

## Barriers to Green Supply Chain Management in the Petrochemical Sector

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**Abstract:** Green supply chain management has emerged as an important organizational performance to reduce environmental risks. This study is used the Analytic Network Process (ANP) method to find influential Barriers in implementation of GSCM. The results of this paper indicate that the Lack of understanding among supply chain stakeholders is the most important Barrier in implementation of Green Supply Chain Management. Also less important Barrier in implementation of Green Supply Chain Management is Competition and Uncertainty. The managerial implications and conclusions are discussed.

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### 1. Introduction

In recent years, green supply chain management (GSCM) initiatives have gained considerable prominence. However, how much value it brings to organizations is still being investigated. As a result of global economic development and high levels of industrialization, the environmental protection problems faced by each country grow on a daily basis and are greatly endangering the natural environment. Environmental management has thus become a topic of mutual concern of businesses, government and consumers. GSCM can be considered as an environmental innovation from the DoI view. Since its introduction by Rogers (1962), DoI has been widely applied to describe the patterns of innovation adoption, explain the mechanism, and assist in predicting whether and how an innovation will be successful. Important characteristics of an innovation include: relative advantage, compatibility, complexity, trialability, and observability. As an emergent environmental management philosophy which incorporates supply chain members, GSCM can be considered as a relatively advanced organizational technological innovation for manufacturers to improve their environmental performance (Narasimhan and Carter, 1998). GSCM can be also used in parallel, and overlaps, with other current environmental innovations such as cleaner production and environmental management systems, further indicating its compatibility. Today's business

environment is characterized by increasing uncertainties. GSCM has emerged as an important new approach for enterprises to achieve profit and market share objectives by reducing environmental risk and impact. In supply chains with multiple vendors, manufacturers, distributors and retailers, whether regionally or globally dispersed, performance measurement is challenging because it is difficult to attribute performance results to one particular entity within the chain. Theoretical research suggests that supply chain integration provides a significant competitive advantage. However, apart from contributing to a better understanding of SCM, it falls short of proposing any specific implementation path to SCM.

Green Purchasing is defined as an environmentally conscious purchasing initiative that tries to ensure that purchased products or materials meet environmental objectives set by the purchasing firm, such as reducing the sources of wastage, promoting recycling, reuse, resource reduction, and substitution of materials. Use and secondary use (repairability, remanufacturability and recyclability). Redesigned products will only be effective if they are able to provide at least the services of the products they replace. Life-cycle analysis is an important sub-concept to Green Design. Life-cycle analysis was introduced to measure environmental and resource related products to the production process. Reverse logistics activities differ from those of traditional

logistics .Reverse logistics networks have some generic characteristics related to the coordination requirement of two markets, supply uncertainty, returns disposition decisions, postponement and speculation Dowlatshahi and Carter and Ellram define reverse logistics as a process where a manufacturer accepts previously shipped products from the point for consumption for possible recycling and re-manufacturing. Recent studies of GSCM can be separated into two ways: framework for GSCM, and performance measurement. Some frameworks propose how to improve the collaborative relationships between manufacturers and suppliers, to explore the gaps between the framework and the present state, to aid managerial decision making, or to develop general procedure towards achieving and maintaining the green supply chain (Beamon, 1999). The idea of GSCM is to eliminate or minimize waste (energy, emissions, chemical / hazardous, solid wastes) along supply chain (Hervani et al. 2005). In green product design, analysis is made to assess the environmental impact during the useable life cycle and afterwards, and attempts are made to minimize adverse effects. Modular design and easy disassembly options help in repair and remanufacturing of the end-of-use returns, and recycling of end-of-life returns. Logistics is the function responsible for moving materials through supply chains, where a supply chain is the series of activities and organisations through which materials move on their journey from initial suppliers to final customers. Logistics management is essentially an integrative process that seeks to optimise the flows of materials and supplies through the organisation and its operations to the customer. Logistics has always been central to, and essential for, economic activity. Decisions about transportation involve mode selection, shipment size, and routing and scheduling. GSCM is one of the best strategies for meeting the challenge to reduce carbon emission and enhance sustainability because of its potential to improve the environmental performance of any organizations.

## 2. Literature review

### 2.1. Supply chain management

Supply chain management (SCM) can be defined as the “systematic and strategic coordination of the traditional business functions within a particular company and across businesses within the supply chain, with the aim of improving the long-term performance of the individual companies and the supply chain as a whole” (Mentzer et al., 2001). Supply chain management often refers either to a process-oriented management approach to sourcing, producing and delivering goods and services to end consumers or, in a broader meaning, to the coordination of the various actors belonging to the same supply chain (Harland, 1996) . SCM is such a broad

notion that it can be approached from many different perspectives: purchasing and supply, logistics and transportation, industrial organisation, marketing, strategic management, and many others (Croom et al., 2000) the breadth of the concept is also the main reason why it still lacks a unitary and widely accepted definition. In SCM, each supply chain member performs a specific added value function in relation to the product/service as it progresses towards the final consumer” (Ritchie and Brindley 2002). Although SCM adds value to the process, it is important to note that a basic premise of SCM is that value must increase faster than the costs associated with creating that value; i.e., efficiently managing the supply chain (Lockamy and Smith 1997). The core purpose of SCM has been, since it was established more than two decades ago (Stevens, 1989), to break down functional silos and cooperate within the same logistics system, with the common goal being to serve the end customers with a smooth, flexible and cost efficient flow of goods (Mentzer et al., 2001). As a key factor for SCM, the matter of coordination also becomes the main challenge from top management’s point of view (Lancioni, 2000). The nature of SCM needs a force standing above the functional silos and focusing on the complete “horizontal organisation” (Mangan and Christopher, 2005).

### 2.2. Green Supply chain management

Green supply chain management has considered the supply chain of various links of environmental problem and paid attention to environmental protection and to promote coordinated development of economy and environment. Judging from the composition of green supply chain, participate in the green supply chain of basic are mainly suppliers, manufacturers, distributors and retailers enterprise and end users. GSCM, advocating efficiency and synergy between partners, facilitates environmental performance, minimal waste and cost savings (Rao and Holt, 2005), and is attracting the increasing interest of researchers and practitioners of operations and supply chain management. GSCM has emerged “as an important new archetype for enterprises to achieve profit and market share objectives by lowering their environmental risks and impacts while raising their ecological efficiency” (Zhu et al., 2005). Green marketing has been defined by different scholars in different ways. There seem to be three main views on its definitions. The first view is linking green marketing to identifying and satisfying green customers, and promoting environmentally-friendly products. For example, Banyte et al. define it as “determining the need to know the new, so called green, consumer and to adapt marketing decisions to the focus on ascertaining the expectations and satisfying the needs of such a consumer” (Banyte,

Brazioniene, & Gadeikiene, 2010). Sustainable supply chain management is defined as “the strategic, transparent integration and achievement of an organization's environmental, social and economic goals in the systematic co-ordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its chains” (Carter & Rogers, 2008). SSCM is sometimes referred to as closed-loop supply chain management or green supply chain management. Closed-loop supply chains are those supply chains where care is taken of items once they are no longer desired or can no longer be used. A closed-loop supply chain consists of a forward chain and a reverse chain (Yuan & Gao, 2010). First, the green supply chain strategy composed by five basic collocation factors including green operation strategy, green outsourcing strategy, green channel strategy, green client service strategy and green asset network should be established. Second, the green supply strategic culture should be established, and the green supply chain management should be integrated into enterprise culture. Finally, the green supply chain strategy which can be organically integrated with green product strategy and green market strategy should be developed. Therefore, the green supply chain strategy which can accord with the competitive strategy, client demand strategy, strength status of textile and apparel enterprise and fit in with the environment should be developed. Managing supply chain gained notoriety in practice as evidenced by the management and engineering literature in the early 20th century (Svensson, 2001; Askarany et al., 2010). Some of the initial best practices of modern supply chains, such as lean and just-in-time (JIT) manufacturing can be traced to Henry Ford's efforts to vertically integrate the automotive supply chain and organizational practices. The concept of JIT and SCM at that time focused on enhancing operational efficiency and minimizing waste (Bornholt, Faure, 1928). The purpose of the minimization of waste was not for environmental, but economic reasons. Waste means greater economic loss (Lai and Cheng, 2009).

### 2.3. Barriers to the GSCM implementation

Approaches towards Green Supply Chain Management (GSCM) practice have been identified by various researches; they are briefly outlined below. Shang et al. (2010) conducted a study based on six dimensions of green supply chain management i.e. eco design, green manufacturing and packaging, environmental participation, green marketing, stock and suppliers. The results inferred that the firms which were focusing on green marketing had been successful competitors against the rivals. Quinghu Zhu et al (2008) conceptualize Green Supply Chain Management practices implementation as

encompassing different dimensions of practices including Green Procurement, Internal Environmental Management, Eco Design, Customer Cooperation, and Investment Recovery. Ramudhin A., et al. (2010) proposed a strategic planning model and insisted that internal and external control mechanism are of great importance to decision makers while designing sustainable supply chain network. GSCM scope ranges from implementing and monitoring of the general environment management programmes to more creating or controlling practices implemented through various R(Reduce, Re-use, Rework, Reclaim, Recycle, Remanufacture, Reverse logistics, etc.) towards attaining a GSCM waste minimization is being considered as an important strategic. The waste, which is non-value adding activity, carried out in any operation. Waste is the most commonly perceived enemy to environmental protection in manufacturing and production operations. That is, manufacturing and production processes are viewed as the culprits in harming the environment, in the forms of waste generation, ecosystem disruption, and depletion of natural resources (Jamal Fortes, 2009). Table 1 illustrates the Effective Barriers in implementation of GSCM.

Table 1. Barriers to the GSCM implementation

Barriers
-Lack of sustainable GSCM practices in organizations vision and mission
-Lack of corporate leadership and support
-Lack of knowledge and Experience
-Lack of understanding among supply chain stakeholders
-Poor organizational culture
-Lack of green initiatives
-Shortage of resources
-Lack of technology infrastructure
-Competition and Uncertainty
-Financial implications
-Lack of demand and public awareness
-Perceived lack of government support

Source : Balasubramanian (2012)

### 2.4. Analytic network process (ANP)

Analytic network process (ANP) is an MCDM method that takes simultaneously, several criteria, both qualitative and quantitative, into consideration, allowing dependence and feedback and making numerical tradeoffs to arrive at a synthetic conclusion indicating the best solution out of a set of possible alternatives. ANP was officially introduced by Saaty (1996) as a generalization of the analytic hierarchy process (Saaty, 1980). The analytic network process is the generalization of the analytical hierarchy process (AHP) as it incorporates feedback and interdependent relationships among decision criteria and alternatives (Jharkharia and Shankar,

2007). Technically, the model consists of clusters and elements. The dominance or relative importance of influence is the central concept. The ANP provides a general framework to deal with decisions without making assumptions about the independence of higher-level elements from lower-level elements and about the independence of the elements within a level as in hierarchal decision making methods. In fact, the ANP uses a network without the need to specify levels.

The generalized supermatrix of ahierarchy with three levels—which is used in this paper—is as follows:

$$W = \begin{matrix} & \begin{matrix} c1 & c2 & c3 \end{matrix} \\ \begin{matrix} c1 \\ c1 \\ c1 \end{matrix} & \begin{bmatrix} w11 & w12 & w13 \\ w21 & w22 & w23 \\ w31 & w32 & w33 \end{bmatrix} \end{matrix}$$

$W$  is apartitioned matrix because itsentries are composed of the vectors obtained from the pairwise comparisons. Since  $W$  is a column stochastic matrix, its limiting priorities depend on the reducibility and cyclicity of that matrix.If the matrix is irreducible and primitive, the limiting value is obtainedbyraising  $W$  to powers suchasin Eq.(1) in order to obtain the global priority vectors (Saaty andVargas,1998).

$$\lim_{k \rightarrow \infty} W^k$$

Finally, after the supermatrix is assured of being column stochastic, it is raised to a sufficiently large power until convergence occurs (Saaty, 1996). In other words, the supermatrix is the nraised to limiting powers to become  $W^{2k+1}$ , where  $k$  is an arbitrarily large number to capture all the interactions and to obtain a steady-state outcome.

### 3. Research methodology

Questionnaire was adopted to collect data from a series of managers in Petrochemical industry. In this study the ANP method is used to evaluation of Effective Barriers in implementation of GSCM. This research designed one questionnaire for ANP. . The objects were professional experts of the Petrochemical industry in Iran (15 experts). The Effective Barriers in implementation of GSCM in this study are as follows: -Lack of sustainable GSCM practices in organizations vision and mission -Lack of corporate leadership and support -Lack of knowledge and Experience -Lack of understanding among supply chain stakeholders -Poor organizational culture -Lack of green initiatives - Shortage of resources -Lack of technology infrastructure -Competition and Uncertainty -Financial implications -Lack of demand and public awareness - Perceived lack of government support.

### 4. Analysis and results

According to the connections developed in the model, all pairwise comparisons were completed. ANP uses a verbal scale developed by Saaty (1980), which enables the experts to incorporate subjectivity and experience. ANP and its software SuperDecisions also enable the decision-maker to evaluate his/her judgments with the inconsistency ratio denoted by  $I_R$ . The judgment matrixes are said to be consistent if  $I_R \leq 0.1$  (Saaty, 1980, 1996). If there is inconsistency in a matrix, the decision-maker needs to check his/her judgments to make them better to satisfy  $I_R \leq 0.1$ . The resulting final priorities for the proposed ANP model can be read from limit supermatrix (LSM) in Table 2. Final prioritization of Barriers to implementation of Green Supply Chain Management is shown in table 2. Result show that, the Lack of understanding among supply chain stakeholders is the most important Barrier in implementation of Green Supply Chain Management .Also less important Barrier in implementation of Green Supply Chain Management is Competition and Uncertainty. Lack of understanding among supply chain stakeholders is the most important Barrier with weight of 0.1065, followed by Lack of green initiatives with weight of 0.1049, Lack of corporate leadership and support with weight of 0.0981and Poor organizational culture with weigt of 0.0947 etc.

Barriers	prioritization Based on limited weighted supermatrix	prioritization of Un-weighted	Priority
-Lack of sustainable GSCM practices in organizations vision and mission	0.044	0.0744	9
-Lack of corporate leadership and support	0.058	0.0981	3
-Lack of knowledge and Experience	0.054	0.0914	5
-Lack of understanding among supply chain stakeholders	0.063	0.1065	1
-Poor organizational culture	0.056	0.0947	4
-Lack of green initiatives	0.062	0.1049	2
-Shortage of resources	0.051	0.0863	6
-Lack of technology infrastructure	0.049	0.0829	7
-Competition and Uncertainty	0.031	0.0524	12
-Financial implications	0.035	0.0592	11
-Lack of demand and public awareness	0.042	0.0711	10
-Perceived lack of government support	0.046	0.0778	8



## 5. Conclusions

The implementation of green supply chain management can maximize the resource utilization, reduce the resource consumption and enhance its international image with the improvement of its operation performance so as to promote the compatibility between enterprises and society and environment, thus achieving sustainable development. This study is used the Analytic Network Process (ANP) method to find influential Barriers in implementation of GSCM. The results of this paper indicate that the Lack of understanding among supply chain stakeholders is the most important Barrier in implementation of Green Supply Chain Management. Also less important Barrier in implementation of Green Supply Chain Management is Competition and Uncertainty. The managerial implications and conclusions are discussed. The result of this study can hopefully help the company evaluate and analyze the suitable supplier which focuses on this research. There are useful implications of our study for both developed and developing countries on the diffusion of GSCM and other corporate environmental practices. We found that international policies can influence developing country adoption of environmental management practices. This study contains several limitations that future studies need to have further examine. First, this study applies the ANP to influential Barriers in implementation of GSCM through individual rather than a full-fledged industrial survey. Second, GSCM is still a fairly new concept which has not been widely implemented in the industry; hence, the expert system only bases on few industrial and professional experts. Future research can also use different methods to identify more criteria to justify the GSCM performance.

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