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AERONAUTICAL AND MECHANICAL ENGINEERING**GREEN SUPPLY CHAIN MANAGEMENT- A REVIEW****Rajesh Kumar¹, Dr.Shiena Shekhar²**

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Abstract

With the development of society and the gradual improvement of economic construction in the world, environmental situation is becoming severe. The theory and practice of green supply chain management in relation to sustainable development are paid more attention to by many enterprises and researchers. In recent years, climate changes such as global warming have been a topic that has attracted a lot of interest world over. Such changes have necessitated the need to identify the causes and solutions to these climatic changes. In an effort to mitigate these changes, legislations and environmental requirements have been put forward by governments and environmental agencies. The demand for environmentally friendly products has increased over the years and so is the shifting of loyalty of consumers .Also, the ever increasing costs of energy and inputs has forced business to find new ways to reduce energy use in order to reduce costs.

Keywords: environment; consumers; economic construction; Green Supply Chain Management (GSCM); global warming.

1. INTRODUCTION

Green supply chain management is involved in the following three problems: supply chain management problem, environmental protection problem, resources optimization problem. Green supply chain management is the crossover and integration of the three parts. However, traditional supply chain management rarely deals with environmental protection and resource conservation. Traditionally, the only goal for the enterprise is to pursue the maximal economic benefits. In order to pursue its own interests, the enterprise will not undertake the corresponding responsibility at the expense green supply chain management increases the information of environmental impact and the transmission of resources protection, and combines the information, logistics and energy flow of supply chain management and systematically integrates and optimizes them.

2. Traditional Supply Chain Management

The function goal of traditional supply chain management only contains four ones of T (time), Q (quality) and C (cost), S (services), while the function goal of green supply chain management contains 6 factors ones of T

(time), Q (quality) and C (cost), S (services), E (environment) and R (resources). The traditional supply chain management is just a one-way process from suppliers to consumers

3. The Philosophy of Green Supply Chain

The green supply chain management (GSCM) is a powerful way to differentiate a company from its competitors and it can greatly influence the plan success. With increased awareness to corporate responsibility and the requirement to meet the terms with environmental policy, green supply chain management (GSCM) is becoming increasingly important for Indian manufacturers. Companies that have adopted GSCM practices with a focus on distribution activities have successfully improved their business and environmental performance on many levels. Green supply chain management experiences the whole closed cycle of design, procurement, production, package, sales, use and recycling. It covers each process of the product life cycle. Researchers categorize it into strategic, inter-organization, internal service quality, addressing the challenge of selecting green suppliers and purchasing perspective in order to improve firm's competitiveness. GSCM can be defined as the direct involvement of firms with its suppliers and customers in planning jointly for solutions to reduce the environmental impact from production processes and products, for environmental management and exchange of technical information with a mutual willingness to learn about each other's operations plan, and for setting goals for environmental improvement.

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 .

The trend towards developing Green Supply Chain (GSC) is increasing owing not only to the innumerable environmental damage caused by the supply chain processes and the pressure from the various regulations and laws brought forward by the government, but also the commercial gains and competitiveness achieved by taking up Green Supply Chain Management (GSCM).

Organizations have been concentrating on improving supply chain (SC) visibility and refining efficiency and effectiveness, however in the recent years, environmental management in the SC has been receiving increasing attention among researchers and practitioners. Various human activities are causing raw materials to diminish, waste sites to overflow and pollution levels to increase drastically. The SC processes are considered to be such related activities. They degrade the environment and take away earth's capability to compensate and recover (Beamon, 1999). To reduce resource depletion and waste generation a number of steps need to be taken towards being environmental friendly. But organizations have to note that it is not just about protecting the environment, it is also about good business and increasing profits (Srivastava, 2007).

There has been widespread concern over GSCM, especially due to environmental and consumer interest groups (Fiksel, 1996; Beamon, 1999). Organizations are facing competitive and community pressures along with environmental legislations and regulations enforced by the government. As a fact, they are being forced to balance both economic and environmental performance (Shultz and Holbrook, 1999; Zhu et al., 2004). In practice, the GSCM helps to keep this balance. However, it should make sure that profits are achieved, environmental risks and impacts are lowered and ecological efficiency is raised in business (Van Hock and Erasmus, 2000; Zhu et al., 2004). Several organizations have proved that there is a link between improved environmental performance and financial gains. The companies like IBM, HP and Xerox have already undertaken a number of measures by integrating corresponding suppliers, distributors, and reclamation facilities in order to green their SCs (Ashley, 1993; Bergstrom, 1993; Maxie, 1994; Sheu et al., 2005). Leading electronic industry companies like Dell, HP, Motorola, Sony, Panasonic, NEC, Fujitsu and Toshiba have adopted GSCM as a business strategy (Zhu and Sarkis, 2005; Sheu et al., 2005). Some of these organizations are also enhancing their competitiveness through improvements in their environmental performance (Bacallan, 2000). It can in general be noted that organizations are finding cost saving by reducing the environmental

impact of their business processes by re-evaluating their entire SC from green perspectives. In the literature revisited the definition and scope of sustainability in the SC is a large. It covers the concept of green purchasing (Zhu and Geng, 2001; Srivastava, 2007), green design (Chen, 2001), production planning, control for remanufacturing and product recovery (Guide and Wassenhove, 2001; Guide et al., 2003), reverse logistics (Carter and Ellram, 1998; Fleischmann et al., 2001; Zhu and Sarkis, 2004), closed loop SC (Guide and Wassenhove, 2006a; 2006b), design of the green logistics network (Jayaraman et al., 2003) and sustainability integration along the SC (Srivastava, 2007). It is very clear that the scope of the GSCM has been expanding. It moves from reactive environmental management programs to more proactive practices (Srivastava, 2007).

The SC is all those activities associated with the transformation and flow of goods and services from the sources of materials to the end users (Bowersox and Closs, 1996). Adding the “green” component to SCM integrates environmental management with SCM that addresses the influence and relationships of SCM to the natural environment (Hervani and Helms, 2005; Srivastava, 2007). It is therefore not surprising that GSCM finds its definition in SCM.

Many authors have defined GSCM in various ways keeping a different perspective in front. Green et al. (1996) addressed GSCM as the way in which innovations in SCM and industrial purchasing may be considered in the context of the environment. Narasimhan and Carter (1998) stated that environmental SCM consists of the purchasing function’s involvement in the activities that include reduction, recycling, reuse and the substitution of materials. Godfrey (1998) explained GSCM as the practice of monitoring and improving environmental performance in the SC. Srivastava (2007) integrated an environmental thinking into SCM, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product. Seurind and Muller (2008) defined GSCM as a clear strategic and integrated thinking to achieve economic, social and environmental objectives of business.

4. Circular Economy

It is generally acknowledged that circular economy refers to the generic terms for the reducing, reusing and recycling activities in such process as production, circulation and consumption. Circular economy is essentially an ecological economy, which requires human economic activities in line with 3R principle, namely Reduce, Reuse and Recycle. Reduce means reducing the amount of substance in the process of production and consumption; Reuse is involved in extending the time intensity of product and service; Recycle focuses on the regeneration of renewable resources after use. Circular economy changes the traditional one-way linear economic model of “resource – product - waste” into feedback circular economy mode of “resource – product – waste – renewable resource”, which conforms to the concept of sustainable development, utilizes resource and protects environment more effectively so as to gain maximal economic and social benefits with minimal resource consumption and environment cost. It is circular economy that further strengthens the consciousness of resource conservation and environmental protection, thus promoting the implementation of the strategy of green supply chain management to a certain extent.

5. Contents of Green Supply Chain Management

Green supply chain management with rich contents is involved in each link of enterprise’s supply chain.

Strategy

Green supply chain management focuses on and relies on strategic management. Environmental consciousness is integrated into the whole supply chain from the strategic perspective, which is the premise of supply chain greening. Green supply chain is not the greening operation of a single enterprise and the key is to achieve the greening operation of the entire process of supply chain. Therefore, to effectively carry out green supply chain management, the enterprise should aim at the optimization of the economic benefits and environmental benefits of the whole supply chain and set the target suitable for its own level, thus establishing the strategic position of green supply chain management in the enterprise.

Design

The basic idea of green design shall be introduced here. To radically prevent pollution and conserve resources and energy, we should make full consideration of the impact on environment after the product is manufactured, sold, used and scrapped in the design stage, thus optimizing its process with good environment friendliness and global economy, rather than take preventive measures after the adverse effects on environment (e.g., the terminal treatment is often used at present). In the design of the whole process of the life cycle of the product, including purchase, production, logistics and use process, the enterprise should make full consideration of resource consumption and environment friendliness, thus optimizing all design factors; the enterprise should make comprehensive consideration of the function, quality, development cycle and cost of the product, thus achieving the minimal resource consumption and the maximal environment friendliness.

Procurement

In product design, the enterprise should choose green materials as far as possible, namely, which has good performance and has the characteristics of low energy consumption in the whole life cycle of the production, processing, use and recycling after being scrapped, reusability, high resource utilization rate, easy recycling, no or few pollution to environment, high environmental friendliness. Green materials are mainly involved in their advancement, the safety of production process, the rationality of the materials used and satisfying the requirements of modern engineering, etc. To achieve the goal of green materials is to choose recyclable and reuse materials, renewable materials, degradable materials, easy handling materials and biodegradable materials, etc.

Production and processing

The enterprise should carry out ISO1400 standards in its production and processing and adopt the production process scheme and route with low energy consumption, few waste and pollution to environment. Green supply chain not only requires the product with environmental protection, which shall not threat the health of the product user, but also requires the production process is harmless to workers with the minimal energy consumption and pollution.

Logistics

Green logistics is a kind of work of the implementation of the whole production logistics for the purpose of improving green degree, including green package and reverse logistics, etc. Green package indicates that this is especially evident in the way package shall consider environment protection problems in the design and implementation of commodity package and design, namely, Package Reduce, Package Reuse, Package Recycle and Package Degradable. The friendliness of packaging materials contains the choice of the packaging materials without poisonous ingredient such as lead, mercury and tin, the choice of the recycling and reusable packaging materials, the choice of degradable packaging materials. Structural design should follow the principle of "zero package", namely quality, development cycle and cost of the product, thus achieving the minimal resource consumption and the maximal environment friendliness.

GSCM = Green purchasing + Green manufacturing/materials management + Green Distribution / marketing + Reverse logistics.

Green supply chain management requires thoroughly changing the idea of "treatment after pollution" and emphasizes the concept of "reduction of pollution at source, prevention first, treatment second, namely, at the design of product and purchase stages, full consideration shall be made about its impact on environment, thus reducing enterprise treatment costs and improving enterprise environmental performance and economic performance.

Year	Title/Author	Findings	Variables	Country
2013	Review and development of key factors of green supply chain management practices and its correlation with GSCM function and strategies Rituraj et al	Relation between GSCM functions and GSCM practices has been established	47 sub-factors	India
2011	Drivers of Green Supply Chain Management Performance: Evidence from Germany Large, R.O. & Thomsen, C.G.	The degree of green supplier assessment and green collaboration has direct influence on environmental performance. These two practices are driven by the strategic level of the purchasing department and the level of environmental commitment of the firm. • Commitment influences green assessment directly; the impact of commitment on green collaboration is mediated by the capabilities of the purchasing department. •Environmental performance has a positive impact on purchasing performance.	Five potential drivers of green supply management performance: • Green supply Management The strategic level of Purchasing department • The level of environment commitment • The degree of green supplier assessment • The degree of Green collaboration with suppliers Performance: Environmental performance and purchasing performance	Germany
2011	Is ISO 14001 a gateway to more advanced voluntary action? The case of green supply chain management Arimura <i>et al</i>	ISO 14001 contributed to GSCM practices which facilities with ISO 14001 are 40% more likely to evaluate their suppliers' environmental performance and 50% more likely to ask their suppliers undertake specific environmental practices. • Government program of encouraging EMS adoption indirectly influences ISO 14001 adopters to implement GSCM practices.	ISO 14001 • Facility's GSCM practices	Japan

2011	The Influence of Greening the Suppliers and Green Innovation on Environmental Performance and Competitive Advantage in Taiwan Chiou, T.Y. <i>et al.</i>	<p><input type="checkbox"/><input type="checkbox"/>Greening the suppliers leads to green innovation and competitive advantage.</p> <p><input type="checkbox"/><input type="checkbox"/>The finding also support that the intervening variables of green innovation contribute to competitive advantage.</p> <p><input type="checkbox"/><input type="checkbox"/>Taiwanese companies have started to implement actions toward greening their suppliers and developing greener products and manufacturing Process</p>	<p><input type="checkbox"/><input type="checkbox"/>Green innovation (Product innovation, Process innovation, Managerial Innovation)</p> <p><input type="checkbox"/><input type="checkbox"/>Environmental performance</p> <p><input type="checkbox"/><input type="checkbox"/>Competitive advantage</p>	Taiwan
2011	Research on the Performance Measurement of Green Supply Chain Management in China Yan Li	<p><input type="checkbox"/><input type="checkbox"/>Chinese enterprises have tried to implement a variety of GSCM practices to improve their environmental performance in response to the export philosophy.</p> <p><input type="checkbox"/><input type="checkbox"/>Internal environmental management,(commitment from top level managers and support from mid-level managers) will be necessary for development of any GSCM programs in China.</p>	Eco-design level; green purchasing level; green manufacturing capacity; green marketing and consumption; recycling products processing ability; level of information technology; comprehensive level	China
2011	Sustainable Production: Practices and Determinant Factors of Green Supply Chain Management of Chinese Companies Liu, X. <i>et al.</i>	<p><input type="checkbox"/><input type="checkbox"/>Chinese companies are still at a preliminary stage of GSCM practices.</p> <p><input type="checkbox"/><input type="checkbox"/>Their environmental management in cooperation with external members of the supply chain is very marginal.</p> <p><input type="checkbox"/><input type="checkbox"/>A company's LGSCM is significantly and positively associated with external pressures from regulatory, domestic clients</p>	<p>External pressures</p> <p><input type="checkbox"/><input type="checkbox"/>Internal factors</p> <p><input type="checkbox"/><input type="checkbox"/>GSCM practices</p> <p><input type="checkbox"/><input type="checkbox"/>Controls (company's size, industrial sector)</p>	China

		and business competitors. □□A company's learning capacity in internal factors greatly measured LGCM		
2011	Evaluating Green Supply Chain Management among Chinese Manufacturers from the Ecological Modernization Perspective <i>Zhu et al.</i>	The results highlighted the varying pace of Chinese manufacturers to ecological modernize with GSCM practices and the significance of regulatory pressure to diffuse the practices adoption by Chinese manufacturing industry	Awareness of environmental regulations/policies	China
2011	The impact of green supply chain practices on company performance: the case of 3PLs 8 <i>Cagno et al.</i>	Still limited adoption of GSCP among the 3PLs service providers, sometimes oriented only to a compliance with environmental regulations. Some participant have shown a pro-active attitude and gained significant benefit from the adoption of GSCP.	Green supply chain practices (GSCP) □□3PLs performance	Italy
2010	Green Supply Chain Management in Leading Manufacturers- Case Studies in Japanese Large Companies <i>Zhu et al.</i>	Japanese large manufacturers implement one key GSCM practice, internal environmental management at a significantly higher level than Chinese manufacturers. □□The four other GSCM practices were implemented at similar levels when compared to Chinese manufacturers. □□It was found that large Japanese companies have made significant improvements for environmental and financial performance but not for operational performance.	GSCM drivers(Normative pressure, Coercive pressure, Mimetic pressure) □□GSCM practices (Internal & external dimensions) □□GSCM performance (Economic, financial, operational)	Japan

2009	An Empirical Study of Green Supply Chain Management Practices Amongst UK Manufacturers Holt, D. & Ghobadian, A.	Manufacturers identify the greatest pressure to increase environmental performance is legislation and internal drivers (IDs). □□GSCM practices among the UK manufacturers are focusing on internal higher risk, descriptive activities. □□Environmental attitude (EA) is a key predictor of GSCM activity and those organizations that have progressive attitude are also operationally very active.	External drivers (Legislation, competitive, supply chain, societal) □□Internal drivers	UK
2009	ISO 14001 in environmental supply chain practices Nawrocka <i>et al.</i>	□□ISO 14001 has a facilitating role in the environmental activities between a customer and a supplier. □□Closer relationship with suppliers was seen as beneficial both for the successful outcomes of projects and as a facilitator for environmental work. □□The purchasing function, and its interplay with the environmental function and other company functions, was seen as important for engaging in supply chain activities	Communication of environmental Requirements between a customer and a supplier. □□Motivation and enabling of a supplier company to comply with the requirements. □□Mechanisms for control and follow-up.	Sweden
2008	Green Supply Chain Management Implications for “Closing the Loop” Zhu <i>et al.</i>	□□Investment recovery seemed to get less attention in China. □□However, more Chinese manufacturing have realized the importance of GSCM due to potential regulatory pressure in China as well as pending marketing pressure from Europe when	GSCM dimensions: Internal environmental management, green purchasing, customer cooperation with environmental concern, investment recovery, and eco-design	China

		they export products.		
2008	Drivers for the participation of small and medium-sized suppliers in green supply chain initiatives Su-Yol Lee	Buyer environmental requirements and support have positive effect to their suppliers' willingness to participate in green supply chain initiatives. <input type="checkbox"/> <input type="checkbox"/> The government can play an important role in motivating these suppliers. <input type="checkbox"/> <input type="checkbox"/> The more slow resources and organizational capabilities suppliers had, the more willingly they were to participate in those initiatives	Buyer GSC practices, government involvement, GSC readiness, GSC participation	South Korea
2008	Influences, practices and opportunities for environmental supply chain management in Nova Scotia SMEs Raymond <i>et al.</i>	<input type="checkbox"/> <input type="checkbox"/> Small suppliers and medium-sized enterprises, have difficulties in allocating resources to initiatives that are not viewed as directly related to their core function, namely manufacturing the product or providing the service. <input type="checkbox"/> <input type="checkbox"/> This study clearly demonstrated that opportunities exist to reduce greenhouse gas emissions and solid waste within supply chains	Environmental performance <input type="checkbox"/> <input type="checkbox"/> Environmental issues	Canada
2005	Green Supply Chain Management in China: Pressures, Practices and Performance Zhu <i>et al.</i>	Chinese enterprises have increased their environmental awareness due to regulatory, competitive and marketing pressures and drivers. <input type="checkbox"/> <input type="checkbox"/> However, this awareness has not been translated into strong GSCM practice adoption, let alone into improvements in some areas of performance, where it was expected.	GSCM drivers (regulatory, supply chain partners, competitors, market) <input type="checkbox"/> <input type="checkbox"/> GSCM practices <input type="checkbox"/> <input type="checkbox"/> GSCM performance	China

6. Conclusion:

GSCM can act as a powerful tool for the improvement of productivity coupled with the improvement in the environmental scenario of the region but the fact remains that it should become a culture and not just another industrial activity.

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