

# Greening Supply Chain Management

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**Abstract:** The last few decades have seen an increase in environmental consciousness. More and more people are aware of the world's environmental problems such as global warming, toxic substance usage and the decrease of non-replenishable resources. Governments have released campaigns to promote this problem to people. Several logistic organizations responded to this by applying green principles to their company, such as using environmental friendly raw materials, reducing the usage of fossil based power and using recycled papers for packaging. Green supply chain management (GSCM) has been emerging in the last few years. This idea covers every stage in the manufacture from the first to the last stage of the life cycle, i.e. from product design to recycling. Transportation cannot be replaced as it is a part of the production chain. Societies are horizontally and vertically differential. The manpower, the stock, the semifinished and finished products must be transported, thus the importance of the transport sector is unquestionable. The purpose of this paper is to describe the importance of greening the supply chain.

*Keywords: greening the supply chain, environmental impact*

## 1. Introduction - Transport logistics related environmental pollution

In the last two or three hundred years there was an explosion in the development of industrial and technical sector, which gave people a multiplied set of tools to encroach nature. The motorization has developed so dynamically that the air, soil, water pollutions are considerable to the amounts of air, soil and water of Earth. The sustainable development is a development, where the pace of technical development, the satiation of increasing supply and the raw materials and resources of Earth are poised so that the rate of living and opportunities of the next generations need not to be worse. Transportation cannot be replaced because it is the part of the supply chain. Societies are horizontally and vertically differential. The manpower, the stock, the semi finished and finished products must be transported. The importance of the transportation sector is indicated by the sector production which is 10% of the GDP of the European Union and more than 10 million people are working in this sector. One of the most emphasized goals of the transport policy of the European Union is sustainable mobility.

For this reason transportation systems must be developed and standardized, the effectiveness of transportation service must be increased, while the environmental pollution must be decreased or prevented.

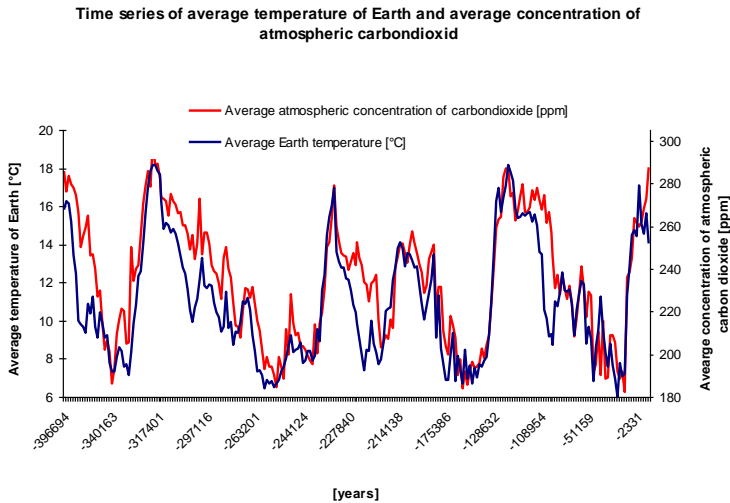


Figure 1. Normalised time series of CO<sub>2</sub> and temperature before human impact [16]

There is a strong correlation between atmospheric CO<sub>2</sub> concentration and the average temperature of the Earth. ( $r=0,8657$ , Figure 1.) Nowadays with the human impact which is considerable to the size of the atmosphere, the relation can be changed. More than the quarter of the total emission of CO<sub>2</sub> caused by the humanity is produced by road transport (Figure 2.).

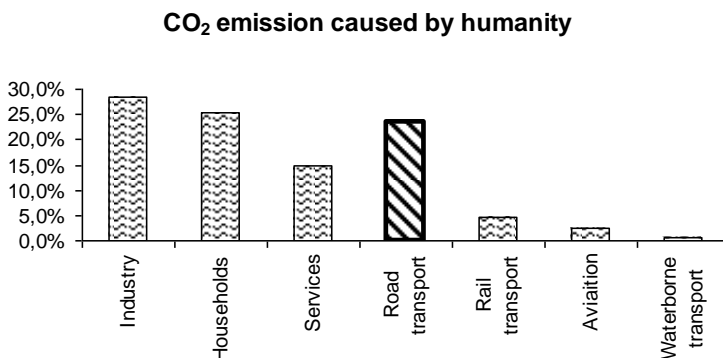


Figure 2. Transportation on the road contributes to climate change [16]

There is a common, social will to protect the Earth and the environment and at the same time the connection is strong between the environment and the supply chains as these affect the environment by emitting pollutants and greenhouse gases, but the environment also influences supply chains through the climate change. From this point of view supply chains have to play a major role in fulfilling the challenge presented by the environment, the society and the economy.

## 2. Supply chain management

Supply Chain Management includes managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer. Supply chain management has emerged as the term defining the integration of all these activities into a seamless process. Supply Chain is the interrelated collection of processes and associated resources that starts with the acquirement of raw material and extends to the delivery of end items to the customer. It includes suppliers, manufacturers, logistics service providers, warehouses, distributors, wholesalers and all other entities that lead up to delivery to the final customer. In more advanced operations it may extend to the customer of the immediate customer. A supply chain is the system of organizations, people, technology, activities, information and resources involved in moving a product or service from supplier to customer. Supply chain activities transform natural resources, raw materials and components into a finished product that is delivered to the end customer (Figure 3.) [1].

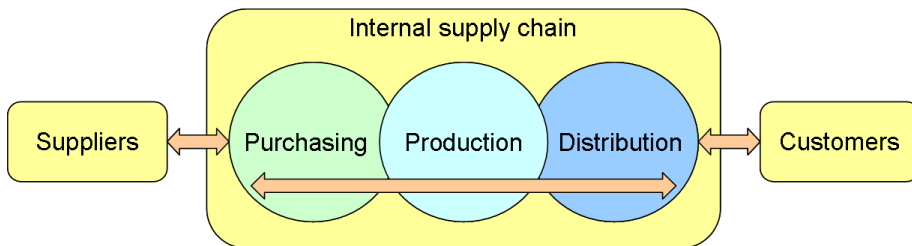


Figure 3. An illustration of a company's supply chain; the arrows stand for supplier-relationship management, internal SCM and customer-relationship management [2]

In the 1980s, the term Supply Chain Management (SCM) was developed to express the need to integrate the key business processes, from end user through original suppliers, original suppliers being those that provide products, services and information that add value for customers and other stakeholders. The basic idea behind the SCM is that companies and corporations involve themselves in a supply chain by exchanging information regarding market fluctuations and production capabilities. If all relevant

information is accessible to any relevant company, every company in the supply chain has the possibility to and can seek to help optimizing the entire supply chain rather than suboptimize based on a local interest. This will lead to better planned overall production and distribution which can cut costs and give a more attractive final product leading to better sales and better overall results for the companies involved. Incorporating SCM successfully leads to a new kind of competition on the global market where competition is no longer of the company versus company form but rather takes on a supply chain versus supply chain form. The primary objective of supply chain management is to fulfill customer demands through the most efficient use of resources, including distribution capacity, inventory and labor. In theory, a supply chain seeks to match demand with supply and do so with the minimal inventory. Various aspects of optimizing the supply chain include liaising with suppliers to eliminate bottlenecks; sourcing strategically to strike a balance between lowest material cost and transportation, implementing JIT (Just In Time) techniques to optimize manufacturing flow; maintaining the right mix and location of factories and warehouses to serve customer markets, and using location/allocation, vehicle routing analysis, dynamic programming and, of course, traditional logistics optimization to maximize the efficiency of the distribution side.

### **3. Importance of GSCM**

As in any emerging research area, the early literature focuses on the necessity and importance of GSCM, defines the meaning and scope of various terms and suggests approaches to explore the area further. Fundamentals of greening as a competitive initiative are explained in [3], [4]. Their basic reasoning is that investments in greening can be resource saving, waste eliminating and productivity improving. Three approaches in GSCM, namely reactive, proactive and value-seeking, are suggested [5], [6]. In the reactive approach, companies commit minimal resources to environmental management, start labelling products that are recyclable and use 'end of pipeline' initiatives to lower the environmental impact of production. In the proactive approach, they start to pre-empt new environmental laws by realizing a modest resource commitment to initiate the recycling of products and designing green products. In the value-seeking approach, companies integrate environmental activities such as green purchasing and ISO implementation as strategic initiatives into their business strategy. The perspective then changes from greening as a burden to greening as a potential source of competitive advantage [6]. Owen [7] and Sarkis [8] discuss environmentally conscious manufacturing. Friedman [9], Guide and Wassenhove [10] and Gupta [11] discuss the changing role of the environmental manager. Interactions among various stakeholders on integrated GSCM and advantages that may accrue to them have been described by Gungor and Gupta [12]. At the end of the 1990s, integrating these issues into the mainstream was identified as the future research agenda [13]. In a study linking GSCM elements and performance measurement, Beamon [14] advocates for the establishment and implementation of new performance measurement systems. He suggests that the traditional performance measurement structure of the supply chain must be extended to include mechanisms for product recovery (RL).

In today's business world, the competition among companies is very high. To impress customers the company needs to distinguish itself from others. Being environmentally friendly is one way to make a difference. Besides, when competitors have already adopted GSCM, this puts an extra pressure on the given company. Therefore it is advisable to implement GSCM independently of whether the competitors have already adopted it or not.

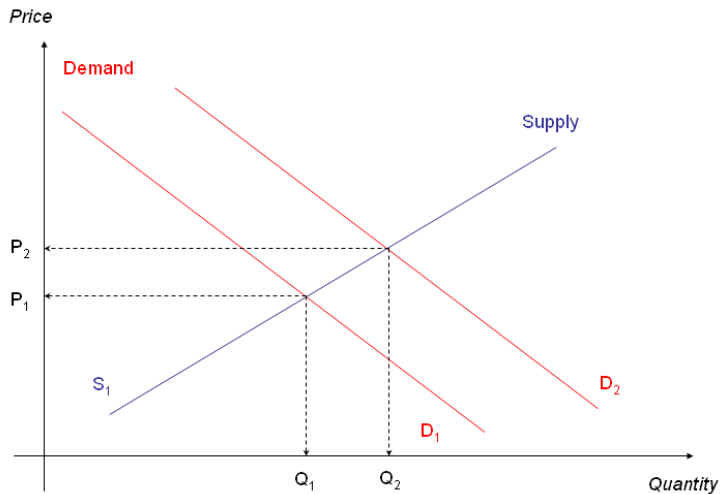


Figure 4. Change of the demand curve [17]

Not only competitors, but customers also play a role in the company's decision to adopt the GSCM. In many cases it was the customers who required special treatment or special products. Consequently the company needed to make changes to satisfy them and keep them as customers [15]. Practical uses of supply and demand analysis are often centred on the different variables that change equilibrium price and quantity, represented as shifts in the respective curves (Figure 4). Comparative statics of such a shift traces the effects from the initial equilibrium to the new equilibrium. In our case the company that uses GSCM can have a gain on market compared to other companies.

That means that we had a wanted right-ward shift in demand that increases both equilibrium price and quantity. When consumers increase the quantity demanded at a given price, it is referred to as an increase in demand. At each price point, a greater quantity is demanded, which can be depicted as a move from the initial curve D1 to the new curve D2. In the diagram, this raises the equilibrium price from P1 to the higher P2. Mathematically the demand function can be described as:

$$x_t = a \cdot p_t + \alpha, \text{ as demand function} \quad (1)$$

In the example above, there has been an increase in demand which has caused an increase in (equilibrium) price. At each point, a greater amount is demanded (when there is a shift from D1 to D2). Mathematically the supply function can be described as

$$y_t = \beta + b \cdot p_{t-1}, \text{ as supply function} \quad (2)$$

It is well known that market equilibrium is when demand  $x_t$  and supply  $y_t$  are equal. For every time period  $t$  there is an equilibrium that can be described with

$$\begin{aligned} a \cdot p_t + \alpha &= b \cdot p_{t-1} + \beta \\ a \cdot p_t &= b \cdot p_{t-1} + (\beta - \alpha) \end{aligned} \quad (3)$$

Where:

$$x_t = a \cdot p_t + \alpha, \text{ as demand function}$$

$$y_t = b \cdot p_{t-1} + \beta, \text{ as supply function}$$

$p_t$ : price in time  $t$

We reach the market equilibrium when  $p_t = p_{t-1}$ . Therefore, we get

$$\hat{p} = \frac{\beta - \alpha}{a - b} \quad (4)$$

and the actual price differs from the market equilibrium price by

$$\tilde{p} = p_t - \hat{p} = p_t - \frac{\beta - \alpha}{a - b} \quad (5)$$

Now the market equilibrium can be described as:

$$\begin{aligned} a \cdot \tilde{p}_t &= b \cdot \tilde{p}_{t-1} \\ \tilde{p}_t &= \frac{b}{a} \cdot \tilde{p}_{t-1} \end{aligned} \quad (6)$$

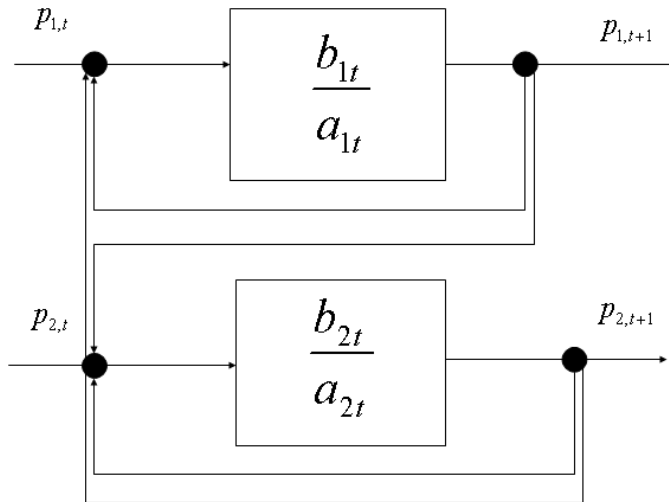


Figure 5. Cybernetic model of market equilibrium with two concurring companies [17]

Logistics are estimated to account for 10-15% of the final cost of finished products and businesses are increasingly seeking to cut costs by reducing fuel consumption and time spent in queues. That is why the greening of logistics has not only an environmental dimension for companies, but is also a question of efficiency. The worldwide demand for Green Solutions increases the demand for GSCM. It will increase the price of products from P1 to P2 for those firms which invest in it.

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