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Green supply chain management: practices, performance and pressure within manufacturing industry

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Abstract: In this paper we report on results from a cross-sectional survey with manufacturers in four major manufacturing industries, i.e., chemical/petroleum, electrical/electronic, automobile, and plastics to evaluate their perceived green supply chain management (GSCM) practices, performance, and pressure. Our findings provide insights into the capabilities of manufacturing organizations on the adoption of GSCM practices in different industrial contexts and that these practices are not considered equitably across the four industries. The results show that the chemical/petroleum, plastics enterprises have experienced high and increasing regulatory and market pressures and at the same time have strong internal drivers for GSCM practice adoption.

Keywords: GSCM practices, Performance, pressure

I. Introduction

The concept of green supply chain is new concept, appearing in recent literatures. Although this has been very important in business, it is introduced recently and now also literature for environment friendly supply chain is still limited. "Sustainable Development" is the key concept as discussed in 1992 Earth Summit in Rio, in this, governments and other international organizations decided to take useful measures to protect environment for long term economic development. Today's highlighted agenda is to raise environmentally responsible consumption and production to recover environmental quality, reduce poverty and bring about economic growth, with resultant improvements in health, working conditions, and sustainability.

Green supply chain management is the term that refers to the way in which organizational innovations and policies in supply chain management respond to the need for a more sustainable environment. GSCM aims to find ways to improve some of the impacts that a company has on the environment. As important as these changes may be for the environment, they are often accompanied by cost savings, improved efficiency, and/or profitable customer awareness. GSCM as integrating environment thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product after its useful life. GSCM concept has ranged from green purchasing to integrated supply chains starting from supplier, to manufacturer, to customer, and reverse logistics. This research aims to survey and analyze current green activities for adopting GSCM in Indian manufacturing industries.

II. GSCM Components

GSCM is defined as "green procurement +green manufacturing +green distribution +reverse logistics". The GSCM is made from these four components.

Green Procurement: Green procurement is defined as an environmental purchasing consisting of involvement in activities that include the reduction, reuse and recycling of materials in the process of purchasing. Besides green procurement is a solution for environmentally concerned and economically conservative business, and a concept of acquiring a selection of products and services that minimizes environmental impact (Salem, 2008).

Green Manufacturing: Green manufacturing is defined as production processes which use inputs with relatively low environmental impacts, which are highly efficient, and which generate little or no waste or pollution. Green manufacturing can lead to lower raw material costs, production efficiency gains, reduced environmental and occupational safety expenses, and improved corporate image.

Green Distribution: Green distribution is consists of green packaging and green logistics. Packaging characteristics such as size, shape, and materials have an impact on distribution because of their affect on the transport characteristics of the product.

Reverse Logistics: Reverse logistics deals with the activities of the various processes which are necessary for returning waste material and used goods to their producer respectively resulting into a complete economic cycle compared to the traditional flow economy.

III. An Overview of the Indian Manufacturing Industry

Indian manufacturing industry can be traced back in nineteenth Century, but rapid modernization and development began after independence in second five year plan. The Indian industrial sector underwent significant changes as a result of the economic reforms of 1991, which removed import restrictions, brought in foreign competition, led to privatization of certain public sector industries, liberalized the FDI regime, improved

infrastructure and led to an expansion in the production of fast moving consumer goods. India recorded the highest growth rates in the mid-2000s, and is one of the fastest-growing economies in the world.

Study report on the manufacturing industry has concluded that India has a working population of 75%. India is labor intensive and provides the requisite number of employment units in the country.

The Economy of India is the ninth largest in the world. The industrial sector accounts for around 27.6% of the India GDP and it employs over 17% of the total workforce in the country. In absolute terms, India is twelfth in the world in terms of nominal factory output. India is the seventeenth largest exporter and eleventh largest importer in the world. Economic growth rates are projected at around 7.5%-8% for the financial year 2011-2012 (http://en.wikipedia.org/wiki/Economy_of_India#Industry_and_services). The growth for 2010-11 is being estimated by CII at 8.5%. (<http://www.cii.in/Economy.aspx?enc=LqAXY5bXIb2PzUHQxy2iQ==>) and Indian economy grew by 7.4% in 2009-10. The Growth Rate of the Industrial Sector came to 9.8% in 2006- 2007, 7.6% in 2005- 2006 and the manufacturing sector contributed 9.0%, 7.4% in 2004- 2005, with 8.1% manufacturing sector contributing, 6.6% in 2003- 2004 and the manufacturing sector contributed 7.1% in India GDP, 5.2% in 2002- 2003 and the manufacturing sector contributed around 5.7%. This shows that industry growth rate in India GDP has been on the rise over the last few years.

Manufacturing sector is traditionally the strongest segment of the Indian economy, and is an important component which continues to experience steady growth, additionally; India's manufacturing sector ranks as the fourth largest in the world among emerging economies. Manufacturing industries are on the rise in India. While the service According to a recent report commissioned by the Confederation of Indian Industry, manufacturing exports could grow from \$48 billion (US dollars) in 2003 to \$300 billion by 2015, achieving a twenty five percent share of the Indian GDP. Exports of manufactured goods in India accounted for 75% in comparison to exports of manufactured goods all over the world.

IV. Environmental Sustainability of the Indian Manufacturing Industry

The Indian manufacturing industry's rapid growth relates to two major dimensions affecting environmental sustainability, environmental burden and resource shortage.

The much needed impetus to industrial development has resulted in huge residuals, having undesirable effects on the environment air, water and land, disproportional to their contribution to overall economic growth. For instance, the iron and steel industry contributes 55% of the particulate matter load while adding 16% to the total industrial output. The industrial BOD load from chemicals and food processing industries is as much as 86% against the industry's contribution of 25% to the total industrial output.

These unsustainable growth trends increase the vulnerability of the economically weaker sections to environmental degradation and pollution, on account of their direct dependence on natural resources like land, forests and various common property sources for fuel wood, fodder, and water. In the absence of alternatives, the imbalanced competition for natural resources could significantly contribute to weakening the support base of the poor further and perpetuating poverty and a poor quality of life. Hence for a developing country like India, the key to poverty elimination is the country's ability to regenerate its environment and assist its masses to retain control over their living conditions.

The increase in the number of vehicles contributes significantly to the total air pollution load in many urban areas. The number of motor vehicles in India has increased from 0.3 million in 1951 to 40.94 million in 1998 (MoST 2000). CO (Carbon monoxide) and HC (hydrocarbons) respectively account for 64% and 23% of the total emission load due to vehicles in all cities considered together (Shaheen Singhal, India-2025). Thus, air pollution has become a serious problem, especially in big cities. Water pollution, in the industrial sector is concentrated within a few subsectors mainly in the form of toxic wastes and organic pollutants. Of the total pollution load generated by industrial subsectors, 40%–45% is contributed by the processing of industrial chemicals. In terms of the total organic pollution, expressed as BOD, nearly 40% arises from the food industries followed by industrial chemicals and the pulp and paper industry. Such continuous or even accelerating growth in such manufacturing industries in India has added to concerns regarding further environmental degradation (Shaheen Singhal, India-2025).

V. GSCM Practices, Performance, and Pressure in Indian Manufacturing Industries

The Indian manufacturing industries have experienced increasing environmental pressure while simultaneously recognizing various benefits and incentives to green their supply chains (Zhu *et al.*, 2005; Zhu and Sarkis, 2006). Internal awareness is a key dimension for enterprises to implement environmental practices such as GSCM. Proactive companies usually have greater implementation of environmental practices beyond requirements of laws and regulations, while reactive companies only seek compliance with regulatory requirements.

In India, the diversity in the adoption rates has seen some manufacturing supply chain companies proactively implementing environmental strategies such as green purchasing and eco-design. Many enterprises considered or initiated some GSCM practices such as investment recovery, eco-design and internal environmental management. Zhu and Sarkis (2004) concluded that GSCM practice has a positive relationship with

environmental performance, positive economic performance, and negative economic performance. Positive economic performance is defined as benefits gained through GSCM while negative economic performance is defined as increased investment and costs. The Indian manufacturers meeting environmental pressure have implemented environmental practice to improve environmental and/or economic performance. All institutional pressures (normative, coercive, and mimetic) have the capacity to influence an organization's responsiveness to the adoption of GSCM initiatives.

a) GSCM Practices Implementation

GSCM has emerged as an effective management tool and philosophy for proactive and leading manufacturing organizations. The scope of GSCM practices implementation ranges from green purchasing (GP) to integrated life-cycle management supply chains flowing from supplier, through to manufacturer, customer, and closing the loop with reverse logistics. Similar to the concept of supply chain management, the boundary of GSCM is dependent on researcher goals and the problems at hand, e.g., should it be just the procurement stage or the full logistics channel that is to be investigated (Lai *et al.*, 2004).

Prescriptive models for measures of GSCM practices implementation with a focus on GP and GSCM have been developed. Handfield *et al.* (2002) developed a decision model to measure environmental practice of suppliers using a multi-attribute utility theory approach. Kainumaa and Tawarab (2006) proposed the multiple attribute utility theory method for assessing a supply chain including re-use and recycling throughout the life cycle of products and services. Using the tool of life-cycle assessment, Faruk *et al.* (2002) put forward aspects to measure GSCM practices implementation, that is, materials acquisition, preproduction, production, use, distribution, and disposal. Sarkis (2003) developed a strategic decision framework for GSCM practices implementation to evaluate alternatives adopted by companies that will affect their external relationships with suppliers and customers. Sheu *et al.* (2005) developed a linear multi-objective programming model that optimized the operations of both forward and reverse logistics in a given green supply chain. These models and frameworks included and defined a variety of characteristics, attributes, and scales for GSCM practices implementation, yet none attempted to rigorously validate these scales (Zhu *et al.*, 2008).

b) GSCM Performance Measurement

Bhagwat and Sharma (2007) described performance measurement as the feedback on operations which are geared towards customer satisfaction and strategic decisions as well as objectives. Thus, GSCM performance measurement involves quantifying the efficiency and effectiveness of all the activities and processes geared at achieving a GSCM. Performance measurement reflects the need for improvement in operational areas which are found wanting in their performance measures (Bhagwat and Sharma, 2007). Performance measurement helps decision makers to benchmark and compare alternative scenarios which might lead to the development of better products and processes including reverse logistics (Beamon, 1999). This assessment also serves as a provision of knowledge of an organization's products, which leads to a robust basis for price calculations and provides an avenue for a closer communication with customers, other interest groups and the society at large, thus significantly contributing to the maintenance or creation of a positive corporate image (Tsoufas and Pappis, 2008). Finally, performance measurement for a GSCM also ensures that information is made available which can aid in the fulfillment of limitations and obligations posed by regulations and certain environmental legislations. On the other hand, it will induce the overall achievement of sustainability in an organization's supply chain.

According to Shepherd and Gunter (2006) there have been numerous studies that have focused on performance measurement in supply chain management. They study went ahead to reveal that more than 40 studies have focused on performance measurement systems and metrics for supply chains. Most of these studies dealt with traditional supply chain performance measurement which involved the normal supply chain without consideration on the environment.

c) GSCM Pressures

The existence of competitive and regulatory pressures influence organization to implement green supply chain practices that eventually help in building positive organizational image especially when these pressures cause adoption of green purchasing and green services.

Institutional pressures persuade organizations to undertake similar strategic actions to increase their external legitimization (DiMaggio and Powell, 1983; Hoffman and Ventresca, 2002). Legitimate businesses are those whose actions are seen or presumed to be desirable or appropriate within some socially constructed system of norms, values, beliefs and definitions (Suchman, 1995). Applied to the decision to adopt a GSCM practices, the external pressures an organization endures to implement one practice may be similar in that they arise from regulators, markets and communities.

Regulatory pressures are often associated with an organization's decisions to utilize GSCM practices. It may encourage organizations to adopt proactive environmental practices in an effort to form collaborative relationships and explore more non-regulatory ways in which government can encourage greater environmental improvements (Andrews *et al.*, 2003). These less coercive forms of regulatory pressure are becoming

increasingly relevant as governments expand their programs that encourage GSCM practices. In adopting GSCM practices, organizations may be able to communicate more effectively to government that they are committed to improving their environmental performance.

VI. Evaluation of GSCM

Based on the literature survey the variables of GSCM practices, performances, pressures, and barriers are mentioned in the following questionnaire. In this survey the respondents were asked to indicate the significance of the listed variables on a five point Linkert scale. A total of 105 questionnaire were administered to Indian manufacturing industries, out of 105 questionnaire, 63 partially filled and 34 complete filled up questionnaire received.

Descriptive statistics, alpha coefficients and item-total correlations are used to initially analyze the survey data after application of a principal components factor analysis (see Table 6.1). All of the factors for GSCM drivers/pressures, practices, performance, and pressure have a reliability (alpha) value above 0.70, the threshold value recommended by Nunnally and Bernstein. All the factors of GSCM practice and performance have high item-total correlation values, i.e., >0.60, to their corresponding higher- level constructs. Although the four factors of GSCM drivers/ pressure have relatively low item-total correlations, their values were considered acceptable, i.e., >0.40, for an exploratory research study like this study. On the basis of the alpha coefficients and item-total correlations, we confirmed the three factors on GSCM pressures/drivers, i.e., market, regulation and competition. The five factors for GSCM practices, i.e., internal environmental management, green purchasing, customer cooperation with environmental concerns, investment recovery, and eco-design. We also classified company performance into three dimensions, namely, environmental, positive economic, negative economic.

Table 1: Descriptive statistics and Cronbach alpha values

Factors	Variables	No. of items	Inter total correlation	Cronbach's alpha	Mean	S.D
Practices	Internal environmental management	9	0.68	0.93	4.32	1.13
	Green purchasing	4	0.62	0.89	3.58	1.19
	Eco design	6	0.61	0.85	3.74	1.28
	Cooperation with customers	3	0.64	0.87	3.65	1.16
	Investment recovery	3	0.63	0.82	3.86	1.04
Performance	Environmental performance	7	0.72	0.91	4.36	0.77
	Economic performance	5	0.73	0.90	4.31	0.87
	Negative economic	4	0.64	0.80	3.68	1.24
Pressure	Market	1	0.51	0.8	4.12	0.69
	Regulatory	3	0.49	0.72	3.65	1.05
	Competition	2	0.45	0.76	3.69	1.28

VII. Conclusion

GSCM Practices: The survey shows that the Indian manufacturing industries carry out to some degree of GSCM practices adoption with mean value over 4.00 for five GSCM factors; especially for environmental management system exit with the highest mean value of 4.32. Besides GSCM practices adoption rate lagged, with the lowest mean value 3.12 is eco-labeling of product.

GSCM Performance: All GSCM performance dimensions are ranked higher to some degree to relatively significant, with mean values consistently within the 3.5 and 4.5 ranges. Both environmental and positive economics are in relatively significant.

GSCM Pressure: Indian manufacturing industries have experienced significant pressure and incentives to implement GSCM, with mean values over 4.00 for two driver factor. Pressure from environmental regulations is the highest with a mean value of 4.21 and export is the second important pressure driver.

Questionnaire Items

The questionnaire contained following three sections.

GSCM Practice Variables

The questions about current GSCM practice adoption were answered by using a five point Linkert scale (1-Not considering, 2-Planning to consider, 3-Considering it currently, 4-Initiating implementation, 5-Implementing successfully)

Internal environmental management

1. Commitment of GSCM from senior managers
2. Support for GSCM from mid-level managers
3. Cross-functional cooperation for environmental improvements

4. Total quality environmental management
5. Environmental compliance and auditing programs
6. ISO 14001 certification
7. Environmental Management Systems exist
8. Eco-labeling of products
9. Support of regulations environment

Green purchasing

1. Cooperation with suppliers for environmental objectives
2. Environmental audit for suppliers' inner management
3. Suppliers' ISO14000 certification
4. Second-tier supplier environmentally friendly practice evaluation

Eco-design

1. Design of products for reduced consumption of material/energy
2. Design of products for reuse, recycle, recovery of material, component parts
3. Design of products to avoid or reduce use of hazardous of products and/or their manufacturing process
4. Design of product for support regulation
5. Design of products to be easy set up for the users in the most energy saving way
6. Design usability of part particularly for Extend using products, repair easy and increase efficiency

Cooperation with customers

1. Cooperation with customer for eco-design
2. Cooperation with customers for cleaner production
3. Cooperation with customers for green packaging

Investment recovery

1. Investment recovery (sale) of excess inventories/materials
2. Sale of scrap and used materials
3. Sale of excess capital equipment.

GSCM Performance Variables

The questions about the influence of implementing GSCM performance factors were answered by using a five point Linkert scale.

(1- Not at all, 2- A little bit, 3- To some degree, 4- Relatively significant, 5- Significant).

Environmental performance

1. Reduction of air emission
2. Reduction of waste water
3. Reduction of solid wastes
4. Reduction of physical
5. Decrease of consumption for hazardous/harmful/toxic materials
6. Decrease of frequency for environmental accidents
7. Improvement of an enterprise's environmental situation)

Positive Economic

1. Decrease of cost for materials purchasing
2. Decrease of cost for energy consumption
3. Decrease of fee for waste treatment
4. Decrease of fee for waste discharge
5. Decrease of fine for environmental accidents

Negative economic

1. Increase of investment
2. Increase of operational cost
3. Increase of training cost
4. Increase of costs for purchasing environmentally friendly materials

GSCM Pressure Variables

The questions about GSCM pressure variable factors were answered by using a five point Linkert scale.

(1 - Not at all important, 2- Not important, 3- Not thinking about it, 4- Important, 5- Extremely important)

Market

1. Export

Regulatory

1. Central governmental environmental regulations
2. Regional environmental regulations
3. Export countries' environmental regulations

Competition

1. Competitors' green strategies
2. Industrial professional group activities

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