Assessment of Barriers of Green Supply Chain Management Using Structural Equation Modeling

Somesh Agarwal, Mohit Tyagi, and R. K. Garg

1 Introduction

In today's era, the major global problem arising is environmental degradation. Due to the upsurge in the raw material and energy consumption, natural resources are depleting at a very rapid rate. Moreover, pollution and waste production have also been increased significantly. Therefore, concurrently, there are twin challenges for the industries viz. competitive and environmental demands. The concept of GSCM is thus generated due to the alarming environmental issues and emerging economic opportunities. The assimilation of environmental concerns and the values of SC give rise to GSCM [1].

In the last two decades, most of the multinational industry and SME are turning toward GSCM for the sake of alarming environmental conditions. The demand for GSCM has risen nowadays as public awareness, environmental, economic or governmental reasons. But it is not an easy assignment. To make a model of various interrelated barriers to implement GSCM in Indian Rubber Industries and then validate that model using SEM is the main objective of this research.

1.1 Motivation

GSCM is a very good practice to be done for dealing with and minimizing the environmental issues that we are facing today. The boundary of GSCM is dependent on the researcher's goals and the problems which are at tips similar to the concept of SCM. The very initial green SC came into the framework by Kelle and Silver's

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[2]. Apart from the operations perspective, considerable work has been done to facilitate the GSCM implementation in the industries at various stages by analyzing the barriers for the implementation of GSCM. GSCM activities are constrained on part of the suppliers by their unwillingness to support and lack of attentiveness. The outdated mindset of the supplier firm is the main key, which reflects suppliers' and the total network interests as being. Government guidelines can inspire or depress the acceptance of alterations.

Customers, investors and non-governmental organizations can be treated as external drivers. Rao [3] explored the idea of GSCM by empirical survey initiative in the Philippine context.

2 Review of the Literature

2.1 Supply Chain (SC)

SC is the progress of products as they move from their source to the end customer. Regularly, a SC is additionally depicted by the term worth chain, which mirrors the concept that worth is included along the chain.

2.2 Green Supply Chain Management (GSCM)

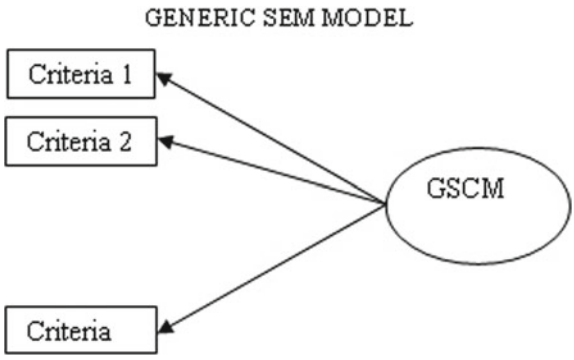
To minimize or reduce waste in the form of energy, emission, dangerous solid and waste chemicals is the main aim of GSCM. The addition of the 'green' component to SCM includes addressing the influence and connection between SCM and the natural environment [4, 5].

The main aim of the organizations is to adopt GSCM practices to enhance their environmental and financial performance [6, 7].

2.3 Structural Equation Modeling (SEM)

For testing and estimating the fundamental relationship, SEM approach is used by a combination of statistical data and qualitative triggered assumptions. Unlike other methods, number of variables and limitations are not a case for SEM; hence, it is considered as the best approach. Jiang et al. [8] presented a new Bayesian nonlinear SEM approach for the hierarchical valuation of dynamic systems, considering uncertainty in predicted and measured time series. The proposed model and assumptions were validated using SEM. Although the SEM approach has been used by researchers for numerous problems, the application of SEM to model a GSCM barrier system

Fig. 1 Generic SEM model



has been found to be very limited. The application of SEM to a GSCM barrier model has not been found in more practices. This research study was initiated in this context (Fig. 1).

3 Problem Description

Due to environmental issues, GSCM finds a great need in society. For that purpose, to study the hindrances or barriers that organizations are facing in the implementation of GSCM is the main objective of this research. For that, firstly, we should know about which barriers are influencing the SC. In view, a lot of pollution is caused by disposing of the waste rubber as they are burned after use which causes a lot of smoke and pollution. So, there is an utmost need to reduce the wastes of rubber. For that, recycling of rubber should be done. For that purpose, rubber industries are chosen for reference. In this research, it aims to find the barriers which cause hindrances in the rubber industry and then to validate these barriers using SEM.

3.1 Research Methodology

The objective of this research is to create a model by considering different barriers of GSCM and evaluate them using structural equation modeling (SEM). For this, barrier is identified which hinders rubber industries to adopt GSCM using survey and expert opinion. Then, hypothesis has been developed relating to these barriers. Data was collected using questionnaire-based survey and was analyzed using SEM, and then, validation of hypothesis has been done. The result thus obtained will show that the validated hypothesis will influence the system and vice versa.

3.2 Identification of GSCM Barriers

GSCM is a very good practice to be done for dealing with and minimizing the environmental issues that we are facing today. Many researchers contribute to this topic, and they had found barriers related to different kinds of industries, namely plastic, manufacturing, automobile, etc. (Table 1).

3.3 Methodology

Firstly, the research hypothesis was prepared based on the barriers related to the implementation of GSCM in the rubber industry. Then, a questionnaire was prepared to keep in mind the exhaustive and extensive factors in order to get the awareness of the industry regarding GSCM. The data attained from the responses to the questionnaire was analyzed using SEM with the help of LISERAL software.

3.4 Research Hypothesis

According to the available literature, the hypothesis has been synthesized considering the barriers to the implementation of GSCM in mind. Each major barrier found by the literature gives augmentation to each hypothesis as follows:

H1: Lack of top management support has a positive relationship with GSCM and they hinder in GSCM practices.

H2: Inability or unwillingness to share information has a positive relationship with GSCM and they hinder in GSCM practices.

H3: Inability or unwillingness to share risk and rewards has a positive relationship with GSCM and they hinder in GSCM practices.

H4: Inflexible organizational system and processes has a positive relationship with GSCM and they hinder in GSCM practices.

H5: Communication gap between management and shop floor workers has a positive relationship with GSCM and they hinder in GSCM practices.

H6: Unawareness of customers has a positive relationship with GSCM and they hinder in GSCM practices.

Table 1 Identification of barriers

S. No.	Barrier name	Description	Author
1	Lack of top management support	The top management is the only key for modifying the existing system from all points of consideration, but it should not have any negative impact on the system the main objective	Luthra et al. [9], Tyagi et al. [10]
2	Inability or unwillingness to share information	When the information flow is exaggerated by negligence or unwillingness, a big disorder is created in the process flow and chances of further development will decreases	Chen et al. [11], Roarty [12], Jose [13]
3	An unwillingness to share risks and rewards	If organizations are failing to take risks, it implies failing to progress and sometimes even failing to grow. The rewards should also be shared, not enjoyed selfishly	Sharma [14]
4	Inflexible organizational systems and processes	The organization should be so designed that it can rearrange itself for any forthcoming changes	Jose [13], Klassen and Whybark [15]
5	Communication gap between management and shop floor workers	There must not be proper interaction and proper understanding between management and workers. Also, it is due to under-educated workers	Ravi and Shankar [16]
6	Unawareness of customers	A most important type of external pressure is customer demand as they have to be strictly followed by the company	Zhu et al. [17]
7	Lack of training of workshop floor workers	Continuous improvement is a must objective which can be achieved by training for survival and excel in the field	Yu Lin et al. [18]
8	Incapable of achieving the exact design standard	They are incapable of achieving the same design as that obtained by the simple process	Hosseini [19]

(continued)

Table 1 (continued)

S. No.	Barrier name	Description	Author
9	Lack of financial supports	High investment is needed by green methods such as green design, green manufacturing and green labeling of packing which in turn upsurges the product cost	Klassen and Whybark [15]
10	Cost implications	The high investment requirement by green methodologies such as green design, green manufacturing and green labeling of packing which in turn increases the product cost	Hosseini [19], Mudgal et al. [20]
11	High initial capital cost	For the first implementation of the setup, the high initial cost is required	Hosseini [19], Mudgal et al. [20]
12	High cost in managing hazardous wastes	For the disposal of different types of wastes, different methods are used, which in turn is an expenditure of a bundle of money	Mudgal et al. [20]
13	Administrative and financial burden of tax	The direct and indirect taxes should be properly planned and managed for better financial consideration within the reverse chain	Chen et al. [11], Jose [13]
14	Market competition and uncertainty	Global competitiveness and customer's requirements give rise to market uncertainties and competency	Zhu et al. [17], Mudgal et al. [21]
15	Lack of Government support systems	No compensation to industries from the government for GSCM implementation	Yu Lin et al. [18], Tyagi et al. [22]
16	Lack of demand for GSCM	The market demand for the product is less	Mudgal et al. [21]

H7: Lack of training of workshop floor workers has a positive relationship with GSCM and they hinder in GSCM practices.

H8: Incapable of achieving the exact design standard has a positive relationship with GSCM and they hinder in GSCM practices.

H9: Lack of financial supports has a positive relationship with GSCM and they hinder in GSCM practices.

H10: Cost implications have a positive relationship with GSCM and they hinder in GSCM practices.

H11: High initial capital cost has a positive relationship with GSCM and they hinder in GSCM practices.

H12: High cost in managing hazardous wastes has a positive relationship with GSCM and they hinder in GSCM practices.

H13: Administrative and financial burden of tax has a positive relationship with GSCM and they hinder in GSCM practices.

H14: Market competition and uncertainty have a positive relationship with GSCM and they hinder in GSCM practices.

H15: Market lack of government support systems has a positive relationship with GSCM and they hinder in GSCM practices.

H16: Lack of demand for GSCM has a positive relationship with GSCM and they hinder in GSCM practices.

Then, for importance and the scale of each measure, the factor loading of each measure on GSCM is verified, irrespective of the sign will give the influence of that barrier of GSCM. These values are used for arriving at the relative weight of attributes. To bring out the above process, the SEM model with LISREL symbolization can be established by assuming the connection between the observed variables and their underlying factors. Using LISREL notations, the hypothesized conceptual models are presented.

We can summarize its configuration by writing the series of Equations/statements. The equations for model factor structure are as:

$$Y_1 = \lambda_1 h_1 + e_1,\ Y_2 = \lambda_2 h_1 + e_2,\ Y_3 = \lambda_3 h_1 + e_3,\ Y_4 = \lambda_4 h_1 + e_4 \ldots Y_n = \lambda_n h_n + e_n$$

And vector form of the above equations can be written as:

$$\begin{matrix} Y & \Lambda & \varepsilon \end{matrix}$$

$$\begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \\ Y_4 \\ . \\ . \\ . \\ Y_n \end{bmatrix} = \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \\ . \\ . \\ . \\ \lambda_n \end{bmatrix} \begin{bmatrix} \\ \eta \\ \\ \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \varepsilon_4 \\ . \\ . \\ . \\ \varepsilon_n \end{bmatrix} \tag{1}$$

Also, summarization of the above lower-order structure can be:

$$Y = \Lambda_Y \eta + \varepsilon \tag{2}$$

where model factor loadings are Λ the and error terms measurement is ε; thus, relative influence or weight of attributes on barriers can be established by SEM.

The achieved results from LISREL for the model are depicted in Fig. 2

4 Results and Discussion

According to the results obtained from the model demonstrates optimistic values for the entire path coefficient; at $p < 0.05$, all the t-values of the variables are statistically important. Thus, according to Table 2, the structural model supports all the 16 hypotheses of the projected model. The influence of all the listed barriers for GSCM has been proved by hypotheses H1, H2, H3, H4, H5, H6, H7, H8, H9, H10, H11, H12, H13, H14, H15 and H16. So, the projected model explicated a substantial percentage of variance in the barriers of GSCM. Thus, the SEM model confirms the consistency of the proposed model and achieves an acceptable level.

5 Conclusion

In the research, SEM approaches were proposed to implement green SC in the Indian rubber industry. This research is focused on the empirical validation of a real working environment using the SEM approach. SEM examines a set of associations between one or more independent variables (IV) and one or more dependent variables (DV). Here, a model is presented for which all the barriers are validated using SEM. This model validated the hypothesis made for the barriers, and it gives the right path for

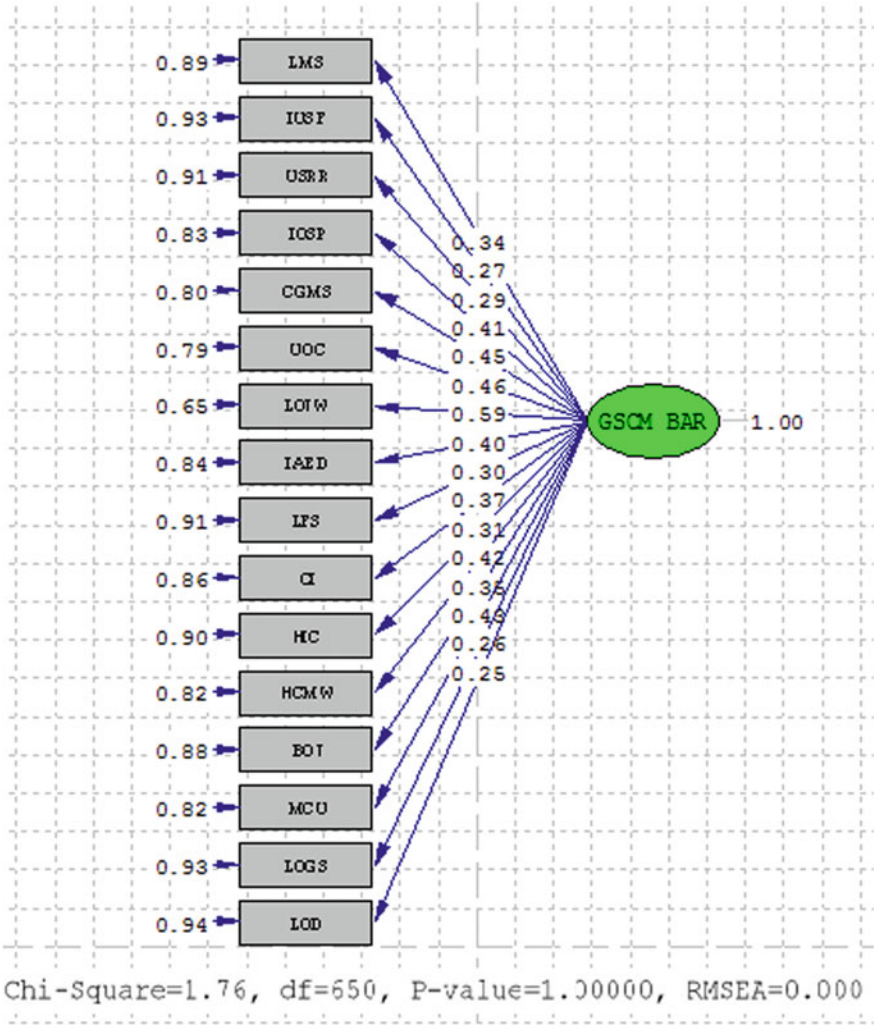


Fig. 2 Higher-order SEM model

the industries to work on. The Cronbach's alpha value demonstrates the reliability standard, which is greater than 0.96 for all criteria.

6 Managerial Implications

Researchers are confronted to provide a guide for selecting the technique that is both theoretically well originated and almost operational to crack the real problems.

Table 2 Results of hypothesis table

Hypothesis	Casual-path	Point estimates	t-values	Hypothesis support
H1	LMS	0.48	8.46	Yes
H2	IUCF	0.38	9.27	Yes
H3	USRR	0.42	8.88	Yes
H4	IOSP	0.58	12.42	Yes
H5	CGMS	0.63	10.9	Yes
H6	UOC	0.65	9.98	Yes
H7	LOTW	0.83	8.97	Yes
H8	IAED	0.57	9.8	Yes
H9	LFS	0.43	12.23	Yes
H10	CI	0.52	11.11	Yes
H11	HIC	0.44	10.23	Yes
H12	HCMW	0.53	9.89	Yes
H13	BOT	0.5	7.87	Yes
H14	MCU	0.6	8.86	Yes
H15	LOGS	0.36	8.85	Yes
H16	LOD	0.36	9.89	Yes

Result obtained shows that the barriers are hindering the supply chain performance for rubber industries. Suggested framework provides the barriers which are influencing the GSCM practices. This research provides an in-depth study of barriers and their implication on supply chain performance. Managers and decision makers are required to implement GSCM keeping the above-mentioned barriers in mind.

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