Green Supply Chains – a new priority for supply chain managers

Ittmann Hans W, CSIR Built Environment

1. Introduction

Logistics, or supply chain management, describe the transport, storage and handling of products as they move along the chain from the raw material source, through the production system to their final point of sale or consumption. These activities have come to be regarded as a key determinant of business performance over and above the fact that these activities are also fundamental to economic development and social wellbeing. Maximizing profitability has been in many cases the overriding objective. However over the last 10 to 15 years environmental concerns have put companies under more and more pressure to address and reduced the environmental impact of their logistics operations. The adverse effects of distributing goods are diverse including impairing air quality, generating noise and vibration, causing accidents and contributing significantly to global warming. The effect of logistics and supply chain management on climate change has increased mainly because of the realisation that global warming presents a much greater and more immediate treat than previously thought. Freight transport is estimated to contribute roughly 8 per cent of energy-related CO_2 emissions worldwide (Kahn Ribeiro and Kobayashi, 2007), however, making logistics "sustainable" in the longer term will involve more than just cutting carbon emissions.

This article is not a comprehensive overview of Green Logistics. What it endeavours to do is to sensitise, in a very summarised way, those involved in logistics and supply chain management about the importance of green logistics and to highlight where this originated, what is presently the main issues and what the importance will be in future. A definition is given of green logistics in the next section followed by the historical developments around green logistics. We point out the importance of assessing environmental effects and then discuss various efforts to attain environmental sustainability.

2. What is Green Logistics?

Concerns about the future of mankind came to the fore very strongly in a report published by the United Nations in 1987. In the report the word sustainability was defined. This word is derived from the Latin *sustinere* (*tenere*, to hold; *sus*, up). Dictionaries provide many meanings for *sustain*, the main ones being to "maintain", "support", or "endure". However, since the United Nations report *sustainability* has been used more in the sense of human sustainability on planet Earth and this has resulted in the most widely quoted definition of sustainability and sustainable development namely that of the Brundtland Commission (1987) of the UN: "*sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" As a key business performance activity logisticians and supply chain managers could no longer ignore the importance of sustainability in logistics. Profitability and sustainability don't have to be mutually exclusive. By considering environmental issues when

setting financial objectives for a supply chain network it is possible to successfully balance the trade-offs between them.

Logistics is the integrated management of all the activities required to move products through the supply chain. For a typical product this supply chain extends from a raw material source through the production and distribution system to the point of consumption and the associated reverse logistics. The logistical activities comprise freight transport, storage, inventory management, materials handling and all the related information processing.

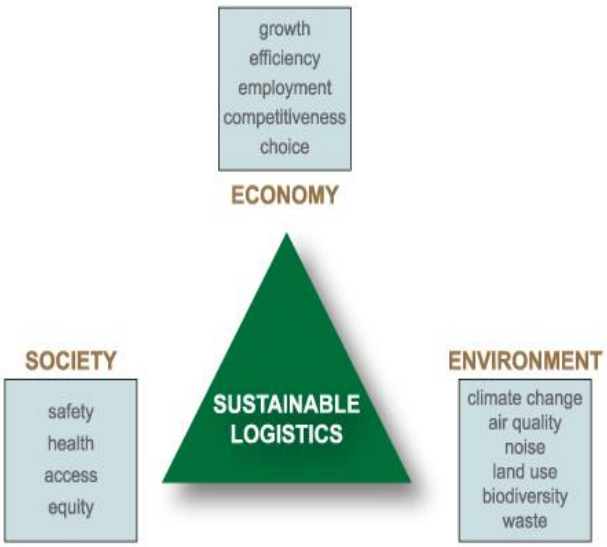

Figure 1: Green Logistics Framework (www.greenlogistics.org)

The main objective of logistics is to co-ordinate these activities in a way that meets customer requirements at minimum cost. In the past this cost has been defined in purely monetary terms. As concern for the environment rises, companies must take account of the external costs of logistics associated mainly with climate change, air pollution, noise, vibration and accidents. Green logistics is therefore defined as efforts to examining ways of reducing these externalities and achieving a more sustainable balance between economic, environmental and social objectives, see figure 1. All the efforts in the "green" logistics arena are therefore focussed on contributing towards, and ensuring, sustainability.

3. Evolving Perspectives in Green Logistics

Although the focus on green logistics seems to be a recent phenomena there has been different research initiatives conducted over the past 40 years which attempted to address the environmental concerns. McKinnon (2010) discuss these under the following five headings:

3.1. Reducing Freight Transport Externalities

During the 1970s the focus, especially in the UK, was on "lorries" that were much noisier and more polluting than is the case today. There was substantial growth of freight by road and efforts were put in place to rationalise this freight, tightening

regulations on emission levels, etc. In this way there was a gradual reduction in transport externalities.

3.2. City Logistics

Urban freight transport plays a vital role in the sustainable development of cities. There are, however, many challenges facing urban freight transport, including high levels of traffic congestion, environmental impacts, high energy usage and labour problems. This has led to research in what is now called city logistics, a process to optimise urban logistics within all the difficult conditions that impact urban freight movements (Taniguchi *et al*. 2001). The work in this area has led to modelling of city logistics, demand and supply models, impact models, vehicle routing and scheduling, etc. All of these efforts contributed to addressing the environmental issues.

3.3. Reverse Logistics

In a world of limited resources, it becomes critical that products such as "white goods" (washing tubs, stoves, fridges, etc.) are recovered. This has led to the extension of logistics to include reverse logistics, which incorporates the flow of goods in both directions. This development has a strong element of waste management, and sustainable development. Reverse logistics is defined as "*the process of planning, implementing and controlling the efficient, effective inbound flow and storage of secondary goods and related information opposite to the traditional supply chain direction for the purpose of recovering value or proper disposal"* (Fleischman 2001). In traditional "forward" logistics, quantitative models have proved to be powerful supporting tools for these types of decisions.

Hand-in-hand with reverse logistics go closed-loop supply chains (Dekker *et al.* 2004 and Stock, 1999). Closed-loop supply chains have traditional forward supply chain activities and a set of additional activities required for the reverse supply chain. For example, mobile phone models change regularly. The older models need to be recovered, sent back, refurbished, recycled and redistributed. These additional activities include (Daniel *et al*. 2003):

- *Product acquisition* – the activities required to obtain the products from the end users;
- *Reverse logistics* – the activities required to move the products from the points of use to a point(s) of disposition;
- *Test, sort and disposition* – the activities to determine the condition of the products, and the most economically attractive reuse option;
- *Refurbish* – the activities required to execute the most economically attractive option: direct reuse, repair, remanufacture, recycle, disposal; and
- *Distribution and marketing* – the activities required to create and exploit markets for refurbished goods and distribution.

The major difference between closed-loop supply chains and traditional forward supply chains is for a forward supply chain, the customer is at the end of the processes, and for a closed-loop supply chain, there is value to be recovered from the customer or end-user. The value to be recovered is significant.

3.4. Logistics in Corporate Environmental Strategies

During the 1980s, businesses started, more formally, to formulate environmental strategies based on assessments of their impact on the environment. Standards such as ISO 14000 were introduced and environmental programmes received accreditation. It became clear that in logistics management, economic and environmental objectives are closely aligned and Rao and Holt (2005) found that if they green their supply chains, not only would firms achieve substantial cost savings, but they would also enhance sales, market share and exploit new market opportunities to lead to greater profit margins.

3.5. Green Supply Chain Management

Green supply chain management can be defined as the "alignment and integration of environmental management within supply chain management" (Klassen and Johnson, 2004). There is a clear recognition that the environmental impact of a firm extends beyond its boundaries. In addition, the definition includes product design, all stages of manufacturing and distribution and all aspects of reverse logistics.

4. Green Logistics Uptake

McKinnon (2010) indicates that although companies promote their green credential through the management of logistics, it is not clear whether this is because of a sincere desire to help the environment as opposed to enhancing public relations. Gilmore (2008) echoes this scepticism in stating "the corporate support for Green is as much for the potential to sell new products and technologies as it is about saving the planet".

Various surveys have looked at the key drivers for greening of logistics and supply chains (Eyefortransport (2007), Aberdeen Group (2008) and Insight (2008)). Some of these include:

- Improving public relations;
- Improving customer relations;
- Part of their corporate responsibility agenda;
- Financial return on investment;
- Government compliance;
- Desire to be thought leader in sustainability;
- Rising cost of energy/fuel;
- Gaining competitive advantage/differentiation;
- Optimise logistics flow;
- Improve corporate image; and
- Reduce logistics costs.

Clearly, a whole diverse range of drivers, not always focussed on the greening issue.

5. Measuring and Assessing Environmental Effects

As indicated previously logistics is responsible for various externalities including air pollution, congestion, accidents, noise, etc. The main emphasis currently is on greenhouse gas because of climate change. The question then is how to measure or assess the impact of these. Over the past number of years several of these have been measured and management standards have been introduced. For example emission standards for heavy-duty diesel engines, known as EURO emission standards, have

been developed with enforcement dates – see table 1. By adopting these standards companies with heavy- duty vehicles can make a significant impact.

Tier	Date of Implementation	CO	HC	NO	PM
Euro I	**1992 (>85kw)**	**4.5**	**1.1**	**8.0**	**0.36**
Euro II	**1998**	**4.0**	**1.1**	**7.0**	**0.15**
Euro III	**2000**	**2.1**	**0.66**	**5.0**	**0.10**
Euro IV	**2005**	**1.5**	**0.46**	**3.5**	**0.02**
Euro V	**2008**	**1.5**	**0.46**	**2.0**	**0.02**
Euro VI	**2013**	**1.5**	**0.13**	**0.4**	**0.01**

Table 1 – Emission standards for heavy-duty diesel engines (g/kWh) (www.nao.org.uk)

Governments have introduced reduction targets for carbon emissions and hand in hand with this, guidelines have been published to measure, report and manage the carbon footprints. For example, in the UK, the Carbon Trust (2006) gives a guide for auditing the carbon in the supply chains of newspapers and potato crisps. Internalising the environmental costs for logistics is the logical next step. In the latest State of Logistics Survey for South Africa, Havenga (2010) has done this at a national level.

6. Making Supply Chains Environmentally Sustainable

Given the pressure around reducing the impact of logistics and supply chain operations on the environment, and specifically on climate change, there are numerous ways of addressing these. A number of these are highlighted:

- Re-assess and restructure supply chains to incorporate environmental issues and factors;
- Transferring freight to "greener" transport modes. World-wide, the growth in freight has mainly been on roads which are not very "green" friendly. There are renewed efforts to move some types of freight from road to rail for example;
- Developing "greener" vehicles, aircraft, ships, etc. Table 1 illustrates what is being done with heavy-duty diesel vehicles;
- Reducing the impact of warehousing, i.e. improving energy efficiency, etc.;
- Improving vehicle utilisation, including optimising the routing of vehicles;
- Increasing the fuel efficiency in the road freight sector; and
- Initiatives such as city logistics and reverse logistics are aimed at environmental sustainability.

There are various case studies that illustrate what can be achieved. A few examples are mentioned here:

- Schoeman (2010) reports on a case study in South Africa in the fast moving consumer goods sector to reduce "extra(excess) kilometres" and the effect of that on costs and carbon emissions;

- Eroski is a goods distribution company in Spain. Ubeda et al (2010) shows how changes in fleet management were introduced as well as the implementation of a methodology to solve vehicle routing problems with environmental criteria minimisation; and
- Whirlpool, a world-wide leader in home appliances, redesigned their supply chains with the aim towards conserving energy and cutting air pollution (Cooke, 2008).

7. Conclusions

A recent article (Melnyk et al, 2010) on the outcome of a five year research programme, started in 2005, into "Supply Chain Management 2010 and Beyond", found that supply chains of tomorrow must delivery varying degrees of six outcomes, namely, *cost*, *responsiveness*, *security*, *sustainability*, *resilience* and *innovation*, depending on key customers' needs. The cost, responsiveness and resilience outcomes are fairly well known, or at least, have been addressed at length in the literature. Two of the other three outcomes, security and sustainability, are relatively new and reconfirms and re-emphasises the importance of the drive towards green logistics or green supply chains. *Security* is possibly on the borderline as far as greening is concerned. Nevertheless it is defined as an outcome that has recently garnered a great deal of attention, with instances of tainted food products from China and tainted generic drugs from India. It implies that the supply chain's products will not be contaminated. On the other hand *sustainability* is defined as "green" – environmentally responsible – supply chains that eliminate waste, reduce pollution and contribute in a positive manner to improving the quality of the environment through eco-friendly processes, subassemblies and finished goods. Carbon footprint reduction along the supply chain is one example. According to Melnyk et al (2010) supply chains with the sustainability outcome objective have the following design traits:

- Visibility/transparency throughout the supply chain to ensure that all members are aware of threats or opportunities;
- Greater emphasis on the Three Ps (product design, process, packaging);
- Integrated supply chain planning and management, in recognition that design must begin with resource extraction and end with product disposal/renewal;
- Use of broader performance measurement systems and measures (total cost of ownership, triple bottom line);
- Extensive supplier prequalification and assessment to ensure that the "right" suppliers are selected and that they understand what is required;
- Extensive use of audits and certification standards throughout the supply chain (ISO 14001); and
- Introduction of systems for product take-back (reverse logistics) and marketing waste.

The above reiterates that green logistics and green supply chains, which are sustainable, are going to be a prerequisite in future. Environmental pressures and concerns around climate change are going to grow and this will increase the emphasis that governments as well as consumers are going to place on this critical aspect. This

therefore must become a priority for supply chain managers. They will only succeed if they understand the needs of customers and strive to maintain the alignment between the supply chain's design and its customers' changing needs and desires.

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