Green Supply Chain Management: A Hierarchical Framework for Barriers

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Abstract – The research paper presents a hierarchical sustainable framework for evaluating the barriers to the implementation of the green supply chain management (GSCM) in an organization. A total of 14 barriers to the implementation to the GSCM are identified through extensive literature review and expert opinion to academics professionals. The nature of the identified barriers is complex and interdependent; an Interpretive Structural Modeling (ISM) technique is applied to develop a structural model. Driving and dependence power analysis (DDPA) is used to classify and identify critical barriers. An efficient evaluation technique developed by the framework can be used in decision making policies by policy makers and stakeholders of the organization which can identify and prioritize the critical barriers important for adoption of GSCM in the organization.

Keywords–Green Supply Chain Management, Barriers, Interpretive Structural Modeling (ISM), Dependence power analysis (DDPA).

I. INTRODUCTION

A Green Supply Chain aims at confining the wastes and also recognizes the disproportionate environmental impact of the supply chain processes within the industrial system, hence helps to conserve the energy and prevent the dissipation of dangerous material into the environment. This research paper deals with the 14 barriers (listed in the TABLE III), which were identified on the basis of extensive literature review (as mentioned in the TABLE I) and expert opinion of academics professionals. An Interpretive Structural Modeling (ISM) technique is applied to develop a structural model to the barriers for the implementation of GSCM in an organization and resultant ranking is done for the specific barriers, which is to be given priority for the eliminating process taken under considerations by the policy makers and top level management system of the industry**.**

II. LITERATURE REVIEW

Interpretive Structural Modeling (Warfield, 1974) was adopted by many researchers to model GSCM. ISM model to evaluate the barriers of GSCM in the automobile industry in India was taken under study by Luthra et al. (2011). Vimal et al. (2011) applied ISM technique to study the adoption of renewable energy in India. Ming and Yuan (2011) developed ISM based model for municipal solid waste management in Taipei metropolitan. Huang et al. (2005) proposed integrating ISM and analytical network process (ANP) to deal with problem of interdependence among subsystems. Mudgal et al. (2010) used ISM to model the enablers and barriers of GSCM in the Indian manufacturing industries. Chang (2010) used SEM to test the validity of interactive management (IM). Driving and dependent power analysis (DDPA) was developed by Martilla and James (1977) to indicate the degree of dependence and driving power of criteria. The following tables (TABLE I & II) shows the list of research papers and the respective list of journals which were taken under study.

TABLE I:
Concepts and models related to environmental issues have been suggested by different researchers is summarized in the following table (Source: Kshitij Dashore and Nagendra Sohani, April 2013)

Year	Title	Author	Description
2012	An Overview of Green Supply Chain Management in India	Nimawat Dheeraj & Namdev Vishal	The paper seeks out environmental performance index (EPI) of India and four activities of the green supply chain management; namely green purchasing, green manufacturing, green marketing and reverse logistics.
2012	Examining Green Production and its Role within the Competitive Strategy of Manufacturing	Tim Banies, Steve Brown, Ornella Benedettini, Peter Ball	It relates and summarizes the core knowledge on green production, aligns to production and operations management prospective.
2012	A Hierarchical Framework of Barriers to Green Supply Chain Management in the Construction Sector	Sreejith Balasubramanian	In this paper barriers are identified and then they are classified as external and internal barriers to the organization which help policy makers to focus on specific barriers important to the adoption of GSCM in the UAE construction sector.

2012	Modeling the Knowledge Sharing Barriers using an ISM Approach	B. P. Sharma, M. D. Singh and Neha	Variables which resists knowledge sharing (KS) in the organizations are known as Knowledge Sharing barriers (KSBs) were identified and ISM model is proposed showing solutions.
2011	Barriers to implement Green Supply Chain Management in automobile industry using Interpretive Structural Modeling (ISM) Technique – An Indian Perspective	Sunil Luthra, Vinod Kumar & Abid Haleem	An industry based approach was used to develop a structural model of the barriers to implement green supply chain management.
2011	Research on the Performance Measurement of Green Supply Chain Management in China	Yan Li	The paper tries to improve the environmental performance by implementing a variety of GSCM practices in additionally top level manager's commitment is necessary for development of any GSCM program.
2010	Evaluating Green Supply Chain Management among Chinese Manufacturers from the Ecological Modernization Perspective	Zhu, Q., Geng, Y., Sarkis, J., & Lai, K.H.	The study includes a comparison between Chinese manufacturers and Japanese manufacturers which implies more significant improvements made in environmental and financial performance and additionally four other GSCM practices were implemented.
2009	Opportunities in Green Supply Chain Management	Jonny C. Ho, Maurice K. Shalishali, Tzu-Liang Tseng and David S. Ang	A comparison is performed between traditional and green supply chain. It includes several important opportunities in green supply chain management, including those in manufacturing, bio-waste, construction, and packaging.
2009	An Empirical Study of Green Supply Chain Management Practices Amongst UK Manufacturers	Daine Holt and Abby Ghobadian	The paper identifies various operational activities within a supply chain and also suggests the factors which are driving these operational changes.
2008	Knowledge management barriers: An interpretive structural modeling approach	M. D. Singh and R. Kant	The paper identified KM barriers to the organization and a relationship among them is made, further giving solutions by using ISM methodology.

TABLE II:
Journals Reviewed for literature
(Source: Kshitij Dashore and Nagendra Sohani, April 2013)

Sr. No.	Year of Published	Journals Reviewed
1.	2012	Research Journal of Recent Sciences (Vol. 1)
2.	2012	International Conference on Information and Knowledge Management (Vol. 45)
3.	2012, 2011	Journal of Industrial Engineering and Management
4.	2012	Journal of Sustainable Development (Vol. 5)
5.	2011, 2008	Business Strategy and the Environment
6.	2011	Resources, Conservation and Recycling
7.	2011	Journal of Purchasing and Supply Management (Vol. 17)
8.	2010	Transportation Research Part E, 47
9.	2011	Journal of Sustainable Development (Vol. 4)
10.	2008	Business Strategy and the Environment
11.	2009	The Coastal Business Journal (Vol. 8)
12.	2008	Journal of Cleaner Production (Vol. 16)
13.	2008	International Journal of Management Science and Engineering Management (Vol. 3)

III. FINDINGS

From the literature review and expert's opinion from academics professionals following 14 barriers to implementation of GSCM are taken under study. The barriers are taken in such a way that they are found to be common to different authors & the particular are mentioned in the TABLE III as follows.

TABLE III:
Barriers for GSCM
(Source: Kshitij Dashore and Nagendra Sohani, April 2013)

Sr.No.	Barrier to Implement GSCM	Description	Resource
1.	Lack of top level management commitment	It means top level management resisting towards implementation of green practices.	M.D. singh (2012); Shreejith B. (2012); Gioconda Q. (2011); Xianbing Lui (2011); Sunil L. (2010); Daine Holt (2009); Abby Ghobadian (2009); Mudgal et al. (2010); Sarkis (2009); Mudgal et al. (2009); Zhu (2007); Ravi V. et al. (2005); Digalwar et al. (2004).
2.	Lack of integration of Information Technology system	It uses various computer based applications programs and various IT enabled procedures and software which may be o utility during the various data and information exchange process.	Shreejith B. (2012); Gioconda Q. (2011); Xianbing Lui (2011); Daine Holt (2009); Abby Ghobadian (2009); Wu et al. (2009); AlKhidir et al. (2009); Ravi et al. (2005); Mclaren et al. (2004); Rogers et al. (1998).
3.	Lack of acceptance of advancement in new technology	It emphasis on adoption of various advancement in technology to the older established technology in existing organization.	Shreejith B. (2012); Christian B. (2011); Jie Yang (2011); AlKhidir et al. (2009); Daine Holt (2009); Hsu et al. (2008); Hosseini (2007); Digalwar et al. (2004); TSai et al. (1999); Gant (1996); Cooper (1994).
4.	Poor organizational culture	It directs towards the participation of top level management in motivating the employee.	Brooks W. (2011); Cunkuan Bao (2011); Abby Ghobadian (2009); Yu Lin et al. (2008); Yu Lin (2007); Hsu et al. (2008); Chien et al. (2007); Ravi et al. (2005).
5.	Lack of skilled human resource professionals in GSCM	It reflects the lack of skills in human resource department of the organization with special context to their recruitment policies and trainings in GSCM.	Shreejith B. (2012); Xianbing Lui (2011); Gioconda Q. (2011); Yu Lin et al. (2008); Hsu et al. (2008); Chien et al. (2007) ; Yu Lin (2007).
6.	Lack of energy management and waste management of the organization	It shows poor management of organization towards its resources.	M.D. Singh (2012); Daine Holt (2009); Alemayche (2008); Roger and R.S. (1998).
7.	Uncertainty and competition in market	Market competition and uncertainty is high due to global competitiveness and varying customer's requirements.	Jie Yang (2011); Mudgal et al. (2010); Daine Holt (2009); Hosseini (2007); Yu Lin (2007).
8.	Lack of government initiatives system for GSCM practitioners	It means government not making industry friendly policies toward GSCM and not giving special benefits to those organizations implementing GSCM.	Shreejith B. (2012); Gioconda Q. (2011); Xianbing Lui (2011); Sunil L. (2010); Daine Holt (2009); Abby Ghobadian (2009); Mudgal et al. (2010); Mudgal et al. (2009); Yu Lin et al. (2008); Hsu et al. (2008); Srivastva (2007); Hosseini (2007); Scupola (2003).
9.	Lack of knowledge, experience and training to personals in GSCM	Lack of knowledge and experience among the supply chain stakeholders in executing GSCM and lack of training given to the employee of the organization, thus resisting enhancement of overall performance of supply chain and green practices in it.	B.P. Sharma (2012); Sixiao Qu. (2011); Daine H. (2009); Yu and Hui (2008); Yu and Hui (2008); Bowen et al. (2001); Cooper et al. (2000); Tsai and Ghosal (1999).
10.	Lack of green architects, consultants, green developers, contractors in the region	Lack of green practitioners available in the region for an organization.	Sixiao Qu. (2011); Daine H. (2009); Yu and Hui (2008); Tsai and Ghosal (1999).
11.	Cost of implementation for GSCM	It reflects to the high initial cost investment required to implement various green methodologies such as green design, green manufacturing, green labeling of packing etc.	Shreejith B. (2012); Gioconda Q. (2011); Xianbing Lui (2011); Sunil L. (2010); Daine Holt (2009); Abby Ghobadian (2009); Mudgal et al. (2009); AlKhidir et al. (2009); Hosseini (2007); Ravi et al. (2005).
12.	Supplier's flexibility to change towards GSCM	This means suppliers unwillingness to be involved in design process and technology, which affects overall performance of whole chain.	B.P. Sharma (2012); Shreejith B. (2012); Tomohiro Shishime (2011); Sanjay K. (2010); Lettice et al. (2010); Hsu et al. (2008); Kannan et al. (2008); Srivastva (2007); Sarkar et al. (2006); Ravi et al. (2005).
13.	Lack of management initiatives for	It shows poor managerial management of	M.D. Singh (2012); Daine Holt (2009).

	transport and logistics	logistics in the organization.	
14.	Lack of customer's awareness towards GSCM and Green products	This reflects customers do not know about green products and their benefits.	B.P. Sharma (2012); Shreejith B. (2012); Tomohiro Shishime (2011); Sanjay K. (2010); Mudgal et al. (2009); Zhu et al. (2008); Zhu et al. (2007); Ravi et al. (2005).

by Warfield and used to identify contextual relationship among the specific variables (in this case barriers) taken under study. The following figure (Fig.1.) gives the flow chart for the ISM.

IV. METHODOLOGY

A) Interpretive Structural Modeling (ISM): Interpretive Structural Modeling (ISM) was firstly developed in 1970's

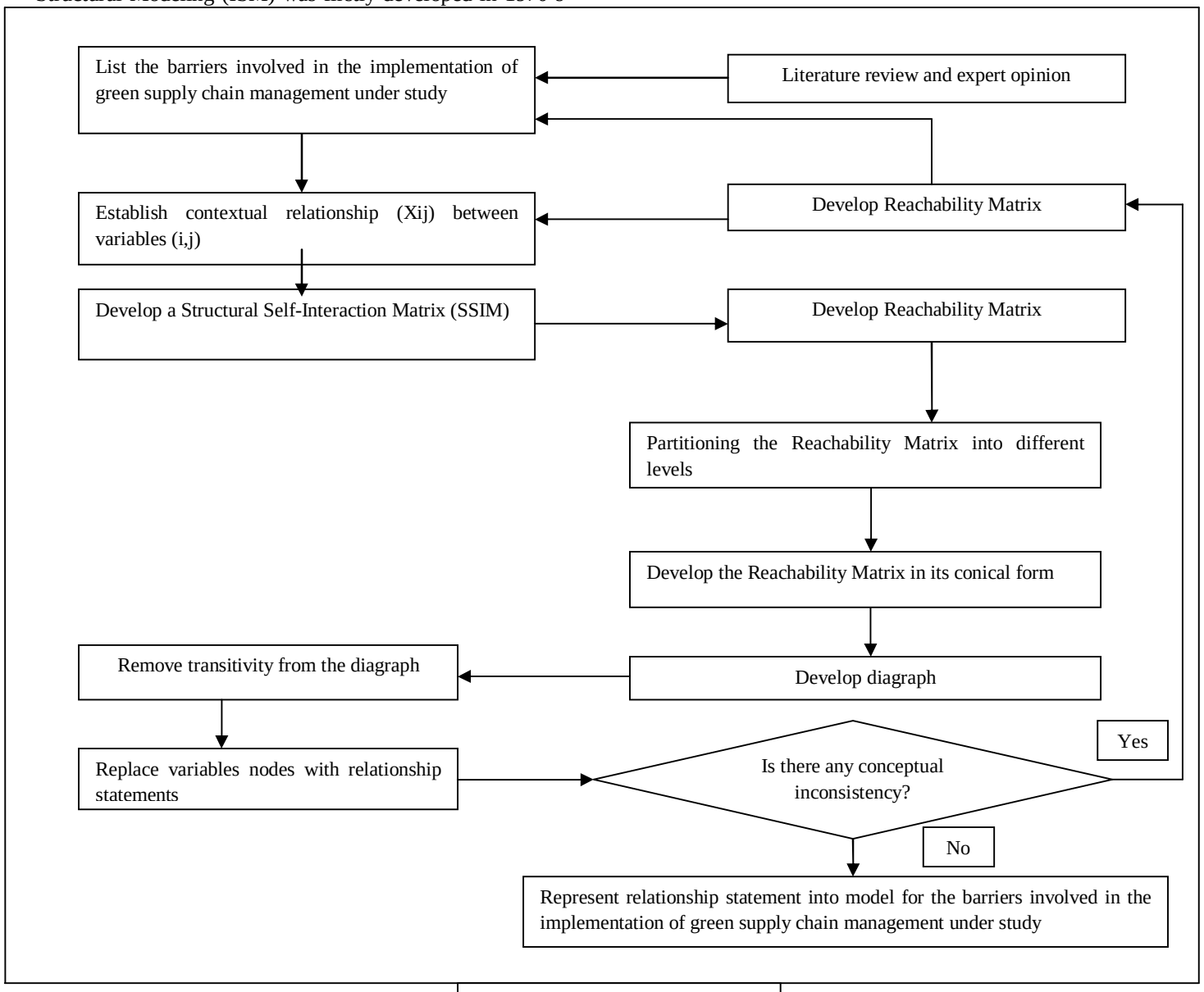

Fig.1. Flow chart for the ISM

B) Steps involved in ISM

The various steps involved in the ISM methodology are given below (Kannan and Haq, 2007; Kannan et al., 2009)

Step 1: The barriers affecting the implementation of green supply chain management for the firm under study are listed.

Step 2: For each pair of barriers identified in Step 1, a contextual relationship is established.

Step 3: A Structural Self-Interaction Matrix (SSIM) is developed, which indicates pairwise relationships among barriers of the system under consideration.

Step 4: A reachability matrix is developed from the SSIM and the matrix is checked for transitivity. The transitivity rule states that if a variable 'A' is related to 'B' and 'B' is related to 'C', then 'A' is necessarily related to 'C'.

Step 5: The reachability matrix obtained in Step 4 is partitioned into different levels.

Step 6: Based on the relationships given above in the reachability matrix, a directed graph is drawn and the transitive links are removed.

Step 7: The resulting digraph is converted into an ISM by replacing the variable nodes with statements.

Step 8: The ISM model developed in Step 7 is reviewed to check for conceptual inconsistencies, and necessary modifications are made.

Table IV

Structural Self-Interaction Matrix for the barriers

Sr. No.	Barriers for GSCM	14	13	12	11	10	9	8	7	6	5	4	3	2	1
1.	Lack of top level management commitment	O	V	V	A	O	O	A	O	V	V	V	V	V	X
2.	Lack of integration of Information Technology system	O	O	O	V	A	A	O	O	O	V	O	V	X	
3.	Lack of acceptance of advancement in new technology	X	O	V	V	O	A	O	V	X	A	V	X		
4.	Poor organizational culture in GSCM	O	V	V	V	O	A	O	O	V	V	X			
5.	Lack of skilled human resource professionals in sustainability and GSCM	O	V	V	V	A	A	O	V	V	X				
6.	Lack of energy management and waste management system	X	V	A	V	A	A	O	O	X					
7.	Uncertainty and competition in market	O	O	O	V	O	A	O	X						
8.	Lack of government initiatives system for GSCM practitioners	V	V	V	V	V	V	X							
9.	Lack of knowledge, experience and training to personals in GSCM	O	V	O	V	V	X								
10.	Lack of green architects, consultants, green developers, contractors in the region	O	V	V	V	X									
11.	Cost of implementation for GSCM	X	A	A	X										
12.	Supplier's flexibility to change towards GSCM	O	X	X											
13.	Lack of management initiatives for transport and logistics	O	X												
14.	Lack of customer's awareness towards GSCM and Green products	X													

Based on contextual relationship among identified the barriers, a Structural Self-Interaction Matrix (SSIM) was developed (TABLE IV). This matrix indicates the pairwise relationships among the barriers affecting the implementation of green supply chain management initiatives for a firm. The symbols used to denote the direction of the relationship between the barriers are given below. Let us assume that the barriers under study are i and j, then the symbol 'V' denotes that barrier i will help to achieve barrier j, the symbol 'A' means that barrier j will be help to achieve barrier i. The symbol 'X' means the barriers i and j will help each other to be achieved, and the symbol 'O' means barriers are unrelated. Using this, an initial reachability matrix is made as shown in TABLE V.

C) Reachability matrix

We derived the reachability matrix from the structural self-interaction matrix (SSIM) developed in the previous step. The initial reachability matrix is constructed from the structural self-interaction matrix (SSIM) using the following rules:

- If the (i, j) entry in the SSIM is V, the (i, j) entry in the reachability matrix is set to 1 and the (j, i) entry is set to 0.
- If the (i, j) entry in the SSIM is A, the (i, j) entry in the reachability matrix is set to 0 and the (j, i) entry is set to 1.
- If the (i, j) entry in the SSIM is X, the (i, j) entry in the reachability matrix is set to 1 and the (j, i) entry is set to 1.
- If the (i, j) entry in the SSIM is O, the (i, j) entry in the reachability matrix is set to 0 and the (j, i) entry is set to 0

The final reachability matrix (TABLE VI) is constructed from the initial reachability matrix taking into

account the transitivity rule, which states that if a variable 'A' is related to 'B' and 'B' is related to 'C', then 'A' is necessarily related to 'C'.

D) Partitioning of levels

The reachability matrix obatained in TABLE VI was partitioned into different levels. The reachability and antecedent set for each barrier were found from the final reachability matrix (TABLE VII). The levels are been decided by taking MICMAC analysis shown in Fig. 2. Into consideration and subsequent iterations are been done. The hierarchy for the barriers is obtained after 10 iterations. The different levels for barriers are shown in TABLE VIII as the level partition of barriers – final iteration.

TABLE V
Initial Reachability Matrix

Sr. No.	Barriers for GSCM	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Lack of top level management commitment	1	1	1	1	1	1	0	0	0	0	0	1	1	0
2.	Lack of integration of Information Technology system	0	1	1	0	1	0	0	0	0	0	1	0	0	0
3.	Lack of acceptance of advancement in new technology	0	0	1	1	0	1	1	0	0	0	1	1	0	1
4.	Poor organizational culture in GSCM	0	0	0	1	1	1	0	0	0	0	1	1	1	0
5.	Lack of skilled human resource professionals in sustainability and GSCM	0	0	1	0	1	1	1	0	0	0	1	1	1	0
6.	Lack of energy management and waste management system	0	0	1	0	0	1	0	0	0	0	1	0	1	1
7.	Uncertainty and competition in market	0	0	0	0	0	0	1	0	0	0	1	0	0	0
8.	Lack of government initiatives system for GSCM practitioners	1	0	0	0	0	0	0	1	1	1	1	1	1	1
9.	Lack of knowledge, experience and training to personals in GSCM	0	1	1	1	1	1	1	0	1	1	1	0	1	0
10.	Lack of green architects, consultants, green developers, contractors in the region	0	1	0	0	1	1	0	0	0	1	1	1	1	0
11.	Cost of implementation for GSCM	1	0	0	0	0	0	0	0	0	0	1	0	0	1
12.	Supplier's flexibility to change towards GSCM	0	0	0	0	0	1	0	0	0	0	1	1	1	0
13.	Lack of management initiatives for transport and logistics	0	0	0	0	0	0	0	0	0	0	1	1	1	0
14.	Lack of customer's awareness towards GSCM and Green products	0	0	1	0	0	1	0	0	0	0	1	0	0	1

Table VI
Final Reachability Matrix

Sr. No.	Barriers for GSCM	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Driving Power
1.	Lack of top level management commitment	1	1	1	1	1	1	1*	0	0	0	1*	1	1	1*	11
2.	Lack of integration of Information Technology system	0	1	1	1*	1	1*	1*	0	0	0	1	1*	1*	1*	10
3.	Lack of acceptance of advancement in new technology	0	0	1	1	1*	1	1	0	0	0	1	1	1*	1	9
4.	Poor organizational culture in GSCM	0	0	0	1	1	1	1*	0	0	0	1	1	1	1*	8
5.	Lack of skilled human resource professionals in sustainability and GSCM	0	0	1	1*	1	1	1	0	0	0	1	1	1	1*	9
6.	Lack of energy management and waste management system	0	0	1	1*	1*	1	1*	0	0	0	1	1*	1	1	9
7.	Uncertainty and competition in market	0	0	0	0	0	0	1	0	0	0	1	1*	1*	1*	5
8.	Lack of government initiatives system for GSCM practitioners	1	1*	1*	1*	1*	1*	1*	1	1	1	1	1	1	1	14
9.	Lack of knowledge, experience and training to personals in GSCM	0	1	1	1	1	1	1	0	1	1	1	1*	1	1*	12
10.	Lack of green architects, consultants, green developers, contractors in the region	0	1	1*	1*	1	1	1*	0	0	1	1	1	1	1*	11
11.	Cost of implementation for GSCM	1	1*	1*	1*	1*	1*	1*	0	0	0	1	1*	1*	1	11
12.	Supplier's flexibility to change towards GSCM	0	0	0	0	0	1	1*	0	0	0	1	1	1	1*	6
13.	Lack of management initiatives for transport and logistics	0	0	0	0	0	0	0	0	0	0	1	1	1	1*	4
14.	Lack of customer's awareness towards GSCM and Green products	0	0	1	1*	1*	1	1*	0	0	0	1	1*	1*	1	9
	Dependence Power	3	6	10	11	11	12	13	1	2	3	14	14	14	14	128

TABLE VII
Partitioning of levels

Sr. No.	Barriers for GSCM	Reachability Set	Antecedent Set	Intersection Set	Level
1.	Lack of top level management commitment	1,2,3,4,5,6,7,11,12,13,14	1,8,11	1,11	
2.	Lack of integration of Information Technology system	2,3,4,5,6,7,11,12,13,14	1,2,8,9,10,11	2,11	
3.	Lack of acceptance of advancement in new technology	3,4,5,6,7,11,12,13,14	1,2,3,5,6,8,9,10,11,14	3,5,6,11,14	
4.	Poor organizational culture in GSCM	4,5,6,7,11,12,13,14	1,2,3,4,5,6,8,9,10,11,14	4,5,6,11,14	
5.	Lack of skilled human resource professionals in sustainability and GSCM	3,4,5,6,7,11,12,13,14	1,2,3,4,5,6,8,9,10,11,14	3,4,5,6,11,14	**I**
6.	Lack of energy management and waste management system	3,4,5,6,7,11,12,13,14	1,2,3,4,5,6,8,9,10,11,12,14	3,4,5,6,11,14	**I**
7.	Uncertainty and competition in market	7,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12,14	7,11,12,14	
8.	Lack of government initiatives system for GSCM practitioners	1,2,3,4,5,6,7,8,9,10,11,12,13,14	8	8	
9.	Lack of knowledge, experience and training to personals in GSCM	2,3,4,5,6,7,9,10,11,12,13,14	8,9	9	
10.	Lack of green architects, consultants, green developers, contractors in the region	2,3,4,5,6,7,10,11,12,13,14	8,9,10	10	
11.	Cost of implementation for GSCM	1,2,3,4,5,6,7,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12,13,14	1,2,3,4,5,6,7,11,12,13,14	
12.	Supplier's flexibility to change towards GSCM	6,7,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12,13,14	6,7,11,12,13,14	
13.	Lack of management initiatives for transport and logistics	11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12,13,14	11,12,13,14	
14.	Lack of customer's awareness towards GSCM and Green products	3,4,5,6,7,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12,13,14	3,4,5,6,7,11,12,13,14	

E) MICMAC Analysis

In the MICMAC analysis, the driving and dependence power of the variables are analyzed shown in Fig. 2. The barriers are classified into 4 sections – autonomous, dependent, linkage and driver. In the final reachability matrix, shown in TABLE VI, the driving power and dependence of each of the drivers are calculated. The barriers that have weak driver power and weak dependence will fall in sector I and are called autonomous elements. Barriers that have weak driver power, but strong dependence power will fall in sector II and are called dependent elements. Barriers that have both strong driver power and dependence power will fall in sector III and are called linkage elements. These elements are unstable due to the fact that any action on these elements will affect the others, and may also have a feedback effect on them. Barriers that have strong driver power but weak dependence power will fall in sector IV and are called driver/independent elements (Kannan and Haq, 2007).

F) Formation of ISM model

With the help of the level partitioning shown in TABLE VII and TABLE VIII, a model of various barriers important to implementing green supply chain management for an organization taken under study was developed and shown in Fig.3.

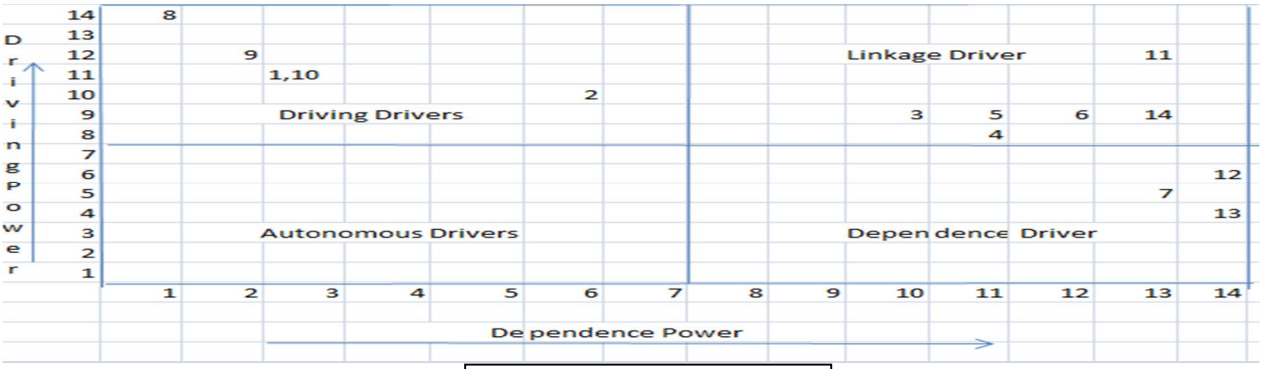

Fig.2. MICMAC Ananlysis

Level partitioning of barriers – after 10 iterations

Sr. No.	Barriers for GSCM	Levels
1.	Lack of top level management commitment	**V**
2.	Lack of integration of Information Technology system	**VIII**
3.	Lack of acceptance of advancement in new technology	**VII**
4.	Poor organizational culture in GSCM	**X**
5.	Lack of skilled human resource professionals in sustainability and GSCM	**I**
6.	Lack of energy management and waste management system	**I**
7.	Uncertainty and competition in market	**XI**
8.	Lack of government initiatives system for GSCM practitioners	**III**
9.	Lack of knowledge, experience and training to personals in GSCM	**IV**
10.	Lack of green architects, consultants, green developers, contractors in the region	**VI**
11.	Cost of implementation for GSCM	**II**
12.	Supplier's flexibility to change towards GSCM	**IX**
13.	Lack of management initiatives for transport and logistics	**IX**
14.	Lack of customer's awareness towards GSCM and Green products	**VII**

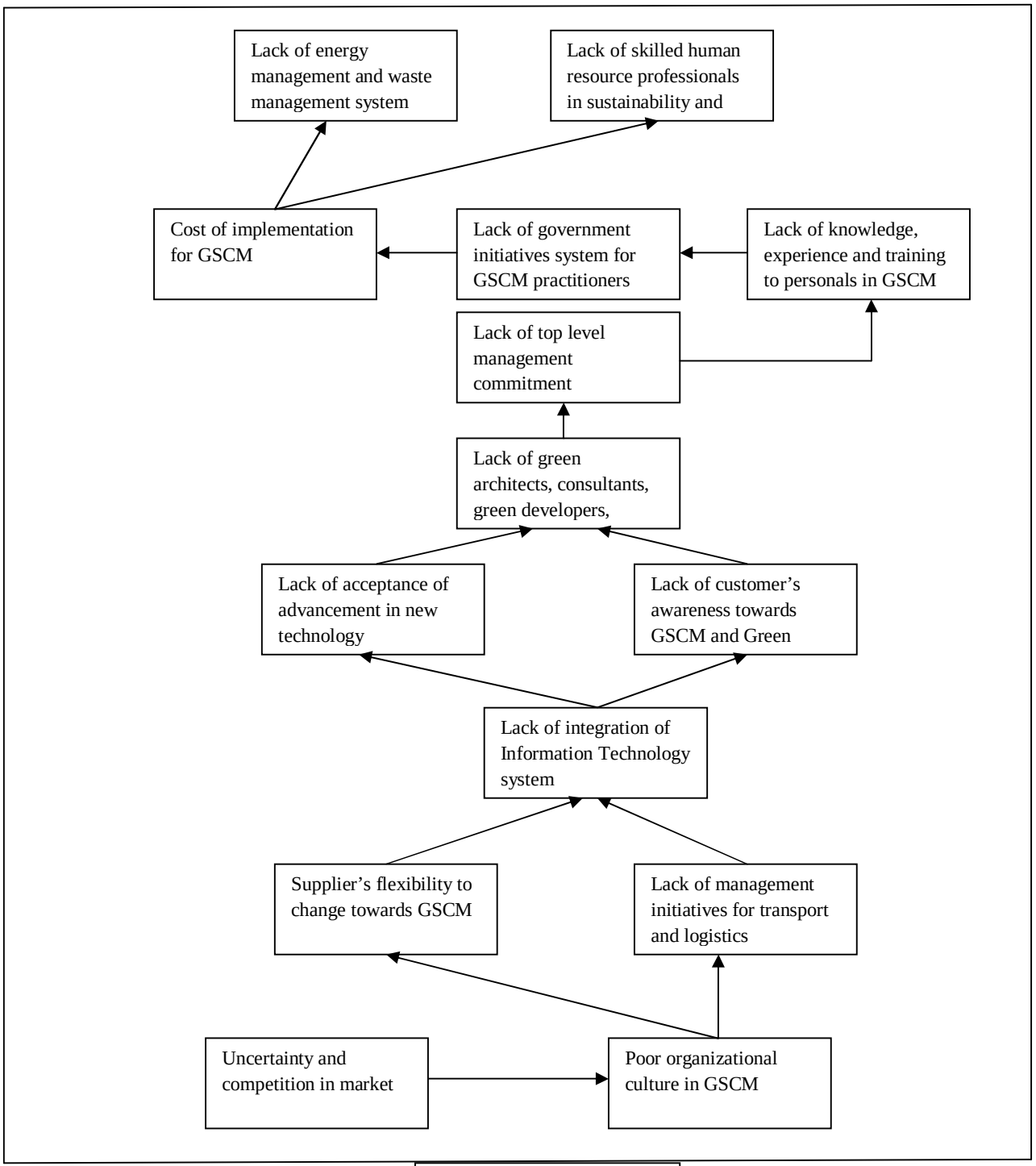

Fig.3. ISM Model for barriers

V. CONCLUSION

The barriers involved in the implementation of green supply chain management taken under study were solved in a hierarchical process by means of ISM modeling. Due to the complexity of GSCM practices, customer and cost pressures and regulation uncer-tainty, implementing GSCM is considered as a thankless task that increases overall product cost (Hsu and Hu, 2008, A. Diabat and Govindan 2011). The 14 different barriers, an ISM model developed and the interaction between these barriers were analyzed for the organizations using the ISM model and MICMAC analysis.

From Fig. 3, it is evident that Uncertainty and competition in market and Poor organizational culture in GSCM are significant barriers to achieve the Supplier's flexibility to change towards GSCM and Lack of management initiatives for transport and logistics, which is in tern critical to achieving the Lack of integration of Information Technology system, which will effect to Lack of acceptance of advancement in new technology and Lack of customer's awareness towards GSCM and Green products. Lack of customer's awareness towards GSCM and Green products placed at an intermediate level of the ISM model. Lack of top level management commitment, Lack of knowledge, experience and training to personals in GSCM, Lack of government initiatives system for GSCM practitioners, Cost of implementation for GSCM, Lack of skilled human resource professionals in sustainability and GSCM and Lack of energy management and waste management system are at the top level of the ISM hierarchy.

The above model is based on the Interpretive Structural Modeling methodology, which has its own limitations. For example the model is highly dependent on the judgements of the expert team. In the future, we plan to validate this model using a structural equation modeling (SEM) framework.

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