

Assessment and analysis of GSCM barriers using AHP

Pradeep C G₁,

¹M tech student, Dept. of Production Engineering, Govt. Engineering College Thrissur, Kerala, India

Abstract-As a part of reducing environmental issues most of the manufacturing industries started adopting green concept in their supply chain management. But, the process of implementing green concept in their supply chain management was found to be very difficult due to identification of barriers. This research work aims to identify and prioritize those barriers while implementing GSCM in plastic industries. There were 47 barriers identified, from detailed literature study and interviews with industrial experts and it was executed with the help of a questionnaire based survey. The first phase survey mainly emphasizes the essential barriers from total 47 common barriers. From the second phase these barriers are prioritized using analytical hierarchical process based on calculated values.

Keywords: Green SCM implementation, Barrier analysis, Analytic hierarchy process.

1. INTRODUCTION

In the modern global manufacturing scenario, environmental and social issues are considered as the most important criteria in managing any business. Green supply Chain Management (GSCM) is an approach to improve performance of the process and products according to the requirements of the environmental regulations (Hsu & Hu, 2008). GSCM has emerged in the last few years and covers all phases of product's life cycle from design, production and distribution phases to the use of products by the end users and its disposal at the end of product's life cycle (Borade & Bansod, 2007). It's an integrating environmental thinking. Most of the organizations have to focus on the energy utilization and resources for producing eco friendly products.

This paper has a motive in identifying the GSCM implementation barriers and these barriers are analyzed, studied and prioritized with the aid of Analytical Hierarchy Process (AHP). The major application of the analytic hierarchy process (AHP) method is due to its flexibility, easiness to handle, and simplicity. This study was carried out among different plastic industries. These results may have an impact in environmental adoption ensuring easiness in the process of elimination of essential barriers. The results, discussions and conclusions are successfully attained from industry visits, interviews and the detailed analysis.

2. GREEN SUPPLY CHAIN MANAGEMENT

Green Supply Chain Management includes entire delivery of products and services from suppliers, manufacturers to end customers. It is basically achieved through material flow, information flow and cash flow among various departments. Supply Chain Management emphasis on Total Quality, optimum Cost and best service which can be adopted. Supply chain managers play a vital role in developing innovative environmental technologies for tackling the problems faced by the economy on environmental problem. Lean Manufacturing mainly deals with elimination of waste at each stage of supply chain. It majorly focuses on production of economically and environmentally friendly high quality products which satisfies customer requirements. It is the advantageous since it aims at reducing inventory, saving space and energy. Thus Lean manufacturing leads to the Green environment. EPI is a device for measuring the effectiveness of environmental performances of a country. This measure is to identify how close the countries can establish environmental friendly policies and procedures.

3. COMMON BARRIERS IN GSCM IMPLEMENTATION

1. Difficulty in transforming positive environmental attitudes in to action
2. Lack of human resources
3. Lack of technical expertise
4. Fear of failure
5. Complexity of design to reuse/recycle used products
6. Lack of new technology, materials and processes
7. Current practice lacks flexibility to switch over to new System
8. Lack of effective environmental measures
9. Complexity of design to reduce consumption of resource/energy
10. Problem in maintaining environmental suppliers
11. Lack of government support to adopt Environmental friendly policies
12. No proper training/reward system for suppliers
13. Products potentially conflict with laws

14. Complexity in measuring and monitoring suppliers' environmental practices
15. Lack of an environmental partnership with suppliers
16. Need for extra human resources
17. Cost of environment friendly packaging
18. Non availability of bank loans to encourage green products/ processes
19. Risk in hazardous material inventory
20. Expenditure in collecting used products
21. Cost of switching to new system
22. High cost of hazardous waste disposal
23. Financial constraints
24. High investments and less return-on-Investments
25. Lack of Environmental Knowledge
26. Perception of "out of responsibility" zone
27. Difficulty in identifying environmental opportunities
28. Lack of Eco literacy amongst supply chain members
29. No specific environmental goals
30. Lack of green system exposure to professionals
31. Complexity in identifying third parties to recollect used products
32. Disbelief about environmental benefits
33. Difficulty in obtaining information on potential environmental improvements
34. Lack of awareness about reverse logistics adoption
35. Hesitation/fear to convert to new systems
36. Not much involvement in environmental related programs/meetings
37. Lack of training courses/consultancy/institutions to train, monitor/mentor progress specific to each industry
38. Restrictive company policies towards product/process stewardship
39. Poor supplier commitment/unwilling to exchange information
40. Lack of Interdepartmental co-operation in communication
41. Lack of involvement of top management in adopting green supply chain management
42. Lack of awareness of the environmental impacts on Business
43. Inadequate management capacity
44. Market competition and uncertainty
45. Lack of support and guidance from regulatory authorities
46. Lack of customer awareness and pressure about GSCM
47. Lack of Corporate Social Responsibility

Table -1: common barriers in GSCM implementation [1]

4. PROBLEM DEFINITION

In current industrial practices, most of the firms are basically profit oriented with less consideration about its environmental impacts. This strategy adversely affects the ecological balance. So Industries must consider green issues as their vital problem and producing green/eco products can give them great marketing advantages and a good corporate image. Also, by promoting eco products, organizations should bring their own contribution to economic benefits and environmental protection for society. The major reasons for GSCM issues are found as follows (Mudgal et al., 2010):

- Industries mainly focus on low energy & resource consumption, due to increased pollution level and fewer availability of resources which can be reduced through GSCM.
- Customers environmental consciousness has highly forced the industries in adopting greenness in their supply chain, which resulted in energized market share and sustained industrial environment
- The different factors which stand as a barrier in process of GSCM implementation in plastic industries.

5. SOLUTION METHODOLOGY

A detailed questionnaire was formed in the first phase on the basis of available literature studies and discussions. The data's were gathered from the experts in various plastic industries. The significant barriers are determined on the basis of questionnaire survey and from literatures. These significant barriers were then used for the preparation of second phase survey (AHP based). The results from the survey are analyzed and sorted out. These results are very useful in the process implementing greenness in their supply chain.

Fig -1: The four level hierarchy processes are described as below

Level-I: Objective/overall goal.

Level-II: Barrier category.

Level-III: Specific barriers.

Level-IV: Priorities of essential barriers.

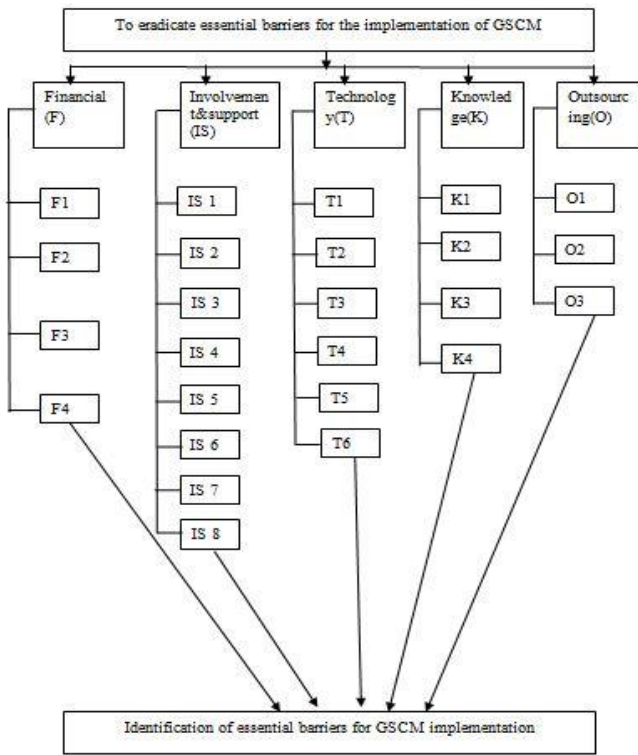


Fig -1: AHP frame work for identifying essential barriers of GSCM implementation.

5. OVERVIEW OF AHP

AHP is a widely used method for decision support in business and manufacturing industries. The Analytic Hierarchy Process (AHP) includes a set of axioms which precisely delimits the scope of the problem environment (Saaty, 1986). It is fundamentally based on a well-defined mathematical structure of consistent matrices and their associated right Eigen vector's ability to generate true or approximate weights (Merkin, 1979; Saaty, 1980). The AHP methodology compares criteria, or alternatives with respect to a criterion, in a natural, pair-wise mode (Saaty, 1980). For more details about AHP, please see Borade et al. (2013). The three steps of the AHP methodology are: (1) identifying barriers and structuring a hierarchy prioritization model, (2) constructing a questionnaire and collecting data, and (3) determining normalized weights for each barrier category and each specific barrier. Opinions from different industries including automobiles, electrical and electronics, textiles, paper, food, plastic, textiles and apparel, iron and steel, power plant, and chemical industries were collected through carefully designed questionnaires and then synthesized and analyzed by the AHP technique.

5.1 Consistency Check for Pair-Wise Comparison Matrix

The consistency ratio is calculated based on the following steps (Haq and Kannan, 2006a, 2006b):

1. Calculate the eigenvector or relative weights and λ_{max} for each matrix of order n
2. Compute the consistency index for each matrix of order n by the formulae:

$$CI = \frac{\lambda_{max} - n}{n(n-1)}$$

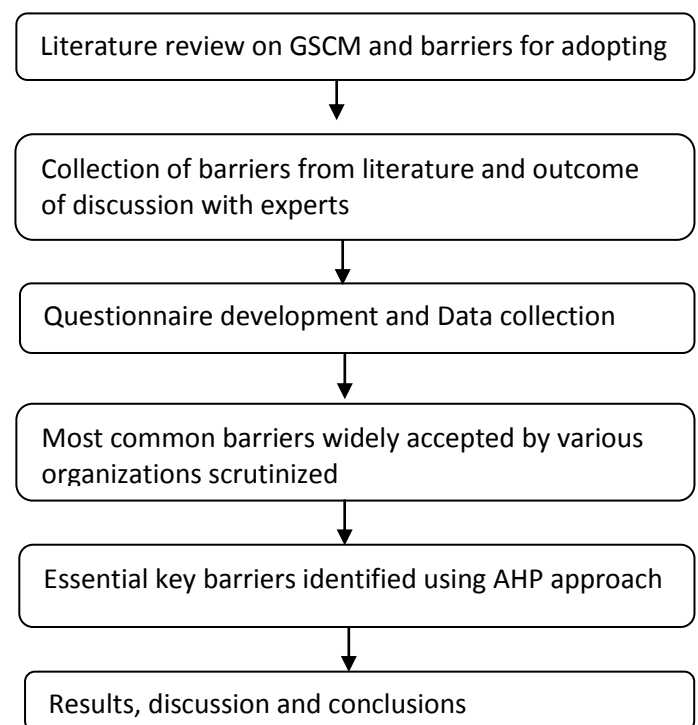
The consistency ratio is then calculated using the formulae: $CR = \frac{CI}{RI}$

6. APPLICATION OF PROPOSED MODEL

6.1. Developing the questionnaire

Questionnaires were designed to facilitate data collection. Data collection's have two phases. Phase 1: Initial survey to identify common barriers, and Phase 2: Identification of essential barriers. The survey questionnaire was distributed to 10 plastic industries located in Kerala, Of the 10 participants, 10 responded to the questionnaire. All industrial participants started adopting environmentally-friendly activities (ISO 14001 environmental management certification) and their commitment to green practices underscores the importance of this study.

Fig -2: Flowchart of research



6.2. Data Collection

A sample dual choice (YES/NO) questionnaire was prepared from the barriers identified through literature survey and from the discussions with industrial experts. Before the start of the survey, GSCM concepts were provided to the target respondents by proper documents for ensuring the better understanding of various questions in the survey questionnaire.

6.3. Phase 1: Initial Survey to Identify the Common Barriers

From the 47 recommended barriers, the respondents were asked to identify the important barriers (given the choice of Yes or No for each barrier) for GSCM implementation in their industry. A Survey based on written Questionnaire was conducted in a plastic company. The duration for this initial survey was fixed as two months. Malhotra and Grover (1998) suggested that a response rate of 20% was enough for a positive assessment of the survey. From this initial survey we observed that plastic industries are aware of the environmental impact on their business but are still at the initial stages of GSCM implementation.

6.4. Phase 2: Identification of Essential Barriers

In this section, the identification of essential barriers for GSCM implementation was done using the AHP approach. After the initial survey, 22 common barriers were identified and raised to a priority level of concern. This phase is categorized into four hierarchy decision process levels and the same as shown in Fig.1. The 22 barriers identified from Phase 1 were sent to relevant experts of the corresponding companies and data collected accordingly.

Outsourcing (O)
Lack of government support to adopt Environmental friendly policies (O1)
Complexity of measuring/monitoring environmental practices of suppliers (O2)
Problems in maintaining environmental suppliers (O3)
Technology (T)
Lack of new technology, materials and processes (T1)
Complexity to design, reuse/recycle products (T2)
Lack of technical expertise (T3)
Lack of Human resource (T4)
Lack of effective environmental measures (T5)
Fear of failure (T6)
Knowledge (K)
Lack of professionals exposed to green systems (K1)
Lack of Environmental Knowledge (K2)

Perception of "out-of-responsibility" zone (K3)
Disbelief about environmental benefits (K4)
Lack of awareness about reverse logistics (K5)
Financial (F)
High cost for hazardous waste disposal (F1)
Financial constraints (F2)
Non-availability of bank loans to encourage green products/ processes (F3)
High investments and less Return-on-Investments (F4)
Involvement and support (IS)
Lack of training courses (IS1)
Lack of customer awareness and pressure about GSCM (IS2)
Lack of Corporate Social Responsibility (IS3)
Lack of top management involvement in adopting green supply chain management (IS4)
Restrictive company policies towards product/process stewardship (IS5)
Poor supplier commitment, unwilling to exchange information (IS6)
Lack of Inter departments cooperation in communication (IS7)
Less involvement in environmental related programs and meetings (IS8)

Table -2: Selected essential barriers

	T	I & S	O	F	K
T	1	0.888	0.916	0.333	0.4
I & S	1.222	1	1.222	0.25	0.333
O	0.666	0.888	1	0.285	0.428
F	3	10.66	3.77	1	2
K	4.6	3.375	7	0.5	1

Table -3: Pair-wise comparison matrix for barrier category

Barrier category	Sorted weight value
F	0.403
K	0.264
T	0.121
I & S	0.111
O	0.101

Table -4: AHP weightage for barrier category

Barrier category	Relative weights using AHP	Barriers	Relative weights using AHP	Global weights using AHP	Rank
Financial (F)	0.402	(F2)	0.462	0.186	1
		(F3)	0.356	0.143	2
		(F1)	0.180	0.072	3
Knowledge(K)	0.264	(K 2)	0.344	0.344	1
		(K 3)	0.253	0.253	2
		(K 4)	0.224	0.224	3
		(K 1)	0.176	0.176	4
Technology(T)	0.120	(T 3)	0.342	0.041	1
		(T 2)	0.241	0.029	2
		(T 4)	0.217	0.026	3
		(T 1)	0.199	0.024	4
Involvement & support (IS)	0.110	(I&S 6)	0.284	0.031	1
		(I&S 7)	0.236	0.026	2
		(I&S 4)	0.148	0.016	3
		(I&S 3)	0.095	0.010	4
		(I&S 5)	0.089	0.009	5
		(I&S 1)	0.081	0.009	6
		(I&S 2)	0.063	0.007	7
Outsourcing (O)	0.101	(O 4)	0.490	0.490	1
		(O 1)	0.190	0.190	2
		(O 2)	0.189	0.189	3
		(O 3)	0.130	0.130	4

Table -5: Local and global weights of all barrier categories and specific barriers for the implementation of GSCM

7. RESULT AND DISCUSSION

7.1 BARRIER CATEGORY

We infer from Table (1) that the Finance barrier is the first priority among the barrier categories. The result there by showing that industries commonly need more finances to extend their environmental management systems. Economy is critical in implementing GSCM (Ninlawanetal.,2010; Callejaetal.,2004; Hervanietal.,2005; Lee,2008).). The knowledge barrier category receives that next highest weight. Björklundetal (2012) has found that there is a lack of knowledge in measuring environmental performance in supply chain management. Technology barrier category receives that next highest weight. Technology change is an expensive and crucial barrier for GSCM implementation (Calleja et al., 2004; Ninlawan et al., 2010). Involvement and support barrier category is the fourth priority and is not

essential for comparison with other barrier categories. The outsourcing barrier category receives the last priority. Green purchasing was explored to determine the key factors affecting the buying firms choice of suppliers, including major barriers and obstacles (Rao,2007; MinandGalle,2001).

7.2 PROPOSALS FOR IMPROVING BARRIERS

Suggestion for improving financial barriers:

- Reuse, Remanufacturing, Recycling etc
- For encouraging industry to implement GSCM, Tax structure need to be favorable for companies.
- To implement GSCM, we need new technology adaptation. So, the government should encourage new technologies.

Suggestion for improving Knowledge barriers:

- Training of work force and that of the members of supply chain to raise their eco-literacy level is important for efficiently managing and ultimately making GSCM profitable.
- Conduct awareness programs about advantages of new system for supply chain members.
- Reverse logistics can lead to economic benefits by recovery of the returned products for reuse, remanufacturing, recycling or a combination of these options. so, encourage the benefits of reverse logistics.
- Make good relationship between third parties for recollect used products.
- Select higher quality of human resources in supply chain management.
- Quality human resources can provide new ideas for companies, learn new technique easily, and share knowledge with each other and use new technologies to solve problems.

Suggestion for improving Technology barriers:

- Green design, green manufacturing, green labeling of packaging etc
- Reduce the complexity and make process simpler.
- Proper maintains of machineries and adopting better technologies can reduce pollution.

Suggestion for improving involvement and support barriers:

- Conducting environmental related programs
- Increase the corporation among workers
- Motivate and encourage workers
- Departmental level programs to increase competitiveness

Suggestion for improving Outsourcing barriers:

- Make good partnership with suppliers who promote green manufacturing.

- Provide awareness about Green supply chain management to the suppliers.

8. CONCLUSION

Manufacturing industries started adopting the green concept in their supply chain management recently to focus on environmental issues. But, the process of implementing green concept in their supply chain management was found to be very difficult due to identification of barriers. This research work aims to identify and prioritize those barriers while implementing Green supply chain management (GSCM) in plastic industries. Ten plastic industries were approached for studying their supply chain systems.

Forty Seven common barriers were identified, from detailed literature study and interviews with industrial experts and it was executed with the help of a questionnaire based survey. Twenty two numbers of Essential barriers/priorities are identified through recourse to analytic hierarchy process. Pairwise comparison of each barriers were conducted, and were ranked according to the relative weightage. Financial, knowledge and technology barriers were found to be more important. Suggestions to overcome the barriers were formed. The validated Green supply chain management barriers, in the present research can help organizations to identify the weaker areas in their organization needing improvement for effective GSCM implementation.

In this research approach, it was successfully determined the barriers to be eliminated. Among 47, barriers 22 barriers, under five barrier categories, from literature and survey were identified and scrutinized. The suggested AHP approach is very helpful in order to optimize the ranking criteria (priorities) across twenty two barriers based. The AHP results obviously reveal that the financial barrier category is the leading barrier category. Lack of knowledge is considered as the most important obstacle during GSCM adoption. Technology, Involvement & support, and outsourcing barrier categories are the next priorities. But because the involvement & support, outsourcing barrier category ranks last, that ranking reveals that industries, although involved in motivating their systems for GSCM adoption, still face a considerable gap. Compared to the technology barrier category, the involvement and support and outsourcing barrier category is not essential in the industrial expert's point of view.

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