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# A STUDY OF GREEN SUPPLY CHAIN MANAGEMENT BARRIERS FOR MANUFACTURING INDUSTRIES: A DEMATEL APPROACH

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**Abstract**

*Today, green supply chain management (GSCM) barriers have emerged as one of the greatest problems for the industries for implementing the green concepts in their culture, and almost each type of industry is facing this problem. Considering this fact, the present research work is based on determining the casual relationships among the barriers in successful implementation of GSCM in manufacturing industries, using DEMATEL (Decision Making Trial and Evaluation Laboratory) technique. For this purpose, with the help of experts' opinion a list of five barriers was identified from the collection of a larger list, and fed to DEMATEL for obtaining the results.*

***Keywords: Green supply chain management (GSCM), Barriers, DEMATEL (Decision Making Trial and Evaluation Laboratory), manufacturing, industry.***

## 1. INTRODUCTION

According to Gehlot et al. (2023), the Green supply chain management (GSCM) is defined as a concept which includes various processes like product design, manufacturing and production techniques, operations, material selection, waste management and many more as a step to prevent environmental catastrophes, whereas Kumar et al. (2019) tells that it is a kind of unique practice for integrating the supply chain management (SCM) practices with environmental concerns. It involves the integration of environmental considerations in to design, implementation and improvement aspects of existing supply chain activities, and includes the use of eco friendly materials, enhanced packaging techniques, waste reduction, along with the collaboration with suppliers for the purpose of ensuring the successful implementation of environmental considerations in company's existing procedures (Balaji et al., 2014). Dashore and Sohani (2013) also reported that GSCM involves the integration of environmental considerations into the entire product life cycle and managing the environmental impacts of the product and processes. But, the successful implementation of green practices in existing industry culture is hindered by different barriers, and need to be properly addressed. Considering these facts, the present research work is devoted to GSCM barriers, and investigates the casual relationships among them. Following are the objectives of the research work:

To determine the casual relationships among the barriers; and

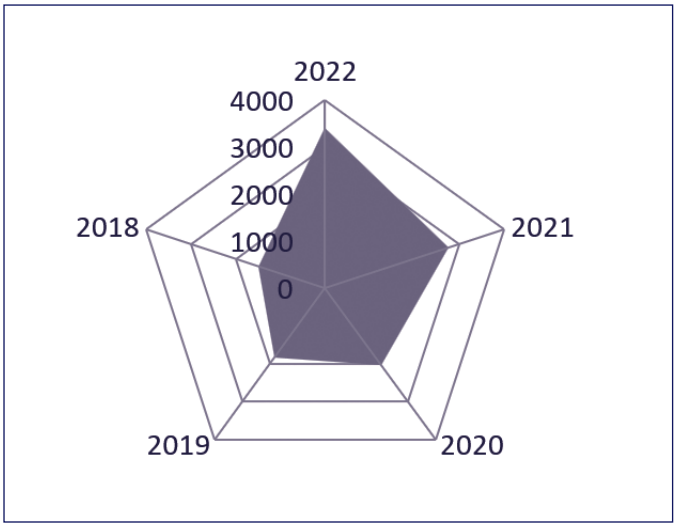
To determine the rankings of barriers with respect to their relative importance.

## 2. LITERATURE REVIEW

The present chapter is devoted to the academic aspects of the research work, and presents the scenario of research in the field of GSCM barriers, contributions of researchers in the field of GSCM barriers, and concludes with the investigated gaps in the research, the details of which are presented in upcoming sub-sections.

**2.1 Scenario of Research in the Field of GSCM Barriers:** Figure 2.1 shows the radar graph drawn on the basis of search terms GSCM barriers, on www.scholar.google.com in last five years.

**Figure 2.1: Radar Graph for search terms GSCM Barriers on www.scholar.google.com in last five years**




From the above figure, one can easily realize the importance of research work in the proposed field.

**2.2 Contributions of Researchers in the field of GSCM Barriers:** So far, the researchers around the world have contributed a lot in investigating the barriers in the successful implementation of GSCM practices. Gehlot et al. (2023) investigated GSCM practices in automobile industry, while

Yassin et al. (2022) performed an empirical study on drivers and barriers for solar energy companies. Proceeding in the similar manner, Narayanan et al. (2019) analyzed GSCM barriers in rubber products manufacturing industry whereas Mujumdar and Sinha (2018) analyzed the same in clothing industry. Kaur and Awasthi (2018) created a collection of literature on GSCM barriers whereas Gopal and Thakkar (2016) investigated for the same in automobile industry. Proceeding in the similar manner, Mangla et al. (2018) analyzed the barriers for effective circular supply chain management, and Gupta et al. (2020) investigated the barriers for sustainable supply chain in Indian manufacturing industries. Raut et al. (2017) investigated the critical success factors for oil and gas industries, whereas Luthra et al. (2016) investigated the same for automobile industries. Govindan et al. (2016) investigated the influential strength of factors for adopting GSCM practices in mining industry, whereas Luthra et al. (2011) adopted interpretive structural modeling approach to model the barriers in successful implementation of GSMC in Indian automobile industry. Table 2.1 present the lists of barriers investigated by different researchers.

**Table 2.1: GSCM Barriers**

| S. No | Researcher(s)(Year) | Barriers |
|---|---|---|
| 1. | Menon & Ravi(2021) | Lack of commitment from top management, Financial Constraints, Organizational culture inhibitive to sustainability/CSR, Lack of green purchasing, Lack of regulations and enforcement of environment standards, Lack of R&D on sustainability, Lack of training/ human expertise onsustainability, Resistance to change and adopting innovation in sustainability, Lack of performance metrics/evaluation standards on sustainability |
| 2. | Caldarelli et al.(2021) | Technological, Organizational barriers, Environmental barriers, Internal barriers, Environmental barriers, External barriers |
| 3. | Nazam et al. (2020) | Lack of sustainable outsourcing, lack of sustainable production and distribution, fear and resistance towards sustainable competitivenessand innovation, trust deficit on sustainable buyer–supplier relationship, lack of sustainable marketing and organizational culture, difficulty in sustainable knowledge sharing, complexity in adopting sustainable technology practices. |
| 4. | Kormych et al.(2019) | Lack of government support policies, Lack of government regulation and legislation, Corruption, Market competition and uncertainty, Lack of demand and public awareness, Lack of internal sustainability audits within the organization, Lack of integration of IT system |
| 5. | Dhull and Narwal(2016) | Lack of skilled human resource in implementation of GSCM, Poor supplier commitment, Not willing to change trade information, Lack of government support |
| 6. | Dube and Gawande (2014) | Lack of integration of IT system, Lack of acceptance of advancement in new technology, Poor organizational culture in GSCM, Lack of skilled human resource professionals in sustainability and GSCM etc |
| 7. | Balaji et al. (2014) | Lack of government regulation and legislation, Lack of knowledgeand experience, Cost of implementation of green supply chains, Lack of top management support, Technology |
| 8. | Dashore and Sohani (2013) | Challenges like Lack of skilled human resource professionals in sustainability and GSCM, Uncertainty and competition in market. Lack of government initiatives system for GSCM practitioners, Poorimplementation of green practices within a supply chain, Lack of top level management commitment |

**2.3. Gaps in the Research:** Following points represent the investigated gaps found from the survey of available literature:

1. There were very limited numbers of research papers which focused on casual relationships among the barriers;
2. There were very limited research papers which focused on rankings on barriers.

## 3. SOLUTION METHODOLOGY

The present research used the DEMATEL technique for solving the research problem. DEMATEL (Decision Making Trial and Evaluation Laboratory) is a pairwise comparison based decision making technique. It is used for investigating the model of casual relationships among the variables. The basic advantage of this technique is that with this technique the experts become able to be more comfortable in expressing their opinions about the variables. Following points represent the stepwise procedure of the technique:

**Step 1: Generation of Direct relation Matrix (X)**

To identify the model of the relations among the n criteria, an n × n matrix is first generated, as follows.

$$X = \begin{bmatrix} 0 & \cdots & x_{n1} \\ \vdots & \ddots & \vdots \\ x_{1n} & \cdots & 0 \end{bmatrix} \quad (3.1)$$

**Step 2: Computation of Normalized Direct-relation Matrix (N)**

In the next step, direct-relation matrix (N) was created, as follows.

$$N = \frac{1}{k} * X \quad (3.2)$$

... where, $k = max\{max \sum_{j=1}^{n} x_{ij}, \sum_{i=1}^{n} x_{ij}\}$

**Step 3: Computation of Total Relation Matrix (T)**

In the next step, direct-relation matrix (T) was created, as follows.

$$T = N \times (I - N)^{-1} \quad (3.3)$$

**Step 4: Setting of Threshold Value**

In the next step, the threshold value was decided for obtaining information for further analysis. It is used to calculate internal relationship map, on the basis of which, the partial relations are neglected and network relationship map is plotted. In order to compute the value of threshold value, average value of matrix T is calculated. In the next step, all the values smaller than threshold value in T matrix are set to zero. In the present research work, the threshold value is equal to 0.142.

**Step 5: Final Output and create a Causal Diagram**

In the next step, final outputs in the terms of D+R and D-R are calculated, using the following expressions, and cause effect diagram is created.

$$D = \sum_{j=1}^{n} T_{ij} \quad (3.4)$$

$$D = \sum_{j=1}^{n} T_{ij} \quad (3.5)$$

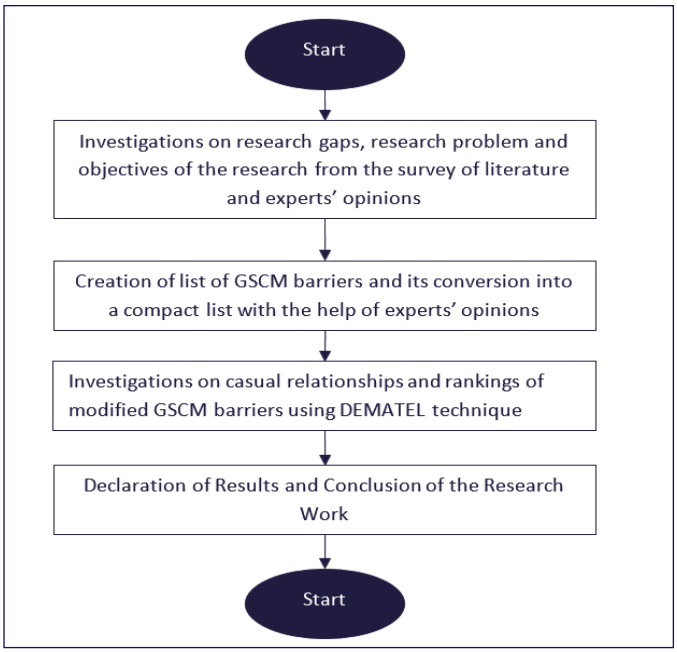
**Step 6: Interpretation of Results**

In the next step, results are interpreted from cause effect diagram. D+R represents the degree of importance between each factor, whereas D-R represents the degree of factor's influence on the system. In general, positive value of D-R represents a casual variable its negative value indicates an effect.

## 4. CASE STUDY

Figure 4.1 represents the stages of obtainment of solution of the research problem.

**Figure 4.1: Stages of obtaining solution from Research Problem**




Details of different stages mentioned in Figure 4.1 are presented as follows:

First of all with the help of the survey of available literature and experts' opinions, research gaps, problem formulation as well as objectives of the research were finalized;

In the next stage, a list of GSCM barriers was investigated and converted into a compact one with the help of experts' opinions, as a result of which following GSCM barriers were identified for the purpose analysis were cost factors, lack of resources, lack of awareness, lack of management commitments, and heavy workloads.

In the next stage, investigations on the casual relationships and rankings of GSCM barriers were made using DEMATEL technique, as follows:

First of all, the direct relation matrix was created as follows.

**Table 4.1: Direct Relation Matrix**

| | Cost Factors | Lack of Resources | Lack of Awareness | Lack of Management Commitments | Heavy Work Loads |
|---|---|---|---|---|---|
| **Cost Factors** | 0 | 0 | 0 | 0 | 0 |
| **Lack of Resources** | 3 | 0 | 1 | 0 | 0 |
| **Lack of Awareness** | 4 | 4 | 0 | 4 | 4 |
| **Lack of Management Commitments** | 4 | 3 | 2 | 0 | 4 |
| **Heavy Work Loads** | 2 | 1 | 1 | 1 | 0 |

In the next step, the normalized direct-relation matrix was computed, as follows.

**Table 4.2: The normalized Direct-Relation Matrix**

| | Cost Factors | Lack of Resources | Lack of Awareness | Lack of Management Commitments | Heavy Work Loads |
|---|---|---|---|---|---|
| **Cost Factors** | 0 | 0 | 0 | 0 | 0 |
| **Lack of Resources** | 0.188 | 0 | 0.062 | 0 | 0 |
| **Lack of Awareness** | 0.25 | 0.25 | 0 | 0.25 | 0.25 |
| **Lack of Management Commitments** | 0.25 | 0.188 | 0.125 | 0 | 0.25 |
| **Heavy Work Loads** | 0.125 | 0.062 | 0.062 | 0.062 | 0 |

In the next step, the total relation matrix was computed, as follows.

**Table 4.3: The total relation matrix**

| | Cost Factors | Lack of Resources | Lack of Awareness | Lack of Management Commitments | Heavy Work Loads |
|---|---|---|---|---|---|
| **Cost Factors** | 0 | 0 | 0 | 0 | 0 |
| **Lack of Resources** | 0.216 | 0.022 | 0.067 | 0.018 | 0.021 |
| **Lack of Awareness** | 0.45 | 0.346 | 0.079 | 0.291 | 0.343 |
| **Lack of Management Commitments** | 0.395 | 0.26 | 0.168 | 0.061 | 0.307 |
| **Heavy Work Loads** | 0.191 | 0.102 | 0.082 | 0.086 | 0.042 |

In the next step, the threshold value of 0.142 was finalized and the total-relationship matrix by considering the threshold value was computed.

**Table 4.4: The Total- Relationships Matrix by considering the Threshold Value**

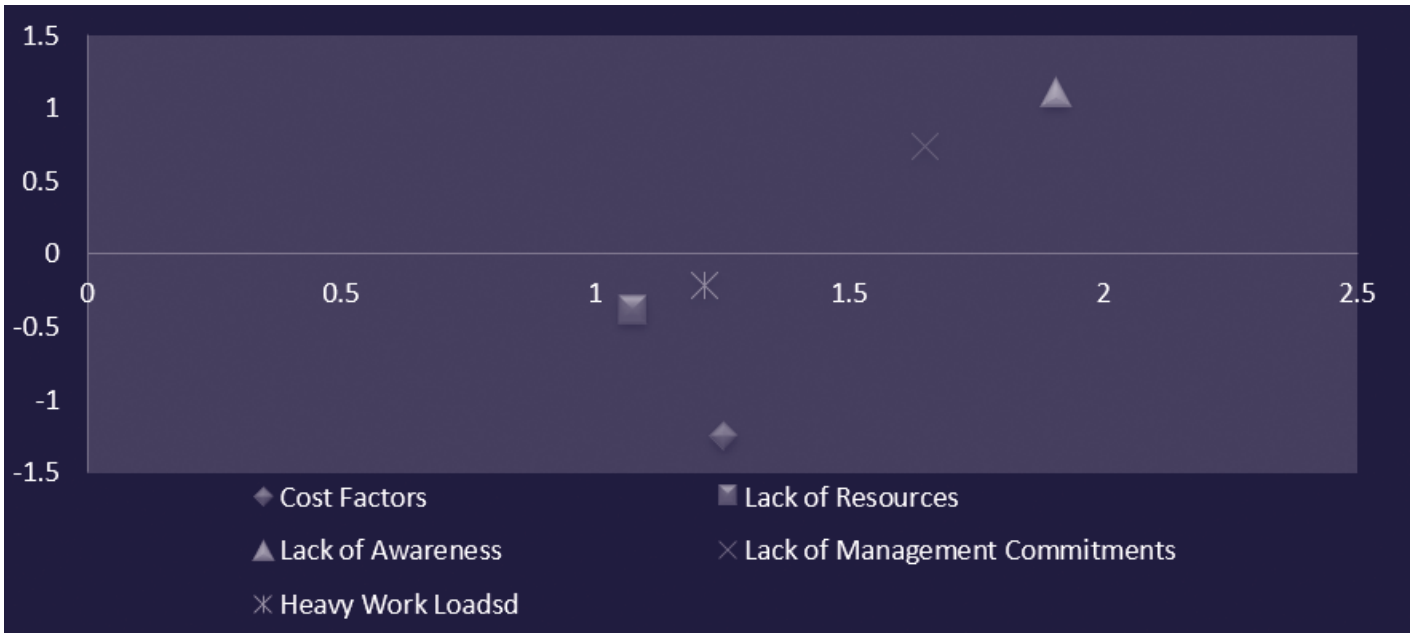
| | Cost Factors | Lack of Resources | Lack of Awareness | Lack of Management Commitments | Heavy Work Loads |
|---|---|---|---|---|---|
| Cost Factors | 0 | 0 | 0 | 0 | 0 |
| Lack of Resources | 0.216 | 0 | 0 | 0 | 0 |
| Lack of Awareness | 0.45 | 0.346 | 0 | 0.291 | 0.343 |
| Lack of Management Commitments | 0.395 | 0.26 | 0.168 | 0 | 0.307 |
| Heavy Work Loads | 0.191 | 0 | 0 | 0 | 0 |

In the next step, final output was investigated and the cause-effect diagram was created, as follows.

**Table 4.5: The Final Output**

| | R | D | D+R | D-R |
|---|---|---|---|---|
| **Cost Factors** | 1.252 | 0 | 1.252 | -1.252 |
| **Lack of Resources** | 0.729 | 0.344 | 1.074 | -0.385 |
| **Lack of Awareness** | 0.397 | 1.51 | 1.907 | 1.112 |
| **Lack of Management Commitments** | 0.456 | 1.191 | 1.648 | 0.735 |
| **Heavy Work Loads** | 0.713 | 0.503 | 1.216 | -0.211 |

**Figure 4.2: The Cause-Effect Diagram**




## 5. RESULTS AND DISCUSSION

Following results are obtained as the result of research work:

1. GSCM barrier, Lack of awareness scored the first rank, whereas lack of management commitments scored the second rank and other factors ranked accordingly on the basis of their scores, as shown by horizontal scores on the cause-effect diagram; and
2. Lack of awareness and lack of management commitments are considered to be as a causal variable, while cost factors, lack of resources, heavy work loadsd are regarded as an effect.

On the basis of above results one can easily realize the importance of awareness for GSCM for any industry, because if there is not any awareness about the GSCM, no one in the firm shall take any kind of initiative. Awareness also creates a sense of self responsibility towards nature. Other than, awareness, management commitments also play important for bringing in the green prosperity in the firm, because the wind of change always flows from higher levels to the lower levels. Besides these two factors, cost factors, heavy workloads as well as lack of resources are also important in implementing green changes in the organization. The results also show that lack of awareness and lack of management commitments are form the casual variable whereas the other three barriers form the effect variable, which is also a self-explanatory result.

## 6. CONCLUSION, LIMITATIONS AND FUTURE SCOPE OF THE RESEARCH

The present research work was based on the investigations on cause-effect relationships among GSCM barriers as well as their rankings, as a result of which the barrier, lack of awareness scored the first rank and lack of management commitment scored the second rank, and Lack of awareness and lack of management commitments are considered to be as a causal variable, while cost factors, lack of resources, heavy work loadsd are regarded as an effect variable. Considering the dire need of time, the present research work should be fruitful for upcoing researchers and industrialists.

Following are the limitations of the research work:

1. The research work is limited a particular number of GSCM barriers; and
2. The research work is also limited to a particular investigation technique.

Following points represent the future scope of the research work:

1. A broader research work involving a greater numbers of barriers may be initiated; and

An extensive research consisting a large number of investigation techniques may be started.

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