



Environmentally responsive supply chains

Learnings from the Indian auto sector

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Abstract

Purpose – The arrival of global manufacturers has brought about new challenges such as environmental concerns and sustainability of supply chains. The purpose of this paper is to identify implementation level, major drivers, various practices and performance of environmentally and socially-conscious supply chain management (SCM) in the context of the automobile industry in India.

Design/methodology/approach – The literature is reviewed to understand various challenges/barriers to the adoption of green supply chain management (GSCM) practices; statistical analysis of various drivers, practices and performance of environmentally and socially conscious supply chain is carried out in the case of an automobile cluster in central India. Personal interviews are conducted and a structured questionnaire is used for data collection from 30 organizations including original equipment manufacturers, first- and second-tier suppliers.

Findings – Environmentally and socially responsive supply chains are in the early adoption stages in India. Companies studied in the auto cluster are not adequately addressing these measures in supply chain design and operations; though awareness and inclination to adopt has been on the rise – actual implementation lacks a holistic approach.

Originality/value – Investigation of GSCM along with social concerns is rarely done in the Indian context. This paper will offer valuable insights for managers in understanding the consequences of non-compliance, especially with the Indian automobile industry recently becoming global.

Keywords India, Automotive industry, Supply chain management, Corporate social responsibility

Paper type Research paper

1. Introduction

Recently, environmental concerns are getting top-most priority among governments and corporate worldwide following fast realization of the deteriorating climatic conditions. Global warming caused by greenhouse gases, ozone layer depletion, haze over Asian countries, fast melting of glaciers, generation of huge amounts of liquid and solid waste, rising air, water and soil pollution levels and irreparable loss of biodiversity are impacts that can be attributed to the coordinated activities of organizations in a supply chain. Much of this arises from manufacturing organizations that continue to produce large amounts of unnecessary waste or emissions rather than investing in better technologies or practices to prevent its generation at the source (Klassen, 2000; King and Lenox, 2002). External pressure applied by customers to achieve the requirements of reduced cost, increasing quality and faster delivery leads to production of unnecessary waste or the choosing of lower-cost but environmentally unsustainable production alternatives (Green *et al.*, 1998).

Sustainable development criteria are of growing interest as managers are forced to deal with social and environmental issues, not only for their own firm, but also related to their supply chain partner (Vachon and Klassen, 2006). Every product generated, transported, used and discarded within the supply chain (SC) causes a certain impact on the environment. Green supply chain management (GSCM) has gained momentum



in recent years as a potential tool to counter the detrimental impacts of the supply chains and Western countries have adopted very stringent measures to arrest the damage caused by large, global supply chains which are energy and capital inefficient and complex in design. Brown (2008) outlines the urgency for outsourcers to adopt environmental practices as competitive edge to remain in international market, citing cost reduction, quality improvement, increased profits and access to new and growing markets as benefits. India has seen an upsurge in outsourcing opportunities and the entry of many major global manufacturers, especially in automobile sector. The Government of India has recently launched the "Automotive Mission Plan 2006-2016" to further propel the growth of the Indian automotive sector and increase its contribution to the GDP of India from 4 per cent to 10 per cent by 2016 (Draft, 2006), but adverse effects of an economic slowdown have been visible on the industry. This has definitely brought about newer challenges such as adopting green measures in the entire supply chain to become competitive and using stringent norms of emissions from vehicles for sustainability in this slowdown period. Indian organizations also need to address the social impacts of the supply chains, as socio-economic conditions of India differ vastly from the most developed countries of the world and the social responsibility of supply chains cannot be overlooked as unemployment and poverty continue to be the dominating problems faced by the country.

No significant research contribution investigating the sustainability aspects of supply chains has been reported in the Indian context so far, and thus it is felt essential to undertake this study which targets the automobile supply chain, keeping in focus environmental and social concerns. The idea is to unearth the various pressures/drivers, practices and performance of the adopted measures for green and socially responsible supply chains.

After a brief discussion about the Indian automobile supply chain, strengths, weaknesses, opportunities and threats (SWOT) analyses have been presented to get a first-hand impression of the present scenario. Various pressures and practices for green and socially responsible supply chains are discussed and statistical analysis has been presented for an automobile cluster in central India. Various insights gained, along with the results and conclusions are presented and limitations, with future scope of studies, are also discussed.

2. GSCM: definition and scope

GSCM is relatively a new field of research mainly owing to growing concerns about climate change, unsustainable consumption of natural resources and very high rate of energy consumption (Sarkis, 2003). Complex, long supply chains are not energy efficient and are perceived as potential threats to the environment owing to excessive usage of materials, large waste, heat and emission generation. Owing to the lack of consensus in the literature, researchers continue to struggle with identifying a clear, unified framework for GSCM. The absence of such a framework partly explains the wide variety of definitions, terms and conceptualizations found in the research and practitioner literature (Vachon and Klassen, 2006). A few definitions of GSCM are presented here to capture a generally acceptable view of it. Table I shows a few such definitions and their thrust areas.

Historically, the focus of research has been on the detrimental effects on the environment of all industrial activities and many terms like environmental management system, green purchasing (Green *et al.*, 1998), clean production, zero waste, total quality environment system, eco design, industrial ecology, design for

S. no.	Author	Definition	Thrust area
1.	Hervani <i>et al.</i> (2005)	GSCM is defined as: green supply chain management (GSCM) = (green purchasing + green manufacturing/materials management + green distribution/marketing + reverse logistics)	Includes distribution and REVLOG
2.	Vachon and Klassen (2006)	Defined two sets of green supply chain practices: Activities using markets or arm's-length transactions conducted by the buying organization in order to evaluate and control its suppliers (environmental monitoring) Activities comprising a direct involvement of the buying organization with its suppliers to jointly develop environmental solutions (environmental collaboration)	Internalization/externalization framework integrating the general characteristics of supply chain
3.	Srivastava (2007)	GSCM is an integrating environment thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers, and end-of-life management of the product after its useful life	Broader look integrating entire supply chain network
4.	Lee (2004)	A GSC initiative can be defined as the programmes striving to transfer and disseminate environmental management, in particular advanced environmental management practices, through the entire supply chain, by using the relationships between large-sized buying firms and their suppliers	Focus on relationship development for holistic approach towards ultimate supply chain
5.	Shukla <i>et al.</i> (2009)	Green supply chain management is all encompassing, strategic set of actions taken by collaborating partners and stakeholders of an ultimate supply chain to mitigate and/or eliminate the detrimental impacts of all business activities, spanning across the chain, on the environment and there by ensuring the sustainability	Broader view of greening efforts and focus on sustainability

Table I.
Definition of green
supply chain
management

environment, recycling, reverse logistics (Tibben-Lembke and Rogers, 2002), product stewardship, green logistics (Aronsson and Brodin, 2006), etc. have been used by researchers but they are unable to capture the entirety of the business process and focus only on specific domains, having a piecemeal contribution to the larger problem of damage to the environment and ultimate climate change. SCM, in its wider scope, captures the entire business activities from cradle to grave, including new product development and design, production, multi-tier supplier network, vendor development, 3PL service providers, packaging, financial institutes, distribution network, warehousing facilities; systems service providers, recyclers, waste disposal service providers, etc. Thus, green supply chain measures are all-encompassing and aimed at

achieving the integration of inbound, internal, outbound and reverse supply chain activities. The concept of closed loop supply chain (Guide and Van Wassenhove, 2003) is also covered in the broader spectrum of the green supply chain. Thus, it is fair to say that GSCM is an all-encompassing, strategic set of actions taken by collaborating partners and stakeholders of an ultimate supply chain.

3. Indian automobile industry

The Indian Automobile industry has witnessed major changes in the past few years. After liberalization of the market, many global automobile manufacturers such as Ford, General Motors, Suzuki, Honda, Mercedes (in the car segment) and Piaggio, Suzuki, Honda, Yamaha, Kawasaki (in the motorbike segment) have established manufacturing bases or international purchase centres in India (Singh *et al.*, 2004).

Broadly, this industry can be divided into three categories: cars, two-wheelers and heavy vehicles. Among the two-wheeler segment, motorcycles have a major share in the market. Hero Honda contributes 50 per cent of motorcycles to the market. Honda holds a 46 per cent share in scooters and TVS makes 82 per cent of the mopeds in the country; 40 per cent of the three-wheelers are used for goods transport purposes – Piaggio holds 40 per cent of the market share. Regarding passenger transport, Bajaj is the leader, making 68 per cent of the three-wheelers. Cars dominate the passenger vehicle market segment by 79 per cent. Maruti Suzuki has around a 47 per cent share in passenger cars and has a complete monopoly in multi-purpose vehicles. In utility vehicles, Mahindra holds a 42 per cent share; in commercial vehicles, Tata Motors dominates the market with more than 60 per cent share, with Ashok Leyland and Volvo-Eicher commercial vehicles at numbers two and three places respectively (Auto SCM India, 2006).

Owing to global recession, Indian auto manufacturers are also facing decline in demand and many companies have shown negative growth in recent quarters. The increasing criticism of the automobiles as the single largest source of pollution has put tremendous pressure on companies to upgrade not only the technology to increase the efficiency and use better emission control devices but also to incorporate green measures in their supply chain networks. The existing Indian original equipment manufacturers (OEMs), ancillaries and auto component manufacturers are definitely short of incorporation of green measures to green up their supply chains. To identify the current status of the industry, an SWOT analysis has been done, as shown below, to identify typical strengths, weaknesses, opportunities and threats. It is based on various points that have emerged through discussions with the top managers of companies during the data collection:

(1) *Strengths*

- Nice track record of growth of Auto industry in last five years.
- Availability of cheap and skilled man power, large network of ITIs.
- Large pool of technically qualified degree and diploma engineers and professionally qualified managers.
- Strong presence of ICT professionals and consultants.
- Large pool of English spoken personnel.
- 50 per cent of the population is youth of age below 30 years.
- Comparatively cheaper raw materials like steel, rubber, aluminium, plastic, etc.
- Large number of ISO 9001 certification among component manufacturers.

- Possession of car perceived as status symbol in society.
- Strong emotional bonding of Indian families with material possessions.
- Large used-car market and resulting larger spare parts market.

(2) *Weaknesses*

- Industry is fragmented and firms can not reap the benefit of economies of scale.
- Poor infrastructure in terms of roads, rail, port and air ports.
- Poor R&D record and facilities.
- Testing and calibration facilities for automobile and equipments in developmental stage.
- Heavy dependence on imports for supply of fuel.
- Large population below poverty line (more than 300 millions).
- Poor environmental protection measures.
- Increasing pollution levels in cities.
- Most component manufacturers belong to SMEs and very large no. around 10,000 in unorganized sector.
- Vendors are not strategically placed and thus larger lead times, poor service level.
- Monopoly of few component manufacturers in select items.
- Low reliability and dependability of the vendors.
- Bureaucratic delays leading to high gestation time for projects.
- Many suppliers relying on secondary market of spare parts rather than having dependency on assemblers.

(3) *Opportunities*

- Growing middle income group (250 million) means growth in demand in future.
- Govt. of India supporting the development of industry and plans are in place to make India hub of small car manufacturing in the world.
- Cheap labour and overheads means potential of attracting more outsourcing of auto components and accessories.
- Arrival of almost all major auto manufacturers of the world.
- Acquisition and mergers in the light of major industry shakeout.
- Increase in exports of vehicle and components though it is small fraction of global market.
- Growing craze for cars and SUVs among youth in India.
- Increase in number of nucleus families resulting in increase in demand for automobiles.
- Growing trend of second car in families.

(4) *Threats*

- Economic slow down resulting in liquidity crisis and sluggish demand.
- Growing concerns about industry's environmental friendliness.

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- Political interference and strong unionism.
 - Fluctuations in price of crude oil.
 - Burgeoning cost of import and cost of subsidy on fuel.
 - Poor availability of loans to industry.
 - Land acquisition and infrastructure developmental activities are very slow.
 - Increasing pollution and emission of green house gases.
 - Growing environmental awareness among the users.
 - Rapid mass transportation system like metro rail in metro cities.

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4. GSCM: need, challenges and barriers in India

An in-depth look is needed in to the practices and philosophy of GSCM in the context of changed socio-economic, political, cultural and value systems of countries like India. Being the second most populated country of the world, naturally, it has a different set of priorities and its large skilled, semi-skilled and unskilled work forces need to be gainfully employed. The kind of automation and dehumanization of industries that took place in western countries may not be needed here and this is true for any other management practices. However, to maintain gross domestic product (GDP) growth rate of over 9 per cent in the past few years, tremendous growth in automobile, telecommunication, information technology and other sectors has been witnessed in India. In a quest for fast economic development, it has been faced with lots of problems from industrial pollution, regarded as the major contributor among the many negative environmental impacts that are causing damage, particularly through excessive exploitation of resources and degradation of the environment. The vast majority of Indian enterprises have been churning out solid waste, much of which consists of substances that are hard to compost or return to the environment. For example, India has become the world's sixth largest and second-fastest growing producer of greenhouse gases and the level of air pollution in at least 20 cities is classified as dangerous (Zubrzycki, 1997). India generates millions of tons of solid waste each year, most of which is disposed off in unsafe ways: burned, dumped in to oceans and other water bodies, or landfilled. Chemicals leak out of land fills, contaminating agricultural land and groundwater supplies. In a country that is densely inhabited, land-filled space comes at the expense of valuable croplands or forests. Small enterprises are basically concerned with the bottom line and environmental management and green issues did not enter into these enterprises' business strategies or operations (D'Souza and Peretiatko, 2002). One partner in a supply chain (normally major stakeholder or OEM is so dominant over the others that it may unilaterally dictate its own terms and conditions over the smaller partners of the value chain (Jharkharia and Shankar, 2006). Small- and medium-sized operators face enormous pressure from the focal company to adopt GSCM practices, but having their own sets of constraints, whether they are equipped to face this challenge is matter of investigation. Another distinct characteristic of the Indian economic environment is the inadequacy of basic inputs normally required to support organized economic activity. The Indian infrastructure – comprising roads, railways, airports, seaports, information and communication technology (ICT), and energy production – is considered very poor when compared to other developed and developing countries (Sahay and Mohan, 2003).

Although the legal framework to support environmental protection is at par with any other country in the world, the degree of enforcement is very low, resulting in very

low priority being given to the environment by the industries. The statutory framework for the environment and energy efficiency includes the Indian Forests Act, 1927, the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Forest (Conservation) Act, 1980, and the Environment (Protection) Act, 1986 (Ministry of Environment & Forests, Government of India, 2007). Despite having an adequate regulatory framework for ensuring the protection of the environment, India is lagging far behind the satisfactory standards, mainly owing to lack of implementation, ease of manipulation, corruption, lack of adoptability and short-term measures. That is why there is an urgent need to address the issues related to GSCM in India.

GSCM practices are difficult to implement owing to their complex nature, the greater degree of coordination needed, resource requirements and lack of willingness to adopt. Few works are reported from where we can draw conclusions about India. Rao (2002) showed that in South-East Asia, greening of the supply chain has already started taking root. However, they were not yet able to arrange funds to help their suppliers buy their equipment for pollution prevention and so on. Individual or institutional buyers in this region are very cost conscious and not willing to pay anything extra for eco-friendly products (Green *et al.*, 1998). In the context of the Indian auto industry, Ravi and Shankar (2005) identified five strong barriers, namely: lack of awareness of reverse logistics, lack of commitment by the top management, problems with product quality, lack of strategic planning and financial constraints.

India can also learn important lessons from China, where rapid industrialization is now proving to be a menace and environmentally damaging practices are now prompting widespread bans from across the world. Milk products, chicken and eggs, and recently toys are few examples to quote. India is faced with similar challenges and need to address the green measures in supply chains to remain competitive in the world market while protecting its environment (Brown, 2008). Interviews conducted with owners, entrepreneurs and senior managers also uncovered the challenges faced by the organizations in successfully implementing GSCM. Table II summarizes these challenges and barriers to GSCM in India. The majority of respondents were convinced that the mammoth population of India places a heavy burden on resources and the situation will worsen further, as there has been an increase in per capita income in last few years, resulting in improved consumption capacity of the middle class. Poverty and non-availability of clean fuel in most parts of rural India result in over-dependence on conventional sources of energy such as fodder, cow dung, wood, coal, etc., leading to very fast deforestation and excessive excavations. Electricity supply is a major problem and demand surpassing supply makes it difficult to introduce green measures (Ministry of Environment & Forests, 2006). Conservation of critical environmental resources, infrastructure development, large number of MSMEs, integration of environmental concerns in economic and social development, efficiency in environmental resource use, non-availability of clean fuel, setting the mindset and behavioural change have emerged as key challenges. Implications of these challenges in the Indian context are briefly outlined to derive important insights.

5. Methodology and survey results

5.1 Questionnaire development

A detailed questionnaire was developed for the empirical data collection based on the existing literature and similar studies done in other parts of the world. The instrument contained four different sections:

S. no.	Challenge	Barriers	Implication
1.	Conservation of critical environmental resources	Poverty in rural areas Use of fossil fuel for cooking and other purposes Population growth Inappropriate technology Consumption choices Intensive agriculture Polluting industry Unplanned urbanization	Uncontrolled consumption of natural resources resulting in rise in raw material cost, depleting forests, disturbance in ecology and hint of climate change
2.	Infrastructure development	Huge gap in demand and supply of electrical energy Poor condition of roads Lack of rail network in many industrial areas Large distance between the industrial area and nearest ports Lack of advanced communication facilities	Lack of sound infrastructure leads to excessive pollution and emission generation due to high lead times, slow traffic, congestion, delays and accidents, wastage of diesel in captive power plants
3.	Large no. of MSMEs	Lack of willingness to adopt Lack of resources Poor technological capabilities Lack of knowledge and awareness Over dependence on the LEs	MSMEs act as suppliers and fail to meet the demands of the LEs resulting in manipulation and fraudulent practices MSMEs are contributing almost 70% of pollution in this region
4.	Integration of environmental concerns in economic and social development	Govt. under pressure to maintain high economic growth to sustain the population Poor enforcement of laws/regulations/guidelines Social problems of illiteracy, unemployment, large pool of unskilled worker Transportation sector in largely unorganized	Poor integration resulting due to high pressure for economic growth, political interference, corruption, etc.
5.	Efficiency in environmental resource use	Lack of advanced technology Poor coordination between various agencies like manufacturing sector, power generation and pollution control boards Lack of waste management techniques Lack of value recovery management	Low efficiency in use of resources due to large wastage, ineffective utilization of byproducts, poor reuse capabilities of heat and energy. Unorganized recycling and waste disposal
6.	Non-availability of clean fuel	Dependence on import Lack of availability of green fuel like CNG and LPG	High emission in transportation as bulk of transport is dependent on road and diesel as main fuel
7.	Setting the mindset and behavioural change	Social problems of unhygienic living conditions, unsafe drinking water, open toilets Space, layout related shortcomings Resistance to change	Most difficult to change the mind set, generally Indian people are not considered hygiene conscious

Table II.
Challenges and barriers to GSCM in Indian context

- (1) Attributes related to pressures or drivers which prompt an organization to adopt GSCM were grouped under four variables namely regulatory factors, market related issues, suppliers' side advances and certain internal factors.
- (2) Various practices which may be followed in order to ensure effective GSCM are grouped under five variables namely, internal management, purchasing, customer cooperation, recovery of investment and implementation of eco-design.
- (3) Performance of organizations under four headings, i.e. environmental performance, positive economic performance, negative economic performance, and operational performance.
- (4) Socially responsible supply chain measures under four variables, namely, internal management, workforce-related issues, selection of partners and social responsibility.

Majority of the attributes are taken from a similar study conducted for the Chinese automobile industry (Zue *et al.*, 2007) because near similar situations prevail in both countries. The socially responsible aspect is added, being more pertinent in the Indian context, as India is a democratic republic and has a different social system. For the first section, comprising 18 items, a five-point Likert scale is used (1 = Not at all important, 2 = Not important, 3 = Not thinking about it, 4 = Important and 5 = Extremely important). Similarly, for the second section containing 23 items, a five-point scale is chosen consisting of responses ranging from 1 = Not considering it, 2 = Planning to consider, 3 = Considering it currently, 4 = Initiating implementation and 5 = Implementing successfully. Section three has 21 items and answers were sought on Likert scale (1 = Not at all, 2 = Little bit, 3 = To some degree, 4 = Relatively significant and 5 = Significant). The last section has 16 items and responses were collected using a scale ranging from 1 = Not considering it, 2 = Planning to consider, 3 = Considering it currently, 4 = Initiating implementation and 5 = Implementing successfully. To explain the attributes and variables and remove confusion during responses, the responders had them explained clearly and a researcher was personally present with them to clarify the doubts. Simultaneously, interviews were also conducted with the managers in-charge of the supply chain or related department of the companies (many organizations, especially small to medium scale, did not have a separate SCM department). Personal interviews were helpful in knowing the various aspects that were not specifically covered in questionnaire.

5.2 Data collection

The Indian automotive industry is geographically spread across the country but one can see seven major clusters near Delhi (North), Pune (West), Kolkata (East), Chennai (South), Indore (Central), Bangalore (South) and recently Uttaranchal (North). If the supplier belongs to a far located cluster it definitely puts the manufacturer on defensive. Indian auto suppliers are not fully geared up to relocate themselves according to needs of the OEMs. Recently, TATA motors had planned a vendor's park integrated into its new plant of ambitious Nano small car but this became the primary cause of their exit from Singur. It was felt that rather than doing survey of scattered companies, an entire cluster must be examined so that various tiers of the supply chain can be approached and a specific study may be conducted which may be generalized at a later stage, as there is little difference in the prevailing condition in these major clusters. Pithampur auto cluster in central India is selected randomly for our study and

the manager at the District Industries Centre (DIC) was contacted to obtain the list of automobile companies in the cluster. In all, 35 micro, small, medium and large enterprises (LEs) were identified and systematically approached for personal interviews and data collection. In total, 30 companies agreed to share data with us and five others had different reasons for not participating, such as a merger process going on, production stopped due to recession, “not sharing information” a management policy and so on. The total was considered fit for conducting the survey as a minimum of 30 samples is necessary for assuming normal distribution of variables. The sample consists of all possible scales of industries including three micro, 16 small, eight medium and three large-scale industries. In a majority of the micro and small industries, the entrepreneurs themselves filled in the questionnaire, whereas in medium and LEs the managers looking after supply chain functions were asked to respond.

5.3 Descriptive statistics

Data were processed using SPSS software and descriptive statistics were found for all variables. The attributes score is added and average of them is taken to obtain the score of the variables in each section and for each variable mean for all the cases together ($n = 30$) and standard deviation is calculated. Reliability is tested using Cronbach's alpha and for 13 out of 17 variables this was more than 0.7, which is acceptable value (Nunnally and Bernstein, 1994). For two variables remaining out of four it is around 0.6, but with a small sample size it was considered acceptable. For the remaining other two variables – “work force issues” and “selection of partners” – the value is very low but they are retained, as in one case, use of child labour stood out (recently Government of India has passed legislation banning child labour), and thus responses were uniform for all 30 respondents. However, it was disappointing to see that small children were serving tea and snacks in many small units from roadside tea stalls. Similarly the awareness about SA8000 was in general very low and thus the item “selecting suppliers and service providers who are SA8000 compliant” evoked “low implementation”, and responses from all samples showed more or less similar responses. Thus we have analysed the possible reasons for the low reliability in these cases and though it was possible to omit the above-mentioned items to increase the reliability but sample size being small, it is felt that we might as well retain them for analysis. Table III shows these measures.

Regulative pressures are in the form of central government rules and regulations, which make mandatory requirements to be fulfilled for environment protection and are obligatory. Similarly, regional (state government and local governing bodies like municipal corporations and pollution control boards) governments also have area-specific rules, which are obligatory for companies to follow. Thus the mean of 3.77 indicates that this is an important driver for implementation of green practices. Second ranked is “internal factor” which includes company's environmental mission, policies and cost of disposal and cost of eco-friendly goods, with a mean of 3.57. The arrival of MNCs in the Indian market has created an urgent need to have environmental missions and policies in place. We figured out that LEs are more aware about projecting their green image, whereas micro and small companies felt that if forced by customers they might go for green measures. There were a few medium-scale companies which also showed remarkable awareness, and it is inferred through interviews that they have plans to supply to MNCs or are already doing so. “Market pressures” is ranked lower and thus confirms that awareness of Indian consumers about the environment is very low and not many organizations perceive exporting as a pressure because they are

Factors		No. of items	Cronbach's alpha	Mean	SD	Composite score
Pressure/driver for GSCM ^a	Regulative (R)	4	0.58	3.77	0.53	3.34
	Market (M)	4	0.72	3.18	0.74	
	Suppliers (S)	4	0.86	2.84	0.76	
	Internal factors (IF)	6	0.61	3.57	0.53	
GSCM practices ^b	Internal management (IM)	8	0.94	1.82	0.88	2.20
	Green purchasing (GP)	5	0.85	1.55	0.57	
	Cooperation with customers (CCER)	4	0.85	2.32	0.64	
	Investment recovery (IR)	3	0.77	2.67	0.96	
	Eco-design (ED)	3	0.75	2.65	0.87	
	Performance ^c	6	0.93	2.53	1.01	
Performance ^c	Positive economic performance (PEP)	5	0.95	1.95	1.13	2.73
	Negative economic performance (NEP)	4	0.94	4.02	0.99	
	Operational performance (OP)	6	0.84	2.42	0.86	
	Socially responsible supply chain ^d	4	0.90	2.44	0.96	
	Work force issues (WFI)	4	0.31	2.38	0.55	
	Selection of partners (SP)	4	0.32	1.79	0.47	
Socially responsible supply chain ^d	Social participation (SOP)	4	0.83	1.82	0.99	2.10

Notes: ^a1 = not at all important, 2 = not important, 3 = not thinking about it, 4 = important and 5 = extremely important; ^b1 = not considering it, 2 = planning to consider, 3 = considering it currently, 4 = initiating implementation and 5 = implementing successfully is planned; ^c1 = not at all, 2 = little bit, 3 = to some degree, 4 = relatively significant and 5 = significant; ^d1 = not considering it, 2 = planning to consider, 3 = considering it currently, 4 = initiating implementation and 5 = implementing successfully

Table III.
Descriptive statistics
and Cronbach's
alpha value

operating in the local market and have not yet come across global partners. "Suppliers' pressure" is ranked last as only large-scale enterprises scored high on this item and many small and micro operators scored pretty low. We observed that most organizations are in reactive mode and view pressures from government authorities to be sole reason to go for greening their supply chains and very few are active in enhancing their image through green orientation.

Regarding the status of implementation of the GSCM practices, the level of implementation looks to be very poor and "investment recovery" and "eco design" are two prime factors, though with not very significant values of the means, lying between 2 and 3 at 2.67 and 2.65. This indicates that most organizations are planning to consider the implementation or are considering it currently. ISO 14000 certification is achieved only by two organizations and in another two it is being considered currently. Implementation has been under consideration by many organizations as they feel that with the probable collaboration of their major customers with MNC this may become mandatory. The factor "cooperation with customer" ranked high, owing to the fact that most of the companies are suppliers to OEM and do not cater to end customers and therefore they are more cautious about their large customers and are ready to cooperate

with them in green packaging efforts and helping them with measures for cleaner production. "Internal management" and "green purchasing" ranked among the last, as none of the organizations has implemented green purchasing practices such as checking suppliers' ISO 14000 certification status, environmental auditing procedures, etc. This reflects very poorly on the overall implementation level of GSCM in the automobile cluster; as we take a composite score for GSCM practices by taking average of means of all five factors, it is only 2.20, which is close to planning stage of consideration in implementation.

For the performance of the organizations, "negative economic performance" has highest score of means close to 4, which is highly significant. It means companies view GSCM implementation negatively related to their economic performance and expect to invest more in training and environmentally friendly material purchase. This is typical traditional mindset and reflects that it is really hard for industries to view green measures seriously and adding to their bottom line. In fact, in interviews, many respondents revealed that they are not convinced about the prospects of economical viability of the green measures. However, "environmental performance" ranked second, with value close to 2.5 means between "little bit" and "to some degree". "Positive economic performance", by design, was negatively correlated to negative economic performance and hence it is not surprising to get a very low score of only 1.95.

"Internal management", though with a low score, has emerged as the most important factor for implementation of socially responsible supply chain practices and most respondents expressed a commitment for considering it currently. During informal discussion, however, they expressed that at times they might have indulged in unethical practices to speed up certain business activities such as freight movement, pollution control board clearances, custom clearance, etc. In "work force related issues" social accountability certification (SA8000) implementation has evoked very low response as only six respondents were aware of it and reported that they were planning to consider it in future. Most micro and small units have reservations about their workers joining associations and unions and "system to include minority and under privileged" also scored low value of mean. As mentioned earlier, preventing child labour and discrimination against women workers had high degree of implementation but informal discussions revealed that in a few organizations contract female workers are paid lesser wages as compared to male workers. Only LEs were cautious in promoting diversity in suppliers and ensuring fulfillment of industrial health and safety norms by their suppliers. Social participation of companies was low, with mean value 1.82, barring a few efforts of organizing blood donation camps and customer awareness camps. Inter correlations between the study variables are summarized in Table IV and there are many statistically significant correlations amongst the variables.

5.4 Regression analysis

It is interesting to investigate the inter-relationships between the pressures/drivers and practices of GSCM. It can be visualized that pressure should prompt the organization to adopt the GSCM practices and there should be a positive relationship between the two. Similarly, once implemented, the practices should result in performance of the supply chains. These interrelationships are checked using two sets of multiple regression (Zhu *et al.*, 2007). In the first set, four pressures are taken as independent variables and each of the practice variables is considered as dependent variable in turn and thus five regression models are built. The results of such regression are tabulated in Table V.

Table IV.
Correlation between
GSCM pressures,
practices and
performance

	R	M	S	IF	IM	GP	CCER	IR	ED	EP	PEP	NEP	OP	IMGM	WFI	SP	SOP
R	1																
M	0.743**	1															
S	0.472**	0.644**	1														
IF	0.494**	0.438*	0.485**	1													
IM	0.251	0.423*	0.316	0.224	1												
GP	0.274	0.396*	0.404*	0.245	0.791**	1											
CCER	0.077	-0.021	-0.001	0.046	0.546**	0.574**	1										
IR	0.283	0.462*	0.482**	0.188	0.523**	0.599**	0.260	1									
ED	0.095	0.189	0.276	0.212	0.643**	0.619**	0.434*	0.759**	1								
EP	0.155	0.321	0.311	0.321	0.671**	0.550**	0.237	0.636**	0.576**	1							
PEP	0.106	0.334	0.459*	0.412*	0.582**	0.462*	0.060	0.606**	0.565**	0.869**	1						
NEP	0.048	-0.083	-0.144	-0.027	0.001	0.232	0.276	0.162	0.245	-0.130	-0.289	1					
OP	0.167	0.357	0.449*	0.193	0.537**	0.693**	0.263	0.760**	0.646**	0.668**	0.698**	0.055	1				
IMGM	-	-	-	-	-	-	-	-	-	-	-	-	-	1			
WFI	-	-	-	-	-	-	-	-	-	-	-	-	-	0.614**	1		
SP	-	-	-	-	-	-	-	-	-	-	-	-	-	0.468**	0.610**	1	
SOP	-	-	-	-	-	-	-	-	-	-	-	-	-	0.775**	0.736**	0.535**	1

Notes: **correlation is significant at the 0.01 level; *correlation is significant at the 0.05 level two-tailed

Independent variables	Internal management (IM)	Green purchasing (GP)	Dependent variables Cooperation with customers including environmental requirements (CCER)	Investment recovery (IR)	Eco-design (ED)
Lognoe (size of firm)	0.536**	0.240	0.249	0.002	0.470*
Regulative (R)	-0.086	-0.020	0.236	-0.098	-0.077
Market (M)	0.566*	0.301	-0.150	-0.351	0.170
Suppliers(S)	-0.202	0.127	-0.102	0.342	-0.005
Internal (IF)	-0.194	-0.078	-0.100	-0.085	-0.095
R ²	0.211	0.277	0.053	0.284	0.211
F	2.55**	1.409	0.269	1.904	1.280

Notes: * $p < 0.10$, ** $p < 0.05$

Table V.
Results of regression analysis between practices and pressure of GSCM (standard estimates)

The number of employees in the organization is taken as the indicator of the firm size and this is adopted as a controlling variable (by taking log of number of employees). The results show that “size of the organization” and “market pressures” have a significant positive relationship with the “internal environment management” and we observe another significant impact of the “size of organization” on “eco-design”. It reflects that LEs are better at implementing environmental management as compared to MSMEs and may be owing to the availability of capital, long-term vision and more awareness about the global trends.

The second set consists of four regression models built by considering performance variables as dependent variables, five variables of GSCM practices as independent variables and size of organization as controlling variable, as shown in Table VI. “Internal management” has a significant positive impact on the “environmental and positive economic performance”, but a significant negative impact on the “negative economic performance”. “Investment recovery” leads positively to “environmental performance”, “positive economic performance” and “operational performance”. Other

Independent variables	Environmental performance (EP)	Positive economic performance (PEP)	Negative economic performance (NEP)	Operational performance (OP)
Lognoe (size of firm)	0.189	0.298*	-0.265	0.070
Internal EM (IM)	0.555**	0.462*	-0.596*	-0.122
Green purchasing (GP)	-0.114	-0.096	0.486	0.502**
Cooperation with customers (CCER)	-0.103	-0.288	0.191	-0.124
Investment recovery (IR)	0.497**	0.452**	-0.204	0.493**
Eco-design (ED)	-0.126	-0.022	0.517	0.062
R ²	0.610	0.622	0.299	0.686
F	6.002****	6.296****	1.633	8.368****

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table VI.
Results of regression analysis between performance and practices of GSCM (standard estimates)

significant positive impacts are that of “size of organization” on the “positive economic performance” and “green purchasing” on the “operational performance”. R^2 values are not very high in both sets of regression and thus not much can be inferred from them, but for second set they are relatively high (in the region of 0.6) and thus explain the variability around the regression line 0.4 times the original variance; in other words we have explained 60 per cent of the original variability, and are left with 40 per cent residual variability. The R^2 value is an indicator of how well the model explains the GSCM performance based on implementation of practices. Through this analysis we can infer that availability of the resources and top management commitment towards green measures are key factors for the implementation of GSCM and if implemented it can positively impact the performance of the organization. The discussion outlines the current status and identifies the gap between current and desired status of the environmental responsiveness of supply chains in India. There is an urgent need for policy planners to set up an action plan for strict implementation of the guidelines set in various regulations framed by the central and state governments. The study also reveals that many organizations are really concerned about the deteriorating environmental conditions but lack motivation and confidence to implement any such measures. Here, the role of policy makers becomes important, as a mere regulatory or controlling mindset is not going to help; a role of facilitator has to be adopted with proper mix of knowledge, training, motivation and encouragement. The managers of the organizations, on the other hand, have to evolve strategies for dissemination of knowledge and techniques and make it available to all stakeholders of supply chains, so that an integrated and coordinated effort may help organizations to minimize the carbon footprints across the chain. The researchers in the field of SCM are predominantly focusing on the economic performance and customer satisfaction metrics of supply chain performance where as it is evident that environmental performance is equally important and not many organizations are taking it seriously beyond fulfilling minimum statutory requirements. Thus, there is scope for future studies in this emerging field and coordinated research with institute-industry interaction can help in addressing this contextual vital issue.

6. Implications of the study

This study provides some very important insights into the environmental and social responsiveness of supply chains. The automobile industry in India is witnessing a transitional period and successful compatibility with world-renowned automobile manufacturers, that have recently started operations in India, largely depends upon the capability to upgrade operations and supply chains to meet challenges pertaining to stringent environmental and ethical norms. Top management and supply chain managers need to act as change agents for cleaner and greener manufacturing and supply chains. A mindset of reactive conformance to laid-down regulations will lead only to avoidance of the legal action but to remain competitive and get an edge over competitors, organizations have to gear up to adopt environmentally conscious supply chains as an order winner. This study reveals that there is huge gap, especially in upstream supply chains of auto OEMs, and issues such as material selection, supplier selection, vendor development, evaluation of vendors, use of clean fuel transporters in inbound and outbound logistics, etc., have to be revisited in light of the impact of supply chains on local environments. Specific performance metrics need to be included in the performance measurement of the supply chains to measure the overall impact of the chain. A few large firms have set up an environmental management system but

have not spread it to its partners. The managers of large firms need to play a proactive role to educate and spread awareness in less capable MSME partners to actively participate in any such drive and should convince them that being green may also improve economic performance of the entire supply chain in the long run. The study systematically identifies practices of and barriers to environmentally responsive supply chains and links the performance to them.

7. Conclusions

GSCM is a relatively less explored domain of SCM, which needs urgent attention of researchers in the present scenario of economic turbulence. Incorporation of green practices in long, complex, energy and capital-intensive supply chains is urgently needed to arrest the heavy damage to the global environment caused by the supply chains. The major findings of this study are that the GSCM is in its early stages of implementation in India and if implemented it may have a direct impact on the economic performance of the supply chains. Organizations need to develop coordinated efforts by resource sharing, and relationship-specific investment is expected to increase the adoption. The Indian automobile industry has a low level of adoption at present but there is a growing concern among the managers to upgrade their systems to meet the stiff challenges which outsourcing is going to bring about. Similarly, the social responsibility of supply chains has not been paid much attention and if not addressed adequately, may aggravate the host of social problems that are unique to India.

The study has many limitations and foremost is the sample size. Since cluster sampling is adopted and in a specific cluster all organizations are approached it was not possible to increase it further. The cluster has a typical set of companies and therefore there could be some problems in generalizing the results to the entire automobile industry in India but, by and large, we are confident that it captures the true scenario. A detailed study with a larger sample size can be attempted in future to get more representative results.

References

- Aronsson, H. and Brodin, M.H. (2006), "The environmental impact of changing logistics structures", *The International Journal of Logistics Management*, Vol. 17 No. 3, pp. 394-415.
- Auto SCM India (2006), *Background Note on Supply Chain Management in Automotive Industry*, Auto SCM India, Chennai.
- Brown, D. (2008), "It is good to be green: environmentally friendly credentials are influencing business outsourcing decisions", *Strategic Outsourcing: An International Journal*, Vol. 1 No. 1, pp. 87-95.
- Draft Automotive Mission Plan 2006-2016 (2006), *Documentation of Inputs for Ten Year mission Plan for Development of the Indian Automotive Industry into a Global Hub*, Ministry of Heavy Industries & Public Enterprises, Government of India, New Delhi.
- D'Souza, C. and Peretiatko, R. (2002), "The nexus between industrialization and environment: a case study of Indian enterprises", *Environmental Management and Health*, Vol. 13 No. 1, pp. 80-97.
- Green, K., Morton, B. and New, S. (1998), "Green purchasing and supply policies: do they improve companies' environmental performance?", *Supply Chain Management*, Vol. 3 No. 2, pp. 89-95.
- Guide, V.D.R. Jr and Van Wassenhove, L.N. (2003), *Business Aspects of Closed-Loop Supply Chains: Exploring the Issues*, Carnegie Mellon University Press, Pittsburgh, PA.

- Hervani, A.A., Helms, M.M. and Sarkis, J. (2005), "Performance measurement for green supply chain management", *Benchmarking: An International Journal*, Vol. 12 No. 4, pp. 330-53.
- Jharkharia, S. and Shankar, R. (2006), "Supply chain management: some sectoral dissimilarities in the Indian manufacturing industry", *Supply Chain Management: An International Journal*, Vol. 11 No. 4, pp. 345-52.
- King, A. and Lenox, M. (2002), "Exploring the locus of profitable pollution reduction", *Management Science*, Vol. 48 No. 2, pp. 289-99.
- Klassen, R. (2000), "Exploring the linkage between investment in manufacturing and environmental technologies", *International Journal of Operations & Production Management*, Vol. 20 No. 2, pp. 127-47.
- Lee, H.L. (2004), "The triple-A supply chain", *Harvard Business Review*, Vol. 82 No. 10, pp. 102-13.
- Ministry of Environment & Forests (2006), *National Environment Policy*, Ministry of Environment & Forests, Govt of India, Centre for Environment Education, Ahmedabad, available at: www.envfor.nic.in/nep/nep2006e.pdf
- Ministry of Environment & Forests, Government of India (2007), "India: addressing energy security and climate change", available at: http://envfor.nic.in/divisions/ccd/Addressing_CC_09-10-07.pdf (accessed 4 February 2009).
- Nunnally, J.C. and Bernstein, I.H. (1994), *Psychometric Theory*, 3rd ed., McGraw-Hill, New York, NY.
- Rao, P. (2002), "Greening the supply chain: a new initiative in South East Asia", *International Journal of Operations & Production Management*, Vol. 22 No. 6, pp. 632-55.
- Ravi, V. and Shankar, R. (2005), "Analysis of interactions among the barriers of reverse logistics", *Technological Forecasting & Social Change*, Vol. 72, pp. 1011-29.
- Sahay, B.S. and Mohan, R. (2003), "Supply chain management practices in Indian industry", *International Journal of Physical Distribution & Logistics Management*, Vol. 33 No. 7, pp. 582-606.
- Sarkis, J. (2003), "A strategic decision framework for green supply chain management", *Journal of Cleaner Production*, Vol. 11, pp. 397-409.
- Singh, R.K., Garg, S.K. and Deshmukh, S.G. (2004), "Competitiveness of small and medium enterprises: case of an Indian auto component manufacturing organization", *IIMB Management Review*, Vol. 16 No. 4, pp. 94-102.
- Shukla, A.C., Deshmukh, S.G. and Kanda, A. (2009), "Green supply chain management: challenges in Indian context", paper presented at the National Conference on *Mapping for Excellence: Challenges Ahead*, Pioneer Institute of Professional Studies, Indore, 16 February.
- Srivastava, S.K. (2007), "Green supply-chain management: a state-of-the-art literature review", *International Journal of Management Reviews*, Vol. 9 No. 1, pp. 53-80.
- Tibben-Lembke, R.S. and Rogers, D.S. (2002), "Differences between forward and reverse logistics in a retail environment", *Supply Chain Management: An International Journal*, Vol. 7 No. 5, pp. 271-82.
- Vachon, S. and Klassen, R.D. (2006), "Extending green practices across the supply chain: the impact of upstream and downstream integration", *International Journal of Operations & Production Management*, Vol. 26 No. 7, pp. 795-821.
- Zubrzycki, J. (1997), "Pollution of rivers in India reaches a crisis", *The Christian Science Monitor-International*, available at: www.csmonitor.com/durable/1997/10/29/intl/intl.6.html (accessed 31 July 2009).
- Zue, Q., Sarkis, J. and Lai, K. (2007), "Green supply chain management: pressures, practices and performance within the Chinese automobile industry", *Journal of Cleaner Production*, Vol. 15, pp. 1041-52.

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