries where we operate."

A special example of green SCM occurs where groups of companies or institutions collaborate to develop a common sustainability code. Many times such a Code can only be implemented if the entire supply-chain is brought into concordance. Such collaboration has occurred especially in the controversial resource sectors of forest products, fisheries, and mining as some of the examples below illustrate.

Example of natural resource management: fish and forests. In order to reduce the deleterious impact on natural resources, a number of initiatives have been launched to avoid (or to prefer) products sourced according to bad/good practices respectively. One of the best known is the Forest Stewardship Council[24], a multi-stakeholder initiative that seeks to ensure that rainforest timber is sustainably managed, harvested and sold. Technical guidelines describe 'sustainable' practices. Operators and suppliers are independently audited. End-distributors agree to only source their timber from such operators. Annual reports of compliance are available, and a multi-stakeholder Council oversees the process. The process is designed to guarantee a high (ethical) value product that attracts a significant clientele, and through consumer pressure to encourage the entire industry to move in this direction. The supply-chain management by the end-distributors does most of the work to ensure the procedures are followed. Independent auditing guarantees that the outcome is credible. Similar arrangements exist for marine fisheries through the Marine Stewardship Council[25] and a number of other collaborative fora with similar aims.[26]

The FSC and MSC examples involve short supply-chains, and are based on a common agreement rather than a traditional SCM approach of formal tendering. Of course the FSC will also involve contracts eventually, but the initial agreement was the result of a conference process rather than contract negotiation. Neither FSC nor MSC extend downstream to the consumer to try to influence how the product is used. The next example shows how it is possible to take this extra step.

Example of chemicals management: cyanide in gold mining. One of the most sophisticated value-chain management instruments is the International Cyanide Management Code.[27] This was developed to help gold producers avoid the stigma of 'dirty gold' ie gold mined and produced in ways that contaminates the environment with this toxic chemical. Rather than ban this chemical outright as various pressure groups had advocated, the industry decided to demonstrate that stringent supply-chain management with all appropriate safeguards can avoid the contamination and human risks that were sometimes seen in the past. The cyanide code requires companies to apply strict rules, both technical and procedural, for handling cyanide. A particular feature is its value-chain reach: even the

[23] http://www.lafargenorthamerica.com/Lafarge_sustainable_development-Sustainable_report_2009.pdf
[24] www.fsc.org
[25] www.msc.org
[26] www.sustainablefish.org
[27] www.cyanidecode.org

upstream chemical manufacturers, suppliers and transporters must comply with the Code requirements before the end-user mining company can purchase the substance. The Cyanide Code is one of the most rigorous examples of life-cycle management in the resource industry. It incorporates pollution, safety and health criteria. It was not designed to cover energy or other social issues so its "sustainability" reach is still only partial. The code concept has now also been used in other related sectors, such as by diamond (the so-called Kimberley process[28])and jewellery suppliers[29]. In each case the entire supply-chain is subject to the sustainability requirements of the end-user – pollution, risks, social conditions etc. The selection of sustainability criteria varies greatly, usually incorporating a strong emphasis on social issues as well as pollution-type factors; however land-use and conservation issues are less extensively incorporated.

3.2 Some lessons learned from the supply-chain management examples provided

The examples above show how green SCM can be used to work towards sustainability objectives. But they also illustrate some of the limitations in the way it is presently used.

A common limitation is the restricted number of sustainability elements taken into consideration. Energy content is a common 'green' factor (e.g. Walmart), alongside also chemical content (e.g. IKEA). Certain social features such as possible child or prison labour are carefully scrutinised by popular brands of clothing or sports items (e.g. Nike). Big mining companies are now careful about workplace safety among their sub-contractors and suppliers. Biodiversity is becoming a more common factor among resource companies generally. While single-issue programmes are still common among the smaller players the larger companies are gradually moving more confidently into multiple-issues. Most are focussing on energy, greenhouse gases, water, and waste as core elements with labour issues also mentioned separately. All the same the number of SCM initiatives that prominently address the entire set of sustainability issues as recommended by global bodies such as the UN, business councils and independent institutes is still small. A contributor to this sustainability myopia is likely to be the perceived relative importance of high-profile issues to which a company has subscribed, whether a labour convention, the cyanide code or a conservation objective etc, and which leads to other issues to take second place in the action agenda. For some it can also be surmised that the 'too hard' factor is at work, and that companies prefer to take a gradual approach, gaining experience and confidence in the process.

As an example we can look at Unilever which has selected greenhouse gases, water and solid waste as the key factors to address, while also aiming at "sustainable agriculture" for its principal source of supply. As well as adopting multiple criteria (four), Unilever has acknowledged the importance of the end-consumer in reducing the impact of its products across the entire value-chain as the box below demonstrates.

Unilever's sustainability strategy addresses environmental impacts across the value chain[30].

"Our commitment to reduced environmental impact extends right across our value chain – ie, from the sourcing of raw materials through our own production and distribution to consumer use and eventual disposal of residual packaging. Consumer use accounts for around 70% of our greenhouse gas footprint. Engaging consumers …. will be key to

[28] www.kimberleyprocess.com

[29] www.responsiblejewellery.com

[30] http://www.unilever.com/sustainability/strategy/vision/index.aspx

achieving our vision. Metrics for our four priority environmental impact areas across the value chain include greenhouse gas (GHG) emissions, water, waste, and sustainable sourcing. These metrics are designed to measure the impacts of our products when used by consumers, such as grams of greenhouse gas per single usage occasion. During 2009 around 1 500 products were assessed to allow us to understand their water, waste and GHG impacts in 14 of our largest markets. In 2009 we also started to develop a set of metrics covering social impacts. For those of our brands with social missions, the metrics seek to measure the benefits they bring to society. In 2010, Lifebuoy will be the first brand to pilot the new metrics, helping track the impact of Lifebuoy programmes on hand washing behaviours over a five-year period".

Expanded and more standardised approaches to SCM will no doubt follow further promotional work by the UN Global Compact as well as greater use of instruments such as the Global Reporting Initiative[31] with its transparent checklists although even in GRI any issue that is not included in the checklists is easily overlooked. In the end, a comprehensive approach depends critically on the depth of a company's sustainability policy and objectives. And it is undoubtedly true that some successful green initiatives such as 3M's Pollution Prevention Pays started out with only single-issue objectives eg reduction of pollution. It could even be argued that their limited objectives gave them the initial tight focus that was responsible for their success. 3M's Pollution Prevention Pays (3P) program[32] celebrated its 30th anniversary in 2005. Over the last 34 years, the program has prevented 2.9 billion pounds of pollutants and saved more than 1.2 billion dollars worldwide. The 3P program continues to be a success worldwide because of its design, measurable results and benefits, and integration into business processes and corporate culture.

Another example comes from the drinks industry. SAB Miller[33], an international brewing company with operations in Africa has identified water as a key sustainability factor. Greater water efficiency in drinks manufacture is important in a dry continent, but so is water availability upstream in the supply chain in the growing of the cereal crops that are the basic raw material in beer manufacture. In partnership with WWF and GTZ, the company used the technique of water footprinting within its value chain. The company also focuses on energy efficiency as an important economic factor.

A second and arguably more serious weakness in most initiatives is the short length of the value-chain that is considered in green SCM. Thus the 'suppliers of the suppliers' mostly drop from view; the longer supply chains in the more sophisticated technology sectors are just too complicated for most operators. One exception to this are the companies involved in the Global e-Sustainability Initiative (GESI) where the controversial labour conditions in the primary extraction of precious metals for the electronics industry (coltan) have led to action along more extended supply-chains. GeSI now also has an increasing downstream focus on the use phase of its products as the description below shows. The GeSI initiative is noteworthy for three aspects, (i) it is sector-wide and engages a large number of companies, (ii) it spans nearly the whole of the value chain from mining of resources to consumer use and end-of-life recycling, and (iii) it includes multiple sustainability criteria from labour/social to energy to waste.

[31] www.globalcompact.org
[32] http://www.mmm.com/sustainability
[33] http://www.sabmiller.com/files/reports/2010_SD_report.pdf

Example on sustainability in the value chain - the Global e-Sustainability Initiative[34] (GeSI), which is an international non-profit association was formed to help Information and Communication Technology (ICT) companies, and the sector as a whole, to become more sustainable. GeSI has linked with the Electronic Industry Code of Conduct (EICC) Implementation Group and other groups to develop a set of tools that meet broad industry needs. These tools include the E-TASC package consisting of a supply chain questionnaire, a risk assessment tool, a common approach to auditing, and a list of web-based resources. Initially the self assessment questionnaire was used only for the first tiers in the supply chain of manufacturing and telecom companies but did not reach to the level of mining the raw materials (where major issues were found). Subsequently GeSI and EICC created an extraction group to provide more information about the sources of the metals. In addition, they joined forces with DigitalEurope and TechAmerica in the creation of an "ICT for Energy Efficiency" (ICT4EE) Forum to address the consumption of energy in the use phase of electronic products (e.g. the battery chargers for mobile devices). Finally, GeSI collaborates with the Solving the E-waste Problem (StEP) Initiative[35] to improve the sustainability performance of the end-of-life of electronic products. For overall sustainability the classical upstream supply chain is thus only a starting point. A full life cycle management approach is needed when striving for global sustainability.

The cyanide code mentioned earlier is perhaps the most complete instrument of all, systematically – and contractually - integrating chemical supplier, transporter, and end-user long the entire value-chain of this material, except for the suppliers of basic chemicals in the initial cyanide manufacture. This is not perhaps a serious criticism since the instrument is quite deliberately focused on cyanide risks and other considerations are beyond the conceptual design boundary of the Code.

Although we are not aware of formal studies to this end, when we read between the lines of various case studies we can infer that many sustainable SCM initiatives are still "add-on" rather than "built-in" i.e. the green supply chain has not been effectively mainstreamed in corporate practice. This is especially so where greening has been externally imposed. Thus the corporate focus on better cyanide management by Code members seems not to have resulted in a significant overhaul of general management practice of other chemicals in these companies. While not necessarily detracting from the effectiveness of the immediate SCM exercise, it represents a missed opportunity for the company, and also for sustainability overall. Where sustainability it is part of a clear business strategy such as in Walmart, the mainstreaming of SCM will be more systematic. Enhanced integration is also more likely where quality issues are critical as for example in the motor industry.

4. Including sustainability factors in supply-chain management

4.1 General considerations

The complexity of the sustainability agenda has led many companies and other organizations to take more systematic approaches to these issues through, for example, use of formal (environmental/ sustainability) management systems and an end-to-end value-chain consideration. These systems co-ordinate the use of appropriate instruments for assessment, ensure a cleaner production approach to manufacturing, put greater emphasis

[34] http://www.gesi.org
[35] www.step-initiative.org

on green design and on social factors, while maintaining appropriate oversight of quality and cost of raw materials and supplies. Monitoring of relevant aspects of corporate operation is the key to achieving and maintaining high performance levels, and ultimately also customer satisfaction and loyalty. SCM is inevitably an integral part of such systems. SCM already considers quality, reliability, resource costs, and increasingly reputational risk (e.g. sourcing products made with child labour). The incorporation of sustainability factors thus adds only a few more parameters to a process that is already established.

We can ask how SCM managers deal with such a complex area in which they may have no formal training. Within large companies considerable guidance and support to SCM managers is available through the various in-house initiatives to link different corporate departments. Detailed advice is also available from manuals, guidelines and handbooks that have been independently published (eg the Global Compact and WBCSD New Zealand publications mentioned in this paper). Here, we will simply mention some of the key steps that will need to be carried out in a systematic effort.

Clearly **identifying the sustainability elements** to be applied is an essential first step. We already mentioned that many companies still rely on a very limited set of elements, perhaps too limited if sustainability pressures continue to increase. Some issues such as pollution and waste, energy efficiency, as well as workplace safety, are now almost universal. Biodiversity, land-use, social justice, among others will be more difficult to deal with. The incorporation of ethical factors will be especially challenging in many companies. For guidance, managers will need to use corporate CSR statements, sustainability reports, and other internal instruments concerning issues SCM should pay regard to. Where such statements and instruments do not yet exist, as in many smaller companies that have no CSR manager, the identifying of relevant sustainability targets in the company would be a necessary first exercise for the SCM manager. Following the identification of issues, and perhaps formulation of quantitative targets, it will be important to undertake consultation with relevant stakeholders, and eventually endorsement by top management.

An important next step is a **description of the supply chains**, the main materials and products, and identifying the main sustainability issues that they embody (independent of the company priority towards such issues). Clear identification of the suppliers – and the 'suppliers of the suppliers' - are important when sensitive issues such as chemicals, pollution or human rights are involved. In some cases the transport aspects are also important e.g. for hazardous chemicals. Social issues such workplace quality and child labours, for example, are site-specific at the supplier's premises and may require further research by the SCM manager. Increasingly the customer dimension of use-pattern and recovery of products are part of the more complete supply-chain descriptions.

How can suppliers be identified and rated/ranked on sustainability factors? Self-assessment performance reports are only credible when independently verified. Short of visiting each supplier (difficult for extended supply-chains) we need a label or certification process. Standardised environmental management systems e.g. ISO 14001 have now become a de-facto way to identify 'good environmental practice' suppliers. SA 26000 does the same for social performance. Nevertheless a number of companies have gone further by putting their own supplier recognition schemes in place, as for example Proctor and Gamble's Supplier Environmental Sustainability Scorecard[36]: Thus: "On May 12 2010, the Procter & Gamble

[36] http://www.pginvestor.com/phoenix.zhtml?c=104574&p=irol-newsArticle&ID=1425862

Company announced the launch of the Supplier Environmental Sustainability Scorecard and rating process to measure and improve the environmental performance of its key suppliers. The new scorecard will assess P&G suppliers' environmental footprint and encourage continued improvement by measuring energy use, water use, waste disposal and greenhouse gas emissions on a year-to-year basis. "We worked closely with a global team of P&G personnel, suppliers and supply chain experts to determine the most effective way to measure the environmental performance of our diverse global supplier base," said Rick Hughes, P&G global purchasing officer. "Our suppliers wanted a tool that was flexible yet grounded in existing measurement standards and, by working together, we developed a framework that will help drive real improvement across all industries."

Following the identification of priorities (an internal exercise within the company), a number of different possibilities for action appear. In most cases there are adequate possibilities for taking action on sustainability. It may be possible to switch to suppliers who have a lower environmental or social footprint. Alternately, joint work with existing suppliers may improve their sustainability performance. Specifying in contractual documents the suppliers' desired environmental and social performance is the most common way of greening supply chains. In large companies contract management is already a sophisticated, well-managed exercise and can easily incorporate the additional criteria.

But there are also in-house options for optimising sustainability such as redesign of the product or of revamping the manufacturing processes to allow the use of alternative raw materials that have better sustainability credentials. These are the so-called eco-design options. There may also be more holistic options such as Product-Service Systems (PSS)[37] that involve a more fundamental rethink to the entire business model. Closing the materials loop by recovering and recycling end-of-life products back into the manufacturing chain is an example of this as shown by the Interface company that leases, recovers and recycles the carpets it makes.

Incorporation of recycling, and especially recycled materials, as is the case with Interface above, causes major shifts in the way SCM is carried out. For one thing, quality control becomes a more exacting task since many recovered products may be contaminated or contain incompatible components. Assurance of supply is also more difficult since the supply of (recycled) raw materials now depends on the consumption cycle. Finally, collection and storage may present additional complications. Conversely, end-of-life products can be seen as a useful, stable source of raw materials supply. The chemical company Safety-Kleen[38] has based its solvents and oils business on a cycle of 'produce-sell-recover-reprocess-resell' that is sheltered from the fluctuations in supply of virgin materials.

Options such as these go a long way to achieving sustainability goals, but require a whole-of-company approach that the SCM manager can certainly initiate, but which transcend his immediate management responsibilities. Most of the above measures can be implemented using conventional management approaches and tools. But there remain some issues in the sustainability agenda that require more thinking. The most prominent is that of sustainable consumption defined as[39] "the use of services and related products which respond to basic needs and bring a better quality of life while minimising the use of natural resources and

[37] http://www.unep.fr/scp/design/pdf/pss-brochure-final.pdf
[38] http://www.p2pays.org/ref/02/01572.pdf
[39] http://www.unep.fr/scp/sc/

toxic materials as well as emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardise the needs of future generations."

In view of the fact that business is trying to maximise its volumes and product turn-over, it may seem a contradiction that the subject of a more programmed sustainable consumption should even be part of its objectives. A number of prominent companies have nevertheless been shifting in this direction with revised business plans and operations as they position themselves for future markets and greater international competition (WBCSD et al., 2002). Whether such initiatives can be mainstreamed into entire business sectors rather than remaining a niche for market leaders remains to be seen.

A particular challenge for sustainable companies is how to influence consumers to follow their lead by using their products in a more considered (from sustainability perspective) way. While such influence has long been accepted for reasons of product safety, the application of other criteria has been slow to be incorporated into company advice and guidance. Still, things are gradually changing as the Unilever example illustrates. Unilever in its objectives on greenhouse gas reduction is encouraging the consumers to wash at lower temperatures and at correct dosage in 70% of machine washes by 2020. While 'encourage' may seem a rather loose notion, the objective at least has the merit of being quantified in terms of target and date. In a similar way, chemical suppliers frequently advise the commercial users on the safety and proper use of their products. But it is still considered the role of governments to make this mandatory.

Whatever approaches and actions are taken to green the supply-chain, it will be necessary to monitor the way in which the various objectives are achieved, and at what cost. This is of course in addition to any monitoring for quality, safety and reliability in the manufacturing cycle. Results of such monitoring are now increasingly incorporated into corporate sustainability reports, whether along Global Reporting Initiative guidelines[40] or otherwise.

Taken together, the above procedures clearly require considerable skill and expertise. Insight is needed into the new issues and parameters that managers have to deal with. Some of the assessment tools are quite sophisticated and are also evolving quickly. Consideration of new management options would benefit from exchange of experience with others who have already applied them. To assist the process of information exchange and professional development various practical manuals and guides have been published by business groups and individual companies - see for example the one from the WBCSD New Zealand[41]. Some universities are now offering formal courses. Below is an extract from the subject content of a green supply-chain management syllabus at the University of California, Santa Barbara:

- Industrial ecology, Life cycle thinking
- Life cycle accounting
- Definition of supply chain management (SCM)
- Definition of green supply chain management (GSCM)
- Environmental and economic dimension
- Economic value vs. environmental impact added Environmental cost accounting
- Cost allocation and life cycle costing. Interest rates, cash flow, NPV, IRR, Payback
- Input productivity
- Contracting / Servicing

[40] www.globalreporting.org

[41] http://www.nzbcsd.org.nz/supplychain/SupplyChain.pdf

- Eco-labeling
- Green procurement
- Cost-sharing, profit-sharing
- Recycled content versus end-of-life recycling
- Reverse Logistics for Green Supply Chain Management
- Pollution prevention

4.2 The role of Life Cycle Assessment and Life Cycle Management

In view of the importance of the evaluation of the supply chain it is useful for SCM managers to become familiar with the Life Cycle Assessment (LCA) tool and its potential. They do not of course need to become LCA experts; but it is important that they can supervise the procedure when carried out by staff or by consultants. It should be noted that LCA has in past focussed chiefly on pollution and energy as these are the easiest parameters to quantify. More recently LCA has also started to develop tools to assess non-quantifiable issues such as land-use, biodiversity, safety, human rights and other social factors. The UNEP/SETAC Life Cycle Initiative[42] provides an international forum for information and exchange of experience on all aspects of LCA development and application, including practical publications.

Life-cycle assessment (LCA) describes the environmental impact during the entire life span of a material or product, according to the boundaries defined to suit the purpose of each particular exercise. LCA studies the embedded raw materials and energy of a product, documents the wastes and other impacts resulting from its manufacture and use. In order to ensure worldwide validity of data and conclusions, assessment procedures have been standardised in the ISO 14040 series. Environmental pressures are often expressed as a 'footprint', quantified in various ways. Carbon footprint refers to impact of greenhouse gas emissions causing climate change. Water footprint is more complex as it may refer to quality as well as quantity. Other footprints are also often proposed. As far as they refer to the product level they are all in line with the ISO 14040 standard series for LCA. Standardisation of calculations of carbon and water footprints is now under development by ISO, but not yet for ecosystem change or eco-toxicity. For this a specific tool called USEtox[43] has been developed by the Life Cycle Initiative referred to above.

Life Cycle Costing (LCC) is an aggregation of all costs that are directly related to a product over its entire life cycle, from resource extraction over the supply chain to use and disposal, and that are directly borne by one "life cycle actor" (producer, consumer, end-of-life actor). Life cycle costing by definition does not consider external effects. Frequently a high share of costs needs to be allocated, but smarter cost models help circumvent this to some extent. Definition of cost categories is difficult especially along supply chains (Ciroth, 2008). LCC can be used to assist management in the decision-making process. The application of life cycle costing in the tendering procedure may help to procure a product with a better environmental performance since, for instance, future energy cost saving due to investments into energy efficiency measures will be highlighted. Such scrutiny will reveal costs of resource use and disposal that may not otherwise have received proper attention. Both LCA and LCC bring important information into SCM, and especially into green SCM.

[42] http://lcinitiative.unep.fr/

[43] www.usetox.org

Based on the above information, **Life-cycle Management (LCM)** takes a systems view to maximise the sustainability performance of the value-chain as a whole rather than optimising each link in this chain separately as is often done at present. The use of LCM results in a more optimum overall outcome and is thus a strategic management approach. Even where the entire value-chain is not dealt with in its entirety, it facilitates the identification of areas of high importance along the chain. The LCA/LCM combination can pinpoint the stages that are especially important for systems optimisation (or for optimisation of key individual parameters e.g. energy) and then apply appropriate management intervention as necessary. It is important to note that LCM uses standard corporate and regulatory management instruments and approaches to achieve an agreed outcome while LCA is chiefly concerned with data gathering and analysis. Because LCM aims to achieve a systems optimisation rather than an improvement in only the end-point of the chain, SCM can thus be considered as a sub-set of LCM. This notion is reinforced by the traditional role of SCM is improving the upstream supply chain of the company, leaving the downstream user interface to be dealt with by other divisions in the company. LCM addresses both the upstream and downstream stages as parts of the overall value-chain. LCM involves all levels of the organization (Fig. 3).

Fig. 3. LCM involves all levels of the organisation (UNEP, 2007)

A simple example will suffice to illustrate the above. In the life-chain of an automobile, the use phase accounts for about 80% of the energy consumed over the life of the product. While efforts to reduce the energy used in the manufacture of the product (i.e. the car) are certainly desirable, it is the design, choice of materials, driving habits of the owner etc that strongly influence fuel consumption during use, and this is where most of the energy over the life of the car will be consumed. (A full systems approach with broader boundaries may even

propose alternatives to the auto in the first place.) LCA can identify the stages with the most impact. LCM can then propose interventions that would achieve the best overall reduction in energy consumption over the life of the vehicle at a defined cost as identified by LCC. It can link with each member in the value chain to orient these partners to better achieve co-ordinated sustainability objectives at their level, and ultimately along the entire value-chain. For example, more efficient metals production (mining, smelting) produces less pollution and also reduces the embedded energy of the product. Better design and lighter materials in frames, panels and components will allow users to drive more frugally, as would industry-sponsored driver education facilities. Authorities can help traffic to flow more smoothly. Recovery at end-of-life returns metals to society, and so on. Such considerations are not unique to the automotive sector. Similar thinking applies in the building industry, where much of the resource consumption and environmental impact calculated over the life cycle actually occurs in the use phase rather than in construction.

Even if some stages are more significant than others, all parts of the value chain can contribute to the optimisation of the entire system. It is the function of LCM to put in place the management objectives, systems and arrangements that allow the various partners along the value-chain to cooperate in achieving this systems optimisation that they cannot achieve by acting on their own. Seuring & Goldbach (2002) identify two options, the co-operative and the coercive models. In reality a mixture of the two would be employed, with the co-operative model generally getting better results in longer value chains.

4.3 Relationship between Life Cycle Management and supply-chain management

It is useful to now consider how LCM can achieve the above optimisation within the context of supply-chain management. It is easy to see how SCM could contribute to lowering some of the 20% of embedded energy in the motor car through judicious choice of energy-efficient suppliers. In terms of the use of lighter materials in vehicles, this has not been the primary role of SCM but rather that of the product designers. Nor have we seen widespread use of SCM in influencing the end-user (although SCM could assist in facilitating end-of-life recycling for example by for example specifying the use of recycled materials in the raw materials). While SCM is gradually reaching down also to the downstream side of production to build a stronger loyalty of the end-consumer to the manufacturer and supplier, LCM is actually better adapted to take on such a systems-wide function. Through this example we see SCM as one of the important instruments in the implementation of LCM, based on the identification of important value-chain steps by LCA. If the exercise were simply the greening of the supply chain, then the LCA/SCM combination would be enough.

Overall, the growing experience with LCM will soon make it an important framework for achieving complex sustainability targets. Both SCM and LCA/LCM have vibrant networks that SCM managers can use to enhance their practice of sustainable SCM.

5. Discussion and synthesis

The increasing prominence of the sustainability agenda has resulted in major changes in decision-making in business and government. Environmental and social factors can be expected to become ever more important considerations in the foreseeable future. The visibility many companies now give to corporate social responsibility is already a reflection of this 'mega trend' that has major implications on corporate practices, including supply-

chain management. Companies are moving quickly to ensure that both their operations and their products are compatible with sustainability principles.

In the supply of sustainable goods and services, 'the world behind the product' is taking on increasing significance. It is now important to understand, and to better manage, the totality of the embedded environmental and social footprints of the products and services we consume. 'Green' or 'sustainable' supply-chain management is thus on the increase. Many large companies already have sophisticated internal procedures to bring suppliers into line with corporate policies on environment, social and ethical issues. In some cases groups of companies, in for example the electronics and resource industries, have joined up to produce global guidelines that define performance of their members' supply chains on selected issues such as water, wastes or labour conditions. We also see more and more independent 'sustainable purchasing' arrangements applying a variety of sustainability criteria, individually or in combination.

Encouraging though these developments are, many of the present initiatives suffer from certain structural deficiencies such as a limited number of sustainability criteria and short length of the supply chains. As a result the global sustainability objectives are often only partly achieved, leaving serious issues in both geographical and thematic locations unaddressed. Incomplete integration and fragmentation of effort is also a common factor. All these problems will not be easy to overcome as they arise from the inherent complexity of managing large networks of relatively independent partners. Fortunately there are also some examples that can serve as inspiration and encouragement.

The picture of a supply-chain is now evolving away from a 'materials life cycle' towards a more holistic concept of 'value chain' where the traditional upstream stages of raw materials and manufacturing are joined also by the downstream elements of product, use, consumption, and end-of-life issues. There are many additional partners involved here and the linear chain concept is gradually transforming itself into a notion of a network, where multiple nodes of suppliers and consumers all warrant attention. Within this concept a wider life cycle management approach is becoming more prominent, dealing in an integrated way with the downstream aspects of the product as well as the upstream management elements of traditional supply chains. LCM uses standard business management instruments to identify, prioritise and act on key sustainability impacts along the value chain in such a way that the sustainability of the total value chain is optimised rather than just each stage individually. LCM relies heavily on the results of expanded techniques of LCA, however it is a management rather than a scientific exercise. Given the range and extent of most value-chains, the use of various techniques of consultation, negotiation and collaboration is a major part of the LCM challenge.

From the corporation's viewpoint, moving to sustainable value-chain management and LCM makes business sense. Systematic value-chain management can better identify appropriate opportunities for adjustments to the entire life-chain of materials and products, including consumer use and end-of-life aspects. Optimising the social and environmental factors inherent in the entire the value-chain has intrinsic advantages for cost and quality management in the company. But in particular it can greatly assist the company in its longer-term product development and marketing strategies.

While the potential benefits are clear, there are also challenges. An expansion of supply-chain considerations into the downstream product cycle brings new partners (both from inside and outside the company) into the picture, as well as additional sustainability

objectives, for example product use efficiency, recycling and end-of-life disposal (or reconversion) of the product. While assessment tools are available for evaluating the options, the design, marketing and service departments within most companies have traditionally not pre-occupied themselves with such considerations. Expanding the value-chain partners beyond the first tier (ie immediate suppliers or clients) will remain a challenge for rigorous companies since the number and complexity of partners increases rapidly. A variety of techniques is available for profiling the various supply chain partners against sustainability criteria, however the lack of co-ordination often causes problems where the suppliers have demands from different customers. It is especially in this respect that greater use of new international standards (including verification systems) will be required. It will also require new methods of communication and negotiation with value-chain partners many of whom will be in remote places, operating in other cultures and languages, and unaware of the nature of the end-products.

Accordingly, at the global level the practice of sustainable value-chain management would benefit from a clearer framework that helps to avoid fragmentation and inconsistencies (and eventually discouragement) at the point of the suppliers and clients. It is important that the suppliers of the suppliers also be linked into the sustainability initiatives, despite the difficulties this may involve. A variety of 'tool boxes' for sustainability management is already available for the practitioners. What is still needed is a set of broader agreements on objectives, boundaries and techniques, to standardise the practices, and give a common reference point to the many partners and players involved. Again, in view of the pattern of global trade now, such agreements should ideally be at international level. At the same time the hierarchical relationships between supply chain management and other management streams such as environmental management systems, CSR, eco-design etc could be further clarified. At present, ISO has not developed any specific standard or guideline on sustainable supply chain management, let alone on value-chain management or on life cycle management. Experience with a number of sector-wide supply chain frameworks that have been established in certain industries could nevertheless provide some useful references on the above.

6. Conclusion and perspectives

In the evolution to new models of supply chain management it is important not to loose sight of the fundamentals. Correct identification of the sustainability issues – both present and those likely to be important in the future – is vital to focus the exercise and deal with the issues most relevant to the company. This identification is not always straightforward for global companies operating in different countries and cultures, or where products will be sold in global markets.

The management of 'green' issues in SCM can be usefully built on experience with traditional corporate practices and techniques by expanding the parameters and adding new knowledge from various assessment tools such as LCA. It is also important to recall that sustainable supply chain management is a further development of, and hence an integral part of, traditional SCM, not an independent additional action to be undertaken in parallel. And close integration of SCM with CSR remains an important ingredient for success.

Taken together the above presents a considerable challenge to SCM managers in all companies and organizations. The moving targets of sustainability, techniques and even regulations require regular updates and exchange of information. While various manuals

and conferences are now available to promote such exchange, further emphasis on professional development training would help smooth the path to a more sustainable future.

Time moves on, sustainability issues evolve and ideas about how to deal with them mature. Both the external and internal business environments can change rapidly. Supply-chain management has traditionally been one of the threads that bind corporate units together. The adoption of a broader view of value chains and of how to manage them leads to a changing business landscape. In this context, corporate social responsibility and product stewardship constantly redefine the concept of sustainable supply-chain management. Dealing with this change will require adaptability and new working methods, but the basic objectives of managing a supply chain for a sustainable future will remain intact.

7. Acknowledgement

Fritz Balkau is an independent advisor, focusing particularly on strategic guidance to assist the transition to future sustainable societies. Until 2005 he was Head of UNEP's Production and Consumption Branch, in Paris, France. Guido Sonnemann is UNEP's Programme Officer for Sustainable Innovation and Coordinator of the Secretariat for the Life Cycle Initiative and science focal point for the Resource Efficiency/ SCP subprogramme.

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Over the past few decades the rapid spread of information and knowledge, the increasing expectations of customers and stakeholders, intensified competition, and searching for superior performance and low costs at the same time have made supply chain a critical management area. Since supply chain is the network of organizations that are involved in moving materials, documents and information through on their journey from initial suppliers to final customers, it encompasses a number of key flows: physical flow of materials, flows of information, and tangible and intangible resources which enable supply chain members to operate effectively. This book gives an up-to-date view of supply chain, emphasizing current trends and developments in the area of supply chain management.

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