INTERNATIONAL STRATEGIC MANAGEMENT REVIEW 3 (2015) 96–109

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INTERNATIONAL STRATEGIC MANAGEMENT REVIEW
USEK HOLY SPIRIT UNIVERSITY OF KASLIK

Evaluating factors in implementation of successful green supply chain management using DEMATEL: A case study

Sumeet Gandhi[a], Sachin Kumar Mangla[b*], Pradeep Kumar[c], Dinesh Kumar[d]

[a,b,c,d] *Department of Mechanical and Industrial Engineering, Indian Institute of Technology, Roorkee 247667, India*
[b]*Assistant Professor, Department of Mechanical Engineering, Graphic Era University, Dehradun- 248002, India*

ARTICLE INFO

Article history:
Received 23 March 15
Received in revised form 09 May 15
Accepted 11 May 15

Keywords:
Green Supply Chain Management
Evaluation factors
DEMATEL
Causal diagram.

ABSTRACT

Increasing pressures from stakeholders, government and non-government agencies are forcing the industries to implement Green Supply Chain Management (GSCM) initiatives. A successful implementation of GSCM is important for industries to increase economic-environmental performances and to ensure sustainability in business. The prime objective of this research is to evaluate the important factors associated with the successful implementation of GSCM. This paper proposes a Decision Making Trial and Evaluation Laboratory (DEMATEL) approach to develop a structural model for evaluating the influential factors among recognized factors. The proposed DEMATEL method enables to study the interrelationship between the evaluated factors through a causal diagram. To show the real-life applicability of the proposed DEMATEL based model, an empirical case study of an Indian manufacturing company is conducted. Research findings indicate that Top Management Commitment, Human Technical Expertise, Financial Factors, has obtained the highest influential power for accomplishing the successful GSCM adoption. Conclusions and implications for managers are also discussed.

1. Introduction

Supply Chain Management (SCM) is one of the most promising research fields in the area of Operations Management. SCM includes various activities starting from the collection of raw material from the sources until the final product reaches in the hands of the customer [5]. Curbing the ill-effects caused by the industries by their traditional SCM practices is one of the major objectives of all the nations and environmental regulatory bodies [60]. One of the best and most effective ways to achieve this objective is by integrating the traditional supply chain practices with environmental friendly practices, which results in a novel concept named Green Supply Chain Management (GSCM) [29, 39, 42, 46, 61]. GSCM can be defined as, "incorporating environmental thinking into SCM, including product design, material sourcing and selection, manufacturing practices, delivery of the final products to the consumers, and end-of-life management of the product after its intended life" [54].

Over the past few years, GSCM is playing an important role in the building of sound economic-environmental performances on various levels in business [2, 46, 59, 61]. This fact can be made evident by back-tracking the growth of industries in developed nation which are engaged in successful implementation of GSCM in their organization. On the contrary, the industries in developing nations like China, India, Taiwan, are still struggling to implement GSCM in their respective industries [4]. Moreover, the building pressure from the international environmental bodies on such nation is paving the way for increased research in the GSCM area to find out the means and corresponding factors for the successful implementation of GSCM [36]. In spite of this, industries, are still struggling to integrate green initiative into their traditional approach. It may be due to their lack of knowledge or lack of

* *Corresponding author.* Tel.:+91-9416824761; fax: +91-9416824761.
E-mail address: sachinmangl@gmail.com

Peer review under responsibility of Holy Spirit University of Kaslik.

http://dx.doi.org/10.1016/j.ism.2015.05.001

expertise in the subject matter [31, 37]. The other reason behind this could be the cost involved in GSCM adoption initiatives [37]. Therefore, to implement GSCM concepts to the point of view of industries, they must be aware of its long term effects in terms of economic benefits, market share, etc. It should be noted that there are various critical factors either external or internal may be associated with an organizational supply chain and are responsible for to plan and implement GSCM concepts [56]. It may include globalization, export norms and regulations, supplier, economic, competition, etc [28, 32, 56].These factors and attributes can accelerate its transition from traditional supply chain to green supply chain (GSC). In view of this, it is important for industries to know the factors related to successful implementation of GSCM. However, any inadequacy in understanding of these factors may further increase the difficulty in implementing the process GSCM from an industrial context. To resolve the issue, researchers are playing a very crucial role in addressing the factors crucial to understand and evaluate the addition of green concepts in the supply chain scenario [7, 25]. In addition, some studies have been conducted that analyzes the drivers/critical success factors/variables related to GSCM implementation by taking the case of various industrial sectors, such as, Mining, Automobile, Paper [7, 25, 28, 32]. These studies indicate that the results obtained hold true for the sector under study. It is therefore proposed a great need to carry out the studies on GSCM success factors identification and their evaluation in manufacturing sector as well [28, 32]. This paper addresses the above-mentioned research gap by evaluating of factors relevant to successful implementation of GSCM initiatives in manufacturing industry in Indian Context. For this, we propose to use the DEMATEL method that not only helps to define the causal relationship between each factor, but also assists to define the importance of each factor with respect to one another [54].

The present research work aims to achieve the objective, mentioned as - Understanding and evaluating of green supply chain management agenda from industrial perspectives. The above mentioned objective has been designed on the basis of fact that the industries in India are still very slow to address the issues pertaining to environment [25]. Therefore, it is becoming vital for them to incorporate GSCM initiatives within their work culture. Hence, to resolve the difficulty in implementing green aspect in the business, this research raises two analysis questions, as follows:

i. What are the factors need to be considered in a successful implementation of GSCM?
ii. How the causal relations among the identified factors in successful adoption and implementation of GSCM should be determined?

The prime purpose of the present research work is to develop a framework to analyze the factors in GSCM dimension. To achieve the above mentioned objective and to answer the raised questions, this research work is carried out in two parts. In first part of the study, the factors critical for the successful implementation of GSCM in context to the Indian Manufacturing Industries has been searched out by means of literature review and expert inputs. In the second part of this study, these factors are evaluated using DEMATEL technique that helps to recognize the causal relationship of all factors within one another. In addition, it also helps in dividing the factor under evaluation into cause and effect group. According to the findings obtained in this study, the factors Government Regulations and Standards (F1), Top Management Commitment (F2), ISO 14001 Certifications (F3), Globalization (F4), Competitiveness (F5), Customer Requirements (F6), Role of Supplier (F7), Employee Involvement (F10), Role of Stakeholders, NGO and Media (F11), Technical Expertise (F12) and Training of Supplier and Employees (F16) are divided into cause group factors. While the Financial Factors (F8), Brand Image Building (F9), Adoption of New Technology and Processes (F13), Sustainability (F14) and Reverse Logistics (F15) comes under effect group.

The rest of this paper include: Section 2 offers the literature survey on the GSCM along with the factors proposed for successful implementation of GSCM. Section 3 describes the proposed model based on the DEMATEL method. Section 4, presents the real-life application of the proposed model, and discusses the results and managerial implications of the research. The conclusions, limitations of the research, and scope for next work are given in Section 5.

2. Literature Review

2.1. Green supply chain management

Increased deterioration of the environment has raised concerns amongst various researchers and academicians. Therefore, many articles have been published in past few years related to GSCM [10, 13, 34, 39, 59]. GSCM is expressed as the addition of environmental contemplation in the business. It has been stated as a useful measure to increase the ecological performance of the enterprise and to reduce the environmental risks [32, 62]. In addition, in a recently conducted study, GSCM has also been linked to human resource management to achieve organizational sustainability and truly sustainable supply chains [25]. GSCM has been recognized as a key part to influence organizational sustainability [48]. In the today's era of globalization, GSCM increases various opportunities for buyers by increasing their focus on improving the environment which not only enhances the process of greening the environment but also increases environmental-economic performances in the supply chain [46].
According to the study of Hervani et al. [15], GSCM comprises of green procurement, green manufacturing or materials management, green distribution or marketing and reverse logistics. It has also been stated that organizations tend to implement GSCM to improvise their competitive advantages and to achieve enhanced profit ratios [29, 51]. Rao and Holt [46], in their work expressed that GSCM is an important organizational attitude, which acts as a significant player in encouraging efficiency and synergy between allies. The implementation of GSCM generates several gains at industrial context, which can be listed as: maximization of environmental performance, minimum waste generation, cost savings resulting in increased profit and market-share objectives etc. The application of green initiatives in the supply chain also helps in improving the ecological proficiency of organizations and their associates. Besides that, an efficient implementation of GSCM in any organization plays a crucial role in acquiring and maintaining competitive gains [62]. Therefore, many researchers had made it evident in their work the GSCM implementation is very vital and result oriented that keep in view the environmental aspects of the organization as well.

2.2. Proposed factors related to implementation of GSCM in a successful manner

Several studies have been conducted to explore the factors in implementation of green in the supply chain. For instance, Diabat and Kanaan [7], listed eleven crucial factors related to efficient implementation of GSCM comprising of – Suppliers related factors, ISO 14001 implementation, government regulations, reverse logistics, etc. Hsu and Hu [17], also explored twenty factors in the Taiwan electrical and electronics industries critical for implementation of GSCM under four main dimensions (supplier management, organizational involvement, recycling and life cycle management). Walker et al. [56], identified the drivers and barriers to implement GSCM initiatives, which includes – internal drivers (such as organizational elements); external drivers (such as government regulation, customers, and competitors); internal barriers (such as cost and lack of legitimacy); as well as external barriers (such as poor regulation, less supplier commitment and industry specific barriers). Quazi and Wee [44], explored seven critical factors in their research for environmental management. Mangla et al. [33], analyzed fourteen variables associated with product recovery process in sustainability focused green supply chain. In another study, Mangla et al. [34], explored fourteen important factors related to GSCM implementation and analyze their effect on the overall performance. Luthra et al. [28], identified and analyzed twenty-five critical success factors in relation to adopt GSCM to achieve sustainability in Indian automobile industries. Duber-Smith [8], named ten reasons for a SME to adopt GSCM such as sustainability of resources, target marketing, lowered cost, increased efficiency, competitive advantage and product differentiation, brand reputation, pressure for various channels, adapting to regulations and reducing risk, employee morale, good return on investment and ethical imperative.

However, in the present study, based on extensive literature survey, total 16 factors related to the successful implementation of GSCM are recognized. These factors were further evaluated using the DEMATEL approach explained in the next section. The factors selected for evaluation are described in Table 1 as following:

Table 1 - Description of factors related to successful implementation of GSCM with their source.

Factors	Description	Source
Government Regulations and Standards (F1)	Central government as well as state government policies and schemes are proven to be one of the major factors for organizations to start up with green initiatives	Green et al. [13], Mangla et al. [34], Walker et al. [56], Zhu and Sarkis [59].
Top Management Commitment (F2)	The commitment of top management is key factor in implementation of GSCM	Dashore and Sohani [6], Walker et al. [56], Zhu and Sarkis [60].
Environmental Certifications (F3)	The environmental certifications are very important and acts as an initial step towards the green initiative	Diabat and Kannan [7], Rao and Holt [46], Zhu et al. [62].
Globalization (F4)	In today globalization era, it has become very important for the organizations to follow the global requirements and policies related to green implementation in business	Mangla et al. [33], Mollenkopf et al. [40], Walker et al. [56], Zhu and Sarkis [60].
Competitiveness (F5)	To sustain the competition in the market, it has become very important for the organization to inculcate the green practices in business activities	Mollenkopf et al. [40], Walker et al. [56], Zhu and Sarkis [60].
Customer Requirements (F6)	Due to increased awareness among the customer, the demand of green products has increased	Mangla et al. [34], Rao and Holt [46], Vachon and Klassen [55], Zhu et al. [62].
Role of Supplier (F7)	Supplier plays a very important role in increasing the GSC effectiveness	Hsu and Hu [17], Kannan et al. [19], Mangla et al. [32, 34].
Financial Factors (F8)	Financial decisions are important for the point of view of industries in initiation and adoption of GSCM practices	Mollenkopf et al. [40], Paulraj [42], Rao and Holt [46], Rao [47].
Brand Image Building (F9)	Incorporating green in organizational policy can help industries in building of its brand name in the market	Duber-Smith [8], Mangla et al. [34].
Employee Involvement (F10)	Employees are directly responsible for implementation of any policy or process in the organization, therefore, coordination and awareness among them plays a very important role in the initiation and sustainability of GSCM concept	Dashore and Sohani [6], Toke et al. [52], Walker et al. [56].

Role of Stakeholders, NGO and Media (F11)	These channels plays very important role by targeting the organization to follow eco-friendly means in business	Green et al. [13], Mathiyazhagan et al. [37], Mollenkopf et al. [40].
Human Technical Expertise (F12)	Human expertise and capabilities are crucial in implementing green practices from the standpoint of industry	Dashore and Sohani [6], Toke et al. [52], Zhu and Sarkis [59].
Adoption of New Technology and Processes (F13)	Adopting new processes and technology will result in increased efficiency and growth of the organization. Implementing GSCM is the need of the hour for the organizations	Hsu and Hu [17], Mathiyazhagan et al. [37], Perron [43].
Sustainability (F14)	Concerns of sustainability in the organizational supply chain helps to achieve ecological-economic benefits	Dashore and Sohani [6], Madaan and Mangla [29], Mathiyazhagan et al. [37].
Reverse Logistics (F15)	Reverse logistics is a part of GSCM. Companies can earn more profits by putting in place the reverse logistics mechanism and in a way it will help the conservation of resources	Holt and Ghobadian [16], Mangla et al. [33], Rao and Holt [46], Rao [47].
Training of Suppliers and Employees (F16)	Training and education of green is very much important at regular interval of time to increase the competency of the employees as well as suppliers and to improve the GSC success rate	Bowen et al. [2], Mathiyazhagan et al. [37, 38], Toke et al. [52].

3. DEMATEL Based Proposed Model

DEMATEL approach was devised by Science and Human Affairs Program of the Battelle Memorial Institute of Geneva between 1972 and 1976. This approach was synthesized to resolve the complex and intertwined problem groups [3, 41, 50, 53, 58]. This approach has been used by various researchers to analyze interrelationships among criteria in multi criteria decision problems [3, 32, 57]. Further, some other techniques like ISM may also be used for the analyzing the criteria interrelationships [7, 33, 37, 45]. In comparison to ISM, the methodology of DEMATEL assists in capturing the contextual relations between elements in the system and defines the strength of their interrelationships as well [22, 58]. DEMATEL helps to analyze the factors by classifying them into cause and effect group and illustrates the interrelationship between them through causal relationship diagram.

To illustrate the utility of DEMATEL in evaluating the multi-criteria decision making (MCDM) problems, for the reader's perspectives, a detailed comparison has been made among the DEMATEL, AHP, and ISM as shown in Table 2. However, a flow diagram for preparing the DEMATEL based model is shown in Fig. 1. And, the steps involved in applying the DEMATEL method are discussed as follows [53, 58].

Table 2 - A comparison to show the utility of DEMATEL with ISM and AHP as reported in literature.

DEMATEL	ISM	AHP
DEMATEL reveals the relationships among factors and prioritizing the criteria based on the type of relationships and severity of their effects on each other criteria.	ISM enables establishing of relationships among specific items/elements to define a problem by means of their dependency and driving power.	AHP does not consider indirect effects for each criterion and assumes that criteria are independent

Sources: Khurana et al. [20], Lin [22], Luthra et al. [26], Madaan and Mangla [29], Mani et al. [35], Wu [58].

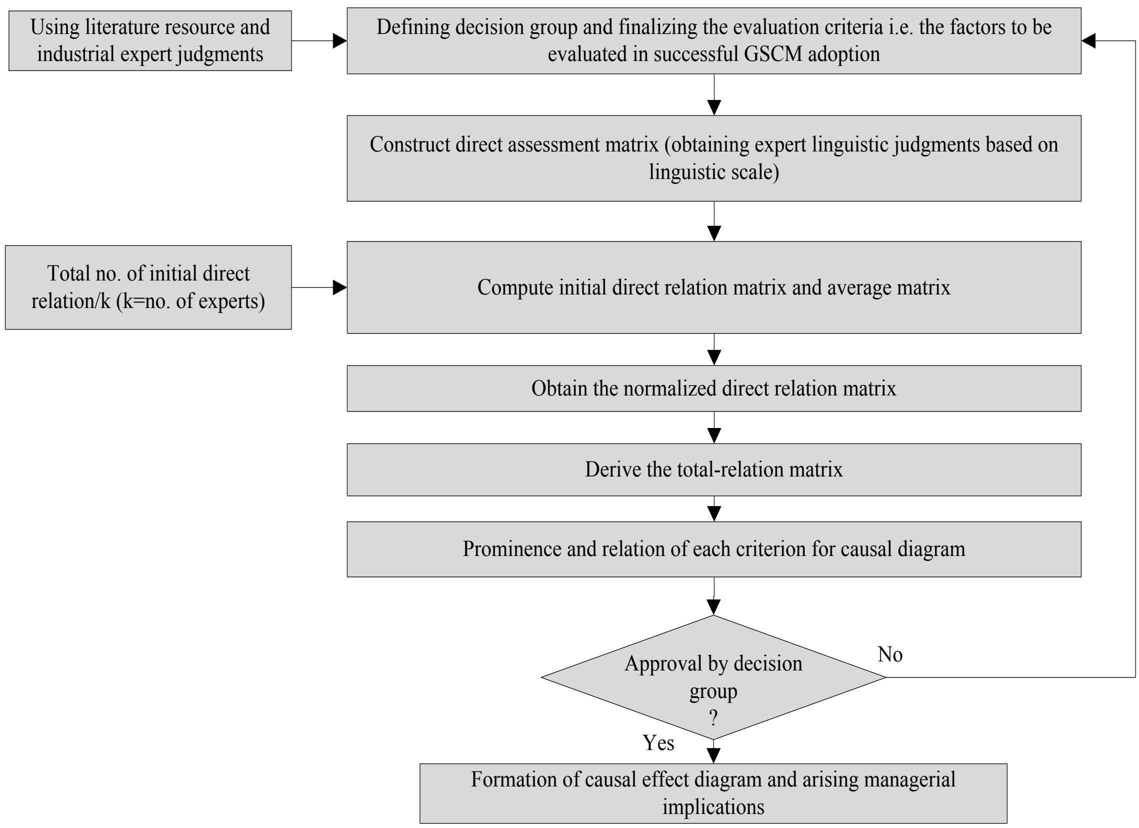

Fig. 1 - Flow diagram for preparing the DEMATEL based analysis model.

Step 1: Defining decision group and evaluation criteria: In this step, a critical review of literature is required to explore and gather relevant data. The expert's judgment is crucial in this, that's why a decision group of experts is necessary to form for discussion on the issue to achieve the objective. The probable factors associated with the successful GSCM are selected and finalized as evaluation criteria based on the information gathered and expert opinion.

Step 2: Derive the initial relation matrix and average matrix (A): Average matrix is formulated from the initial relation matrix which is based on the direct influence between any two factors and is obtained through the expert's judgment by asking them to score the factor on the basis of scale given as:

0 – 'No influence'; 1 – 'Little influence'; 2 – 'High influence'; 3 – 'Very high influence'.

The notation of x_{ij} specifies the extent to which the expert's judgment regarding factor i influences factor j. When i = j, set the value of that cell = 0, and this indicates the presence of no influence. For each respondent, (n × n) non-negative matrix can be devised as $X_k = [xk_{ij}]$, where 'k' is the number of respondents ($1 \leq k \leq H$); n is the number of factors. Therefore, X^1, X^2, X^3 . . . , X^H are the matrices from H respondents. To integrate all opinions from H experts, the average matrix $A = [a_{ij}]$ can be constructed as follows:

$$a_{ij} = \frac{1}{H}\sum_{K=1}^{H} x_{ij}^{k} \quad (1)$$

Step 3: Calculate the normalized initial direct-relation matrix (D): It can be accomplished by using the formula,

$$D = A \times S \quad (2)$$

Where, $S = \min\left[\frac{1}{\max\sum_{j=1}^{n}|a_{ij}|}, \frac{1}{\max\sum_{i=1}^{n}|a_{ij}|}\right]$

Each component in matrix D falls between 0 and 1.

Step 4: Attaining the total relation matrix (T): The total relationship matrix can be defined by using Eq. (3).

$$T = D\,(I - D)^{-1} \quad (3)$$

Where, I represent an identity matrix.

Calculate the summation of rows and columns of the total relation matrix T. If, ri be the sum of ith row in matrix T, then ri summarizes both direct and indirect impacts given by factor i to the other factors. If cj denotes the sum of jth column in matrix T, then cj shows both direct and indirect impacts received by factor j from the other factors. The sum (ri + cj) is known as 'Prominence', and shows the total effects given and received by factor i. The (ri +

cj) indicates the degree of importance for factor i in the entire system. On the contrary, the difference (ri - cj) is known as 'Relation', which represents the net effect that factor i contributes to the system. Specifically, if (ri - cj) is positive, factor i is a cause factor. The factor i is a receiver factor, if (ri - cj) is negative [53].

Step 5: Setting up a threshold value: The average of the elements in total relation matrix T gives the threshold value. Since matrix T provides instances on how one factor affects another, thus, threshold value assists to filter out some insignificant or negligible effects in this context. Further, the effects, which are greater than the threshold value would be chosen and shown in digraph. The digraph can be acquired by mapping the dataset of (r + c, r - c).

4. Application of the Proposed Model: An Industrial Case Study

A heavy equipment manufacturing company located in the western region of India has been identified in this research. Presently, the company is ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007 certified. The company produces a wide variety of products including the HVAC (Heating, Ventilation and Air Conditioning), Air Compressors, Transmission products, etc. The case company intends to improve its contribution towards the environmental performance. The company is committed to implement GSCM as a part of their long term strategic change to achieve sustainability and various other economic-environmental advantages in the business. Managers of the case company desire to identify and evaluate the factors in formulating their plan of action in adopting and implementing a successful GSCM concept.

To analyze the problem, a decision group of five professionals was formed. One representative from the various functions; planning, quality, general administration, production, and environment, of the organization was included in the focus group. These professionals have excellent skills in decision making and have an industrial experience of more than ten years. After discussing with these professionals, the proposed DEMATEL based model was applied to analyze the problem and the computational procedure is summarized as follows:

According to the procedural steps described in the section 3, as a first step, the goal of the study was defined. And, a decision group to analyze the problem is also formed as defined above. From the literature survey, sixteen probable factors important in successful GSCM implementation were identified. After discussion with the decision group, these factors are finalized as the GSCM evaluation success factors (see Table 1). Next, the professionals in the decision group were contacted personally and their responses on evaluating the factors were recorded using the three point scale (i.e., using 0-3 scale). Further, by taking an average of 5 initial direct–relation matrices of the experts, the average initial direct relation matrix (A) is derived using Eq. (1) (Refer Annexure A, Table A.1). The normalized initial direct-relation matrix (D) was derived using Eq. (2) (Annexure A, Table A.2).

Then, based on Eq. (3), the total relations matrix (T) was constructed through the normalized initial direct-relation matrix (Refer Annexure A, Table A.3). Next to this, the sum of all the rows (r_i) and columns (c_j) of the total relation matrix was computed. The threshold value, which can be computed by taking the average of all the elements in the matrix T, was calculated. The calculated threshold value is **0.2619**. Thereafter, the prominence (r + c) and the relation (r - c) were computed. Table 3 represents the values of (r + c, r - c), which helps in arranging all the factors in order of their influential effect (depending upon their (r + c) value) and segregates the factors into cause and effect group (depending upon the positive and negative values of all the elements in the (r – c) column). Finally, a cause and effect diagram was constructed based upon the values of prominence (r + c) and relation (r - c) and is shown in Fig. 2.

Table 3 - The direct and indirect influence.

Factors	r	c	r + c	r - c
F1	4.145	3.442	7.587	0.702
F2	4.645	4.538	9.182	0.107
F3	4.060	3.778	7.838	0.282
F4	4.206	3.657	7.863	0.548
F5	4.336	4.248	8.584	0.088
F6	4.057	3.992	7.963	0.065
F7	3.971	3.931	7.902	0.040
F8	4.128	4.813	8.941	-0.685
F9	4.784	5.138	9.922	-0.354

F10	3.901	3.865	7.765	0.036
F11	3.927	3.417	7.344	0.510
F12	4.342	4.064	8.951	0.277
F13	4.303	4.610	8.913	-0.306
F14	3.980	4.830	8.810	-0.850
F15	4.027	4.630	8.658	-0.603
F16	4.244	4.102	8.346	0.142

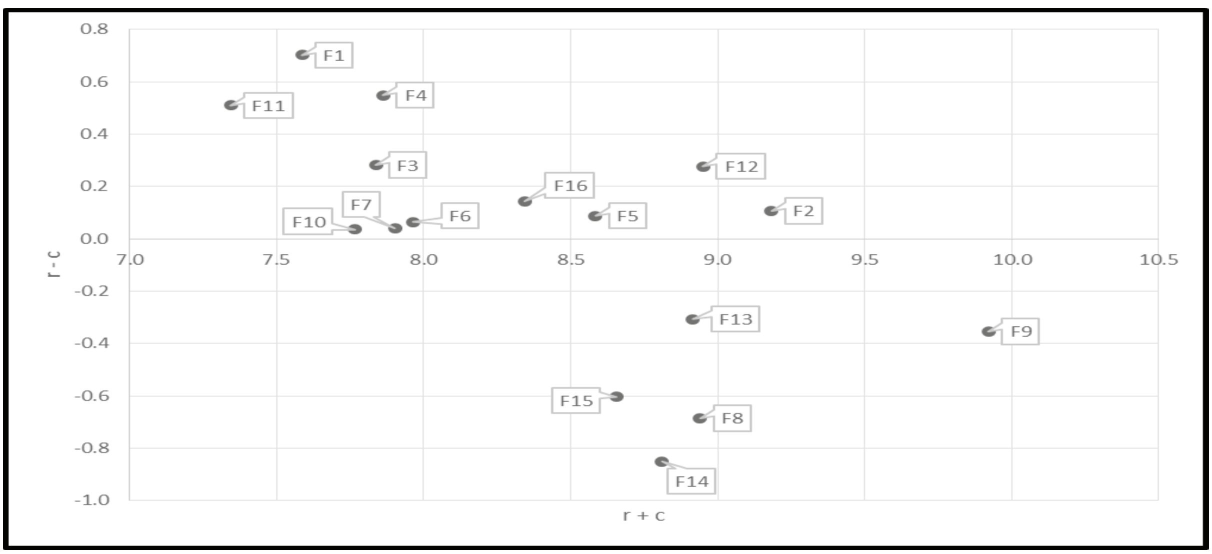

Fig. 2 - The causal diagram.

4.1. Results and discussions

According to the Table 3, the factors are arranged in terms of the degree of their importance based on their respective (r + c) score. The Brand Image Building (F9) factor with (r + c) score of 9.922 has the highest degree of importance followed by F2 > F12 > F8 > F13 > F14 > F15 > F5 > F16 > F6 > F7 > F4 > F3 > F10 > F1 > F11. In addition to this, Considering the value of their respective (r - c) score, the evaluation factors namely Government Regulations and Standards (F1), Top Management Commitment (F2), ISO 14001 Certifications (F3), Globalization (F4), Competitiveness (F5), Customer Requirements (F6), Role of Supplier (F7), Employee Involvement (F10), Role of Stakeholders, NGO and Media (F11), Technical Expertise (F12) and Training of Supplier and Employees (F16) are divided into cause group factors. While the Financial Factors (F8), Brand Image Building (F9), Adoption of New Technology and Processes (F13), Sustainability (F14) and Reverse Logistics (F15) comes under effect group.

The cause group factors are very vital due to their direct impact on the overall system [32]. Thus, it would be significant to focus on the cause group factors. Among all the cause group factors, Government Regulations and Standards (F1) has the highest (r – c) score with 0.702, which implies that (F1) has more impact on the whole system. But its (r + c) score (equals to 7.587) is comparatively low, which can be justified by the fact that Government regulations and standards can have influence over the other factors but receive comparatively less influence in return [7]. Thus, effective government guidelines and directions along with regulatory measures plays a vital role in shaping the organizational perspective towards the successful implementation of GSCM, and therefore, in achieving improved environmental performances [60]. The second highest factor in (r – c) column is the

Globalization (F4) with score of 0.548, which also has a reasonable power to influence other factors as given by influential impact index (r) value equals to 4.206. Globalization is acting as thrust to adopt GSCM in a supply chain context [36, 37]. Further, export norms and increased pressure from the environmental bodies and developed nations makes this fact evident and influences the organizations to adopt green practices [56]. Role of Stakeholders, NGO and Media (F11) with (r – c) score of 0.510 holds third rank in signifying its influence on the overall system in implementing a successful GSCM concept. Similarly, the sequence of the factors in the cause group according to their influence on the other factors can be enlisted as – Environmental Certifications (F3) with (r – c) score of 0.282 which help in curbing ill-effects on environment. Human Technical Expertise (F12) with (r – c) score of 0.277 playing a major role in successful implementation of GSCM w.r.t to its higher influential impact factor (r) of value equals to 4.342. Training of Suppliers and Employees (F16) with (r – c) score of 0.142 is very important in order to increase the performance of GCSM in business. It will help to achieve sustainable business development [48]. Top Management Commitment (F2) with (r – c) score of 0.107 acts as an initiation and decision power for any concept to be introduced within the organization. It has also been supported form previous studies that GSCM implementation is greatly depends on management behavior and approach (commitment) [25]. Competitiveness (F5) with (r – c) score of 0.088 and Customer Requirements (F6) with (r – c) score of 0.065 also play a major role in GSCM implementation and are forcing organizations to be green conscious [46]. Role of Supplier (F7) with (r – c) score of 0.044 together with Employee Involvement (F10) with (r – c) score of 0.036 acts as an influencing factor for the overall implementation of GSCM. Suppliers have a major role in improving ecological-economic performances [14, 23]. Subsequently, the values of (r) and (c) for individual factors signifies the amount of influence given and received on the complete system respectively. Therefore, the factors in the cause group needs to be addressed as per their priority while implementing GSCM for accomplishing the desired objective.

Factors in the effect group tend to be easily influenced by other factors. However, these group factors doesn't have a direct impact on the system, but still, makes a significant contribution [32]. So, these factors need to be discussed to find out their contribution in the overall manner. In all the effect group factors, Sustainability (F14) obtains a least (r – c) score i.e., -0.850, which implies that this factor receives the maximum impact from all other factors. Also, it is among the top factors according to (r + c) score of 8.810 implying the importance of this factor. Sustainability is the most important factors for any policy implementation in the organization as it helps to achieve business stability [6, 32]. GSCM has emerged as an important organizational strategy and an efficient approach for enhancing manufacturing sustainability in modern business environment [22].

The other factors, which follow the sequence of priority list in the effect group, include Financial Factors (F8) with (r – c) score of -0.685, Reverse Logistics (F15) with (r – c) score of -0.603, Brand Image Building (F9) with (r – c) score of -0.354 and Adoption of New Technology and Processes (F13) with (r – c) score of -0.306. Financial factors (F8) are very vital for organizations in implementing GSCM initiatives. Today, GSCM is receiving an increasing level of attention at both the local and global levels [49]. However, initial financial investments can be crucial for the point of view of industries in the early stage of adoption of GSCM practices. Consequently, it may provide several strategic benefits in terms of improved market share and increased competitive edge [29]. Besides, Reverse logistics (F15), is an important decision for achieving GSCM effectiveness in terms of increased economic-environmental performances. Business organizations can earn more profits by putting in place the reverse logistics mechanism and it will further help the conservation of resources [33]. Further, Brand Image Building (F9) is the most influencing cause group factors. GSCM initiatives play a crucial role in improving the brand image and value from an industrial context. Besides, to have knowledge about the technology and its right applicability would be useful in effective adoption of GSCM initiatives [24, 52].

The findings obtained in this study were discussed the industry and field experts and some important managerial implications are derived out for the managers of the case company. This study is an effort to understand and evaluate the GSCM agenda form industrial contexts. It offers several significant contributions to both the theory and practice in the domain of GSCM. The fundamental questions catered in this work are 'what', 'how' and 'why' those form the basis of this paper. The present research work has presented sixteen success factors based on literature review and experts' opinion which are related to successful implementation of GSCM in context to the Indian Manufacturing Industry sector. The enumerated success factors will assist to improve the GSC performance to predict the economic-ecological viability of an organization. The structural model offered by this work effort to suggest how these factors to implement successful GSCM are arranged according to their position in causal diagram. It is worthy to notice that as commonly practitioners' or policy makers' targets on few factors by assuming that these are more important without taking into account the causal effect of other factors. The DEMATEL based proposed model will assist managers to know different factors to implement GSCM initiatives on various levels in business. The proposed model is not only logically sound in evaluating the success factors, but also helpful in answering "how" and "why", in terms of relationships. That would be decisive to further capture the causal relationships among various factors in GSCM implementation. This study will indeed help to practice well for implementation of GSCM initiatives more competently and successfully. The recognized factors are classified as cause and effect groups are more towards performance and result orientation. And, the strategic results effects can be achieved by continuously improving cause group factors. It would be very essential to focus on the cause group factors, as the factors in this group influence the system directly [11]. Therefore, working on the cause group factors is significant for the company managers. These will influence the factors in effect group, and hence result in an increase in system performance. It will improvise not only the GSC overall performance, but also suggest some measures for improving cost-cutting measures, increasing customer satisfaction, conserving minerals and natural resources, managing unproductive times, and reducing wastes as well. The proposed model will help in managing the GSCM adoption and implementation related decisions, while remaining competitive in the market.

5. Conclusions, Limitations, and Scope for Future Work

In the era of globalization, environmental sustainability and green issues have an increasing popularity among researchers and supply chain practicing managers [12, 39, 51]. There are various factors associated with incorporation of the green initiatives in supply chain management [28]. It will be useful for industries to know those factors to increase their economic-environmental performances [7]. The industries are still struggling to understand the way for effective implementation of this concept in their respective areas [36, 38]. In that way, this study aims to evaluate the factors related to the successful implementation of GSCM from the industry context. The present paper aims to build a structural model for analyzing the interrelationships among factors relevant to GSCM adoption.

Using literature and experts inputs, sixteen factors, important in initiation and implementation of successful GSCM initiatives were identified. These factors were further evaluated using the DEMATEL method. An empirical case study was conducted to show the real-life applicability of the proposed DEMATEL based model. The methodology of DEMATEL helps to find the interdependence between the factors and divides the factors into cause and effect group. It would be significant to focus on the cause group factors in the beginning, and the factors in the effect group need to be discussed to find out their contribution in the overall manner. Further, Top Management Commitment (F2), Human Technical Expertise (F12), Financial Factors (F8), comes out to be the most important factors in successful implementation of GSCM.

The models proposed in the research work may provide useful learning insights into understanding and analysis of factors to implement GSCM in a most efficient way. This study will help case company managers to focus their future efforts in implementation of GSCM initiatives efficiently and successfully. Implementation of GSCM aspects will help case organization to achieve a gain in environmental, economic performances in the supply chain.

Regarding next work in this domain of research, the structural model is based on the DEMATEL methodology, which has its own limitations. For example; the model is highly dependent on the judgments of the experts. Opinions of the experts may be biased. Another one could be of selection of factors in successful GSCM implementation, as only sixteen factors were identified. Other factors crucial in successful GSCM implementation have not been identified and classified. Besides that, the effect of uncertainty and human bias in evaluating the factors has not been considered in this study. It could be targeted as an area of research in future work. The proposed DEMATEL based analysis model may also be extended to the different industry sector like service, Construction, Power, in improving their GSCM performance. However, the expert's opinion regarding factor evaluation may vary. The result obtained holds true for the case company under study; the findings should not be generalized [9]. The future research can be conducted to understand the hierarchical intertwined relations among the GSCM success factors using ANP and TOPSIS.

Acknowledgements

The authors wish to thanks to Dr. Charbel Salloum, (Editor-in-chief, International Strategic Management Review) and anonymous reviewers, for your constructive suggestions. We thank you and your reviewers for suggesting us directions for improving the paper. The authors are also thankful to The Ministry of Human Resource Development (MHRD), India for the financial and technical support. The authors also acknowledge great thanks for the support to the research facilities provided by the Department of Mechanical and Industrial Engineering, in Indian Institute of Technology Roorkee, India. The second author also recognizes great thanks for the support to the research facilities provided by the Department of Mechanical Engineering, Graphical Era University, Dehradun, India.

Annexure – A

Table A.1 Average initial direct relation matrix.

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16
F1	0	2.00	3.00	2.00	2.00	1.33	2.00	2.00	1.67	1.00	1.67	1.00	2.67	2.00	2.67	2.00
F2	1.33	0	2.67	2.00	2.33	2.33	2.33	3.00	2.33	2.00	1.00	1.67	2.33	2.33	2.67	2.33
F3	1.67	1.33	0	2.33	2.00	1.67	2.00	1.67	2.67	1.67	2.33	2.00	1.67	2.33	1.33	1.67
F4	2.00	2.00	1.67	0	2.67	1.67	1.67	2.00	2.67	2.00	2.00	1.67	2.00	2.00	2.00	1.33
F5	1.33	2.00	2.00	1.33	0	2.00	1.67	2.67	3.00	2.33	1.67	2.00	1.67	3.00	2.00	1.67
F6	1.67	1.67	1.67	1.33	1.00	0	2.00	2.67	2.67	1.33	2.00	1.33	2.67	2.00	3.00	1.33
F7	1.67	1.67	1.67	2.00	2.33	1.67	0	2.00	2.00	1.00	1.33	1.67	1.67	2.00	3.00	2.00
F8	1.67	2.67	1.67	1.33	1.33	2.33	1.00	0	2.33	2.00	1.00	2.33	2.67	2.00	2.00	2.33
F9	2.00	2.67	2.33	2.33	2.33	2.33	1.33	2.33	0	2.33	2.33	2.33	2.33	2.33	2.00	2.33
F10	1.00	2.33	1.67	1.33	1.67	1.67	1.33	1.67	2.67	0	1.33	2.00	2.33	2.33	1.67	2.00
F11	2.67	2.33	1.33	1.33	1.67	2.33	2.00	2.00	2.33	1.67	0	1.33	1.67	1.67	2.00	1.00
F12	2.00	2.33	1.67	1.33	1.67	1.67	2.33	2.00	2.33	2.00	0.33	0	2.67	3.00	2.33	2.67
F13	2.00	2.00	1.33	2.00	2.33	1.33	1.00	3.00	2.67	1.67	1.67	2.00	0	2.33	2.33	2.33
F14	1.00	2.00	1.67	1.33	2.00	2.00	2.00	2.00	2.33	1.67	1.67	2.33	2.00	0	1.67	2.00
F15	1.67	2.33	1.00	2.00	2.33	1.67	2.00	2.33	2.33	1.67	2.00	1.67	2.00	1.67	0	1.33
F16	0.33	2.33	1.00	1.33	2.00	1.67	3.00	2.33	2.33	2.33	1.33	2.67	2.00	3.00	2.00	0

Table A.2 Normalized initial direct-relation matrix.

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16
F1	0	0.06	0.08	0.06	0.06	0.04	0.06	0.06	0.05	0.03	0.05	0.03	0.07	0.06	0.07	0.06
F2	0.04	0	0.07	0.06	0.06	0.06	0.06	0.08	0.06	0.06	0.03	0.05	0.06	0.06	0.07	0.06
F3	0.05	0.04	0	0.06	0.06	0.05	0.06	0.05	0.07	0.05	0.06	0.06	0.05	0.06	0.04	0.05
F4	0.06	0.06	0.05	0	0.07	0.05	0.05	0.06	0.07	0.06	0.06	0.05	0.06	0.06	0.06	0.04
F5	0.04	0.06	0.06	0.04	0	0.06	0.05	0.07	0.08	0.06	0.05	0.06	0.05	0.08	0.06	0.05
F6	0.05	0.05	0.05	0.04	0.03	0	0.06	0.07	0.07	0.04	0.06	0.04	0.07	0.06	0.08	0.04
F7	0.05	0.05	0.05	0.06	0.06	0.05	0	0.06	0.06	0.03	0.04	0.05	0.05	0.06	0.08	0.06
F8	0.05	0.07	0.05	0.04	0.04	0.06	0.03	0	0.06	0.06	0.03	0.06	0.07	0.06	0.06	0.06
F9	0.06	0.07	0.06	0.06	0.06	0.06	0.04	0.06	0	0.06	0.06	0.06	0.06	0.06	0.06	0.06
F10	0.03	0.06	0.05	0.04	0.05	0.05	0.04	0.05	0.07	0	0.04	0.06	0.06	0.06	0.05	0.06
F11	0.07	0.06	0.04	0.04	0.05	0.06	0.06	0.06	0.06	0.05	0	0.04	0.05	0.05	0.06	0.03
F12	0.06	0.06	0.05	0.04	0.05	0.05	0.06	0.06	0.06	0.06	0.01	0	0.07	0.08	0.06	0.07
F13	0.06	0.06	0.04	0.06	0.06	0.04	0.03	0.08	0.07	0.05	0.05	0.06	0	0.06	0.06	0.06
F14	0.03	0.06	0.05	0.04	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0	0.05	0.06
F15	0.05	0.06	0.03	0.06	0.06	0.05	0.06	0.06	0.06	0.05	0.06	0.05	0.06	0.05	0	0.04
F16	0.01	0.06	0.03	0.04	0.06	0.05	0.08	0.06	0.06	0.06	0.04	0.07	0.06	0.08	0.06	0

Table A.3 Total relationship matrix.

Factors	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	Sum = ri
F1	0.17	0.28	0.27	0.24	0.27	0.24	0.25	0.30	0.30	0.22	0.22	0.23	0.30	0.30	0.30	0.26	**4.145**
F2	0.23	0.26	0.28	0.26	0.30	0.29	0.28	0.35	0.35	0.27	0.22	0.28	0.32	0.33	0.33	0.29	**4.645**
F3	0.21	0.26	0.19	0.24	0.26	0.24	0.25	0.28	0.32	0.24	0.23	0.25	0.27	0.30	0.26	0.25	**4.060**
F4	0.23	0.29	0.24	0.19	0.29	0.25	0.24	0.30	0.33	0.25	0.23	0.25	0.29	0.30	0.29	0.25	**4.206**
F5	0.22	0.29	0.25	0.23	0.22	0.26	0.25	0.32	0.35	0.27	0.22	0.27	0.29	0.33	0.30	0.26	**4.336**
F6	0.22	0.27	0.23	0.22	0.24	0.20	0.25	0.31	0.32	0.23	0.22	0.24	0.30	0.29	0.31	0.24	**4.057**
F7	0.21	0.26	0.23	0.23	0.27	0.24	0.19	0.29	0.30	0.21	0.20	0.24	0.27	0.29	0.30	0.25	**3.971**
F8	0.22	0.30	0.23	0.22	0.25	0.26	0.23	0.24	0.32	0.25	0.20	0.27	0.30	0.30	0.29	0.27	**4.128**
F9	0.25	0.33	0.28	0.27	0.31	0.29	0.26	0.34	0.30	0.29	0.26	0.30	0.33	0.34	0.32	0.30	**4.784**
F10	0.19	0.28	0.22	0.21	0.25	0.23	0.22	0.27	0.31	0.18	0.20	0.25	0.28	0.29	0.26	0.25	**3.901**
F11	0.23	0.28	0.22	0.21	0.25	0.25	0.24	0.28	0.31	0.23	0.16	0.23	0.27	0.27	0.27	0.22	**3.927**
F12	0.23	0.30	0.24	0.23	0.27	0.25	0.27	0.31	0.33	0.26	0.19	0.22	0.31	0.33	0.31	0.29	**4.342**
F13	0.23	0.29	0.23	0.24	0.28	0.25	0.23	0.33	0.34	0.25	0.22	0.27	0.24	0.31	0.30	0.28	**4.303**
F14	0.19	0.27	0.23	0.21	0.26	0.25	0.24	0.29	0.31	0.23	0.21	0.26	0.28	0.23	0.27	0.25	**3.980**
F15	0.21	0.28	0.21	0.23	0.27	0.24	0.24	0.30	0.31	0.23	0.22	0.24	0.28	0.28	0.23	0.24	**4.027**
F16	0.19	0.30	0.22	0.22	0.27	0.25	0.28	0.31	0.33	0.26	0.21	0.28	0.29	0.33	0.29	0.21	**4.244**
Sum = cj	**3.44**	**4.53**	**3.77**	**3.65**	**4.24**	**3.99**	**3.93**	**4.81**	**5.13**	**3.86**	**3.41**	**4.06**	**4.61**	**4.83**	**4.63**	**4.10**	

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