

*Review Article*

# A Review on Green Supply Chain Management in Automobile Industry

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## Abstract

*For meeting challenges in today's globalized world, organizations have tried to green their supply chains to meet with challenges such as energy conservation and pollution abatement. 'Going Green' has now become a priority for organizations to not only allay buyers' environmental concerns but also to maximize profits. The main purpose of this paper is to present the Green Supply Chain Management practices in the highly competitive Automobile Industry. The paper mainly deals with the practices Automobile companies follow with regards to GSCM, i.e. Green Design and Green Operations, and the barriers that they face with regards to its implementation. This greening of supply chains aims to balance marketing performance with environmental issues.*

**Keywords:** Green Supply Chain Management, Automobile Industry, GSCM, Green Design, Green Operations, Green Manufacturing.

## 1. Introduction

Patrick Penfield of the Whiteman School of Management defines Green Supply Chain Management (GSCM) as "the process of using environmentally friendly inputs and transforming these inputs into outputs that can be reclaimed and re-used at the end of their lifecycle thus, creating a sustainable supply chain" (R. Mishra, 2012). Srivastava (2007) defines GSCM as an integrating environmental thinking into supply chain management including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life. A Green Supply Chain is a supply chain that encompasses best practices in reducing carbon emissions across the supply chain, from materials sourcing through product design, manufacturing, distribution, delivery and finally, end-of-life recycling, which in other words can be said as to be one with minimal environmental impact (B. B. Gardas *et al*, 2013). Greening is no longer an idea or a notion, but it has become a strategy in this ever so competitive world to gain a competitive edge over the competition, to improve efficiencies, etc. which eventually lead to savings in resources. According to Wu and Dunn (1995), some organizations simply switch to GSCM as it is the correct thing to do for the environment. But other studies suggest that instigators for organizations to become green in the supply chain may be profitability and reduction in costs (S. K. Srivastava *et*

*al*, 2006; Srivastava, 2007; N. Darnall *et al* 2008). In the study conducted by Zhu and Sarkis (2004) they found that most of the 186 participants agreed that GSCM practices are only about 'win-win relationships on environmental and economic performance'.

Traditionally, Supply chain management (SCM) was viewed as a process wherein raw materials are converted into final products, then delivered to the end-consumer (Fortes, 2009) which involved natural resources to be extracted and exploited (Srivastava, 2007). But we live in the 21st Century where environmental sustainability has been an important factor, hence making it essential for organizations to add the 'green' to their supply chain practices. This 'green' component addresses the concerns and balances the relationship between SCM and the environment. Therefore, "Green" has become a magical big word, which should be attached to all the technologies, to sustain the environmental system. In the last decade GSCM has emerged prominently, covering all phases product's life cycle from design, production and distribution phases to the use of products by the end users and its disposal at the end of product's life cycle (Borade *et al*, 2007).

In today's world, people are more concerned than ever before about the environment and subsequent climate changes. Along with these concerns, in today's globalized world buyers' opportunities have increased. This has led to automobile companies to make adjust their strategies in many areas, including R&D and manufacturing (Schwarz, 2008; Jawahar Babu, 2012). Automobile companies have responded well to these

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concerns with companies like BMW, Ford, Toyota, Renault, and Volkswagen leading the pack.

In this paper we have bifurcated GSCM for Automobile Industry into two practices, namely, green design and green operations as it makes planning, integration and implementation of GSCM less complex. We have also presented application of these practices in some automobile companies. When we talk about implementation, we also face some barriers in implementing these practices. So we have also looked at these barriers from an Indian perspective.

## 2. Methodology

Remko I. van Hoek (2001), has aimed to place greening technological and operations initiatives in a supply chain context to address the gaps on greening from a business point of view. He concluded that in order to realize the strategic approach of greening, the technological and operational practices are not yet fully developed. These conclusions were based on 2 case studies of automobile company's greening attempts (Remko I. van Hoek, 2001). Adding the green component to the application of supply chain management practices by focusing on optimization and implementations of such practices can lead us to the ultimate goal of environment conservation (R. Kumar *et al*, 2012). Ioannis Mallidis and Dimitrios Vlachos have proposed taxonomy of green supply chain practices while promoting the significance of this green element for a companies' sustainability. This taxonomy consists of Green Product Design and Green Operations like Green Transportation and Distribution, Green Warehousing and Reverse Logistics issues. Samir Srivastava (2007) has provided an integrated and fresh look in the area of GSCM considering the reverse logistics angle in which he has aimed to develop a strategy for sustainability of green supply chain practices. Nunes and Bennett (2010) have investigated green operations initiatives in the automotive industry that were documented in the environmental reports of selected companies. They found that car manufacturers are pursuing a wide range of green operations practices such as green buildings, eco-design, green supply chains, green production, reverse logistics, and innovation of the same (Nunes *et al*, 2010). It has been discussed that the automotive industry witnessed a great shortening of product life cycle. This can be perceived as another factor increasing the negative environmental pressure from the industry (Volpato *et al*, 2008). Noor Aslinda Abu Seman *et al* (2012), have reviewed literature on development of GSCM in developed and developing countries. They have concluded that research in examining the adoption and implementation of GSCM practices lacks in developing country. Sarbjit Singh (2010) has tracked the performance of the various Indian manufacturers using various performance indicators and sub-indicators related to Green Sourcing and Procurement, Green Design and Green practices. Christina Bosch *et al*

(2011) in collaboration with the Automotive Industry Action Group (AIAG) found a wide range in the complexity of the greenhouse gas controlling measures of suppliers and have demonstrated the need for a collective methodology between suppliers and OEM part producers to scale down the emissions to a larger extent. Nimawat Dheeraj and Namdev Vishal (2012), have concluded that industries that have implemented GSCM practices in India have enhanced their commercial and environmental performance on many stages as equated to those that haven't adopted these practices by studying Environmental Performance Index (EPI) and four main activities of GSCM.

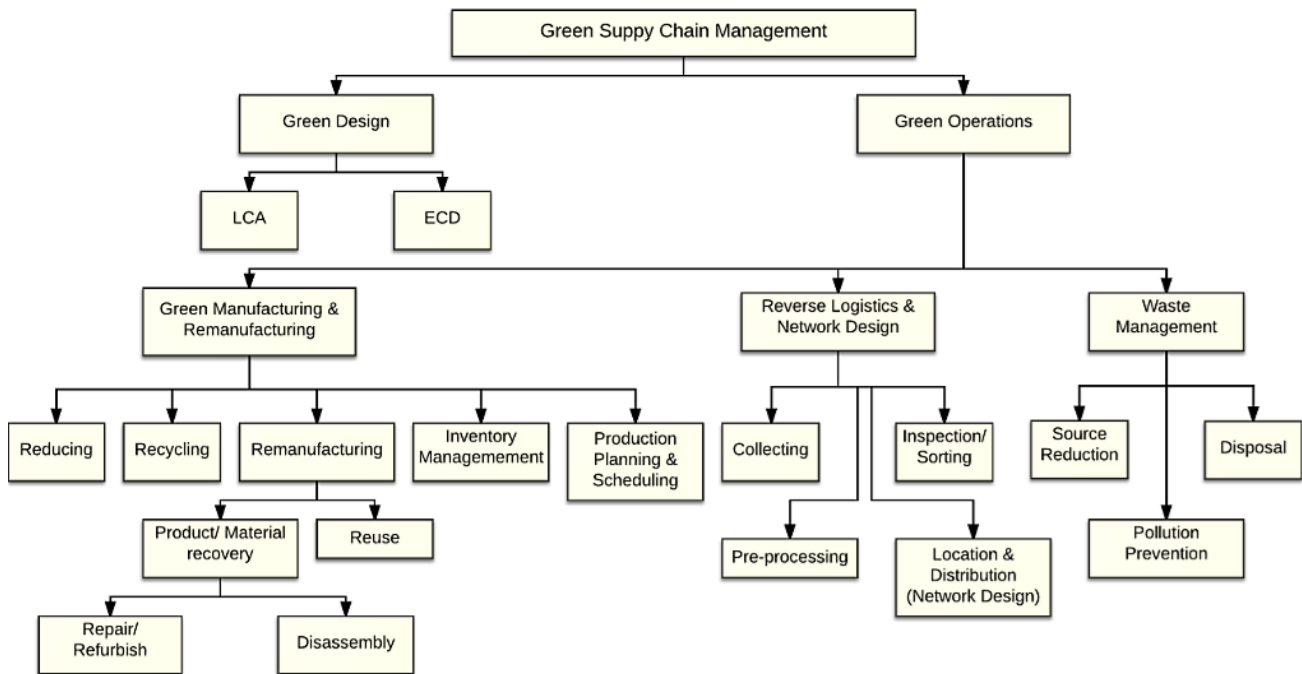
Based on the reviews and conclusions mentioned above we have decided to elaborate on different factors pertaining to GSCM in Automobile Industry viz., Green Design and Green Operations as shown in Figure 1. Most organizations struggle to implement these policies due to the lack of knowledge regarding these subjects. In the process of suggesting factors relevant to a successful GSCM, we will also be analyzing the barriers that slow down or stall the system. These barriers include major factors like cost and legitimacy of product and also consists of other obstacles like improper regulation of events, industry standard barriers, improper design knowledge and poor supplier services. These barriers can be eliminated by introduction of an active and a responsible department which is well versed with all the industry standards. This department will also have the responsibility to extract a prompt and efficient service from suppliers as well distributors in the SCM system.

## 3. Green Design

Green design is an ecological design practice which encourages environmental awareness (Fortes, 2009). The main idea of ecological design was to lessen environment destructive effects by integrating itself with living processes. Green designing emphasizes on the ecological equilibrium between man and nature, and fully take environmental effects into account to minimize damage in the whole designing process (Chen Huiyu *et al*, 2010). According to Srivastava (2007) green design is study of product behaviour in and with the environment. Green design includes (I. Mallidis *et al*):

- 1) Products made from recycled or remanufactured materials.
- 2) Products that can be reused and remanufactured.
- 3) Products with environment friendly packaging.
- 4) Products made from organic components.

On this basis, numerous global companies have redesigned their production lines, by addition of green attributes to their products. McDonald's for example, used environment friendly materials to make its beverage trawls, eliminating 1,000,000 litres of solid waste per year. While Walmart managed to save an equivalent of 800,000 gallons of gasoline just by wrapping four kinds of products in a polymer derived by corn instead of oil (I. Mallidis *et al*).



**Fig.1** Classification of GSCM practices in Automobile Industry (Srivastava, 2007)

The two strategies adopted by automobile companies in green design are environment conscious design (ECD) and life cycle analysis /assessment (LCA) as shown in Figure 1 (Srivastava, 2007).

### 3.1 Life cycle assessment/analysis

LCA includes study of material and energy flow throughout the product life i.e. from retrieval of raw material to dispatching of finished goods to the market. It also evaluates the environmental, professional, health and resource penalties of a product throughout product life (Dube *et al*, 2012; Ghobakhloo *et al*, 2013). This process is summarized in Figure 2.

### 3.2 Environmental conscious design

ECD seeks designs with certain environmental consideration. They use the data from LCA for initial product design of new product (Chen Huiyu *et al*, 2010). It is view of manufacturing that includes the social and technological aspect of design, synthesis, processing and use of products in incessant or distinct manufacturing industries (H. Zang *et al*, 2003). It is an optimization process with the goal of minimizing the detrimental impact of the product through its life-cycle. For the Automobile Industry it includes technologies like:

- 1) MPFi
- 2) CRDi
- 3) Hybrid and Electric cars
- 4) Regenerative Braking, etc.

In multi-point fuel injection (MPFi) engines, more uniform A/F mixture is supplied to each cylinder and

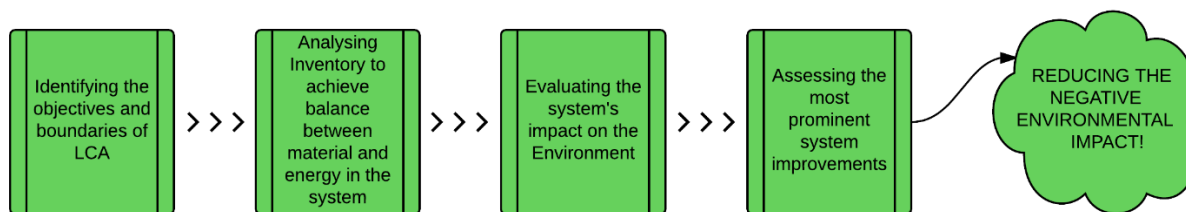
therefore the difference in power generated in each cylinder is minimum as compared to conventional carbureted engine. Vibration from the engine equipped with this scheme is less and due to this the lifespan of engine components is enhanced (V. Rathore, 2015). The new common-rail direct/diesel injection (CRDi) engine scratches fuel consumption by 20%, doubles torque at low engine speeds and upsurges power by 25% (V. Rathore, 2015). Working via dual electric and petrol engines, vehicles such as the Toyota Prius and the Honda Civic Hybrid are more fuel efficient and emit a reduced amount of CO<sub>2</sub> emissions than normal cars (D. Friedman, 2003). It has been evidenced that regenerative braking is efficient and less harmful to the environment (Richard Torrens). The Delhi Metro kept around 90,000 tons of carbon dioxide (CO<sub>2</sub>) from being emitted into the atmosphere by regenerating 112,500 MW hours of electricity by using regenerative braking systems between 2004 and 2007 (S. S. Joshi *et al*).

## 4. Green Operations

Green Operations can be defined as those operations or processes which help in reducing/eliminating the non-ecological raw materials or data which in turn help in preserving the ecosystem. In the Automobile industry the following methods can be implemented:

### 4.1 Green Manufacturing and re-manufacturing

Green manufacturing can be defined as reducing the environmental pressure by using appropriate technology and materials (Nunes *et al*, 2010). Re-manufacturing is recycling-integrated manufacturing.



**Fig.2** Life cycle analysis or assessment (Ghobakhloo et al, 2013)

Recycling can be used to obtain unfinished goods and raw materials which can be re-used again to reduce wastage tremendously. Current example is in automobiles and consumer electronics industry (Vergragt et al, 2007).

**4.2 Reverse Logistics and network design**

Reverse logistics (RL) is known as the process of planning, implementing, and controlling the efficient, cost-effective process of unprocessed material, latest inventory, finished goods and related information from the point of origin to the point of consumption to recapture its value or proper disposal. Initially, the products have to be recovered followed by segregating. Hence, to minimize operations cost proper network design with redesigning and reuse should be implemented in as many processes as possible (S. K. Srivastava et al, 2006).

**4.3 Waste Management**

Waste Management can be defined as supervision and reduction of chemically poisonous and harmful waste generated during processes or operations or can be defined as the process of treatment, storage and disposition (Nunes et al, 2010). The objective of source-reduction/pollution-prevention (SR/P2) focuses on the idea of waste prevention rather than managing it later (S. K. Srivastava et al, 2006).

Some examples of GSCM in Automobile Industry include Ford Motor's requirement for all its suppliers to certify to the ISO14001, while others (e.g., Toyota, BMW) need the incorporation of "supplier activities" in statements of ecological responsibility (Vergragt et al, 2007).

Automobile industries such as BMW and General Motors have been using reverse operations, according to Thierry, Wassenhove, Van Nunen and Salomon (1995). Companies such as Hewlett Packard, Storage Tek and TRW are also using and promoting reverse logistics in supply chain management (M. Thierry et al, 1995).

According to the data available BMW (Europe) and FORD (America) have been practicing all those activities and operations whose use may in-turn help in contributing to Green Supply Chain Management. On the other hand, BYD (China), being a new company, focuses more on creating a brand value for itself in the market, thus neglecting the virtues of Green operations

and sticking to those activities, plans and designs which may not be environment conducive but may be superior on profit margin.

A detailed analysis about the operations used by Ford, BMW, Toyota, and BYD has been given below (Zhu et al, 2006; Nunes et al, 2010) in Table 1:

**Table 1** Application of GSCM in various Automobile companies

		BMW (Europe)	TOYOTA (Asia)	FORD (USA)	BYD (China)
Green Operations	Green Design				
	Life-cycle assessment	✓	✓	✓	
	Environmentally conscious design	✓	✓	✓	
	Green Manufacturing				
	Reducing	✓	✓	✓	✓
	Recycling	✓	✓	✓	✓
	Inventory Management	✓	✓	✓	
	Product Planning and Scheduling	✓	✓	✓	✓
	Remanufacturing				
	Product Material Recovery	✓	✓	✓	
	Reuse	✓	✓	✓	
	Reverse Logistics and Network Design				
	Collecting	✓	✓	✓	✓
	Inspection Sorting	✓		✓	
	Pre-processing	✓	✓	✓	
	Location and Distribution	✓	✓	✓	✓
	Waste Management				
	Source Reduction	✓	✓	✓	
	Pollution Prevention	✓	✓	✓	✓
	Disposal	✓		✓	

**5. Barriers in implementing GSCM in Automobile Industry in India**

According to the statistics provided by Lettice, Wyatt, & Evans, 2010, the Automobile Industry is the biggest manufacturing sector (Lettice et al, 2010). In order to cope up with the ever increasing population (Olugu,

Wong, & Shaharoun, 2010) of the world, the demand for automobiles has tremendously increased. India, being the 2nd most populated country in the world, the growing demand for automobiles is forcing the leading manufacturing and automobile firms (like TATA Motors, Honda, Bajaj, Hyundai, Toyota, etc.) to open new manufacturing hubs across the country or to increase the existing capacity of the current hubs (S. Luthra et al, 2011).

Increase in use of automobiles is directly proportional to increase in pollution levels. As a result, environmentalists are trying to divert the attention of these companies towards Green Supply chain Management (Zhu et al, 2006).

Implementation of GSCM in Automobile Industry may not be as easy as it sounds. These companies face various social, technological and economical obstructions while trying to implement this idea. Some of the major barriers these companies face while trying to implement GSCM are: Deficiency of IT; Usage of age-old techniques; Low quality of Human Resource; No support from Government; Less provision to implement Green ideas; Cost; Benightedness of customers; Lack of support from top management; Uncertainty and competitiveness (S. Luthra et al, 2011).

## Conclusions

From the above research and analysis, we can conclude that Green Supply Chain Management (as a whole) is the need of the hour. With rapid increase in pollution levels, increase in global warming, depletion of ozone layer has pushed our Earth to its limits. Hence, to protect and preserve the ecosystem, GSCM is inevitable, starting with the largest manufacturing sector, Automobiles.

With the advent of the modern age of science and technology, Automobile sector is trying to cope up with the demand from the ever rising population.

Green Supply Chain Management is one of the most effective techniques which can drastically reduce the ecological impact without compromising with quality, cost, performance and reliability. Recycling is one of the major processes in the Green Operation Cycle which largely contributes to GSCM.

Even though Green Supply Chain Management shows direct cost and efficiency benefits in the Automobile Industry, fully fledged utilization of Green SCM is hindered by some social, technical and economic barriers. Automobile companies are still to incorporate the idea of Green SCM in their designs, manufacturing, marketing, etc. Hence, it becomes necessary to enlighten the Indian Automobile sector on the benefits of Green SCM. Further research is required to analyze how the companies should select their products to maximize output without compromising with the brand of the company.

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