

Overview of Green Supply Chain Management: Operation and Environmental Impact at Different Stages of the Supply Chain

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Abstract: *This paper emphasizes upon the application of Supply Chain Management and adding the 'Green' component to it so as to stress upon the need of environment friendly systems. The growing importance of GSCM is driven mainly by the escalating deterioration of environment. The waste and emissions caused by the supply chain have become one of the main sources of serious environmental problems including global warming and acid rain. One of the key aspects to green supply chains is to improve both economic and environmental performance simultaneously throughout the chains by establishing long-term buyer-supplier relationships. Efforts have been made by the authors to study the supply chain of the systems with the focus on its optimization and implementation.*

Keywords: *Green supply chain management (GSCM), Environmentally Preferable, Environmental Impact, Reverse logistic, Eco-design (ECO), Investment Recovery (IR).*

I. INTRODUCTION

Supply chain management has traditionally been viewed as a process where in raw materials are converted into final products, and then delivered to the end-consumer. [4] This process involves extraction and exploitation of the natural resources (Srivastava, 2007). It is important to note however that we live in a decade where environmental sustainability has been an important issue to business practice. The waste and emissions caused by the supply chain have become one of the main sources of serious environmental problems including global warming and acid rain. Green supply chain policies are desirable since reactive regulatory, to proactive strategic and competitive advantages. Green supply chain management (GSCM) is gaining increasing interest among researchers and practitioners of operations and supply chain management. The growing importance of GSCM is driven mainly by the escalating deterioration of environment, e.g. diminishing raw material resources, overflowing waste sites and increasing level of pollution.

However, it is not just about being environment friendly; it is about good business sense and higher profit. The supply chain "system" includes Purchasing and In-bound Logistics (materials management), Production, Outbound Logistics (physical distribution & Marketing), and Reverse Logistics. [1] Greening supply chains aims to balance marketing performance with environmental issues. To meet with challenges such as energy conservation and pollution abatement, enterprises have tried to green their supply chains, that is, to create networks of suppliers to purchase environmentally superior products or to build common approaches to waste reduction and operational efficiencies. Greening the supply chain is increasingly a concern for many business enterprises and a challenge for logistics management in the 21st century. Of particular concern is how to arouse organizational environmental awareness and put environmental activities into practice in the logistics activities of their supply chains. This Paper investigates the correlation of two major factors, organizational learning and management support, with the extent of adoption of green supply chain management (GSCM) practices in Indian manufacturing firms, where their inbound and outbound logistics activities are potential polluters to the environment. Organizational and operational learning was derived from the firm's experience with programs such as total quality management and environmental management systems. Management support included support for GSCM ideas and practices from top and middle level management and cooperation across organizational functions. We find significant positive relationships between organizational learning mechanisms, organizational support and the adoption of GSCM practices, after controlling for a number of other influences including regulations, marketing, supplier, cost pressures, industry levels of the relevant practice and organizational size. Increasing pressures from a variety of directions have caused the supply chain managers to consider and initiate implementation of green supply chain management (GSCM) practices to improve both their economic and environmental performance. Sustainable development has made remarkable progress in establishing environmental and social sustainability towards operations management and the supply chain.

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II. ENVIRONMENTAL IMPACT AT EACH STAGE OF THE SUPPLY CHAIN

Environmental impacts should be considered cumulatively over the stages of the supply chain life cycle of a product or

service to avoid shifting adverse environmental effects from one stage of the life cycle to another (fig. 2.1). It involves considering the impacts of extraction of raw materials, distribution, operation and disposal.

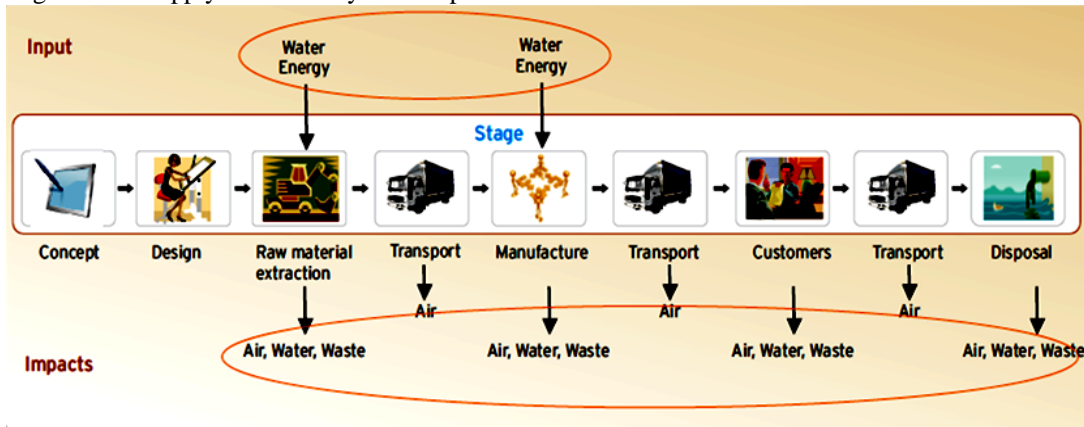


Figure 2.1 Environmental impact at each stage of the supply chain²¹

One of the key aspects to green supply chains is to improve both economic and environmental performance simultaneously throughout the chains by establishing long-term buyer-supplier relationships. Enterprises have developed a diverse set of initiatives for greening SCM, including screening suppliers for environmental performance, providing training to build supplier environmental management capacity, and developing reverse logistics systems to recover products and packaging for re-use and remanufacture. Green SCM can not only generate environmental benefits, but also business benefits.^[2]

Environmentally preferable characteristics include products and services that conserve energy and water, minimize generation of waste and releases of pollutants; products made from recycled materials and that can be reused or recycled; energy from renewable resources such as bio based fuels, solar and wind power; alternate fuel vehicles; and products using alternatives to hazardous or toxic chemicals, radioactive materials and bio hazardous agents.

However, in 1994, the US Office of Technology reported to the Congress that: “By considering pollution prevention separately from other manufacturing needs, such as productivity and quality improvements, most pollution prevention programs fail to develop the vital synergies and working relationships with manufacturers that are essential to drive both pollution prevention and manufacturing competitiveness.”^[3]

III. PROBLEM STATEMENT

The Indian Manufacturing and processing industry’s rapid growth relates to two major dimensions affecting environmental sustainability, environmental burden and resource shortage. The rapid and continuous growth of Indian Industry population has also brought great challenges to India energy resource security. The large transportation system in India is based on gasoline and diesel fuels, which would dramatically increase India’s dependence on oil imports. Indian manufacturing companies have experienced

increasing environmental pressure while simultaneously recognizing various benefits and incentives to green their supply chains. 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 manufacturing supply chain enterprises considered or initiated some GSCM practices such as investment recovery, eco-design and internal environmental management. However, investment recovery and development of recycled material markets in India have not received much attention. That is to say the maturation of the manufacturing product market is still progressing and has yet to create a critical mass to be economically worthwhile for development of a used parts market. However, a regulated manufacturing product take-back system has been in operation in India. These take-back system forces manufacturers to consider environmental effects in the whole life cycle, and thus providing motivation for organizations to further pursue GSCM practices and closing the manufacturing supply chain loop. Thus, GSCM practices have emerged as a systematic approach within the manufacturing industry in India to balance the economic and environmental sustainability of firms.

IV. IMPORTANT FACTORS THROUGH ENVIRONMENTAL IMPACT REDUCES AT STAGES OF THE SUPPLY CHAIN

A. GSCM practices



GSCM is designed to incorporate environmental considerations into decision making at each stage of an organization’s materials management and logistics functions through post-consumer disposal. [26, 27] Definitions vary. In some cases, GSCM has been defined as a simple green purchasing relationship between a buyer and vendor. In other cases more extensive concepts of ‘closed-loop’ supply chains are employed which consider GSCM to be an unending logistics cycle of materials and products use, reuse and management from both an inter- and intra-organizational perspective. [19]

B. External GSCM relationship factors (ER)

ER factors in GSCM can include both upstream and downstream factors external to the organization’s operational boundaries.

- 1) Upstream factors include such inbound logistics(materials management) activities as green purchasing and vendor management. [28,29] For example, items include providing suppliers with design specifications incorporating environmental requirements for purchased items, cooperation with suppliers for environmental objectives; environmental audits for supplier’s internal management and suppliers’ ISO 14001 certification. Investigating the determinants of ER factors in the US, Min and Galle found that organizational size (number of employees), regulatory pressures, source reduction policies and high environmental costs played a significant role in the adoption of green purchasing practices.
- 2) Downstream factors include green outbound logistics (physical distribution) with activities such as distribution and marketing components of a product or organization’s supply chain. Researchers have found supply chain customer–supplier relationships and collaboration around environmental issues to be significant in environmental practice adoption and performance in the Southeast Asia. [30] Environmental pressures from customers and downstream foreign enterprises are especially acute in India, leading Indian enterprises to self-regulate. For example, leading firms from developed countries evaluate not only their direct suppliers but also the suppliers of these suppliers. Also,

even though green purchasing behaviours of Indian consumers lag those of American consumers, younger Indian consumers are developing an increasingly heightened environmental awareness and prefer ‘green’ products. [19]

C. Eco-design (ECO)

Early eco-design work focused primarily on technical improvements to products and processes to mitigate environmental costs. Recognition that more substantial improvements are possible only when design factors outside of the direct control of producers, including relationships with suppliers, consumers, recyclers and governmental authorities, are included for eco-design to become an integral GSCM practice. [31, 32] The success of eco-design requires internal cross functional cooperation among intra-organizational units within a company as well as cooperation with outside partners throughout the supply chain. Studies in the US support this position especially for product-design based integration of suppliers into the green supply chain to meet the specific supply chain environmental design requirements. To further support eco-design’s integral linkage to GSCM practice, the U.S. Environmental Protection Agency’s program has green supply chains as a core aspect of their design for the environment programs. Chinese organizations are also subject to eco-design requirements in their role as supply chain partners, especially given the pressure for international regulatory compliance.

D. Investment Recovery (IR)

IR refers to an organization’s strategic use of reverse logistics recycling, redeployment, reselling and similar techniques to derive greater value from materials and products (Fig.4.1). IR seeks to turn surplus assets into revenue by selling idle assets, reducing storage space and deploying idle assets to other corporate locations to avoid purchasing additional equipment or materials. [33] Out-of-service equipment, excess inventory or raw materials, waste and process by-products and demolished facilities are included in these non-working assets.

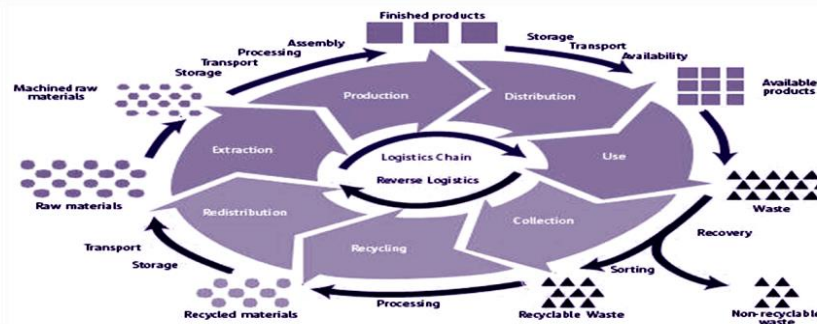


Fig.4.1 Reverse logistic process. [8]

IR can be legitimately viewed as both an economically and environmentally beneficial practice. Cottrill argues that at least 70% of every sales dollar generated by IR becomes part of profit, and this appears to be true in industries as diverse as computer assets, chemicals, forest products, power generators, and healthcare and consumer products. [34] IR

practices are central to a number of reverse logistics practices such as reclamation, remanufacturing, recycling and reuse.



However, pressures from the government have shifted focus from resource subsidies to levying taxes for some resources such as coal and natural gas, leading to a recent renewal of interest in IR practices. Having reviewed the three main GSCM practices that underlie our investigation, and having emphasized their importance in the Indian context, we turn now to organizational determinants of these practices.

E. Organizational learning as a determinant of GSCM practices.

Successful competitive strategies and outcomes (including those in the environmental area) depend on the development, effective deployment and maintenance of these resources and capabilities over time. Organizational learning systems can be viewed as an especially important capability within this resource-based framework since, especially when coupled with an organizational emphasis on continuous improvement, they can help organizations build from more basic 'complementary capabilities' such as those associated with ISO 9000 and TQM systems experience, for example, to more complex systems (especially in terms of higher-order learning proficiencies) such as TQEM, EMS, ISO 14001 and eventually GSCM practices.^[35,36] Organizational learning systems facilitate the intelligent and complementary deployment of a firm's existing resources and capabilities to affect a desired end. This deployment typically occurs through the development of new organizational routines and activities across functional departments via the development of coordination and skills as necessitated by the organization's unique structure, culture and product and process innovations already in place. GSCM practices are especially amenable to the benefits derived from learning because of their people-intensive nature and their dependence upon tacit skill development via employee involvement and coordination of team effort and shared expertise. Using socially complex and intangible knowledge-based processes, it taps the organization's embedded expertise and permits the creation of congruence across the organization's range of strategic, structural and cognitive systems, arguably at lower cost. Russo and Fouts suggest that organizational capabilities are closely tied to environmental performance, and that organizations possessing greater capabilities can more easily adopt proactive environmental management practices.^[37] Other research supports the role of organizational learning systems in particular promoting higher levels of environmental capabilities by drawing on expertise developed earlier in basic levels of environmental management by developing or acquiring the necessary socially complex or process-based resource.^[19] The fact that Indian organizations have quality management experiences that far exceed their environmental management experience may help to provide learning that helps promote successful environmental management practice and associated GSCM practice. Thus, the issue of organizational learning systems, and their potential on GSCM practice adoption, is quite salient at this time and will continue to be so for the foreseeable future.

F. Management support and commitment as a determinant of GSCM practices.

In general, management support is a critical element of adoption and implementation of innovations in an organization, especially environmental systems. Organizational innovations may remain stuck at the initial idea stage absent dedicated champions. Top management support can affect new system initiatives success by promoting employee empowerment, by facilitating employee involvement by promoting a cultural shift and increased commitment by the organization's employees, by instituting rewards and incentives systems to affect employee behaviour, by providing training and increasing communication across units and encouraging teams and teamwork in the organization.^[38] Top management support has been associated with the success of information technology diffusion within organizations, business process reengineering, virtual enterprise formation, environmental purchasing, ISO 14000 implementation, enterprise resource planning (ERP) and EMS. Cross-functional efforts like GSCM are likely to benefit too. Like most other major environmental efforts, GSCM is a broad-based pervasive organizational Endeavour with cross-functional programs. As such, it has the potential to benefit from top management support. It is not just top-level managers from whom support is needed; support from mid-level managers is also important to successful implementation of environmental practices. Support from middle-management levels is important because environmental management is related to almost all departments in an organization, and cross-departmental cooperation is important to successful practices. Strong communication between business managers and environmental professionals with management support is also necessary for effective management of both business and environmental issues.^[19]

V. GLOBALIZATION AND GREENING THE SUPPLY CHAIN

A. Companies

Companies (and any organization which conducts purchasing activities, including governments) should decide what are their real environmental goals regarding extra organizational environmental improvement. Even though an organization may have a policy to promote environmental sustainability, in practice environmental improvement is often focused on internal risk reduction. If companies really want to promote environmental sustainability through purchasing, they will need to recognize that simple strategies such as focusing on product ingredients is not likely to have a significant external effect. They will need to reinforce to suppliers that good environmental performance is integral to their business operation and that the level of performance will be considered in selecting suppliers.

Globalization means that suppliers will increasingly be located in other countries. Buyers will need to educate themselves about the environmental conditions, regulations and other factors in those countries. If the supplier is in a country with well-enforced environmental regulations, the buyer may have

some confidence that at least the supplier is not a serious polluter. But if the country's environmental regulations are lax or poorly enforced, the buyer should begin with the assumption that the supplier may be a serious polluter and potentially a risky source due to environmental concerns. In these situations buyers should ask suppliers to provide documentation regarding pollution discharges, controls in place, etc. When possible, suppliers should be visited to inspect their operations.

B. Governments

Governments are the largest buyers of products and services. Thus government purchasing policies focused on environmental performance can have more direct effect than any other type of environmental pressure. Governments may be constrained in the selection of suppliers by rules regarding low bid selection; nonetheless, suppliers can be questioned regarding their environmental performance. It is not clear if government policies can influence the purchasing behaviour of other organizations, or whether this is even desirable. However, government can act as a Green Purchasing advocate for improved buyer-supplier relationships and can document successes for promotion. We are constantly confronted with environmental changes across the world ranging from weather to a scarcity of water for nearly 2 billion people, nearly 40% of the world's population. Such weather phenomena and reality has created a movement across the globe to identify the causes of global warming and develop solutions to end it before it is too late. In an effort to address the growing evidence of climate change, many nations are passing laws and regulations aimed specifically at reducing carbon emissions and greenhouse gas from the atmosphere. Aside from nations that are actively involved in reducing climate change, many consumers, shareholders, and businesses are becoming more attuned to and involved in the growing green movement. With customer loyalty shifting towards environmentally friendly products, businesses are increasingly trying to make their supply chains greener by introducing sustainability strategies throughout their organizations and supplier relationships.^[21] 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. Facilities with environmental management systems (EMS) certified to ISO 14001 are 40% more likely to assess their suppliers' environmental performance and 50% more likely to require that their suppliers undertake specific environmental practices. Further, government programs that encourage voluntary EMS adoption indirectly promotes GSCM practices. These programs increase the probabilities that facilities will assess their suppliers' environmental performance and require suppliers to undertake specific environmental practices by 7% and 8%, respectively.

An increasing number of governments have started to promote voluntary actions by private corporations to achieve their environmental goals. The popularity of this approach stems from the fact that voluntary actions often are more acceptable to the private sector than prescriptive mandates or

economic instruments like pollution taxes and emissions trading. Partly because of governments' promotion, voluntary actions are becoming more common among industrial facilities. One of the more widely used voluntary actions involves an environmental management system (EMS). Industrial facilities that adopt EMS systematically develop an environmental policy, evaluate their internal processes that affect the environment, create objectives and targets, monitor progress, and undergo management review. In particular, ISO 14001, the EMS standard designed by the International Organization for Standardization (ISO), has received growing attention.^[22] Green supply chain management has emerged as an important organizational philosophy to reduce environmental risks. The various drivers of green supply chain management (GSCM) are identified based on the GSM literature and on consultations with experts in the industry.

VI. CONCLUSION

The present system of functioning of the industries /services is deteriorating the environment and soon a day will come when the damages done to our Earth will become irrevocable. Thus, it can be concluded that GSCM is inevitable if the Earth is to be kept green and appropriate methodology may be adopted by the industries/services to minimise the detrimental effect on the environment. The study done has provided ample reasons for GSCM to be adopted as one of the important measures towards conservation of environment.

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