

Technological Aspect of Green Supply Chain Management in The Global World

Abstract

Slowly and gradually technology has entered into every aspect of human life. Thus environment friendliness and sustainability have been the talk of the town and have become a major part of any business so there is a growing need for integrating robust environment conscious practices in to supply chain management research and this newly found consciousness towards the environment gave birth to Green Supply Chain Management. Green supply chain management broadly includes inbound logistics, production, outbound logistics, marketing and reverse logistics. As the research in this area has increased, there have been multiple literature reviews in this field focusing on performance measurement, supplier/vendor evaluation, analytical modeling efforts, etc. This paper researches already existing papers and aims to find out what is the definition of a green supply chain, focuses on what does a modern green supply chain management constitutes, how this concept of green supply chain management been developed over time what the past was, what the present is and what could be the future.

Keywords: Green Supply Chain Management, Supply Chain Management, Technology Management, Culture Management

Introduction

Earlier companies were focusing on the mass production of products and customers used to wait for months or years for the consumption of the desired product. The supply chain management critically takes much of the dedicated available scarce resources. So earlier supply chain directly or indirectly hampers the society or the environment in many ways. Thus, realizing that sustainability can drive the improvement of the company's bottom line through cost savings, improved market share, and stronger brand images, a growing number of firms have begun to take "greening" (environmental-friendly) initiatives as their strategic weapons. Following this industry trend, the interest of academia on sustainability has also begun to increase substantially in the late 1990s. This growing interest sparked a series of new lines of research dealing with various supply chain activities that have important environmental implications.

These activities include sourcing that involves acquiring, storing, handling, and recovering virgin or recycled materials. In sourcing, for example, the failure to reduce the obsolescence and waste of maintenance, repair, and operating (MRO) supplies or scrap materials can contribute to environmental problems. In manufacturing, for example, the irresponsible disposal of defective products or unwanted manufacturing by-products can adversely impact the environment. Likewise, logistics reliance on transportation modes such as trucks and airplanes using fossil burning fuels and the subsequent emission of CO₂ can pollute the living environment such as air, water, and ground.

Earlier works and reviews have a limited focus and narrow perspective. They do not cover adequately all the aspects and facets of GSCM. For example, Bey (2001) presents a critical appraisal of developments in the field of industrial ecology only, while Zhang et al. (1997) focus only on green design. Much of the work is empirical and does not focus adequately on modelling and network design related issues and practices. Our objective is to present a comprehensive integrated view of the published literature on all the aspects and facets of GSCM, taking a 'reverse logistics angle' so as to facilitate further study, practice and research.

Review of Literature

Literature review may be considered as the primary method of synthesizing previous research on GSCM. Structured literature review



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considers the GSCM research that can be applied both in qualitative and a quantitative way.

The structured review represents an effective tool for analyzing a sample of research document in a systematic and rule-governed way. Over the past 3 years, the authors had several opportunities to collect and study the literature concerning to GSCM. There were two main reasons:-

1. Interactions with the organizations with focus on GSCM and
2. One of the authors is pursuing doctoral in the field GSCM implementation.

The review paper "An Overview on Green Supply Chain Management in India" by Nimavat Dheeraj and Namdev Vishal shows that with the adoption of green practices there will be many benefits to an organization and allow them to have a competitive advantage. It also shows that Environmental Performance Index of India is very poor due to lack of awareness of Green Supply Chain Management so there is scope for working in this direction as well.

In the article "Greening the Supply Chain Through Supply Chain Initiatives Towards Environmental Sustainability" Tareq et al. attempted to show the path and the various steps to be taken by the various business firms to make sustained environmental development. The paper investigated the adoption of green supply chain initiatives and the data was extracted from ISO 14001 certified firms through survey in Malaysia.

The study by Dixit Garg, S. Luthra and A.Haleem in the article "Ranking of Performance Measures of GSCM towards Sustainability: Using Analytical Hierarchy Process" demonstrates the various performance measures useful for any organization. The five perspectives (Environment, Social, Economic, Operational & Cost) and nineteen performance measures were identified and ranked towards sustainability framework using Analytical Hierarchy Process. This paper made a benchmarking framework to take the difficult decisions related to GSCM for any firm to experience increase in benefits.

The authors Noor Aslinda Abu Seman, Norhayati Zakuan, Ahmad Jusoh and MohdShokiMdArif in the paper "*Green Supply Chain Management: A Review And Research Direction*" have briefly reviewed the various literatures and has given a research direction framework for this emerging concept. The author has put emphasis on development of GSCM in developed and developing countries. The study also tells that there is scope for working towards the adoption and implementation of green supply chain management in Malaysia's manufacturing industries.

The paper "Overview of Green Supply Chain Management: Operation and Environmental Impact at different stages of supply chain" by Rajesh Kumar and Rituraj Chandrakar focuses on the need for eco-friendly systems so as to reduce the deterioration of environment.

The author writes by establishing long term relationships between buyer and supplier both environmental and economic performance can be

improved. The author also attempts to study the optimization and implementation of the supply chain system. The paper also gives the importance about why GSCM is an important measure for the conserving the energy.

The article "Designing the green supply chain strategy for Indian Manufacturing firm" by Surajit Bag offers the Indian manufacturers an opportunity to appreciate the green perspectives of supply chain which can help to implement green supply chain strategy to have maximum benefits.

The paper focuses on how to integrate the supply chain strategy with the traditional supply chain. The author has done thorough literature review, examined small, medium and large organizations who are implementing the GSCM in their practices and provided a six step strategic approach for the implementation of green supply chain management. It also tells that the companies can have a sustained competitive advantage if they involve suppliers and third parties.

Research Methodology

Despite the relative youth of GSCM research, its body of literature is abundant. Given this rich GSCM literature, it is important for us to examine, evaluate, and integrate prior studies related to the topic of GSCM. Without the effort to synthesize prior GSCM research, we may end up duplicating what has already been studied, fail to develop a new theory built upon the previous efforts of others, and experience difficulty in identifying emerging research agenda that were often overlooked in the past.

This effort began with the retrieval of past research works on GSCM through the on-line literature search, a summary of research outcomes, critiques of prior research works, identification of key research themes and popular research streams, and integration of past research efforts.

To elaborate, we first defined GSCM in the broadest possible sense so that we could conduct thorough literature searches and determine how GSCM literature was evolved from the theoretical underpinnings of other related social science, economics, business, and engineering fields.

To avoid confusion created by a lack of consensus on GSCM terminology and the introduction of rivaling concepts such as sustainable supply chain management (SSCM) propagated by some circles of the academia, we would like to define GSCM as an incorporation of environment-friendly initiatives into every aspect of supply chain activities encompassing sourcing, product design and development, manufacturing, transportation, packaging, storage, retrieval, disposal, and post-sales services including end-of-product life management.

Green Operations

Some of the key challenges of GSCM such as integrating remanufacturing with internal operations (Ferrer and Whybark 2001), understanding the effects of competition among remanufacturers (Majumder and Groenevelt 2001), integrating product design, product take-back and supply chain incentives (Guide and van Wassenhove 2001, 2002), integrating remanufacturing and RL with supply chain design

(Chouinard et al. 2005; Fleischmann et al. 2001; Goggin and Browne 2000; Savaskan et al. 2004) are posed in this area.

Green manufacturing and remanufacturing. This is a very important area within green operations. The techniques for minimum energy and resource consumption for flow systems in order to reduce the use of virgin materials are based on three fields of study: pinch analysis (Linnhoff 1993), industrial energy (Boustead 1979) and energy and lifecycle analysis (Lee et al. 1995).

Recycling, mainly driven by economic and regulatory factors, is performed to retrieve the material content of used and non-functioning products. Logistics represent up to 95% of total costs (Stock 1998) in recycling. Economically driven recycling finds its application in automobiles (Bellmann and Khare 1999) and the consumer electronics industry (de Fazio et al. 1997; Johnson 1998). Regulatory electronics recycling is also practised (Krikke et al. 1999a,b; Nagel and Meyer 1999; Pohlen and Farris 1992).

Measurement of Green Supply Chain Management

Many firms are adopting GSCM policy due to pressure from public, government, competition, and numerous benefits such as cost reduction supplier integration environmental innovation (Rao 2002). Large firms are not only adopting GSCM but also putting pressure over their suppliers (small firms) to go green (Zhu et al. 2005). To improve environmental image and gain economic profit, GSCM has become emerging environment practice for manufacturer (Zhu et al. 2007). Seeing the importance, it has become obvious to measure the degree of GSCM practice and its contribution to the firm's performance (Zhu et al. 2007).

The relationship between environmental and economic performance is positive and significant (Zhu and Sarkis 2004), however direct impact of GSCM on economic performance probably takes longer time to realize (Bowen et al. 2001). Firms may have to bear short term economic losses when going for improving their environmental performance but in long term, there is possibility of environmental practices due to competitive pressure and other factors which can lead to fetch positive economic performance (Zhu and Sarkis 2007).

Green Purchasing

Green Purchasing means procurement of raw/finished products and services that have less effect on human health and the environmental condition which when compared with same competing products and services they fulfil the same purpose.

This comparison may include raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, and disposal of the product or service. Green purchasing is also defined as environmentally preferred purchasing (EPP), environmentally responsible purchasing, green procurement, affirmative procurement, eco-procurement, and environmentally responsible purchasing.

A green product is one which satisfies and fulfil consumers' desire without damaging the

environment and contributes towards a more sustainable world. Green purchasing allow a firm/industry to offset financial and environmental risk. Customer demand and pressure for suppliers to go green can facilitate environmental purchasing activities such as evaluating environmentally friendly products and packaging, reducing packaging material, and performing product environmental design.

Alternatively, firms/industries now want to involve their suppliers at the basic design stage or to develop a network to pre-qualify suppliers that have responsible environmental management system. Continuous assessments and benchmarking can uplift an organization with their existing process. Green purchasing do bring important benefits as well as advantages for its practitioners.

Green Manufacturing

Green manufacturing is a new tool that can be viewed as a products environmental friend. Green Manufacturing means increasing production efficiency, lowering raw material costs, basic designing, manufacturing, delivering, and disposing products that produce minimum negative effect on environment ie reducing environmental safety expenses in society which are economically viable.

Green manufacturing can be termed as an economically-driven, plant-wide and integrated approach to reduce and eliminate all waste associated with the product i.e. design phase, manufacture, use and/or disposal of products and materials.

The drivers and barriers of green manufacturing practices in India as seen in Small scale industries differ from those large enterprises due to the fact that small scale industries lack the raw data, resources, technical expertise and experience required to implement green manufacturing initiatives. Studies on green manufacturing topic are very few till date.

The implementation of Green Manufacturing in Indian industries is possible only with the collaborated efforts of government and industry in a strategic way by mitigating the Green Manufacturing barriers. In today's scenario the problem of e-waste is the major issue, green technology is the only solution to this as it is the application of one or more of environmental science, green chemistry, environmental monitoring and electronic devices to monitor, model and conserve the environment.

The main goal of Green Manufacturing is sustainability. However, there has been few studies which focus the issue of Green Supply Chain Management performance evaluation. The process of Green Manufacturing involves investing in production process improvements rather than control technology, substitute renewable sources for finite ones, employee recycling and the companies must decide whether to make or buy the product.

Burk and Goughran (2007) also presented another framework for sustainability to realize green manufacturing. The framework on their study was based on SME manufacturers who achieved ISO 14001 certification. Green manufacturing (GM) is defined in most generic manner as "manufacturing

practices that do not harm the environment during any of its journey phases" (Srivastava,2007). It involves green design of products, use of environmental friendly raw materials, eco-friendly packing, distribution, and reuse after end of life of product.

It slows the depletion of natural resources and lowers the trash (Foster,2001). GM concepts originated in Germany, but its scope, nature of activities and focus kept changing with respect to time. GM is not restricted to manufacturing alone. One can notice, it has been continuously evolving and has been demanding comprehensive treatments.

Lean Manufacturing

Lean manufacturing, often pronounced as Toyota production system (TPS) in many academic literature, ea started in Toyota Motor Manufacturing Company after the Second World War when many Japanese firms including Toyota were facing with the new challenge of managing production system with limited resources (Liker, 1998; Pavnaskar et al., 2003). Firms that have successfully reduced their internal waste through lean production methods also implement practices for better environmental management.

Lean manufacturing is a conceptual work identified in many industrial organizational. Accordingly, the goal of lean manufacturing is to minimize the waste in human effort, inventory maintained, product availability timely to market and manufacturing space to become highly responsive to customer demand while producing quality products in the most efficient and economical manner. Lean manufacturing is a concept which mainly aims at sounder, more productive as well as more effective manufacturing by eliminating all elements of waste in the manufacturing process.

Lean manufacturing can be best defined as eliminating waste in a production process (Womak & Jones, 1996). Anything whether process or product which may be tangible and intangible that does not add value to the final product is called waste (Henderson & Larco, 2003). Basically lean manufacturing aims to perform production with zero defects, to reduce costs, so that firm meet customer requests with amount desired, to hold no excess inventories, and to continually make improvements by eliminating waste product.

Elimination of the waste elements is one of the most important elements to obtain the maximum outputs with minimum inputs in all processes in production during the lean manufacturing process. Lean Manufacturing aims at delivering sustainable competitive advantage to organizations as a change and improvement strategy it has not been successfully implemented in manufacturing industries at large.

Green Marketing

The concept of green marketing has now become important in the last few decades due to dramatic increase in environmental awareness worldwide. Green marketing practices as such till date has not received much attention what they deserve, there are several studies on green marketing that indicates both the importance of examining

actions/doings and the social complexity involved in accomplishing green marketing.

Though green marketing is a more fluctuating issue in the western countries, the emerging economies in Asian countries is not left too far behind. A good green consumer can be defined as one who avoids any such product which may harm or damage to any living organism, cause deterioration on the environment during process of manufacturing or during process of usage, and consume a large amount of non-renewable energy.

Green products can be used for a number of reasons, including being manufactured through a green way or products when used make for a greener way of life (Mohanasundaram, 2012). The dramatic growth of new green industries indicated the positive attention by the consumers. There are many evidences that various types of companies are now switching to adopt green philosophies such as traditional manufacturing companies become more profitable after transforming to green manufacturing system.

Reverse Logistics and Network Design

Reverse logistics activities differ from those of traditional logistics (Carter and Ellram 1998). Reverse logistics networks have some generic characteristics related to the coordination requirement of two markets, supply uncertainty, returns disposition decisions, postponement and speculation (Blumberg 1999; Fleischmann et al. 2000; Hess and Meyhew 1997; Jahre 1995; Krikke et al. 1999a, 1999b; Lambert and Stock 1993; Yalabik et al. 2005). As a result, they affect network design to a considerable extent.

Collection is the first stage in the recovery process in which product types are selected and products are located, collected and transported to facilities for remanufacturing. Used products originate from multiple sources and are brought to the product recovery facility in a converging process (Krikke et al. 1998). Inspection/sorting illustrates the need for skill in the sorting of used products (Ferrer and Whybark 2000).

This may be carried out either at the point/time of collection itself or afterwards (at collection points or at remanufacturing facilities). Cairncross (1992) suggests that collection schemes can be classified according to whether materials are separated by the consumer (i.e. separation at source) or centralized (i.e. mixed waste processed).

The need for environmentally responsible logistics systems is highlighted by Wu and Dunn (1995). The importance of RL programmes and the process of their development and implementation have also been described in the literature (Poist 2000; Stock et al. 2002). Redesigning logistics networks to accommodate product returns and remanufacturing and re-use of such parts and components can often be profitable and is assuming greater importance in business as well as in research (Tibben- Lembke 2002).

The physical location of facilities and transportation links need to be chosen to convey used

products from their former users to a producer and to future markets again (Fleischmann et al. 2001).

Waste Management

Caruso et al. (1993) model a solid waste management system (including collection, transportation, incineration, composting, recycling and disposal) using a multi objective location-allocation model supported by planning heuristics.

A decision support system, for urban waste management in a regional area, for evaluating general policies for collection and for identifying areas suitable for locating waste treatment and disposal plants is presented by Haastrup et al. (1998). Giannikos (1998) uses a multi-objective model for locating disposal or treatment facilities and transporting waste along the links of a transportation network. Bloemhof-Ruwaard et al. (1996a,b), Richter (1996) and Richter and Dobos (1999) use other mathematical modelling techniques for waste management. Mourao and Amado (2005) describe a heuristics for a refuse collection application.

Green: Life Cycle of A Product

The basic processes involved in the life cycle of a product are procurement of raw materials, manufacturing, transportation, utilization, end of life management and then again procurement and the cycle continues.

The first step towards sustainability can only be taken if the picture is clear in our mind that even if our focus is to maximize profits but it should not be at the cost of the nature. In all of the above mentioned phases, the main focus is on carbon off setting. The step towards environment will not only help us reducing GHG emissions and global warming but also have a competitive advantage.

One also maintains the eco-friendly perspective, by focusing on End of Life management i.e. recycle, reuse, recover. By making use of 3R concept, one is not only able to reduce GHG emissions but also helping in the conservation of precious natural resources also at the same time reducing investment and pollution. After the end of life management, the process again comes to first phase and the cycle continues.

Green Supply Chain and Value Delivery

The Value chain helps in adding the value to the existing product. The value chain consists of two sections, viz. Primary activities and Support activities. Primary activities are directly associated with the creation, maintenance, sales, service, etc. However, the Support activities are just to give support to the primary activities.

The Primary activities consist of Inbound logistics, Operations, Outbound logistics, Marketing & sales and the service. The inbound logistics has relation with distribution and storage of goods internally. Increased cube utilization reduces the wastage of empty trailer space and reduced in house traffic movements.

The Operations help in creating the value as they convert the inputs into outputs. Fuel efficient machinery, solar systems, reverse logistics, collecting material for reuse, returnable and reusable packaging help in improved fuel efficiency, waste management

and reduced solid waste. Design for environment and carbon offsetting reduces the toxic emissions at plant. Outbound logistics is concerned with the distribution and storage externally for the delivery of the product.

Research Findings and Trends

1. With an exception of Journal of Cleaner Production, the main stream business journals (e.g., operations management and supply chain management) still play a prominent role as a viable forum or as a popular publication outlet for the GSCM research activities despite the emergence of specialty journals exclusively dedicated to environmental issues.
2. The research activities dealing with sustainable transportation and warehousing, the life cycle assessment of logistics activities from the environmental perspective, and environmentally conscious sourcing (purchasing) are scant relative to those studies focusing on manufacturing (e.g., green production/design, remanufacturing) and reverse logistics.
3. As such, more future research efforts should be directed toward the impact analyses of transportation (e.g., alternative fuel) and warehousing activities (e.g., recycling of pallets and packages) as well as sourcing practices (e.g., supplier selection and competitive bidding), which encouraged many tiers of suppliers to comply with environmental regulations and rules.
4. Despite the increased government involvement in environmental protection and pollution control in the recent past, the GSCM studies that focus on policy issues are declining as evidenced by its dwindling number of publications for the last 3 years (from a peak of 16 papers in 2008 to 8 papers in 2010, resulting in 50% drop for a 3 year span).
5. The presence of the large percentage (27.94% of total GSCM publications) of policy and synthesis papers that intersects the number of different disciplines suggests that GSCM research is interdisciplinary by nature. However, the analysis of the past literature reveals that the use of research tools that reflect its interdisciplinary nature are still lacking. As such, there is a growing need for the use of hybrid research methodologies (e.g., a mixture of both case study and analytic methods) that combine the merits of different research tools and address interdependent environmental issues encompassing the entire spectrum (from the upstream to downstream) of supply chain issues.
6. It is apparent that the case study method is still the popular research methodology for GSCM due in part to the increased difficulty in collecting empirical or secondary data. There is no doubt that this pattern will continue in the future given the increased recognition of this type of a research method as the legitimate research tool given the practical importance of environmental initiatives and the company's interest in best-in-class environmental practices.

However, in the GSCM research field, it should be noted that a relatively large number of

GSCM case studies were concentrated in the reverse logistics, purchasing, and manufacturing areas. These studies do not necessarily meet the rigor or orthodox norm of case research methods needed in the supply chain field in the sense that most existing case studies in those areas (especially manufacturing area) did not go beyond the summaries of anecdotal stories heard from practitioners.

Conclusion

The world population has grown almost exponentially over the last century. As of 2011, it reached the seven billion mark, representing more than 430% jump from an estimate of 1.6 billion people at the beginning of twentieth century. As the world population continues to grow tremendously, resources in our planet earth are further strained. Without finding systematic ways to sustain our resources and surrounding environments, the quality of our lives will deteriorate rapidly and may reach the point of no return.

One of such ways includes the environment-friendly management of supply chain activities from the beginning to the end, which is dubbed GSCM. For the last 15 years, we have seen a wealth of articles addressing GSCM-related issues. In an effort to gain valuable insights into the evolution of GSCM research and grow this line of research further, this paper describes the past development and current state of GSCM research, synthesizes the focused areas of GSCM research, captures the emerging perspectives of GSCM research, and points the directions for future research opportunities.

As the GSCM research is beginning to mature as a subfield of mainstream supply chain studies, we should not lose sight of major drivers of GSCM: the incorporation of eco-efficiency into value chains, links among sourcing, making, and delivering activities, and externalities influencing those activities.

GSCM can reduce the ecological impact of industrial activity without sacrificing quality, cost, reliability, performance or energy utilization efficiency. It involves a paradigm shift, going from end-of-pipe control to meet environmental regulations to the situation of not only minimizing ecological damage,

but also leading to overall economic profit. The area throws various challenges to practitioners, academicians and researchers.

A state-of-the-art literature is presented here and review of GSCM integrating the whole gamut of activities in the area. The literature review highlights the ongoing integration process in GSCM. We find that the depth of research in various categories has been different. Many specific empirical studies have been carried out, and categories such as remanufacturing have been studied to a great depth. Even, within remanufacturing disassembly has been studied to a very detailed level. Of late, other categories such as RL have started getting more attention. We focus more on relatively unexplored categories, as they offer potential for further exploration and research.

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