

# Analysis of Dimensions of Green Supply Chain Using DEMATEL Method

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## Abstract

Green Supply Chain Management (GSCM) is where the SCM objective is fulfilled by giving preference to eco-friendly ways. Green practices in Supply Chain have capabilities to reduce environmental impact, increase environmental consciousness, to deal with the reduction in pollution, to eco-friendly product design, development, and production, to deliver products and services, to recycle and remanufacture things. The implementation of GSCM is governed by several dimensions, which need to be analyzed. This study identifies those dimensions using DEMATEL methodology and divides them into cause-and-effect nature. DEMATEL methodology also weighs the dimensions on their importance and their affecting weight on other dimensions. It ranks them on their importance based on cause-and-effect criteria which help in the prioritization of dimensions. This study also shed some light on why these dimensions need to be analyzed and what could be the most priorities dimension in the implementation of GSC sets and the DEMATEL Technique.

## Keywords

Green supply chain management, DEMATEL, Environmental strategy, Top management support, Green outsourcing, Reverse logistics

## Introduction

In this advancing world, the advancement of technology and innovation and harnessing of resources at a huge level has a huge impact on our environment. The vast utilization of resources affects our earth in various ways, like an increase in CO<sub>2</sub> level in the environment [1] which lead to increasing global warming, e-waste [2], various chemicals that cause contamination, and other pollution.

To tackle these, companies, governments, and humans start developing awareness and responsibilities toward the environment and earth. This awareness forces the companies to shift their goal of only profit to environmental welfare. As we know, to get a competitive edge and to fulfill govt policies and criteria, companies are shifting from company vs. company to supply chain vs. supply chain concept [3].

GSCM is the way where SCM objective is fulfilled by giving preference to eco-friendly ways as firms start their designing, planning, and operation framework with keeping the environment in mind.

GSCM is a process where products, services, and funds are transferred from their raw form to finished form to their end user by integrating the environmental process into their traditional supply chain [4, 5].

To implement green technologies in every sector, phase and operation, there are some major dimensions where we have to look forward to implementing

green or environmentally friendly ways. These dimensions need to be analyzed so that we can tackle the environmental issues [6]. The objective of this study is to identify, analyze and establish the relationship between dimensions of GSCM.

Integrated DEMATEL (Decision Making Trail and Evaluation Laboratory) approach has been followed to analyze the dimensions. In it, the “No Influence” to “Very High Influence” technique establishes the relationship between the dimensions. Since the initial opinion is subjective, it is less sensitive. Hence normalized inputs are used to make the DEMATEL more sensitive. It considers the extent of effectiveness and to find the relation between the dimensions, expert opinions have been taken into account.

The remaining layout of this work is organized as follows. The literature related to this work and GSCM dimensions is provided in section 2. Research methodology and DEMATEL technique are explained in section 3. The Cause-Effect diagram is explained and shown in section 4. Discussion of results and implications is explained in section 5. Finally, conclusions and future potential in the area are explained in section 6.

## Literature Review

This section provides the literature about GSCM practices, various dimensions in GSCM, and the benefits of green practices over the traditional SC.

**GSCM:** In SCM study and practice, environment-friendly choices are becoming increasingly significant. A survey of the literature suggests that a comprehensive framework for GSCM has yet to be defined. Regulatory bodies that develop regulations to solve social and environmental challenges suffer in their absence. Businesses and the economy struggle to thrive in their absence. A short summary classification system is needed to help academics, researchers, and practitioners understand the broader perspective of GSCM. A more integrated GSCM is necessary from a broader perspective. Furthermore, there is much literature available to justify a categorization like this. This work presents a comprehensive and innovative approach to the field of GSCM. The literature on GSCM is carefully explored from its inception and conception, mainly from the perspective of designing, planning, and operation framework [7].

**GSCM dimensions:** A literature search, published interviews with industry experts, and industry reports were utilized to determine the parameters in the implementation of the green supply chain. Specialists then examine these dimensions to determine their importance, and they are chosen in such a way that a link can be built between them. Fifteen GSCM dimensions, listed in table 1, are selected for this study.

## Research Methodology

Using dimensions from academic journals, published interviews, and industrial reports, we'll now determine the link between these dimensions. DEMATEL methodology will be used as it is a popular tool for creating and analyzing structural models that include causal connections between criteria. The basics of the DEMATEL technique are addressed below to

lay the framework for expanding the DEMATEL approach for group decision-making. DEMATEL methodology turn illegible data into understandable and well-defined data [18]. Due to the length restriction of the paper, DEMATEL methodology will not be further discussed.

## Cause and effect model development

The main idea behind the DEMATEL approach is to partition a complex system into several subsystems and create a cause-effect model using insights derived from literature research and specialists' knowledge experience. This justifies the use of DEMATEL approach used to examine the link between dimensions and GSCM.

**Identifying decision goals:** The GSCM dimensions identified in this paper have mostly been carried out via mobilizing various types of literature review. Considering the following electronic database: Elsevier (Science direct), Emerald Insight, Scopus, and Springer over the 2006-2021-time frame period, including scientific papers, journals, articles, government reports, and business reports from companies. Fifteen GSCM adoption dimensions are selected for the final study mentioned in section 2.2. The contextual relationship among dimensions was developed by using an extensive literature review and expert opinion. In this study, the expert opinion of 3 experts from academia having Ph.D. as minimum qualification and experience of more than 5 years in area of SCM and 4 experts from industry having profile of senior manager have been considered.

**Direct relation matrix:** Experts make pairwise comparison matrices of order  $n \times n$  between dimensions with the help of five points linguistic scale, where 0 indicates “No Influence” and 4 indicates “Very High Influence”. The formula of the direct relation matrix is shown in equation (1).

$$Z = [Z_{ij}]_{n \times n} \quad (1)$$

**Total relation matrix:** Total Relation matrix shows the final matrix with direct or indirect effects with the formula shown in equation (2).

$$T = Y * (I - Y)^{-1} \quad (2)$$

Where, Y is the normalized matrix of Z, and I is an identity matrix of order  $n \times n$ .

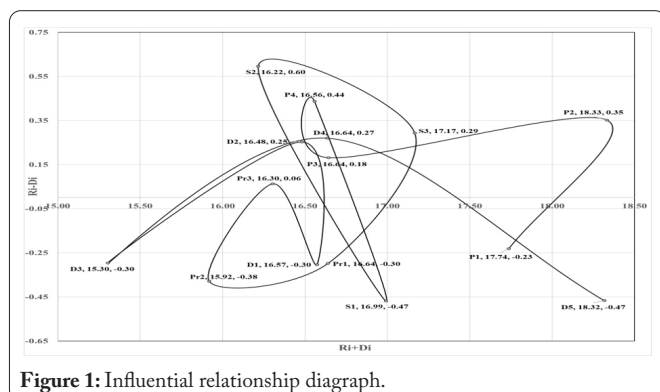
## Influential relationship matrix

In this paper, the fifteen dimensions were identified based on an extensive literature review and expert opinion. Among cause element, ‘Environmental Strategy’ plays the most dominant role among them which is followed by ‘Green Outsourcing’ then ‘Top Management Support’, ‘Green Distribution’ later by ‘Environmental Education and Training’ and ‘Green Packaging’ then ‘Manpower Involvement’ and then ‘Green Procurement’. Among effect elements, ‘Supplier Evaluation and Selection’ is the topmost effect criteria which is followed by ‘Reverse Logistics’ then ‘Eco-Friendly Products’, ‘Green Marketing’, ‘Green Manufacturing’, ‘Green warehousing’, and then ‘Eco-design’ as shown in table 2.

Table 1: GSCM Dimension.

Sr. No	Dimension	Description	Notation	Reference
1	Eco-design	A planned method aimed at lowering environmental effect across the whole life cycle, from raw material extraction through trash disposal or end destination.	P1	[8, 9]
2	Environmental Strategy	Considers ways for developing environmental objectives and plans that are aligned with the SC strategy, such as ISO 14,000-like certifications, eco-labeling, and cleaner manufacturing processes.	P2	[8, 10]
3	Top Management Support	Establish controls, undertake long-term planning, provide complete financial and technical support, and inspire staff to implement resource management in SC.	P3	[11, 12]
4	Environmental Education and Training	Employee training and education is a planned and systematic attempt to alter or improve knowledge/skill/attitude through 'learning' experience in order to achieve successful performance in an activity or set of activities.	P4	[5, 11, 13]
5	Supplier Evaluation and Selection	Choosing suppliers on the basis of their green practice in raw material extraction or services.	S1	[4, 14]
6	Green Procurement	Supplier selection based on environmental criteria means Purchasing environmentally appropriate raw materials. Putting pressure on the supplier to implement environmental measures.	S2	[5, 8, 9]
7	Green Outsourcing	The eco-friendly way to avail service, operation or semi-finish goods besides the internal operations.	S3	[14]
8	Green Manufacturing	Green manufacturing is the new approach to producing items. Green manufacturing, like any other green activity, focuses on conserving resources and reducing waste.	Pr1	[8, 9, 14]
9	Eco-friendly products	Considers the design of environmentally sustainable goods, taking into account the complete life cycle and waste reuse.	Pr2	[8, 15]
10	Manpower Involvement	Considering human resources in companies' operations framework such as planning, manufacturing, and distribution.	Pr3	[11, 16]
11	Green Marketing	Marketing with minimum damage to the environment such as digital mode of advertising, eco-friendly way to make aware the customer about products.	D1	[8, 17]
12	Green Packaging	Using environmentally responsible packaging that may be returned, re-used, or recycled.	D2	[5, 14]
13	Green Warehousing	An eco-friendly place to store goods and services that utilize renewable energy in their operation.	D3	[14, 8]
14	Green Distribution	Using eco-friendly transportation systems that use green fuels such as LPG, CNG, hydrogen, and hybrid vehicles in transportation.	D4	[8, 14, 17]
15	Reverse Logistics	The return of materials, components, and products into the 'forward logistics' chain is referred to as reverse logistics.	D5	[8, 9, 14]

All the fifteen dimensions are drawn based on D+R and D-R values to the obtained causal diagram as can be seen in figure 1, which shows the dimensions as cause and effect.



## Results and Discussion

The final DEMATEL model created with the aid of the total relation matrix clearly demonstrates that 'Environmental Strategy', 'Reverse Logistic', 'Eco-Design', 'Green Outsourcing', 'Supplier Evaluation and Selection', 'Top Management Support', 'Green Manufacturing', and 'Green Distribution' are crucial dimensions in implementation of green supply chain management and these dimensions are then followed by 'Green Marketing', 'Environmental Education and Training', 'Green Packaging', 'Manpower Involvement', 'Green Procurement', 'Eco-friendly Products', 'Green Warehousing' and all these dimensions combined leads to the implementation of green supply chain in an organization.

Among all the cause group dimensions, P2 has the highest (R+D) score indicating that it is the essential element [11,

**Table 2:** Influential relationship matrix.

Sr No.	Influential Relationship Matrix (IRM)	Notation	Ri	Di	Ri+Di	Rank	Ri-Di	Rank	Nature
1	Eco - Design	P1	8.75	8.98	17.74	3	-0.23	7	E
2	Environmental Strategy	P2	9.34	8.99	18.33	1	0.35	13	C
3	Top Management Support	P3	8.41	8.23	16.64	6	0.18	9	C
4	Environmental Education and Training	P4	8.50	8.06	16.56	10	0.44	14	C
5	Supplier Evaluation and Selection	S1	8.26	8.73	16.99	5	-0.47	1	E
6	Green Procurement	S2	8.41	7.81	16.22	13	0.60	15	C
7	Green Outsourcing	S3	8.73	8.44	17.17	4	0.29	12	C
8	Green Manufacturing	Pr1	8.17	8.47	16.64	7	-0.30	5	E
9	Eco-Friendly Products	Pr2	7.77	8.15	15.92	14	-0.38	3	E
10	Manpower Involvement	Pr3	8.18	8.12	16.30	12	0.06	8	C
11	Green Marketing	D1	8.13	8.44	16.57	9	-0.30	4	E
12	Green Packaging	D2	8.37	8.11	16.48	11	0.25	10	C
13	Green Warehousing	D3	7.50	7.80	15.30	15	-0.30	6	E
14	Green Distribution	D4	8.45	8.18	16.64	8	0.27	11	C
15	Reverse Logistics	D5	8.92	9.39	18.32	2	-0.47	2	E

13]. P3 has a (R+D) score of 16.64, indicating that it has influence on the other dimensions [11], and P4 has 16.56 as (R+D) score implies that it is critical for improving GSCM's business success. It will contribute to long-term business development [13]. S2 has (R+D) score of 16.22, indicating it affects the other dimension and also helps the organization to practice green in their operations [11, 12]. S3 has (R+D) score of 17.71 implies that the green practice among outsourced stakeholders leads to the external involvement of GSCM [11, 14]. Pr3 has (R+D) score 16.33, indicating that this factor impacts other dimensions [11, 13]. D2 and D4 have acted as influencing factors for the overall implementation of GSCM [14].

Factors in the effect category are easily changed by other factors. However, while these group characteristics do not have a direct influence on the system, they do make a major contribution. P1 has (R+D) score of 17.74, indicating that it receives impact by other dimensions to a great extent [11, 13]. S1 has (R+D) score of 16.99 implies that it is the most influenced dimension after P1. Many criteria come into the picture in the selection of suppliers, such as material extraction in eco-friendly ways, have a legal way of extractions, etc. [11, 18]. Pr1 has (R+D) score of 16.64, indicating that this dimension receives impact by others. This dimension means less generation of waste and minimum pollution during manufacturing [18, 19]. Pr3 has (R+D) score of 15.92 implies that it receives influence from other factors, and this also gives a competitive edge in the market and D3 has 15.30 as (R+D) score implies it is impacted by other dimensions [19]. D1 has (R+D) score of 16.57 implies that other dimensions affect it. Marketing in an eco-friendly way has a good impact among customers [13]. D5 has (R+D) value of 18.32 give that is affected by other dimensions. It is an approach of remanufacturing, reuse, repair

the used product that helps in GSCM practice.

Some factors like 'Environmental Strategy', 'Top Management Support', 'Govt. Rules and Regulations' are the forcing elements that make the organization adopt green practices. Govt. start instructing the stakeholders of firms to implement green practices in their organizations. Supplier selection on the basis of their environmental performance and the way they extract their raw material, funds, data etc. must be free from illegal or conflict metals. In firms' internal operations, green procurement and outsourcing are the very beginning process of green practices. Manufacturing with workforce involvement has a good influence on an organization, so to implement green practices. Nowadays, the customer is becoming environmentally conscious. These things push the firms to start producing eco-friendly products. Marketing has a severe role to aware customers about company's products and operations. Distribution is the field where practicing green is very important because a large number of resources are consumed in product distribution. The government has also started new technologies to bring down the inverse impacts, such as subsidies E-vehicles to boost the green adoption in distribution, hydrogen as an alternate fuel for the future. Now reverse Logistics has started a new chapter in SCM, and many e-commerce has implemented it in their operation, such as Flipkart, which started taking the old electronic gadget to refurbish to reuse their components.

### Conclusion

This research highlights the dimensions that are prevalent in the adoption of Green Supply Chain, finds their cause-and-effect elements and weighs them using DEMATEL



methodology. This study shows that out of the 15 dimensions identified, 8 fall into the cause group and 7 fall into the effect group. Eco-design came out to be the most prevalent dimension according to our study. A number of researcher and SCM organization experts also agrees on the point that with the advancement of GSC based startups, GSC practice adoption is gaining momentum, but there are various dimension or factors where we have to focus to pace the implementation of GSC. Institutions and organizations need to come together to do further research in various dimensions of GSC, and organizations can help institutions to choose research as per their needs. To motivate about practicing of GSC, some valuable interacting sessions can be organized within the organization about green practices and their benefits so that there will be familiarization with green operations in their works.

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## Conflict of Interest

There is no conflict of interest.

## Credit Author Statement

Kunal Saurabh and Manish Gupta: Design, Experimentation, Data analysis; Anuj Kumar Bhamriya: Writing - original draft preparation, Writing - review and editing. All the authors read and approved the manuscript.

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