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Modeling the enablers of green supply chain management

An integrated ISM – fuzzy MICMAC approach

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Abstract

Purpose – The purpose of this paper is to identify and develop the relationships among the green supply chain management enablers (GSCMEs), to understand mutual influences of these GSCMEs on green supply chain management (GSCM) implementation, and to find out the driving and the dependence power of GSCMEs.

Design/methodology/approach – This paper has identified 35 GSCMEs on the basis of literature review and the opinions of experts from academia and industry. A nationwide questionnaire-based survey has been conducted to rank these identified GSCMEs. The outcomes of the survey and interpretive structural modeling (ISM) methodology have been applied to evolve mutual relationships among GSCMEs, which helps to reveal the direct and indirect effects of each GSCMEs. The results of the ISM are used as an input to the fuzzy Matriced' Impacts Croisés Multiplication Appliquéeá un Classement (MICMAC) analysis, to identify the driving and the dependence power of GSCMEs.

Findings – Out of 35 GSCMEs 29 GSCMEs (mean $\geqslant 3.00$) have been considered for analysis through a nationwide questionnaire-based survey on Indian automobile organizations. The integrated approach is developed, since the ISM model provides only binary relationship among GSCMEs, while fuzzy MICMAC analysis provides precise analysis related to driving and the dependence power of GSCMEs.

Research limitations/implications – The weightage for ISM model development and fuzzy MICMAC are obtained through the judgment of few industry experts. It is the only subjective judgment and any biasing by the person who is judging might influence the final result.

Practical implications – The study provides important guidelines for both practitioners, as well as the academicians. The practitioners need to focus on these GSCMEs more carefully during GSCM implementation. GSCM managers may strategically plan its long-term growth to meet GSCM action plan. While the academicians may be encouraged to categorize different issues, which are significant in addressing these GSCMEs.

Originality/value – Arrangement of GSCMEs in a hierarchy, the categorization into the driver and dependent categories, and fuzzy MICMAC are an exclusive effort in the area of GSCM implementation.

Keywords ISM, Survey, Fuzzy MICMAC, Green supply chain management, GSCM enablers

Paper type Research paper

1. Introduction

Due to the changing scenario in the business worldwide, it is very essential to have a proper balance between demand and supply, and to reduce loss as much as possible. The green trend of preserving the Earth's resources and protecting the environment is devastating, thereby, exerting anxiety on organizations due to increased awareness of the environmental safety worldwide (Chien and Shih, 2007). Strict government regulations and increased societal pressure have forced organizations to effectively integrate the environmental concerns into their product/service and business goals (Zhu *et al.*, 2008). It is essential that organizations contribute to make themselves able to participate in corporate activities and develop a concrete environmental-friendly alignment (Cosimato and Troisi, 2015). The present competition among the business is not at the organizational level, but at the supply chain (SC) level. SC is the major factor in the depletion of natural resources, climatic problems, waste generation, harmful emission of gases, and disruptions in the ecosystem

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(Muduli *et al.*, 2013). Environmental management is a significant subject in supply chain management (SCM) (Govindan *et al.*, 2015). Over the past couple of decades, SCM and environmental concerns within green supply chain management (GSCM) have evolved as a vital strategy for manufacturing organizations and their SCs to advance their overall performance and competitive position (Zhu *et al.*, 2012). A large number of organizations have started developing and implementing GSCM (Muduli *et al.*, 2013). GSCM maximizes the global environmental profit by implementing a life cycle tactic through manufacturing, material selection, product design, and sales and recovery, and hence, supports the organizations to understand their sustainable growth and development (Shi *et al.*, 2012). There has been widespread concern over GSCM due to environmental and consumer interest groups, and potentiality to demonstrate their sincere commitment to sustainability. The GSCM facilitates managers to think about the potentially unfavorable impacts of the SC process on the environment at the source, ideally before any adverse impact occurs (Nikbakhsh, 2009).

The concept of GSCM is not new, but there is no clear and perfect policy for GSCM implementation in the organizations. There are number of variables which support the GSCM implementation. These variables are known as green supply chain management enablers (GSCMEs). The GSCM implementation requires identification of these GSCMEs. Through a nationwide questionnaire-based survey on Indian automobile organizations conducted in this study checked the deep understanding of GSCM and hence helps in reducing the GSCMEs for analysis. Many researchers, as shown in Table I, have discussed various GSCME. The main objective of this study is to identify and rank the GSCMEs, to establish relationships among them using survey result and interpretive structural modeling (ISM), and to find out driving and the dependence power using fuzzy Matriced' Impacts Croise´s Multiplication Applique´ea´ un Classement (MICMAC) analysis. From survey analysis mean of each GSCME is calculated and used to reduce the number GSCMEs from 35 to 29 (see Table II) by considering mean $\geqslant$3.00 for further analysis to establish relationships and to find out driving and the dependence power among these identified GSCMEs. ISM is a well-established approach for identifying relationships between specific items, which define a problem or an issue (Warfield, 1974; Sage, 1977). Hence, in this research, GSCMEs have been analyzed using the ISM methodology, which shows the interrelationships of the GSCMEs. Further, this paper analyses the driving and the dependent GSCMEs using fuzzy MICMAC analysis. The integrated approach is developed, since the ISM model provides only binary relationship among GSCMEs, while fuzzy MICMAC analysis provides precise analysis related to driving and the dependence power of GSCMEs. The opinions from a group of experts and result of surveys were used in developing the relationship matrix, which is later used in the development of the ISM model. The projected ISM model defined in this study captures the interactions between different GSCMEs of GSCM implementation.

This study is organized into seven sections including introduction. Section 2 briefly describes the literature review of GSCMEs. Section 3 represents the problem description. Section 4 deals with methodology. Section 5 presents integration of ISM and fuzzy MICMAC analysis. Results analysis is shown in section 6. At last Section 7 represents discussion and conclusion followed by managerial implications, limitations, and suggestions for future research.

2. Literature review on GSCMEs

The organizations are conscious of the significance of GSCMEs but fall short of their implementation. These enabling factors deliver a vital sense to GSCM through the identification of essential enablers that are important to its implementation. Many authors (Table I) have researched and written directly on these GSCMEs. It was found that several

GSCMEs	References
1. Top management commitment and support	Muduli *et al.* (2013), Liu, Low and He (2012), Liu, Yang, Qu, Wang, Shishime and Bao (2012), Xie and Breen (2012), Wu *et al.* (2012), Tseng *et al.* (2014), Gavronski *et al.* (2011), Hsu and Hu (2008), Zhu *et al.* (2008), Wee and Quazi (2005), Bowen *et al.* (2001) and US-AEP (1999)
2. Strategic planning	Xu *et al.* (2013), Zhu *et al.* (2012), Kumar *et al.* (2012) and Buyukozkan and Cifci (2012)
3. Willingness toward investment	Hajmohammad *et al.* (2013) and Shi *et al.* (2012)
4. Benchmarking system	Zhu *et al.* (2010), Shaw *et al.* (2010) and Sarmiento and Thomas (2010)
5. Performance measurement system	Björklund *et al.* (2012), Shi *et al.* (2012), De Felice *et al.* (2012), Li (2011), Azevedo *et al.* (2011), Shaw *et al.* (2010), Zhu *et al.* (2007) and Hervani *et al.* (2005)
6. Collaborative research and development with supplier	Lamming and Hampson (1996), US-AEP (1999), Bowen *et al.* (2001) and Rao (2002)
7. Organizational structure	Muduli *et al.* (2013), Shi *et al.* (2012), Lee *et al.* (2012), Arimura *et al.* (2011), Lin and Ho (2011) and Hervani *et al.* (2005)
8. GSCM methodology	Kannan *et al.* (2013) and Carbone and Moatti (2011)
9. Inter-departmental cooperation	Shi *et al.* (2012) and Lee *et al.* (2012)
10. Organizational capabilities	Gavronski *et al.* (2011) and Hervani *et al.* (2005)
11. Green design	Wang *et al.* (2013), Kuo *et al.* (2012), Li (2011), Diabat and Govindan (2011), Hsu and Hu (2008), Zhu *et al.* (2007), Hu and Hsu (2006), Rao (2002) and Yuang and Kielkiewicz-Yuang (2001)
12. Employee empowerment and motivation	Muduli *et al.* (2013), Hsu and Hu (2008) and Zhu *et al.* (2008)
13. Environmental education and training	Zhu *et al.* (2012), Liu, Low and He (2012), Liu, Yang, Qu, Wang, Shishime and Bao (2012), Arimura *et al.* (2011), Lee (2008), Hervani *et al.* (2005), Sarkis (2003) and Yuang and Kielkiewicz-Yuang (2001)
14. Green organizational culture	Muduli *et al.* (2013), Lee *et al.* (2012), Sarkis (2012) and Lin and Ho (2011)
15. Trustworthy teamwork	Muduli *et al.* (2013) and Ofori (2000)
16. Employee involvement	Walker *et al.* (2008) and Rao (2002)
17. Skilled professionals	Carbone and Moatti (2011), Li (2011) and Hu and Hsu (2010)
18. Ethical standards and corporate social responsibility	Seuring (2013) and Eltayeb *et al.* (2011)
19. Environmental related programs and meetings	Arimura *et al.* (2011), Zhu *et al.* (2012), Hervani *et al.* (2005) and Sarkis (2003)
20. Supplier commitment	Zhu *et al.*(2010), Lee (2008), Simpson *et al.* (2007) and Simpson and Power (2005)
21. Effective communication platform within companies and with suppliers	Hu and Hsu (2010)
22. Cooperation among suppliers	Kumar *et al.* (2012) and Large and Thomsen (2011)
23. Green purchasing	Zhu *et al.* (2012), Wu *et al.* (2012), Youn *et al.* (2012), Shi *et al.* (2012), Large and Thomsen (2011), Eltayeb *et al.* (2011), Zhu *et al.* (2010), Zhu *et al.* (2008), Zhu *et al.* (2007), Zhu and Sarkis (2007), Rao (2002) and Yuang and Kielkiewicz-Yuang (2001)
24. Supplier adoptability	Yuang and Kielkiewicz-Yuang (2001)
25. Customer awareness	Kirchoff *et al.* (2011)
26. Environmental policy	Min and Kim (2012), Arimura *et al.* (2011), Yuang and Kielkiewicz-Yuang (2001), Lamming and Hampson (1996) and US-AEP (1999)
27. Government support policy	Arimura *et al.* (2011)
28. Enforcement	Koh *et al.* (2012), Zhu *et al.* (2012), Arimura *et al.* (2011), Zhu *et al.* (2007), Zhu and Sarkis (2007) and Sheu *et al.* (2005)

Table I.
Description of GSCM enablers

(*continued*)

GSCMEs	References
29. Strict supervision	Mishra *et al.* (2012) and Mudgal *et al.* (2010)
30. Compliance statement	Li (2011), Hu and Hsu (2010) and Yuang and Kielkiewicz-Yuang (2001)
31. Information technology infrastructure	Kim and Rhee (2012), Li (2011), Hervani *et al.* (2005) and Yuang and Kielkiewicz-Yuang (2001)
32. Technical expertise	Kumar *et al.* (2012)
33. Integration of system	Yuang and Kielkiewicz-Yuang (2001) and US-AEP (1999)
34. Awareness about new technology	Chun *et al.* (2012)
35. Availability of new technology	Hitchcock (2012) and Arimura *et al.* (2011)

Table I.

Influencing factors	GSCMEs	Mean	SD	Rank
Top management commitment and support	GSCME1	4.32	0.77	1
Supplier commitment	GSCME2	4.15	0.94	2
Environmental policy	GSCME3	4.09	0.85	3
Strategic planning	GSCME4	4.02	0.75	4
GSCM methodology	GSCME5	3.96	0.86	5
Organizational structure	GSCME6	3.95	0.76	6
Willingness toward investment	GSCME7	3.92	0.82	7
Employee empowerment and motivation	GSCME8	3.91	0.92	8
Green organizational culture	GSCME9	3.88	0.93	9
Information technology infrastructure	GSCME10	3.87	0.76	10
Environmental education and training	GSCME11	3.81	0.83	11
Trustworthy teamwork	GSCME12	3.79	0.76	12
Employee involvement	GSCME13	3.75	0.99	13
Compliance statement	GSCME14	3.73	0.85	14
Skilled professionals	GSCME15	3.71	0.91	15
Integration of system	GSCME16	3.70	0.84	16
Performance measurement system	GSCME17	3.69	0.97	17
Technical expertise	GSCME18	3.66	0.90	18
Inter-departmental cooperation	GSCME19	3.64	1.01	19
Cooperation among suppliers	GSCME20	3.60	0.93	20
Organizational capabilities	GSCME21	3.57	1.03	21
Effective communication platform within companies and with suppliers	GSCME22	3.56	1.05	22
Strict supervision	GSCME23	3.56	0.99	23
Enforcement	GSCME24	3.55	0.90	24
Green purchasing	GSCME25	3.44	1.05	25
Ethical standards and corporate social responsibility	GSCME26	3.41	1.05	26
Green design	GSCME27	3.31	1.14	27
Benchmarking system	GSCME28	3.26	1.09	28
Government support policy	GSCME29	3.15	1.33	29
Collaborative research and development with supplier	GSCME30	2.95	1.39	30
Customer awareness	GSCME31	2.94	1.27	31
Availability of new technology	GSCME32	2.94	1.39	32
Awareness about new technology	GSCME33	2.93	1.38	33
Environmental related programs and meetings	GSCME34	2.92	1.39	34
Supplier adoptability	GSCME35	2.87	1.22	35

Table II.
Descriptive statistics

studies have suggested various key GSCMEs for GSCM implementation. Some are extracted from the work of those who have explored GSCM in general or have addressed a particular enabler in detail. On the basis of a literature review and the opinions of experts from both industry and academia the comprehensive list of 35 GSCMEs is organized in Table II.

GSCM promotes competence and interaction between partners and helps environmental performance, minimal waste, and cost savings (Rao and Holt, 2005). Tseng *et al.* (2014) explored the differences between close and open-loop hierarchical structures of GSCM under uncertainty. The results indicate that the close-loop hierarchical structure more closely resembles existing applications. This study developed a better understanding of the differences among the GSCM activity needs and the specific management of interventions by examining the four aspects and 20 criteria to select the supplier in GSCM environment. The green supplier development program effectively improves suppliers' performance (Dou *et al.*, 2014). Mohanty and Prakash (2013) presented an empirical study of GSCM practices in the micro, small, and medium enterprises (MSMEs) in India and revealed that Indian MSMEs face significant pressures from external stakeholders to adopt GSCM practices. Muduli *et al.* (2013) identified 12 behavioral factors, which explore the various behavioral factors affecting GSCM practices and their interactions help to attain green-enabled needs. Jabbour *et al.* (2013) analyzed the factors that affect the GSCM implementation based on empirical evidence from the Brazilian electronic sector and found that the size of the company, previous experience with environmental management systems, and the use of hazardous inputs are positively correlated with GSCM implementation. Diabat *et al.* (2013) focuses on ranking for GSCM practices and performances between organizations conducted in an automotive oranization of a developing country. The results enable automobile manufacturing organizations to appraise their own strengths and weaknesses in implementing these practices.

Buyukozkan and Cifci (2012) observed that the start of GSCM implementation is one of the most important developments, proposing the chance for organizations to align their SC in accordance with environmental and sustainability goals. Zhu *et al.* (2012) empirically tested the theoretical relationships on the GSCM implementation. This study provides practical implications for manufacturers to identify ways for improving environmental and operational performance, as well as economic benefits through proper design of GSCM practices. Green *et al.* (2012) proposed that successful implementation of GSCM practices such as green purchasing, cooperation with customers, eco-design, and investment recovery will lead to improved environmental and economic performance which would support improved operational and organizational performance. Diabat and Govindan (2011) analyze 11 drivers which affect GSCM implementation. These are ISO 14001 certification, environmental collaboration with suppliers, certification of suppliers' environmental management system, green design, reducing energy consumption, government regulation and legislation, integrating quality environmental management into planning and operation process, collaboration between product designers and suppliers to reduce and eliminate product environmental impacts, reverse logistics, reusing and recycling materials and packaging, and environmental collaboration with customers. Azevedo *et al.* (2011) examined the relationships among green practices of SCM and SC performance. The conceptual model provides evidence as to which green practices have a positive effect on quality, customer satisfaction, and efficiency. GSCM practices can build advantage, where early adopters may gain additional market share through their greening efforts (Shang *et al.*, 2010). Holt and Ghobadian (2009) investigated the level and nature of greening the SC in the UK manufacturing sector. It also explored the driving forces behind environmental behavior, the specific management practices, and the relationships among them.

Lee (2008) acknowledged the main drivers for organizations to contribute to the GSCM implementation as government involvement, buyer influence, and GSCM willingness. Zhu *et al.* (2008) examined the correlation of two major factors, organizational learning and management support, to the extent of acceptance of GSCM practices. They found significant positive relationships between organizational learning mechanisms, organizational support, and the adoption of GSCM practices. Walker *et al.* (2008) identified the factors that drive or

hinder organizations to implement GSCM. These include internal drivers such as: organizational factors, and external drivers such as society, customers, competitors, suppliers, and regulatory. Zhu and Sarkis (2007) studied the moderating effect of institutional pressures on GSCM implementation exposed that organizations facing higher regulatory pressures tend to implement GSCM practices. Lee and Rhee (2007) established four types of GSCM implementation strategies: reactive, proactive, focused, and opportunistic. Zhu and Sarkis (2006) compared drivers and practices of GSCM in developing country concentrating on three typical sectors: the thermal power plants, the electronic/electrical industry, and the automobile industry. Kainuma and Tawara (2006) considered the extent of lean and GSCM practices. Wee and Quazi (2005) obtained seven critical factors in their research into environmental management, namely, total involvement of employees, green products/process design, top management commitment, training, measurement, information management, and supplier management. Zhu *et al.* (2005) described the GSCM drivers, practices, and performance between several Chinese manufacturing organizations. Sheu *et al.* (2005) offered a combined logistics operational model to manage the cross-functional product logistics flows and used product reverse logistics flows in a given GSCM. The outcomes of the proposed integrated logistics operational model help to improve the chain-based aggregate net profits and the relative existing operational performance of the SC.

Zhu and Sarkis (2004) examined how two primary types of management operations philosophies, namely quality management and just-in-time (or lean) manufacturing principles, influence the relationship among GSCM practices and performance. Sarkis (2003) offered a strategic decision framework to evaluate GSCM alternatives using an analytical network process (ANP). Rao (2002) investigated that GSCM implementation focused on working collaboratively with suppliers on helping suppliers to establish their own environmental programs, holding awareness seminars, green product designs, and so on. Holt *et al.* (2001) identified seven categories of GSCM implementation for improving an organization's environmental performance: trade associations and sector bodies, governments, individual companies, partnership groups, not-for-profit green business support organizations, green business clubs, and business support organizations. Bowen *et al.* (2001) examined the relationship between supply management competencies and GSCM practices and identified internal drivers for implementing GSCM policies (corporate environmental proactivity, strategic purchasing and supply, and supply management capabilities). Lee *et al.* (2000) alienated green practices into two dimensions of environmental collaboration and monitoring. Narasimhan and Carter (1998) suggested that GSCM practices can be successfully implemented in one organization and their success can be extended to other organizations. Porter and van der Linde (1995) described the essentials of greening as a competitive initiative. Their basic perception is that investments in greening can improve productivity, eliminate waste, and save the resources.

From the above literature review it is concluded that most of the study, except Muduli *et al.* (2013) and Diabat and Govindan (2011), fail to discuss the mutual effect of these GSCMEs over each other during the GSCM implementation. But Muduli *et al.* (2013) considered only 12 behavioral factors, and Diabat and Govindan (2011) considered only 11 drivers of GSCM implementation. Thus, there is a strong need to identify more enabling factors and establish a tight interrelationship among them in order to enhance the capabilities of GSCM implementation. Hence, this study identifies 35 GSCMEs divided into six major criterias, namely, strategic, organizational, social-cultural, buyer-supplier, legislative, and technical enablers (see Table I).

3. Problem description

The Organization X is the medium-scale automobile organization situated in Madhya Pradesh, India. The organization has more than 950 employees with the annual turnover of more

than 50 corers. The organization mission is to transcend to new heights of being recognized as a world class gear manufacturer across the globe. The Organization X caters the ever growing needs of the axle gear market for cars, trucks, and tractors. The organization today manufactures a wide range of crown wheel and pinions, bevel gears, bevel pinions, spider kit assemblies, and differential cages and housings. In addition, fast development of superior quality products with good customer service has enabled Organization X to become an original equipment manufacturer (OEM) supplier to many car and tractor companies in India, Europe, and Asia. The Organization X has self-contained setup with modern equipment, a competent research and development team, trained manpower, and in-house manufacturing of cutting tools, jigs and fixtures, has enabled it to cut down new product development time to just a few months.

The case Organization X is interested in implementing GSCM because it suffers pressure from buyers as well as strong environmental regulations across the world on climate change initiatives. This case organization is interested to identify the important GSCMEs for GSCM implementation. The Organization X utilized the proposed ISM and fuzzy MICMAC technique to evaluate and segment a list of important GSCMEs for GSCM implementation.

4. Methodology

In this research, questionnaire-based survey and ISM methodology have been employed to achieve research objectives. The methodologies and the respective results are separately discussed in the following sub-sections.

4.1 Questionnaire survey

4.1.1 Instrument development, target organizations, and survey administration. A structured questionnaire (the Appendix), running into four pages and having nine questions, was framed to collect responses on a five-point Likert scale. On the scale, 1 stands for strongly disagree and 5 for strongly agree. The questionnaire had two sections and was designed to collect detailed information about the profile of the respondents, organizations, objectives of GSCM (seven questions), GSCMEs (one question) and GSCM Barriers (GSCMBs) (one question). The organizations were carefully selected from the directory of public sector and private sector. These included organizations from the automotive sectors. The organizations selected in automobile sector include both the OEMs as well as the component suppliers. The auto sector is having a quicker rate of development and needs tight relationships between suppliers and OEMs. It is one of the key sectors of the economy (Pfohl and Gareis, 2005; Kant and Singh, 2011). The automobile industry has the strongest drivers and pressure to implement GSCM in developing nations because automobile industry can improve their economic, environmental, and sustainability performances simultaneously (Diabat *et al.*, 2013). Hence, automobile sector is selected for the study. Though no specific SCs were targeted in this subject area, the sample organizations together constituted many diversified SCs. Therefore, a study of the GSCMEs and GSCMBs of these surveyed organizations might provide a fair assessment GSCM adoption for Indian automobile organizations. Before sending the questionnaire to the organizations, a pilot study was carried. A total of six executives were personally contacted. Accordingly, the questionnaire was modified and a final questionnaire was developed. It was then mailed to different organizations.

Questionnaires, including covering letter and a self-addressed and stamped envelope, were mailed to the top executives such as chief executive officer/managing director/vice-president/general manager, senior managers, junior managers, etc. of operations, manufacturing, purchasing, sales and distribution, and materials as these personnel were supposed to have the best knowledge in the GSCM area.

4.1.2 Survey response and respondent's profile. A total of 450 questionnaires was mailed to different organizations throughout the country. Out of the 450 questionnaires mailed, 11 responses were found to be incomplete and therefore not considered for analysis. Only 106 questionnaires were found to be usable. This yields a response rate of 23.50 percent, which is acceptable for such surveys (Vachon, 2007; Hu and Hsu, 2010; Carbone and Moatti, 2011; Lee *et al.*, 2012). Tables III and IV present demographic profile of the respondents and organizations participated in survey, respectively.

4.1.3 Non-response bias and reliability of the questionnaires. To test the non-response bias, early and the late respondents of the survey are compared (Lambert and Harrington, 1990). Therefore, comparing those responses, which were received without a reminder, or after one reminder vs the responses, which were received after sending two or more reminders can provide an indication of non-response bias. The results of the *t*-tests suggest that the early respondents do not significantly differ from the late responses. Thus, non-response bias is ruled out. The responses were considered for the reliability and internal consistency using Cronbach's α (Cronbach, 1951). The value of Cronbach's coefficient more than 0.5 (Nunnally, 1978) and 0.7 (Nunnally and Bernstein, 1994) is considered acceptable for this type of work. Rungasamy *et al.* (2002) used a cut-off value of 0.6. Also, George and Mallery (2003) provide the following rules of thumb: "$\geqslant 0.9$ – excellent, $\geqslant 0.8$ – good, $\geqslant 0.7$ – acceptable, $\geqslant 0.6$ – questionable, $\geqslant 0.5$ – poor, and $\leqslant 0.5$ – unacceptable." The value of α in this study was found to be 0.92. It implies that there is a high degree of internal consistency in the responses to the questionnaire.

4.1.4 Results of survey analysis. To remain within the scope of this study, the relevant portion of the questionnaire survey, which pertains to GSCME, has been used in this study. The relevant descriptive statistics are shown in Table I. In this table GSCMEs are presented in the decreasing order of their significance. Pearson's bi-variate two-tailed correlation test was conducted to find correlations among the GSCMEs on SPSS (Version 18.00) software (see Table III and V).

4.2 ISM

ISM was developed in the period 1971-1973 by John N. Warfield at the Battelle Memorial Institute. ISM is primarily intended as a group learning process, but can also be used individually. Group learning process allows participants to get informal and

Participants position level	Senior	Middle	Junior	
Managerial level	12.9	47.3	39.7	
Educational qualification	Diploma	Bachelor's degree	Master's degree	Doctoral
	16.8	64.9	18.3	0
Experience(in years)	< 5	5-10	11-15	> 15
	34.4	35.9	16.8	13
Age (in years)	Below 30	30-39	40-49	Over 50
	39.7	35.9	16.8	7.6

Table III. Demographic profile of respondents (in percent)

Sector	Public	Private	Government	Others	
	6.8	85.5	3.8	3.8	
Size	Large scale	Medium scale	Small scale		
	58	32.1	9.9		
Number of employees	< 100	101-500	501-1,000	Over 1,000	
	5.3	28.2	24.4	42	
Annual sales turnover (crores)	< 5	5-50	51-100	101-500	Over 500
	9.9	15.3	14.5	26	34.4

Table IV. Demographic profile of organizations (in percent)

GSCMEs	29	28	27	…	…	…	5	4	3	2
GSCME1	−0.12	−0.03	0.10	…	…	…	0.08	−0.01	0.262**	0.417**
GSCME2	0.09	0.178*	0.232**	…	…	…	0.238**	0.338**	0.423**	
GSCME3	0.15	0.12	0.180*	…	…	…	0.11	0.08		
⋮	⋮	⋮	⋮	⋮	⋮	⋮				
GSCME27	0.353**	0.531**								
GSCME28	0.244**									
GSCME29										

Table V.
Correlation analysis

Notes: *,**Correlations are significant at the 0.05 and 0.01 level (two-tailed), respectively

meaningful relationships with their fellow participants and therefore felicitating the learning process (Sheehan, 2004). It is structured on the basis of relationship and the overall structure is pulled out from the complex set of variables (Singh *et al.*, 2003). It is a modeling technique because the specific relationships and overall structure are portrayed in a graphical model (Gorane and Kant, 2015). The transitivity and reachability are two basic concepts in ISM methodology. Transitivity helps in maintaining the conceptual consistency, whereas reachability concept is the building block of ISM methodology. The property of transitivity also allows some of the cells of reachability matrix to be filled by inference (Watson, 1973). It is applied to study the complex case by employing organized and consistent thinking supported by the judgments of experts, to identify complex interrelationships among the variables, and to signify them in a structured manner. It transforms unclear, poorly articulated mental models of systems into visible, well-defined models useful for many purposes (Sage, 1977). Many researchers have used an ISM methodology to impose order and direction on the complex relationships among variables of a system (Table VI). For complex problems, like the one under consideration, a number of GSCMEs may be affecting the GSCM implementation. Nevertheless, the direct and indirect relationships between the GSCMEs describe the situation far more precise than the individual factor taken into isolation. Therefore, ISM develops insights into collective understandings of these relationships.

The flow chart for ISM methodology is shown in Figure 1. The various steps involved in the ISM technique are as follows:

- Step 1: identification of variables which are relevant to the problem or issues and identified with group problem solving such as delphi method, brainstorming and opinion from experts, and also this could be done by survey.

Author	Details
Gorane and Kant (2015)	To develop the relationships among the identified SCMBs and understand mutual influences of these SCMBs on SC implementation
Muduli *et al.* (2013)	To extract the interrelationships among the identified behavioral factors of GSCM
Gorane and Kant (2013)	To identify and classify the key SCMEs that influence SCM implementation in the organization
Diabat and Govindan (2011)	Analyses the drivers affecting the implementation of green supply chain management
Jharkharia and Shankar (2004)	To evolve mutual relationships among IT based enablers of supply chain management
Singh *et al.* (2003)	To develop interdependence among KM variables
Mandal and Deshmukh (1994)	To identify relationships among vendor selection criteria

Table VI.
ISM as reported in literature

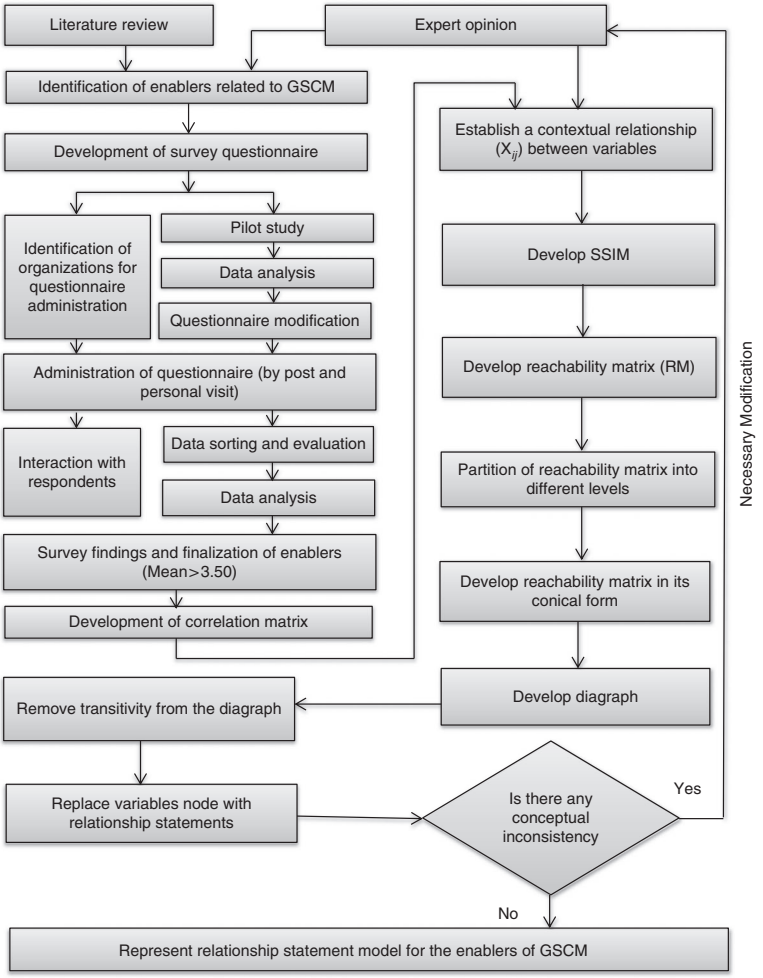

Figure 1.
Flow diagram for development of ISM model

- Step 2: establishing a contextual relationship between variables with respect to which pairs of the variables would be examined. After resolving the variables and the contextual relationship, based on pairwise comparison of variables of the system under consideration, a structural self-interaction matrix (SSIM) is prepared.
- Step 3: developing a reachability matrix from the SSIM, and check the matrix for transitivity.
- Step 4: after obtaining the reachability matrix partitioning of the reachability matrix into the canonical matrix format by arranging the variables to their different levels.
- Step 5: based on the relationships in the canonical matrix form of the reachability matrix, drawing a directed graph (digraph), and removing the transitive links.
- Step 6: convert the resultant digraph into an ISM-based model by replacing variable nodes with the statements.

- Step 7: reviewing the model to check for conceptual inconsistency, and making the necessary modifications.

The steps for constructing an ISM-based model are as follows.

4.2.1 SSIM. Contextual relationship development among the identified GSCMEs is done with the help of expert discussion using group problem solving methods such as delphi, brainstorming, and nominal group method. The expert team of 15 members, well acquainted with GSCM implementation, was formed comprising seven chief general managers representing procurement, manufacturing, design, finance, human resources, three SC executives, three GSCM project implementation executives, and two customers. The data obtained from Pearson's bi-variate two-tailed correlation analysis were presented before these experts to identify the nature of contextual relationship among the GSCMEs. A contextual relationship of "leads to" type is selected for diagnosing the interdependencies among the GSCMEs shown in Table VII. For example, the green organization structure leads to employee empowerment and motivation suggesting that if the organization develops a green structure, it will automatically helps them to enhance, empower, and motivate their employees. Contextual relationships, among other variables, are built up in a standardized way, keeping in mind the contextual relationship for each variable, the existence of any relation between any two variables (i and j), and the associated direction of their intercourse. With the help of four symbols, the direction of the relationship between variables (i and j) is denoted as follows:

- V: factor i will help to achieve factor j;
- A: factor j will help to achieve factor i;
- X: factor i and j will help to achieve each other; and
- O: factor i and j are unrelated.

Based on the contextual relationships, the SSIM is developed for the 29 variables identified as GSCMEs and the following would explain the utilization of the symbols V, A, X, and O in SSIM as shown in Table VII:

(1) GSCME1 helps to achieve GSCME2. This means that enabler, namely, "top management commitment and support" will help to achieve enabler "strategic planning." Thus, the relationship between GSCME1 and GSCME2 is denoted by "V" in the SSIM.

(2) GSCME5 can be achieved by GSCME17. This means that enabler "performance measurement system" can be achieved by the enabler "ethical standards and corporate social responsibility." Thus, the relationship between GSCME5 and GSCME17 is denoted by "A" in the SSIM.

(3) GSCME6 and GSCME7 can help to achieve each other. This means that enabler, namely, "organizational structure" and "GSCM methodology" help to achieve each other. Thus, the relationship between GSCME6 and GSCME7 is denoted by "X" in the SSIM.

(4) GSCME1 and GSCME18 have no relation. This implies that there is no relationship exists between the enablers, namely, "top management commitment and financial backing" and "Supplier commitment." Thus, the relationship between GSCME1 and GSCME18 is denoted by "O" in the SSIM.

4.2.2 Initial reachability matrix. The SSIM is converted into a binary matrix, called the initial reachability matrix (Table VIII) by substituting V, A, X and O by 1 and 0 as

Table VII. Structural self-interaction matrix (SSIM)

GSCMEs	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
GSCME1	V	V	V	V	V	V	V	O	V	V	V	O	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	
GSCME2	V	V	V	V	V	V	V	A	V	V	V	A	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V		
GSCME3	V	V	V	O	O	O	V	A	V	V	V	A	V	V	V	V	V	V	V	V	O	V	X	X	V	V			
GSCME4	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	X				
GSCME5	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A					
GSCME6	V	V	V	V	V	V	V	A	V	V	V	A	V	V	V	V	V	V	V	V	V	V	X						
GSCME7	V	V	V	V	V	V	V	A	V	V	V	A	V	V	V	V	V	V	V	V	V	V							
GSCME8	A	A	A	V	V	V	X	A	X	V	X	A	V	A	A	A	A	A	A	V	V								
GSCME9	A	A	A	V	X	X	O	A	A	V	A	A	V	A	A	A	A	A	A	V									
GSCME10	A	A	A	V	A	A	A	A	A	X	A	A	X	A	A	A	A	A	A										
GSCME11	V	O	O	V	V	V	V	A	V	V	V	A	V	O	V	V	V	O											
GSCME12	V	V	X	V	V	V	V	A	V	V	V	A	V	V	O	O	V												
GSCME13	V	O	O	V	V	V	V	O	V	V	V	A	V	O	X	X													
GSCME14	V	O	O	V	V	V	V	O	V	V	V	A	V	O	X														
GSCME15	V	O	O	V	V	V	V	O	V	V	V	A	V	O															
GSCME16	V	X	A	V	V	V	V	O	V	V	V	A	V																
GSCME17	A	A	A	V	A	A	A	A	A	X	A	A																	
GSCME18	V	V	V	V	V	V	V	O	X	V	V																		
GSCME19	A	A	A	V	A	V	X	A	X	V																			
GSCME20	A	A	A	V	A	A	A	A	A																				
GSCME21	A	A	A	V	V	V	X	A																					
GSCME22	V	O	V	V	V	V	V																						
GSCME23	A	A	A	V	V	V																							
GSCME24	A	A	A	V	X																								
GSCME25	A	A	A	V																									
GSCME26	A	A	A																										
GSCME27	V	V																											
GSCME28	V																												
GSCME29																													

per the substitution rules. The following rules were followed for the substitution of 1 and 0 values:

(1) if the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0;

(2) if the (i, j) entry in the SSIM is A, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1;

(3) if the (i, j) entry in the SSIM is X, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 1; and

(4) if the (i, j) entry in the SSIM is O, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 0.

The final reachability matrix is constructed from the initial reachability matrix by following the principle of transitivity mentioned in step 3 of ISM technique (see Table IX).

4.2.3 Level partitions and lower triangular matrix. The reachability and antecedent set for each GSCME can be attained from the final reachability matrix. The reachability set includes GSCMEs itself and others which it may help to achieve, similarly the antecedent set consists of GSCMEs itself and other enabler which helps in achieving it. Thereafter, the intersection between reachability and the antecedent set is derived for each GSCMEs. If the membership in reachability and the intersection completely agree, then the top priority is obtained and the GSCME is removed from the subsequent iteration, thus this process contributes to final iteration leading to the lowest layer. Table X shows "Performance measurement system" and "Benchmarking system" are found at level I, therefore they would be positioned at the top of the ISM hierarchy. The top-level element in the hierarchy would not help to achieve any other element above its own level. Once the top-level element is identified, it is separated out from the other elements. Similarly, iteration process is repeated to find out the GSCMEs at the next level as shown in Table XI. This process is continued until the level of each element is found (see Table X). These levels help in building the diagraph and final model. The lower triangular matrix shown in Table XII is obtained after iterations are compiled in Table X.

4.2.4 Digraph formation and ISM-based model. From the final reachability matrix, the structural model is generated. If there is a relationship between the GSCMEs i and j, this is shown by an arrow which points from i to j. Digraph is a term derived from directional graph, and as the name indicates, is a graphical representation of the constituents, their directed relationships, and hierarchical levels. The initial digraph is prepared on the basis of the canonical matrix. After removing the transitivity of the ISM methodology, the final digraph is formed (Figure 2) and is converted to ISM-based model by replacing variable nodes with the statements (Figure 3).

Table VIII. Initial reachability matrix

GSCMEs	1	2	3	…	27	28	29
GSCME1	1	1	1	…	1	1	1
GSCME2	0	1	1	…	1	1	1
GSCME3	0	0	1	…	1	1	1
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
GSCME27	0	0	0	…	1	1	1
GSCME28	0	0	0	…	0	1	1
GSCME29	0	0	0	…	0	0	1

GSCMEs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1. SE1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1
2. SE2	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1
3. SE3	0	0	1	1	1	1	1	1	1*	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1*	1*	1*	1	1	1
4. SE4	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. SE5	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. OE1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1
7. OE2	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1
8. OE3	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	0	0	0
9. OE4	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	1	0	0	0
10. OE5	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0
11. SCE1	0	0	0	1	1	0	0	1	1	1	1	0	1	1	1	0	1	0	1	1	1	0	1	1	1	1	0	0	1
12. SCE2	0	0	0	1	1	0	0	1	1	1	0	1	0	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1
13. SCE3	0	0	0	1	1	0	0	1	1	1	0	0	1	1	1	0	1	0	1	1	1	0	1	1	1	1	0	0	1
14. SCE4	0	0	0	1	1	0	0	1	1	1	0	0	1	1	1	0	1	0	1	1	1	0	1	1	1	1	0	0	1
15. SCE5	0	0	0	1	1	0	0	1	1	1	0	0	1	1	1	0	1	0	1	1	1	0	1	1	1	1	0	0	1
16. SCE6	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	1	0	1	1	1	0	1	1	1	1	0	1	1
17. SCE7	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0
18. BSE1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
19. BSE2	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	0	0	0
20. BSE3	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0
21. BSE4	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	0	0	0
22. LE1	0	1	1	1	1	1	1	1	1	1	1	1	1*	1*	1*	1*	1	0	1	1	1	1	1	1	1	1	1	1*	1
23. LE2	0	0	0	1	1	0	0	1	1*	1	0	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	0	0	0
24. LE3	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	1	0	0	0
25. LE4	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	1	0	0	0
26. LE5	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
27. TE1	0	0	0	1	1	0	0	1	1	1	0	1	0	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1
28. TE2	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	1	1	0	1	1	1	0	1	1	1	1	0	1	1
29. TE3	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	0	0	1

Note: *Indicates transitivity

Table IX. Final reachability matrix

Table X.
Partitioning of reachability matrix first iteration

GSCMEs	Reachability set	Antecedent set	Intersection set	Level
1. SE1	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,19,20,21,23,24,25,26,27,28,29	1	1	
2. SE2	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,19,20,21,23,24,25,26,27,28,29	1,2,18	2	
3. SE3	3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,19,20,21,23,24,25,26,27,28,29	1,2,3,6,7,18,22	3,6,7	
4. SE4	4,5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29	4,5	I
5. SE5	4,5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29	4,5	I
6. OE1	3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,19,20,21,23,24,25,26,27,28,29	1,2,3,6,7,18,22	3,6,7	
7. OE2	3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,19,20,21,23,24,25,26,27,28,29	1,2,3,6,7,18,22	3,6,7	
8. OE3	4,5,8,9,10,17,19,20,21,23,24,25,26	1,2,3,6,7,8,11,12,13,14,15,16,18,19,21,22,23,27,28,29	8,19,21,23	
9. OE4	4,5,9,10,17,20,24,25,26	1,2,3,6,7,8,9,11,12,13,14,15,16,18,19,21,22,23,24,25,27,28,29	9,24,25	
10. OE5	4,5,10,17,20,26	1,2,3,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,27,28,29	10,17,20	
11. SCE1	4,5,8,9,10,11,13,14,15,17,19,20,21,23,24,25,26,29	1,2,3,6,7,11,18,22	11	
12. SCE2	4,5,8,9,10,12,16,17,19,20,21,23,24,25,26,27,28,29	1,2,3,6,7,12,18,22,27	12,27	
13. SCE3	4,5,8,9,10,13,14,15,17,19,20, 21,23,24,25,26,29	1,2,3,6,7,11,13,14,15,18,22	13,14,15	
14. SCE4	4,5,8,9,10,13,14,15,17,19,20,21,23,24,25,26,29	1,2,3,6,7,11,13,14,15,18,22	13,14,15	
15. SCE5	4,5,8,9,10,13,14,15,17,19,20,21,23,24,25,26,29	1,2,3,6,7,11,13,14,15,18,22	13,14,15	
16. SCE6	4,5,8,9,10,16,17,19,20,21,23,24,25,28,29	1,2,3,6,7,12,16,18,22,27,28	16,28	
17. SCE7	4,5,10,17,20,26	1,2,3,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,27,28,29	10,17, 20	
18. BSE1	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,23,24,25,26,27,28,29	18	18	
19. BSE2	4,5,8,9,10,17,19,20,21,23,24,25	1,2,3,6,7,8,11,12,13,14,15,16,18,19,21,22,23,27,28,29	8,19,21,23	
20. BSE3	4,5,10,17,20,26	1,2,3,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,27,28,29	10, 17, 20	
21. BSE4	4,5,8,9,10,17,19,20,21,23,24,25,26	1,2,3,6,7,8,11,12,13,14,15,16,18,19,21,22,23,27,28,29	8,19,21,23	
22. LE1	2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,19,20,21,22,23,24,25,26,27,28,29	22	22	
23. LE2	4,5,8,9,10,17,19,20,21,23,24,25,26	1,2,3,6,7,8,11,12,13,14,15,16,18,19,21,22,23,27,28,29	8,19,21,23	
24. LE3	4,5,9,10,17,20,24,25,26	1,2,3,6,7,8,9,11,12,13,14,15,16,18,19,21,22,23,24,25,27,28,29	9,24,25	
25. LE4	4,5,9,10,17,20,24,25,26	1,2,3,6,7,8,9,11,12,13,14,15,16,18,19,21,22,23,24,25,27,28,29	9,24,25	
26. LE5	4,5,26	1,2,3,6,7,8,9,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29	26	
27. TE1	4,5,8,9,10,12,16,17,19,20,21,23,24,25,26,27,28,29	1,2,3,6,7,12,18,22,27	12,27	
28. TE2	4,5,8,9,10,16,17,19,20,21,23,24,25,28,29	1,2,3,6,7,12,16,18,22,27,28	16,28	
29. TE3	4,5,8,9,10,17,19,20,21,23,24,25,26,29	1,2,3,6,7,11,12,13,14,15,16,18,22,27,28,29	29	

GSCMEs	Reachability set	Antecedent set	Intersection set	Level
1. SE1	1	1	1	XI
2. SE2	2	1,2,18	2	X
3. SE3	3,6,7	1,2,3,6,7,18,22	3,6,7	IX
4. SE4	4,5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29	4,5	I
5. SE5	4,5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29	4,5	I
6. OE1	3,6,7	1,2,3,6,7,18,22	3,6,7	IX
7. OE2	3,6,7	1,2,3,6,7,18,22	3,6,7	IX
8. OE3	8,19,21,23	1,2,3,6,7,8,11,12,13,14,15,16,18,19,21,22,23,27,28,29	8,19,21,23	V
9. OE4	9,24,25	1,2,3,6,7,8,9,11,12,13,14,15,16,18,19,21,22,23,24,25,27,28,29	9,24,25	IV
10. OE5	10,17,20	1,2,3,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,27,28,29	10,17,20	III
11. SCE1	11	1,2,3,6,7,11,18,22	11	VIII
12. SCE2	12,27	1,2,3,6,7,12,18,22,27	12,27	VIII
13. SCE3	13,14,15	1,2,3,6,7,11,13,14,15,18,22	13,14,15	VII
14. SCE4	13,14,15	1,2,3,6,7,11,13,14,15,18,22	13,14,15	VII
15. SCE5	13,14,15	1,2,3,6,7,11,13,14,15,18,22	13,14,15	VII
16. SCE6	16,28	1,2,3,6,7,12,16,18,22,27,28	16,28	VII
17. SCE7	10,17, 20	1,2,3,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,27,28,29	10,17, 20	III
18. BSE1	18	18	18	XI
19. BSE2	8,19,21,23	1,2,3,6,7,8,11,12,13,14,15,16,18,19,21,22,23,27,28,29	8,19,21,23	V
20. BSE3	10, 17, 20	1,2,3,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,27,28,29	10, 17, 20	III
21. BSE4	8,19,21,23	1,2,3,6,7,8,11,12,13,14,15,16,18,19,21,22,23,27,28,29	8,19,21,23	V
22. LE1	22	22	22	XI
23. LE2	8,19,21,23	1,2,3,6,7,8,11,12,13,14,15,16,18,19,21,22,23,27,28,29	8,19,21,23	V
24. LE3	9,24,25	1,2,3,6,7,8,9,11,12,13,14,15,16,18,19,21,22,23,24,25,27,28,29	9,24,25	IV
25. LE4	9,24,25	1,2,3,6,7,8,9,11,12,13,14,15,16,18,19,21,22,23,24,25,27,28,29	9,24,25	IV
26. LE5	26	1,2,3,6,7,8,9,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29	26	II
27. TE1	12,27	1,2,3,6,7,12,18,22,27	12,27	VIII
28. TE2	16,28	1,2,3,6,7,12,16,18,22,27,28	16,28	VII
29. TE3	29	1,2,3,6,7,11,12,13,14,15,16,18,22,27,28,29	29	VI

Table XI.
Levels of partitions

GSCMEs	1	2	3	…	1	18	22
GSCME4	1	1	0	…	0	0	0
GSCME5	1	1	0	…	0	0	0
GSCME26	1	1	1	…	0	0	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
GSCME1	1	1	1	…	1	0	0
GSCME18	1	1	1	…	1	1	0
GSCME22	1	1	1	…	1	1	1

Table XII.
Lower triangular matrix

5. Integration of ISM and fuzzy MICMAC analysis

The direct and indirect relationships among the GSCMEs for GSCM implementation in the organization are carried out by ISM and fuzzy MICMAC. A direct reachability matrix is obtained by examining the direct relationship among enabler in the ISM as given in the initial reachability matrix (Table VII). For building up ISM model, the intercourse between two GSCMEs is denoted by 0 and 1. If there is a relationship between two GSCMEs then it is denoted by 1 and if no relationship between two GSCMEs then it is denoted by 0. From Table VII the relationship between GSCME21 and GSCME2, GSCME1 and GSCME2, GSCME18 and GSCME1 having equal importance is denoted by the binary number 1. However the relationship between these GSCMEs cannot be equal. Some relation may be strong, some may be especially strong and some relation may be better. So to overcome this drawback of ISM model, the fuzzy ISM is used for the MICMAC analysis.

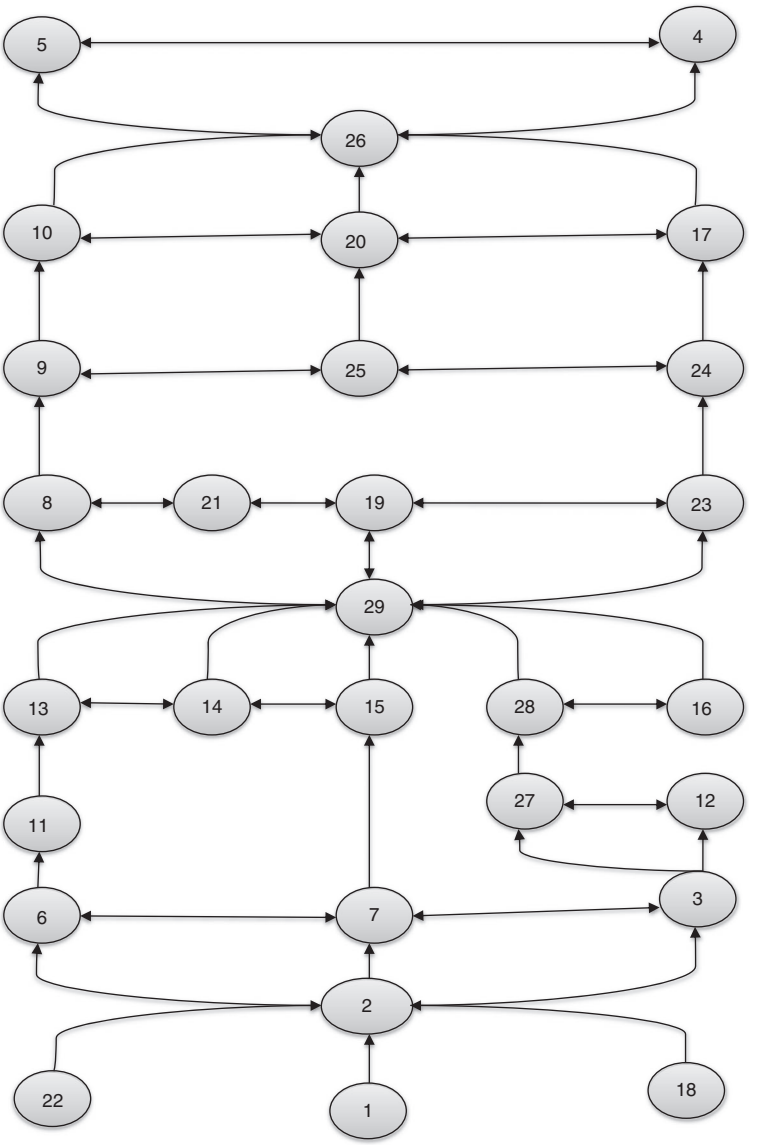

Figure 2.
Final digraph showing relationship between the GSCM enablers

5.1 Binary direct relationship matrix (BDRM)

A BDRM is obtained by examining the direct relationship among the GSCME in ISM as given in Table VII. Change the diagonal entries from 1 to 0 in Table VII to obtain BDRM (see Table XIII).

5.2 Fuzzy direct relationship matrix (FDRM)

The analysis can be further improved by considering the possibility of reachability instead of the simple consideration of reachability used so far. Conventional

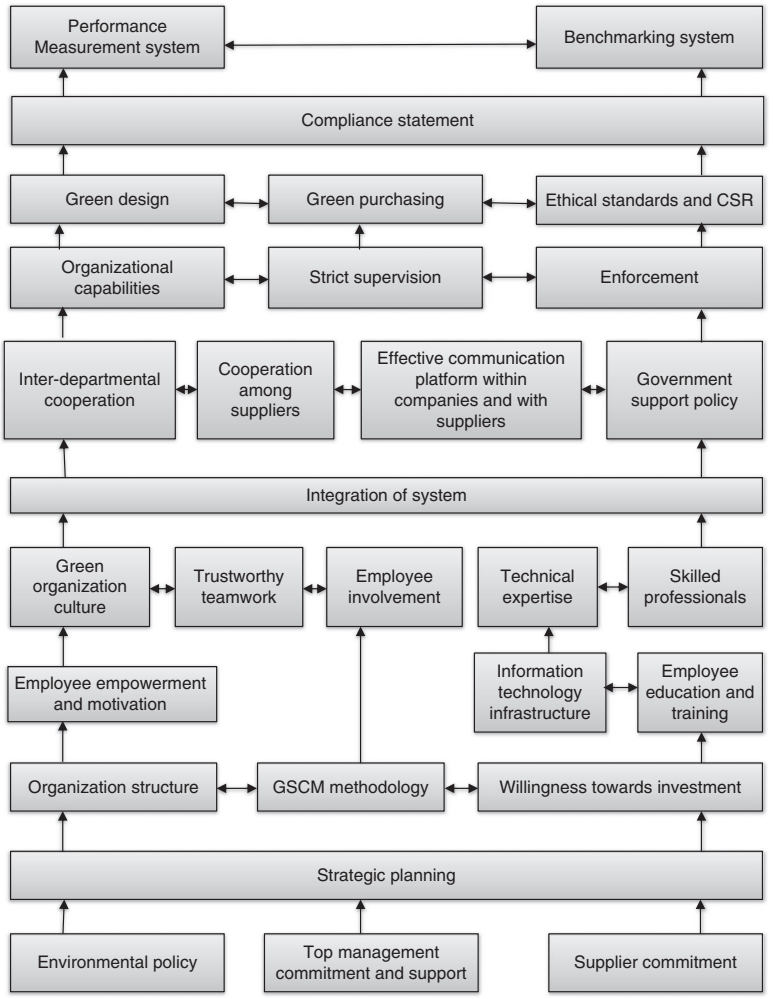

Figure 3.
ISM-based model of GSCM enablers

GSCMEs	1	2	3	…	27	28	29
GSCME1	0	1	1	…	1	1	1
GSCME2	0	0	1	…	1	1	1
GSCME3	0	0	0	…	1	1	1
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
GSCME27	0	0	0	…	0	1	1
GSCME28	0	0	0	…	0	0	1
GSCME29	0	0	0	…	0	0	0

Table XIII.
Binary direct reachability matrix (BDRM)

MICMAC considers only binary type of relationships, but to enhance the former's sensitivity fuzzy set theory (FST) is applied. Fuzzy numbers are a fuzzy subset of real numbers, representing the expansion of the idea of the confidence interval (Dubis and Prades, 1978). Converting fuzzy psychological characteristics into explicit values are

very useful for processing the more varied thinking of people (Wu and Lee, 2007). Given the fuzzy number $\tilde{A}$ be a fuzzy set, with membership function $\mu_{\tilde{A}}(x)$, comprises the following features:

(1) $\mu_{\tilde{A}}(x)$ is a continuous mapping from R to the interval of [0, 1]; and

(2) $\mu_{\tilde{A}}(x)$ is a convex fuzzy subset and $\mu_{\tilde{A}}(x)$ is the normalization of a fuzzy subset which means that there exists a number x_0 makes $\mu_{\tilde{A}}(x) = 1$.

If those numbers fulfill the above mentioned requirements then they are called fuzzy numbers. Triangular fuzzy numbers (TFNs) are defined as a fuzzy number represented by three points as TFNs $= \mu_{\tilde{A}}(x) = A = \left(\tilde{l}, \tilde{m}, \tilde{r}\right)$. The characteristics and membership function of the TFNs are expressed by the following equation and Figure 4:

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x \leqslant l, \\ \frac{x-l}{m-l} & l \leqslant x \leqslant m \\ \frac{r-x}{r-m} & m \leqslant x \leqslant r \\ 0, & x \geqslant r \end{cases} \tag{1}$$

The fuzzy MICMAC analyzes the possibility of interaction defined by qualitative consideration on linguistic variables, as shown in Table XIV.

The opinions of same industry expert are taken to rate the relationship between two GSCMEs. The values of the relationship between two GSCMEs are then superimposed on the BDRM to obtain a linguistic assessment direct relationship matrix (see Table XV).

Since the form of fuzzy numbers is not suitable for matrix operations, defuzzification is needed for further aggregation. Defuzzify, the fuzzy decision matrix into crisp values using the best non-fuzzy performance value. The defuzzified value of fuzzy number can be obtained from the following equation:

$$\mathrm{BNP}_{ij} = \frac{[(r-l)+(m-l)]}{3} + l \quad \forall\, i, j \tag{2}$$

Defuzzification is a method converting fuzzy numbers into a crisp number as shown in a FDRM (see Table XVI).

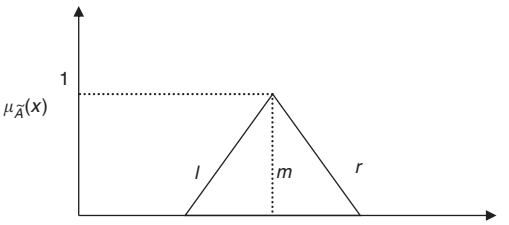

Figure 4.
Triangular fuzzy number (TFNs)

Linguistic terms	Linguistic values
Very high influence (VH)	(0.7, 0.9, 1)
High influence (H)	(0.5, 0.7, 0.9)
Medium influence (M)	(0.3, 0.5, 0.7)
Low influence (L)	(0.1, 0.3, 0.5)
Very low influence (VL)	(0, 0.1, 0.3)
No influence (NO)	(0, 0, 0)

Table XIV.
Linguistic scales for the importance weight

5.3 Fuzzy indirect relationship analysis

The FDRM is taken as the base to start the process of finding the fuzzy indirect relationship of the GSCMEs. The matrix is multiplied repeatedly up to a power until the hierarchies of the driving power and dependence are stabilized. The multiplication process follows the principle of fuzzy matrix multiplication (Kandasamy, 2007). Fuzzy matrix multiplication is basically a generalization of Boolean matrix multiplication (Gorane and Kant, 2013). According to FST, when two fuzzy matrices are multiplied the product matrix is also a fuzzy matrix. Multiplication follows the given rule: product of the fuzzy set A and fuzzy set B is fuzzy set C (see Equation (3)):

$$C = A \times B = \left[\max\left\{\min\left(a_{ij},\ b_{ij}\right)\right\}\right] \tag{3}$$

where $A = [a_{ij}]$ and $B = [b_{ij}]$ are two fuzzy matrices.

5.4 Fuzzy MICMAC stabilized matrix

A stabilized matrix is shown in Table XVII. Using Equation (3), the driving power of the GSCMEs is derived by summing the entries of possibilities of interactions in the rows, and the dependence of GSCMEs is determined by adding the entries of possibilities of interactions in the columns. The ranks of the driving power of enabler decide the hierarchy of enabler in the system (see Table XVII and Figure 5).

6. Results analysis

In this research, the GSCMEs are classified into four clusters (Figure 5). The objective behind the classification of GSCMEs is to analyze driving power and dependence power of enablers that influence the GSCM implementation.

6.1 Independent GSCMEs

The enablers which have strong driving power and weak dependence on the other enablers are said to be independent enablers. From Figure 5, the GSCMEs, namely, GSCME1 (top management commitment and support), GSCME2 (strategic planning), GSCME18

GSCMEs	1	2	3	…	27	28	29
GSCME1	0	VH	H	…	H	H	H
GSCME2	0	0	0.9	…	H	H	H
GSCME3	0	0	0	…	VH	H	H
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
GSCME27	0	0	0	…	0	H	H
GSCME28	0	0	0	…	0	0	H
GSCME29	0	0	0	…	0	0	0

Table XV. Linguistic assessment direct reachability matrix (LADRM)

GSCMEs	1	2	3	…	27	28	29
GSCME1	0	0.9	0.7	…	0.7	0.7	0.7
GSCME2	0	0	0.9	…	0.7	0.7	0.7
GSCME3	0	0	0	…	0.9	0.7	0.7
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
GSCME27	0	0	0	…	0	0.7	0.7
GSCME28	0	0	0	…	0	0	0.7
GSCME29	0	0	0	…	0	0	0

Table XVI. Fuzzy direct reachability matrix (FDRM)

Table XVII.
Fuzzy MICMAC stabilized matrix

GSCMEs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Row sum
GSCME1	0	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.7	0.7	0.7	0.9	0.7	0.7	0.7	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0.9	0.7	0.7	19.6
GSCME2	0	0	0.9	0.9	0.9	0.9	0.9	0.7	0.7	0.7	0.7	0.9	0.7	0.7	0.7	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0.9	0.7	0.7	18.7
GSCME3	0	0	0.9	0.9	0.9	0.9	0.9	0.7	0.7	0.7	0.7	0.9	0.7	0.7	0.7	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0.9	0.7	0.7	18.7
GSCME4	0	0	0	0.9	0.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.8
GSCME5	0	0	0	0.9	0.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.8
GSCME6	0	0	0.9	0.9	0.9	0.9	0.9	0.7	0.7	0.7	0.7	0.9	0.7	0.7	0.7	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0.9	0.7	0.7	18.7
GSCME7	0	0	0.9	0.9	0.9	0.9	0.9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0.7	0.7	0.7	18.3
GSCME8	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0	0	0	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0	9.3
GSCME9	0	0	0	0.9	0.9	0	0	0	0.7	0.7	0	0	0	0	0	0	0.7	0	0.7	0.7	0	0	0	0.7	0.7	0.5	0	0	0	7.2
GSCME10	0	0	0	0.9	0.9	0	0	0	0	0.7	0	0	0	0	0	0	0.7	0	0	0.7	0	0	0	0	0	0.5	0	0	0	4.4
GSCME11	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0.7	0.7	0.7	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0.7	12.1
GSCME12	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.7	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0.7	0.7	0.7	14.9
GSCME13	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0.7	0.7	0.7	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0.7	12.1
GSCME14	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0.7	0.7	0.7	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0.7	12.1
GSCME15	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0.7	0.7	0.7	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0.7	12.1
GSCME16	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0	0	0	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0.7	0.7	11.4
GSCME17	0	0	0	0.9	0.9	0	0	0	0	0.7	0	0	0	0	0	0	0.7	0	0	0.7	0	0	0	0	0	0.5	0	0	0	4.4
GSCME18	0	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.7	0.7	0.7	0.9	0.7	0.7	0.7	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0.9	0.7	0.7	19.6
GSCME19	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0	0	0	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0	9.3
GSCME20	0	0	0	0.9	0.9	0	0	0	0	0.7	0	0	0	0	0	0	0.7	0	0	0.7	0	0	0	0	0	0.5	0	0	0	4.4
GSCME21	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0	0	0	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0	9.3
GSCME22	0	0.9	0.9	0.9	0.9	0.9	0.9	0.7	0.7	0.7	0.7	0.9	0.7	0.7	0.7	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0.9	0.7	0.7	19.6
GSCME23	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0	0	0	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0	9.3
GSCME24	0	0	0	0.9	0.9	0	0	0	0.7	0.7	0	0	0	0	0	0	0.7	0	0.7	0.7	0	0	0	0.7	0.7	0.5	0	0	0	7.2
GSCME25	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0	0	0	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0	9.3
GSCME26	0	0	0	0.9	0.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.8
GSCME27	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0.7	0.7	0	0	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0.7	0.7	0.7	13.5
GSCME28	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0	0	0	0.7	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0.7	0.7	11.4
GSCME29	0	0	0	0.9	0.9	0	0	0.7	0.7	0.7	0	0	0	0	0	0	0.7	0	0.7	0.7	0.7	0	0.7	0.7	0.7	0.5	0	0	0	9.3
Column sum	0	2.7	6.3	26.1	26.1	6.3	6.3	15	16	18	4.9	7.5	9.1	8.4	8.4	7.7	18	0	16.1	18	15	0	14.7	16.1	16.1	13	7.5	7.7	10.5	

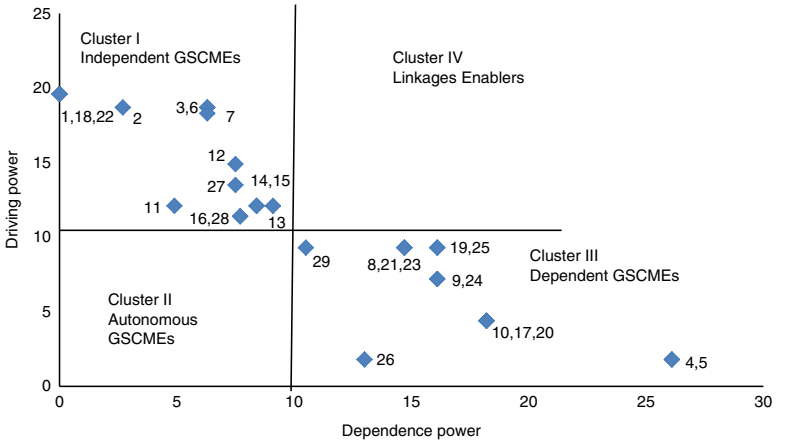

Figure 5.
Driving and dependence power of GSCMEs

(supplier commitment), GSCME22 (Environmental policy), GSCME3 (willingness toward investment), GSCME6 (organizational structure), GSCME11 (employee empowerment and motivation), GSCME7 (GSCM methodology), GSCME12 (environmental education and training), GSCME27 (information technology infrastructure), GSCME16 (skilled professionals), GSCME28 (technical expertise), GSCME13 (green organizational culture), GSCME14 (trustworthy teamwork), and GSCME15 (employee involvement) are strong drivers but are weak dependent on others. It has been observed that these GSCMEs help to achieve the GSCMEs which appear at the top of the ISM hierarchical relationship structure. Those GSCMEs processing higher driving power in the ISM need to be taken care in priority basis because there are few other dependents GSCMEs being affected by them. Thus, management needs to address these GSCMEs more cautiously and may be treated as the root cause of all the GSCMEs. Therefore, it will be necessary that management should work out tactics to facilitate these independent GSCMEs for successful GSCM implementation in Indian automotive organizations.

6.2 Autonomous GSCMEs

The driving dependence power diagram indicates that there were no autonomous GSCMEs in the process for GSCM implementation. Autonomous GSCMEs are weak drivers and also weak dependent. The autonomous GSCMEs are relatively disconnected from the system with which they have only a few links, which may not be strong. Hence, they do not hold much influence on the organization. Thus, the 29 selected GSCMEs have much influence on the GSCM implementation. Hence, top management cannot take lightly any of these GSCMEs if they are very serious to make GSCM implementation successful.

6.3 Dependent GSCMEs

The enablers which have weak driving power and strongly dependent on the other enablers are said to be dependent enablers. From Figure 5, GSCME4 (benchmarking system), GSCME5 (performance measurement system), GSCME20 (green purchasing), GSCME10 (green design), GSCME17 (ethical standards and corporate social responsibility), GSCME9 (organizational capabilities), GSCME24 (enforcement), GSCME25 (strict supervision), GSCME19 (effective communication platform within the companies and with the suppliers), GSCME8 (inter-departmental cooperation), GSCME21 (organizational capabilities), GSCME23 (government support policy), GSCME26 (compliance statement), and GSCME29 (integration

of system) are weak drivers but are strongly dependent on others. They are seen at the top of the hierarchical relationship structure, therefore considered as important GSCMEs. This indicates that they require all other enablers to come together for building trust in GSCM. The managers should critically investigate dependence and accord high priority in tackling these GSCMEs on other related enablers while implementing GSCM in Indian automotive industries. Besides tackling these GSCMEs, management should also understand the dependence of these GSCMEs on the lower level of the ISM.

6.4 Linkages GSCMEs

There were no GSCMEs in the linkage category which have strong driving power and also strong dependence. Any change occurring to these GSCMEs will have an effect on others and also on feedback given to them. Hence, these GSCMEs are unsteady in nature which may affect the successful GSCM implementation either in a negative or positive way. The absence of any linkage GSCMEs in this study indicates that no GSCMEs are unstable among all chosen 29 GSCMEs.

7. Discussion and conclusion

The objectives of this research are to study, examine, and rank the various GSCMEs for successful implementation of GSCM to establish relationship between them and to find out the driving and the dependence power of these GSCMEs. This study identified all the GSCMEs by reviewing a number of research articles and discussion with experts. The present study shows the utilization of an innovative approach to the GSCM implementation in Indian manufacturing organization where the case of automobile sector is considered. The nationwide questionnaire survey of Indian automobile industries was conducted to prioritize these GSCMEs. From survey analysis mean of each enabler is calculated and used to reduce the number enablers from 35 to 29 GSCMEs (see Table II) by considering mean $\geqslant$3.00 for further analysis. The ISM and fuzzy MICMAC approach have been applied to analyze the contextual relationship and developed an integrated model between these 29 GSCMEs. Through the ISM, an interrelationship model among GSCMEs has been developed. This model has been developed on the basis of literature review, questionnaire survey, and input from experts. The result of the ISM is used as an input to the fuzzy MICMAC analysis to identify the driving and dependence power.

It has been observed from Figure 3 that environmental policy, top management commitment and support and supplier commitment are at the first level of ISM model and lead to strategic planning which constitutes a second level. The level 3 constitutes the mutual relationship between organizational structure, GSCM methodology and willingness toward investment. The management, attitude will provide the sufficient financial and investment support to the organization. The level 3 will lead to the formation of level 4, i.e. employee empowerment and motivation, while information technology infrastructure and employee instruction and training are mutually supporting each other. At level 5, green organization culture, trustworthy teamwork, and employee involvement are mutually related as well as technical expertise and skilled professionals are also mutually related to each other. And finally, the GSCMEs of level 5 leads to the integration of systems (level 6). The integration of system drives in building mutual relationship among all the three levels, i.e. levels 7, 8, and 9 and all the GSCMEs, namely, inter-departmental cooperation, effective communication platform within companies and with the suppliers, government support policy, organizational capabilities, strict supervision, enforcement, green design, green purchasing, ethical standards and corporate social responsibility constitutes a mutual relationship between each other. If all the nine levels are implemented in the organization, preparation of compliance statement (level 10) leads to evolution of level 11 in which performance measurement system and benchmarking system are mutually

related to each other. These key finding offers a meaningful base to deepen the understanding for implementation and also an indication to develop an effective GSCM implementation in a stepwise manner.

The second objective of this study was to analyze the driving and the dependence power of the GSCMEs that influence the GSCM implementation through fuzzy MICMAC analysis. In fuzzy MICMAC analysis, the GSCMEs are classified into four clusters (see Figure 5). The first cluster consists of the independent GSCMEs having strong driving power but weak dependence. A second cluster consists of the autonomous GSCMEs that have weak driver power and weak dependence. These GSCMEs are relatively disconnected from the system, with which they have only a few links, which may be substantial. Third cluster has the dependent GSCMEs that have weak driving power but strong dependence. The fourth cluster includes the linkage GSCMEs that have strong driving power and also strong dependence. The top management of the case organization should address the driving and dependent enablers more cautiously, so that the decision makers of the case organization can apply a phased implementation approach beneath the limitations of existing resources to provide the assurance for the effective GSCM implementation.

7.1 Managerial implications

The study establishes the basis for integrating organization's strategic intent with the identification of GSCMEs of GSCM implementation. The integrated model of ISM and fuzzy MICMAC approach is developed, which may be useful to GSCM managers of the case organization to employ this model to identify and classify the significant GSCMEs for their needs. This model also reveals the direct and indirect effect on each enabler on the GSCM implementation. The integrated approach is developed to overcome the drawback of the ISM model by introducing the fuzzy relationship instead of binary relationship (in ISM) for predicting the relationship between variables. This study has strong practical implication for both practitioners as well as academicians. The practitioner needs to concentrate on identified GSCMEs more cautiously during GSCM implementation in their organizations. On the other hand academicians may be encouraged to categorize different issues, which are significant in addressing these GSCMEs. ISM model identifies the hierarchy of actions to be considered by practitioners to maximize the effect of these GSCMEs in order to implement GSCM successfully. The fuzzy MICMAC analysis indicates the category of the GSCMEs which needs attention by practitioners according to their dependence power and driving power. Practitioners should concentrate on those GSCMEs which have higher driving power because of these GSCMEs should be emphasized for successful implementation. These higher driving GSCME are the root cause for other GSCMEs which have higher depending. Once these higher driving power GSCMEs are identified, the top management could formulate a strategy for enhancing their effects during GSCM implementation in automobile industries. Accordingly, GSCM managers may also strategically plan its long-term growth strategy to meet GSCM action plan.

7.2 Limitations and future scope

The weightage for ISM model development and fuzzy MICMAC are obtained through the judgment of industry experts. It is the only subjective judgment and any biasing by the person who is judging the GSCMEs might influence the final result (Gorane and Kant, 2013). Despite of many advantages of this study, similar to any other model it does have disadvantages like its analysis is very tedious and time consuming. When the number of factors and relationships increases its complexity can also geometrically increases. This study has been conducted considering the only Indian automobile industry, further such type of analysis can be conducted considering some other type of industries of India

and outside India using integrated ISM and fuzzy MICMAC approach or with some other decision making tools such as ANP. The future scope also offers to test and validate this model using structural equation modeling approach which delivers the power to examine the hypothesized model statistically.

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(The Appendix follows overleaf.)

Appendix. Details of survey questionnaire

SECTION–I: GENERAL

Please indicate (√) your Personal Information

Position: ☐ Senior management level ☐ Middle management level ☐ Junior management level ☐

Educational qualification: ☐ Diploma ☐ Bachelor's degree ☐ Master's degree ☐ Doctorate ☐

Year of Experience: ☐ Less than 5 years ☐ 5 to 10 years ☐ 11 to 15 years ☐ More than 15 year ☐

Age group: ☐ Below 30 ☐ 30-39 ☐ 40-49 ☐ Over 50 ☐

Please indicate (√) your Organizational Information

1. Sector: ☐ Public sector ☐ Private sector ☐ Government department ☐ Others (Please specify)----

2. Organization is : ☐ Large scale industry ☐ Medium scale industry ☐ Small scale industry ☐

3. Please indicate (√) the approximate number of employees in your organization.

1. 100 or less ☐ 2. 101 - 500 ☐ 3. 501 - 1000 ☐ 4. Over 1000 ☐

4. Please indicate (√) the approximate *annual turnover* of your organization.

1. Under Rs. 5 Crores ☐ 2. Rs. 5- 50 Crores ☐ 3. Rs. 51 - 100 Crores ☐

4. Rs. 101 - 500 Cores ☐ 5. Over Rs. 500 Crores ☐

5. Please indicate (√) the trend in *annual sales turnover* during the last three years

1. Increased up to 10% ☐ 2. Increased above 10 % ☐ 3. Constant ☐ 4. Decreased ☐

6. Please indicate (√) the *trend in profits* during the last three years

1. Increased up to 10% ☐ 2. Increased more than 10 % ☐ 3. Almost same ☐ 4. Loss ☐

7. Please indicate (√) the performance measurement usually takes place in your organization.

1. Never ☐ 2. Once a year ☐ 3. Twice a year ☐ 4. It is a continuous process ☐

SECTION–II: GSCM Enablers and Barriers

8. Please indicate (√) the enablers for implementation of GSCM.

It is specifically requested; please use following scale to answer each item.

1=Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree

	1	2	3	4	5
8.1 Strategic Enablers					
i. Top management commitment and support	☐	☐	☐	☐	☐
ii. Strategic planning	☐	☐	☐	☐	☐
iii. Willingness towards investment	☐	☐	☐	☐	☐
iv. Benchmarking system	☐	☐	☐	☐	☐
v. Performance measurement system	☐	☐	☐	☐	☐
vi. Collaborative research & development with supplier	☐	☐	☐	☐	☐
8.2 Organizational Enablers					
i. Organizational structure	☐	☐	☐	☐	☐
ii. Organizational capabilities	☐	☐	☐	☐	☐
iii. Inter-Departmental cooperation	☐	☐	☐	☐	☐
iv. GSCM Methodology	☐	☐	☐	☐	☐

v. Green design					
8.3 Social-Cultural Enablers					
i. Green organizational culture					
ii. Trustworthy teamwork					
iii. Skilled professionals					
iv. Environmental education and training					
v. Employee empowerment and motivation					
vi. Ethical standards and corporate social responsibility					
vii. Employee involvement					
viii. Environmental related programs and meetings					
8.4 Buyer and Supplier Enablers					
i. Supplier commitment					
ii. Supplier adoptability					
iii. Customer awareness					
iv. Effective communication platform within companies and with suppliers					
v. Cooperation among suppliers					
vi. Green purchasing					
8.5 Legislation					
i. Enforcement					
ii. Environmental policy					
iii. Strict supervision					
iv. Compliance statement					
v. Government support policy					
8.6 Technical enablers					
i. Information technology infrastructure					
ii. Integration of system					
iii. Technical expertise					
iv. Awareness about new technology					
v. Availability of new technology					

9. Please indicate (√) the intensity of barriers/obstacles in GSCM implementation.

It is specifically requested; please use following scale to answer each item.

1=Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree

	1	2	3	4	5
9.1 Strategic Barriers					
i. Lack of top management commitment					
ii. GSCM is not well understood					
iii. GSCM is not integrated with SC process					
iv. Lack of GSCM strategy					
v. Lack of financial resources					
vi. Lack of benchmarking system					

vii. Lack of performance measurement system					
9.2 Organizational Barriers					
i. Lack of cross-functional structure					
ii. Lack of formal rules, guidelines and procedure					
iii. Lack of organizational resources that would provide adequate GSCM					
iv. Lack of organizational capability to execute GSCM					
v. Lack of interdepartmental cooperation					
vi. Disbelief about environmental benefits					
9.3 Social-Cultural Barriers					
i. Lack of employee trust and commitment					
ii. Lack of green organizational culture					
iii. Lack of Environmental education and training					
iv. Lack of skilled professionals					
v. Lack of employee support, encouragement, and motivation to adopt GSCM					
vi. Lack of empowerment to work for GSCM					
vii. Lack of ethical standards and corporate social responsibility					
viii. Less involvement in environmental related programs and meetings					
9.4 Buyer and Supplier Barriers					
i. Poor supplier commitment					
ii. Supplier reluctance to change towards GSCM					
iii. Lack of cooperation between company and its suppliers					
iv. Lack of customer awareness about GSCM					
v. Fear of failure among suppliers					
vi. Lack of communication and information sharing on GSCM					
9.5 Legislation					
i. Lack of enforcement					
ii. Lack of environmental policy for GSCM					
iii. Lack of strict supervision					
iv. Lack of government support policy for GSCM					
9.6 Technical Barriers					
i. Lack of Information Technology infrastructure system like environmental monitoring system					
ii. Resistance to new technological adoption					
iii. Lack of technical expertise					
iv. Lack of integration of new technology with GSCM					
v. Lack of awareness about new technology					
vi. Unrealistic expectation of employee's what technology can do and cannot do					

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