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"ANALYTIC HIERARCHY ANALYSIS WAS IMPLEMENTED IN INDUSTRIES USING BARRIERS TECHNIQUE FOR GSCM "

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ABSTRACT

Manufacturing industries started adopting the green concept in their supply chain management recently to focus on environmental issues. But, industries still struggle to identify barriers hindering green supply chain management implementation. This work focuses on identifying barriers to the implementation of a green supply chain management (Green SCM) based on procurement effectiveness. A total of 47 barriers were identified, both through detailed literature and discussion with industrial experts and through a questionnaire-based survey from various industrial sectors. Essential barriers/priorities are identified through recourse to analytic hierarchy process. Finally, a sensitivity analysis investigates priority ranking stability.

Keyword: *Green SCM implementation Barrier analysis Procurement effectiveness Analytic hierarchy process*

I. INTRODUCTION

Supply chain management plays a vital role in the improve-ment and implementation of a firm's competitive advantage. Literature offers many studies and related evidence revealing the benefits of

environmental initiatives for businesses . The identification of benefits for environmental initiatives and performance by businesses is important for dissemination of such initiatives in Small and Medium Enterprises .

However, it will be impossible to eradicate all barriers simultaneously. Hence, industries should identify those barriers which have essentially to be removed in the initial stages of GSCM adoption. This paper has, as its goal, the identification of such essential barriers so that they might be eradicated during.

II. SOLUTION METHODOLOGY

Based on literature reviews and discussions with the industrial experts, a detailed questionnaire was framed and circulated to various industries in the southern part of India. Later, the returned questionnaires were scrutinized and the most common barriers accepted by various organizations were identified. From these identified common barriers, the essential key barriers were picked using an AHP approach.

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III. Overview of AHP

The AHP methodology compares criteria, or alternatives with respect to a criterion, in a natural, pair-wise mode (Saaty, 1980). For more details about AHP, please see Borade et al. (2013).

The three steps of the AHP methodology are:
(1) identifying barriers and structuring a hierarchy prioritization model,
(2) con-structing a questionnaire and collecting data, and
(3) determining normalized weights for each barrier category and each specific barrier. Opinions from different industries including automobiles, electrical and electronics, textiles, paper, food, plastic, textiles and apparel, iron and steel, power plant, and chemical industries were collected through carefully designed questionnaires and then synthesized and analyzed by the AHP technique.

3.1 Consistency Check For Pair-Wise Comparison Matrix

The consistency ratio is calculated based on the following steps

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 ¼ ðλmax nÞ=ðn
3 The consistency ratio is then calculated using the formulae: CR ¼ CI=RI

IV. Application of Proposed Model

4.1. Developing the questionnaire

Questionnaires were designed to facilitate data collection. Our data collection's two phases are discussed in the following Section 6.2.1,
Phase 1: Initial survey to identify common barriers, and Section 6.2.2,
Phase 2:Identification of essential barriers.The demographic profile of the initial survey including respon-dent industry categories, employee size, ownership, and turnover are summarized in Table 2.

The questionnaire was distributed to 373 participants located in South India (Tamilnadu), Of the 373 participants, 103 responded to the questionnaire. All 373 partici-1Þpants wereð1Þ selected with help of a 1CII (Confederation of Indian Industry) directory. All 373 ð2Þindustrial participants started adopting environmentally-friendly activities (ISO 14001 environmental man-agement certification) and their commitment to green practices underscores the importance of this study. After four months, email and telephone remainders were sent to the participants resulting in 103 participants responding to our questionnaire.

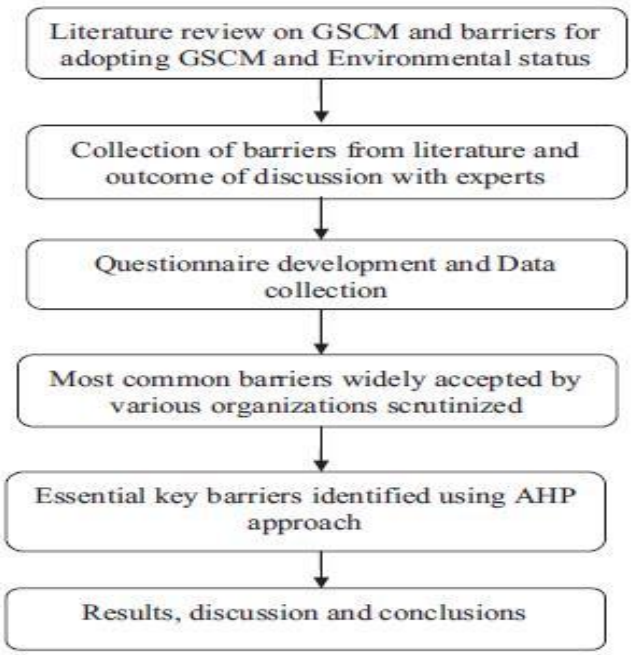

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Table2: Profile of the responding Indian companies.

Industry type	Total	Percentage
Paper	10	9.70
Chemical	5	4.85
Food	10	9.70
Plastic	6	5.82
Textiles and Apparel	8	7.76
Iron & Steel	7	6.79
Electrical/electronics	24	23.3
Auto components	21	20.38
Power plant	12	11.65
Total	103	100
Size (Employees)		
> 3000 (Enterprises)	07	6.79
2001–3000 (Large)	19	18.44
701–2000 (Medium)	27	26.21
501–700 (Small)	50	48.54
Total	103	100
Ownership		
Private	69	67
Foreign Direct Investment or Joint Venture	34	33
Total	103	100

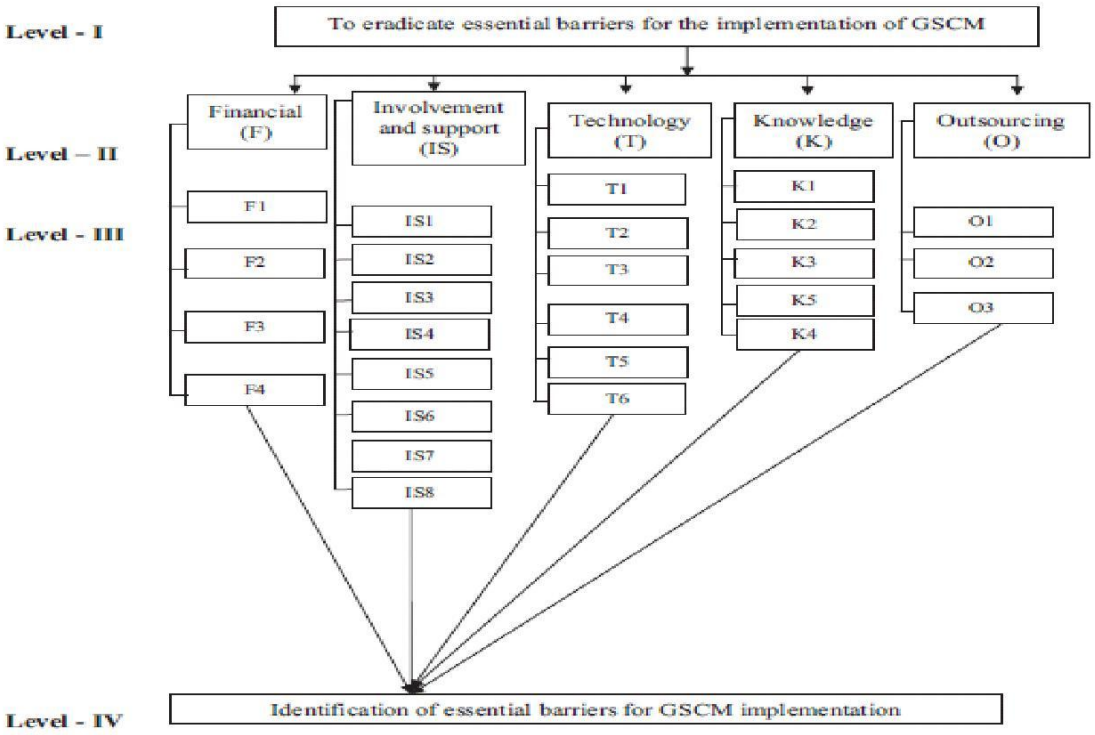

Fig.2. AHP frame work for identifying essential barriers of GSCM implementation

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V. RESULTS & DISCUSSIONS

5.1. Barrier Category

The financial barrier category obtained less than half of the weight of the technology barrier category, thereby showing that industries commonly need more finances to extend their environmental management systems. Economy is critical in implementing GSCM The knowledge barrier category ranks fourth has found that there is a lack of knowledge in measuring environmental performance in supply chain management, which reveals that the involvement and sup- port barrier category is not essential for comparison with other barrier categories.

5.2. Barrier Ranking For GSCM Implementation In Indian Industries

The ranking of specific barriers 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. The result of each barrier, based on barrier categories, is discussed in the following sections.

5.3 Technology

Industries need to develop and update themselves on new trends and technologies when implementing GSCM (Mudgal et al., 2010). In the technology barrier category, a lack of new technology, materials and processes (T1) barrier ranks first.

Table3 Local and global weights of all barrier categories and specific barriers for the Implementation of GSCM.

O	0.2345	O1	0.2618	0.0614	4
		O2	0.6265	0.1469	1
		O3	0.1117	0.0262	15
T	0.3565	T1	0.3663	0.1306	2
		T2	0.1213	0.0432	8
		T3	0.112	0.0399	11
		T4	0.1141	0.0407	10
		T5	0.2385	0.0850	3
		T6	0.0496	0.0177	17
K	0.1482	K1	0.3025	0.0448	7
		K2	0.1972	0.0292	14
		K3	0.2329	0.0345	13
		K4	0.1072	0.0159	18
		K5	0.1603	0.0238	16
F	0.1762	F1	0.2339	0.0412	9
		F2	0.2952	0.0520	5
		F3	0.2589	0.0456	6
		F4	0.212	0.0374	12
IS	0.0846	IS1	0.1758	0.0149	20
		IS2	0.16	0.0135	21
		IS3	0.1805	0.0153	19
		IS4	0.0754	0.0064	26
		IS5	0.1114	0.0094	23
		IS6	0.0855	0.0072	24
		IS7	0.1335	0.0113	22
		IS8	0.078	0.0066	25

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5.4. Outsourcing

In this category, of the three barriers, O2 (Complexity to measure/monitor environmental practice of suppliers) is the most essential barrier. The normalized global weight of O2 shows that most Indian industries do not have proper monitoring/measuring systems for their suppliers' environmental practices. Due to lack of direction and legislation on environmental management, indus-tries do not know what they should measure and how to measure what should be measured (Shaw et al. 2010).

5.4. Financial

In GSCM implementation, the lack of financial support is usually considered as the most important constraint to environ-mental actions. In this barrier category, financial constraints (F2) are a dominant barrier. It reveals that Indian industries are unable to fulfill their economic needs and hence do not spend much for GSCM implementation. Lack of finances can hinder GSCM applications

5.5.Knowledge

The Knowledge barrier category is comprised of five barriers. Lack of green system exposure professionals (K1) barrier comes first in this category. The survey results show that professionals in industries are less exposed to green systems. The succeeding barrier is the perception of ―out-of-responsibility‖ zone (K3) barrier. Industries are reluctant to take responsibility to adopt and update environmental issues barrier. Finally, low priority is obtained for Lack of awareness about reverse logistics (K5) barrier. It proved to be a big obstacle to minimize waste and improve profits. A chief barrier of reverse logistics, seen in the Indian automobile industry supply chain, is the lack of awareness about the benefits of reverse logistics .

5.6.Involvement And Support

In implementing any system, involvement and support of management is important especially in issues such as GSCM adoption Both the identification of barriers and the insights on GSCM provided contribute to the importance of this survey. This change is reflected in the other category barriers with the outsourcing barrier category showing maximum variation. The changes in other barrier category values are tabulated in Table 4. Hence, specific barrier weights and rank also change accordingly. At 0.1 of technology category barrier, barrier O2 holds first rank and barrier T6 the last rank. Barrier O2 retains first rank till the normal value of 0.3565. From 0.4 to 0.9 T1 holds first rank, and the ranks of other barriers vary. Priority (rank) changes are illustrated in a chart in Fig. 3. It shows that changes in

VI. SENSITIVITY ANALYSIS

Table 3 reveals that technology barrier category has more weight and thereby influences the other barrier categories. Chang et al. (2007) and Kannan et al. (2013) mentioned that small changes in relative weights would provide major changes in the final ranking. Such weights are usually based on highly individual judgments and therefore, ranking stability under varying barrier category weights should be tested. Sensitivity analysis can be performed for this method of validation. Here, the technology category barrier is selected with its value varying from 0.1 to 0.9 with 0.1 as increment.

Table 4 :Barrier category values after increasing technological category barrier.

Barriers	Barrier category values									
O	0.2345	0.32797	0.29153	0.25508	0.21864	0.18220	0.14576	0.10932	0.07288	0.03644
T	0.3565	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
K	0.1482	0.20727	0.18424	0.16121	0.13818	0.11515	0.09212	0.06909	0.04606	0.02303
F	0.1762	0.24643	0.21905	0.19167	0.16428	0.13690	0.10952	0.08214	0.05476	0.02738
IS	0.0846	0.11832	0.10517	0.09202	0.07888	0.06573	0.05258	0.03944	0.02629	0.01314
Total	1	1	1	1	1	1	1	1	1	1

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Table 5 Ranking for barriers when increasing technological barrier category value from 0.1 to 0.9 by sensitivity analysis

Barriers	Technological barrier category values in sensitivity analysis									
	0.1	0.2	0.3	Normal (0.3565)	0.4	0.5	0.6	0.7	0.8	0.9
O1	2	2	4	4	4	7	7	8	8	8
O2	1	1	1	1	2	3	3	6	6	7
O3	10	12	15	15	15	16	16	16	16	16
T1	11	3	2	2	1	1	1	1	1	1
T2	20	14	11	8	5	4	4	3	3	3
T3	22	16	13	11	8	6	6	5	5	5
T4	21	15	12	10	7	5	5	4	4	4
T5	13	8	3	3	3	2	2	2	2	2
T6	26	23	20	17	17	14	9	7	7	6
K1	5	6	7	7	10	10	11	11	11	11
K2	9	11	14	14	14	15	15	15	15	15
K3	8	10	10	13	13	13	14	14	14	14
K4	14	17	17	18	18	18	18	18	18	18
K5	12	13	16	16	16	17	17	17	17	17
F1	6	7	8	9	11	11	12	12	12	12
F2	3	4	5	5	6	8	8	9	9	9
F3	4	5	6	6	9	9	10	10	10	10
F4	7	9	9	12	12	12	13	13	13	13
IS1	16	19	19	20	20	20	20	20	20	20
IS2	17	20	21	21	21	21	21	21	21	21
IS3	15	18	18	19	19	19	19	19	19	19
IS4	25	26	26	26	26	26	26	26	26	26
IS5	19	22	23	23	23	23	23	23	23	23
IS6	23	24	24	24	24	24	24	24	24	24
IS7	18	21	22	22	22	22	22	22	22	22
IS8	24	25	25	25	25	25	25	25	25	25

priority (rank) vary according to change in the technology category barrier. Changes of specific barrier ranks are tabulated in Table 5. It is inferred that technology category barrier has more impact on the GSCM implementation and so this category demands greater attention. If the technology category barrier is eliminated, there is a high possibility of eliminating the remaining category barriers, so the. elimination procedure for specific barriers is also easier. By following this, industries can implement GSCM without difficulty.

VII. CONCLUSION

Identification of essential barriers for GSCM implementation is tricky due to its numerous characteristics. This paper has attempted to present a benchmark-ing framework to ease these complicated elements and to trim down barrier identification difficulties to make managers‘ efforts towards environmental improvement a little easier.

MANAGERIAL IMPLICATION AND LIMITATIONS

It is evident from the results that identification of essential barriers in industries during GSCM adoption is helpful to ensure a pollution-free environment. The most important Level 2 and specific Level 3 barrier categories are considered. The technology barrier category is important during GSCM adoption and industries need to concentrate more on technological development. The outcome of this research helps to adopt GSCM easily in industries in the Indian scenario. This work can be extremely useful to industries that need to convert their traditional supply chain management to GSCM.

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