MODELLING THE BARRIERS OF SUSTAINABLE SUPPLY CHAIN MANAGEMENT PRACTICES IN INDIAN INDUSTRIES

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***Abstract*:** Market dynamism and industrial growth have resulted in both pressure and drivers for organizations to improve their environmental and social performance. Several organizations are contemplating the integration of sustainability practices into their business strategy and operations as a potential approach to gain and sustain competitive advantage. Worldwide enterprises have started adopting the sustainable and/or green concept in their supply chain management. Sustainable supply chain management (SSCM) is emerging to be an important approach for enterprises to improve their economic performance and to become more environmentally benign and socially conscious. But, enterprises still lack knowledge about the barriers hindering the implementation of SSCM. The present work focuses on identifying barriers to the implementation of SSCM using a two-stage approach. A total of 39 barriers under five barrier categories were identified on the basis of extensive literature analysis and in-depth interviews with academic experts and industrial experts from various industrial sectors. In the first stage based on carefully designed questionnaire essential important barriers were identified. Next, the critical barriers obtained were are prioritized applying analytic hierarchy process (AHP).

***Index Terms* - Sustainable SCM, Modelling, Barrier analysis, Analytic hierarchy process**

I. INTRODUCTION

Supply chain management plays an important role in the improvement and implementation of a firm's competitive advantage. As mentioned in recent studies, in the coming years, most manufacturing firms will face environmental issues in Asia (Shipeng, 2011; Wu et al., 2011; Luthra et al., 2011, 2016; Diabat and Govindan, 2011; Zhu et al., 2012; Mathiyazhagan et al., 2013; Sari, 2017; Singh, 2017; Kaur et al., 2018; Mathiyazhagan et al., 2018). This is also true for Indian industries and these industries will have to develop traditional supply chains from an environmental sustainability point of view by modifying it to green and/or sustainable supply chain management (SSCM) through initiation and implementation of sustainable strategies (Mudgal et al., 2010; Luthra et al., 2011; Mangla et al., 2015; Sari, 2017; Kaur et al., 2018; Mathiyazhagan et al., 2018).

Conventionally, most innovations and practices in supply chain management only aimed to reduce waste for economic rather than environmental reasons, and it was not until recently that the term sustianble, with reference to protecting the environment, gained widespread use and recognition (Zhang et al., 2009; Luthra et al., 2011; Mathiyazhagan et al., 2013; Mangla et al., 2015; Sari, 2017; Singh, 2017; Kaur et al., 2018). SSCM is defined as one of the "main efforts aiming to integrate environmental parameters (or requirements) with supply chain management systems" (Jung, 2011). The transition from traditional SCM to SSCM and its adoption can be anticipated with some barriers. Industries must equip themselves to remove these barriers. However, it will be impossible to eliminate all barriers simultaneously. Hence, industries should identify those barriers which have essentially to be removed in the initial stages of SSCM adoption. This paper focuses on the identification and ranking of such vital barriers so that they might be eliminated during SSCM adoption and implementation through the Analytical Hierarchy Process (AHP).

II. LITERATURE REVIEW

Literature offers evidence revealing the benefits of environmental initiatives for businesses (Mudgal et al., 2010; Luthra et al., 2011; Sarkis et al., 2011, 2012; Shipeng, 2011; Mathiyazhagan et al., 2013; Kaur et al., 2018; Mathiyazhagan et al., 2018). SSCM is a potential novel (innovative) concept to instil environmental thinking in traditional supply chain management (Zhu et al., 2012; Mangla et al., 2015; Luthra et al., 2016; Singh, 2017). It cuts across varied boundaries encompassing business activities integration, sourcing, production, and delivery processes (Min and Kim, 2012; Sari, 2017; Kaur et al., 2018). It considers emphasizing environmental issues in supply chain management, in both upstream and downstream business enterprises (Shipeng, 2011; Luthra et al., 2011; Mangla et al., 2015; Singh, 2017; Mathiyazhagan et al., 2018). Green procurement or purchasing can be referred to as the integration of environmental considerations into purchasing policies, programs and actions to reduce waste and to help achieve a SSCM (Varnäs et al., 2009; Mangla et al., 2015; Luthra et al., 2016; Sari, 2017). However, it is still argued that "SSCM is still relatively new concept for most organizations in many industries (Lin and Ho, 2008; Luthra et al., 2011; Zhu et al., 2012; Mathiyazhagan et al., 2013) and countries (Seuring and Müller, 2008; Seuring et al., 2008; Sari, 2017; Kaur et al., 2018). Thus, it is evident from the literature that both academicians and practitioners are fully aware and are interested in analyzing barriers to SSCM adoption and implementation.

To date, there is little work available on the analysis and identification of important barriers to SSCM adoption and implementation in an Indian context. A few research studies have attempted to analyze barriers to SSCM adoption and implementation from an Indian industry perspective (Luthra et al., 2011; Mudgal et al., 2010; Mathiyazhagan et al., 2013; Singh, 2017; Kaur et al., 2018). However, most studies dealt with a limited number of barriers. In addition, no study has undertaken the analysis with different industrial perspectives from the Indian scenario. Clearly, there exists a literature gap exists in the identification of important barriers against SSCM implementation. Further, the studies analyzed SSCM adoption in an Indian

context, but they failed to analyze insights into barriers against SSCM adoption. As every nation has its own environmental policies and regulations, such studies in other countries do not seem to have had any impact in the Indian context (Zhu and Sarkis, 2006; Mathiyazhagan et al., 2013; Mangla et al., 2015; Luthra et al., 2016; Singh, 2017; Kaur et al., 2018; Mathiyazhagan et al., 2018). Research is needed on the identification of essential barriers for SSCM adoption and implementation in an Indian scenario.

III. METHODOLOGY

A detailed questionnaire was framed on the basis of literature analysis and discussions with the industry experts. The questionnaire was circulated to 200 participants from various industries in India who have already started adopting and implementing sustainable and green practices. Thus, the most common barriers accepted by various organizations were identified from various industrial sectors. From these identified common barriers, the essential key barriers were ranked and prioritized using an AHP approach.

Next, experts' opinions from different industries including automobiles, electrical and electronics, textiles, paper, food, plastic, iron and steel, power plant, and chemical industries were collected through carefully designed questionnaires and then synthesized and analyzed by the AHP technique. In AHP, pair-wise comparisons were conducted at two separate levels: first at the specific barrier level, and then at the barrier category level. An improved nine-point scale was used to assign relative weights to pair-wise comparisons between categories and specific barriers (Saaty, 1980, 1986).

IV. AHP TECHNIQUE

Analytic Hierarchy Process (AHP) is a widely used decision support tool in business industries. AHP is based on a set of axioms which carefully delimits the scope of the problem environment (Saaty, 1986). It consists of a well-defined mathematical structure of consistent matrices and their associated right Eigenvector's ability to generate true or approximate weights (Saaty, 1980). The AHP methodology compares criteria, or alternatives with respect to a criterion, in a natural, pair-wise mode (Saaty, 1980). The three steps of the AHP methodology are as follows

1. Identifying barriers and structuring a hierarchy prioritization model,
2. Constructing a questionnaire and collecting data, and
3. Determining normalized weights for each barrier category and each specific barrier.

The consistency ratio is calculated based on the following steps (Haq and Kannan, 2006a, 2006b): 1 Calculate the eigenvector or relative weights and λmax for each matrix of order n
2 Compute the consistency index for each matrix of order n by the formulae:
$CI = (\lambda max - n)/ (n - 1)$
The consistency ratio is then calculated using the formulae: CR = CI/RI.

V. DATA COLLECTION

The data for the study was collected from senior and higher management levels from various industries. Prior to data collection the objective of the survey, together with the SSCM concepts, were introduced to the target respondents by proper documents to ensure that they fully understood various items in the survey questionnaire, its overall goals and objectives of the research, and how the data would be used.

Stage 1 - Initial survey to identify the common barrier

39 recommended common barriers were identified from exhaustive literature analysis and experts' discussions. A questionnaire was prepared and mailed to 200 various industries. From the 39 barriers, the respondents were asked to identify the important barriers (given the choice of 'Yes' or 'No' for each barrier) for SSCM implementation in their industry. From this initial survey, we observed that Indian industries are aware of the environmental impact on their business but are still at the initial stages of SSCM implementation.

Stage 2 - Ranking and prioritization of important barriers using AHP

In this section, the identification of essential barriers for SSCM implementation was done using the AHP approach. The outcome of the initial survey initial survey yielded 22 common barriers. The 22 barriers used in this phase are provided in Table 3. This phase is categorized into four hierarchy decision process levels. The four-level hierarchy processes are described as below,
Level-I: The objective/overall goal.
Level-II: This level represents the barrier category.
Level-III: This level of the hierarchy contains specific barriers.
Level-IV: Priorities of essential barriers are found at this level.
The 22 barriers identified from stage 1 were sent to experts of the 100 companies. Participating companies were requested to give the pair-wise comparison weight from Saaty's method using nine-point scale values (1-9) as shown in Table 1.

Table 1 - AHP scale of preference

Preference weights/Level of importance	Definition	Details
1	Equally preferred	Two factors contribute equally to the objective.
3	Moderately	Experience and judgment slightly favour one factor over another.
5	Strongly	Experience and judgment strongly or essentially favour one factor over another.
7	Very strongly	A factor is strongly favoured over another and its dominance is demonstrated in practice.
9	Extremely	The evidence favouring one factor over another is of the highest degree possible of affirmation.
2,4,6,8	intermediates	Compromise between the preferences
Reciprocals	Reciprocals for inverse comparison	-

VI. RESULT AND DISCUSSIONS

In this research, 39 barriers, under five barrier categories relevant to SSCM implementation were considered, with the help of literature and experts discussion. Of the 39 barriers, only 22 barriers identified from the questionnaire survey were considered to isolate important and critical essential barriers using AHP. The results obtained after AHP calculations are presented below in Table 2 and Table 3. All the values were found to be acceptable. The priority ranking of barrier category is exhibited in Table 2.

Ranking of barrier category

Table 2 - Ranking of barrier category

Barrier	AHP weights	Rank
Technology	0.4677	1
Outsourcing aspects	0.3567	2
Financial aspects	0.1853	3
Knowledge management	0.1591	4
Participation and support (Involvement)	0.0957	5
Eigenvalue λ Max = 6.535498		
CI = 0.1059		
RI =1.12,		
Consistency ratio CR = 0.09456		

The technology barrier gains first priority among the barrier categories. Technology change is a crucial barrier to SSCM implementation considering the expenses and cost involved. Next, the outsourcing barrier category receives the highest weight. This can be attributed to the reason that sustainable and green purchasing determines the important factors influencing the buying firms' choice of suppliers, including major barriers and obstacles. The financial barrier category obtained third rank less in the barrier category, thereby showing that industries commonly need more finances to extend their environmental management systems i.e. economy is critical in implementing SSCM. The knowledge barrier category ranks fourth. In many industries, there is a lack of knowledge in measuring environmental performance in supply chain management, which also reveals that the involvement barrier category is not essential and less important than other barrier categories.

Ranking of specific barrier category under each barrier category

The ranking of specific barriers under each category is shown in Table 3, revealing that overall ranking is based on the global weight values of the AHP approach. Global weights are obtained by multiplying the relative weight of barrier category values with the relative weights of each specific barrier.

Table 3 - Ranking specific barriers under each category

Barrier category	Rank of barrier category	Relative weights using AHP	Specific barrier	Rank of specific barriers
Technology	1	0.4677	Lack of new technology, materials and processes.	2
			Complexity to design, reuse/recycle products.	8
			Lack of technical expertise.	11
			Lack of standard environmental measures.	3
			Uncertain challenges and failure.	10
Outsourcing aspects	2	0.3567	Government support to adopt Environmental friendly policies	4
			The complexity of measuring/monitoring environmental supporting suppliers.	1
			Environmental friendly suppliers relationships	15
Financial aspects	3	0.1853	Cost for waste disposal.	9
			Financial constrictions.	5
			Non-availability of finance to encourage sustainable and green products/processes	6
			High investments and less return-on-investments.	12
Knowledge management	4	0.1591	Lack of sustainability system professionals.	7
			Lack of environmental knowledge	14
			Lack of extended producer responsibility or out-of-responsibility zone.	13
			Lack of knowledge of environmental benefits	16
Participation and support (Involvement)	5	0.0957	Stakeholder pressure and lack of customer awareness.	18
			Top management involvement and commitment.	17
			Restrictive company policies towards product/process stewardship.	20
			Poor supplier commitment and information sharing.	19
			Lack of Inter-departments co-operation and communication	21
			Less involvement in environmental related programs and meetings	22

VII. CONCLUSIONS

SSCM implementation in industries is crucial and requires coordination from all level of the workforce. Identification of critical barriers for SSCM implementation is somewhat complex due to its involvement of various factors and characteristics. The results of the study reveal that the identification of essential barriers during SSCM adoption and implementation will be helpful to industries to ensure a pollution-free environment.

The AHP results clearly show that the technology barrier category is the leading barrier category and industries need to concentrate more on technological development. Results suggest that the lack of suitable technology is the most important hurdle in SSCM adoption and implementation. Outsourcing, financial aspects, and knowledge barrier categories are the next priorities. Ranking reveals that industries, although involved in motivating their systems for SSCM adoption, still face a considerable gap as the involvement barrier category ranks last and is least important and they can be relegated.

The present research has identified important and critical barriers requiring elimination during SSCM implementation. Further, it assigns ranks to barrier categories and specific barriers by using AHP. However, in the initial phases, it is not possible to remove all obstacles when adopting SSCM implementation in industries. The present study provides industries with general solutions for the identification of important barriers during the SSCM implementation. The present study can be useful to industries that need to convert their traditional supply chain management to SSCM.

The results of the present may help to adopt SSCM easily in industries in the Indian scenario. The study revealed that Indian industries are interested in improving environmental performance, however, they still prefer economic performance over environmental performance improvements. This is because Indian industries also have low awareness on sharing of environmental knowledge and updating environmental technologies. Similarly, the availability of financial support for new raising environmental system adoptions is an obstacle. In future, research should consider more barrier categories and barriers. Further, various sectors in the industry could also be considered for the exhaustive investigation leading to further improved ways for SSCM implementation.

REFERENCES

[1] Diabat, A. and Govindan, K. 2011. An analysis of the drivers affecting the implementation of green supply chain management. Resources, Conservation and Recycling, 55(6):659-667.

[2] Haq, A. N. and Kannan, G. 2006a. Design of an integrated supplier selection and multi-echelon distribution inventory model in a built-to-order supply chain environment. International Journal of Production Research, 44(10):1963-1985.

[3] Haq, A. N. and Kannan, G. 2006b. Fuzzy analytical hierarchy process for evaluating and selecting a vendor in a supply chain model. The International Journal of Advanced Manufacturing Technology, 29(7-8):826-835.

[4] Jung, J. J. 2011, September. A bibliometric analysis on green supply chain management: A preliminary result. In Commerce and Enterprise Computing (CEC), 2011 IEEE 13th Conference on (pp. 418-420). IEEE.

[5] Kaur, J., Sidhu, R., Awasthi, A., Chauhan, S. and Goyal, S. 2018. A DEMATEL based approach for investigating barriers in green supply chain management in Canadian manufacturing firms. International Journal of Production Research, 56(1-2):312-332.

[6] Lin, C. Y. and Ho, Y. H. 2008. An empirical study on logistics service providers' intention to adopt green innovations. Journal of Technology Management & Innovation, 3(1):17-26.

[7] Luthra, S., Kumar, V., Kumar, S. and Haleem, A. 2011. Barriers to implement green supply chain management in automobile industry using interpretive structural modeling technique-An Indian perspective. Journal of Industrial Engineering and Management, 4(2):231-257.

[8] Luthra, S., Mangla, S. K., Xu, L. and Diabat, A. 2016. Using AHP to evaluate barriers in adopting sustainable consumption and production initiatives in a supply chain. International Journal of Production Economics, 181(1):342-349.

[9] Mangla, S. K., Kumar, P. and Barua, M. K. 2015. Risk analysis in green supply chain using fuzzy AHP approach: A case study. Resources, Conservation and Recycling, 104(1):375-390.

[10] Mathiyazhagan, K., Datta, U., Singla, A. and Krishnamoorthi, S. 2018. Identification and prioritization of motivational factors for the green supply chain management adoption: case from Indian construction industries. OPSEARCH, 55(1):202-219.

[11] Mathiyazhagan, K., Govindan, K., NoorulHaq, A. and Geng, Y. 2013. An ISM approach for the barrier analysis in implementing green supply chain management. Journal of Cleaner Production, 47(1):283-297.

[12] Min, H. and Kim, I. 2012. Green supply chain research: past, present, and future. Logistics Research, 4(1-2):39-47.

[13] Mudgal, R. K., Shankar, R., Talib, P. and Raj, T. 2010. Modelling the barriers of green supply chain practices: an Indian perspective. International Journal of Logistics Systems and Management, 7(1):81-107.

[14] Saaty, T. L. 1986. Axiomatic foundation of the analytic hierarchy process. Management Science, 32(7):841-855.

[15] Saaty, T.L. 1980. The Analytic Hierarchy Process. McGraw-Hill International, New York, NY.

[16] Sari, K. 2017. A novel multi-criteria decision framework for evaluating green supply chain management practices. Computers & Industrial Engineering, 105(1):338-347.

[17] Sarkis, J. 2012. A boundaries and flows perspective of green supply chain management. Supply Chain Management: An International Journal, 17(2):202-216.

[18] Sarkis, J., Zhu, Q. and Lai, K. H. (2011). An organizational theoretic review of green supply chain management literature. International Journal of Production Economics, 130(1):1-15.

[19] Seuring, S. and Müller, M. 2008. Core issues in sustainable supply chain management–a Delphi study. Business Strategy and the Environment, 17(8):455-466.

[20] Seuring, S., Sarkis, J., Müller, M. and Rao, P. 2008. Sustainability and supply chain management–an introduction to the special issue. Journal of Cleaner Production, 16(15):1545-1551.

[21] Shipeng, Q. and Linna, D. 2011, May. A study on green supply chain management of enterprises based on self-locking theory. In E-Business and E-Government (ICEE), 2011 International Conference on (pp. 1-4). IEEE. (http://dx.doi.org/10.1109/ICEBEG. 2011.5881683).

[22] Singh, M. 2017. Identification of Critical Success Factors (CSF's) to implement Green Supply Chain Management (SSCM) in an automobile industry using Analytical Hierarchy Process (AHP) technique. Journal of Automation and Automobile Engineering, 2(2, 3):1-19.
[23] Varnäs, A., Balfors, B. and Faith-Ell, C. 2009. Environmental consideration in procurement of construction contracts: current practice, problems and opportunities in green procurement in the Swedish construction industry. Journal of Cleaner Production, 17(13):1214-1222.
[24] Wu, K. J., Tseng, M. L. and Vy, T. 2011. Evaluation the drivers of green supply chain management practices in uncertainty. Procedia-Social and Behavioral Sciences, 25:384-397.
[25] Zhang, B., Bi, J. and Liu, B. 2009. Drivers and barriers to engage enterprises in environmental management initiatives in Suzhou Industrial Park, China. Frontiers of Environmental Science & Engineering in China, 3(2):210-220.
[26] Zhu, Q. and Sarkis, J. 2006. An inter-sectoral comparison of green supply chain management in China: drivers and practices. Journal of Cleaner Production, 14(5):472-486.
[27] Zhu, Q., Sarkis, J. and Lai, K. H. 2012. Green supply chain management innovation diffusion and its relationship to organizational improvement: An ecological modernization perspective. Journal of Engineering and Technology Management, 29(1):168-185.
[28] Zhu, Q., Sarkis, J. and Lai, K. H. 2012. Green supply chain management innovation diffusion and its relationship to organizational improvement: An ecological modernization perspective. Journal of Engineering and Technology Management, 29(1):168-185.