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ORIGINAL ARTICLE

Analysis of the influential pressures for green supply chain management adoption—an Indian perspective using interpretive structural modeling

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Abstract Presently, industries face tremendous pressure from customer's environmental awareness and stricter environmental regulations to incorporate ethical and environmental considerations in all facets of traditional supply chain management (TSCM). Green supply chain management (GSCM) is a well-known and established concept to incorporate ethical, environmental considerations in TSCM which satisfies the needs of environmental policies and customers and restricts hazards. The objective of this paper is to identify the key pressures of motivation for adoption of GSCM in TSCM. This paper, initially identified 25 pressures from previous literature sources, secondly influential pressure was determined with help of interpretive structural modeling technique through expert's opinion. This technique identified five level of influential pressures from recommended 25 pressures based on the impact. The result of this paper inferred that Indian auto component manufacturing industries are facing pressure from government and regulation policies categories. The study result is helpful to visualize which pressure provides more motivation to GSCM practices and which pressure is motivation-less to engage GSCM in traditional activities, especially to maintain environmental regulation policies. This approach was conducted with 16 auto components manufacturing industries in Tamilnadu, South India.

Keywords Green supply chain management · Pressures for green supply chain management · Interpretive structural modeling

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1 Introduction

Industries worldwide have shown a growing concern for the environment over the last few decades due to pressures from environmental regulations, customers, and competitions in the market [13]. In this way, there is growing awareness of customers in India and the world about environmental safeguards, need of better concepts to protect the environment and reduce consumption of the earth resources, and the need to protect the environment from pollution. Green management is a tremendous concept for industries to achieve a pollution- and hazard-free environment. Globally, India is ranked among the top ten and is one of the biggest manufacturing economies [34]. Toke et al. [59] argued that green supply chain management (GSCM) is now getting special attention among researchers and academicians. Increasing importance of GSCM is due to weakening of environment, e.g., diminishing raw material resources, overflowing waste sites, and increasing pollution levels. Generally, industries are less than willing to change/modify traditional activities without external motivations /pressures /stresses. Adoption of GSCM requires motivation pressure from government, customers, and stockholder. Yang and Sheu [66] pointed out that stresses from regulations and key customers enhance green collaborations. These pressures promote the environmental performance of industries [11, 68]. Earlier literature reveals that Indian industries started to integrate the supply chain with environmental issues [12, 18, 34, 42, 56] due to pressure. GSCM is an integrated approach with industrial traditional supply chain management (TSCM) activities, from purchasing raw materials to finished products; it increases reuse, recycling, and remanufacturing used products and decreases usage of fresh raw materials and industrial wastes [34]. Generally, different industries have different pressures and all do not have the same impact towards GSCM adoption [69]. Due to these reasons industries do not give equal

importance to all pressure. It is essential for industries to identify and prioritize the pressure for GSCM adoption. The objective of this research was fixed on this point. This study was to analyze the pressure for the adoption of GSCM and especially, determine how industries deal with all pressures. Based on our study we intend to address the following research questions:

- What are the pressures industries face to engage GSCM from extensive literature
- Determine the inter relationships between recommended pressures
- Identify influential pressure to motivate GSCM adoption in automotive industries based on experts opinion

2 Literature review

From the early 1990, manufacturers were facing pressure to incorporate environmental management into their TSCM [1]. Nowadays, research is done on analysis of environmental issues in industrial activities globally. Increasing environmental concern has steadily become part of the overall corporation culture and, in turn, helped to re-engineer strategies of corporations [11]. Especially, in recent year's TSCM received concern about environmental issues. GSCM philosophy is to integrate environmental concept into TSCM. Many researchers give extensive explanation about GSCM because of its benefits economically and environmentally. However, GSCM definition is not clear, for the reason that corporate environmental management and supply chain management is a relatively new area of research and practice [65, 70]. From 1990 onward researchers defined GSCM concepts from their perspectives. Some GSCM definitions are summarized below: "Environmental supply chain management consists of purchasing function's involvement in activities that include reduction, recycling, reuse, and the substitution of materials" [43]; "The practice of monitoring and improving environmental performance in the supply chain" [15]; "The term 'supply chain' describes the network of suppliers, distributors and consumers. It also includes transportation between the supplier and the consumer, as well as the final consumer… the environmental effects of researching developing, manufacturing, storing, transporting, and using a product, as well as disposing of the product waste, must be considered" [65].

2.1 Pressure for GSCM

The purpose of GSCM adoption ranges from reactive monitoring to proactive practice. A range of aspects on GSCM were covered, including GSCM drivers and/or pressures and GSCM practice [65, 68]. Hall [22] mentions that suppliers do not have similar pressure from external stakeholders as their customers, so environmental pro-activity/innovation often comes from higher links in the supply chain [32]. Industries need to adopt effective integrated environmental concept based on pressures from the regulations and increased community and consumer pressures [57]. Presently, business organizations (manufacturing and service) have awareness of hazardous and pollution. For example, Gilaninia et al. [14] feels that the major attention of governments is toward tourism and to pristine natural environment. Generally, pressure is because stakeholders are given improper definition of the environmental impact of the industry [47], and also due to the large number of clients or the size of their projects. Big firms are the visible link which targets them for high public attention and the media [16].

Large firms and also many large-scale suppliers are facing pressure from customers regarding environmental products [22, 65]. Zhu and Sarkis [68] pointed out that all organizations do not face the same pressure for GSCM adoption. Different industry sectors in different countries face different pressures. For example, Bristol-Myers Squibb, IBM, and Xerox have encouraged their Chinese suppliers to implement environmental management systems consistent with ISO 14001, while, suppliers of Ford, GM, and Toyota are required to obtain the ISO certification. Also the latest global environmental issues are much more sensitive than others and will be emphasized. For example, the Kyoto Protocol requires the reduction of greenhouse gas emissions; hence industries which are heavy emitters of greenhouse gases (e.g., power generation) will be subject to increased pressure. Industries which are globally focused (e.g., electronic or clothing and shoes) will bear both national and international pressures and motivations for incorporating GSCM practice [68]. Raynsford [49] mentions that environmental tax exception is indirectly motivating industries to think of GSCM adoption. It also is encouraging the benefits of GSCM and highlighting the harmful impact on the environment.

Xiao [65] suggests five environmental pressures from the stakeholder point of view: (a) government as regulatory stakeholder, (b) media, (c) local resident as a community group, (d) contractors and clients, and (e) other stakeholders including related organization which can affect the company financially. Thipparat [57] evaluates adoption of GSCM practices between contractors with help of fuzzy analytical hierarchy process (FAHP) and Neurofuzzy system. Similarly Kumar et al. [34] investigated the relationship between the GSCM practices and environmental performance in electrical and electronics industry in India and analyzed the impact of environmental regulation pressure. It gives a clear view of how industries are to fulfill customers' environmental requirements. Pressures from various directions like statutory control, intensified competition, various stakeholders, social responsibility and corporate image, business enterprises, especially those with environmental sensitivity (including heavy

manufacturing, oil, and chemical industry) have changed their corporate policies and operating practices and procedures [23]. The view of environmental issues should be shifted from "considering environmental issues as tangential to business to a holistic view of business and sustainable development" [65].

Yang and Sheu [66] conducted a case study in Taiwan computer industry's GSCM practices with compliance practices. Many pressures are grouped according to internal and external. External pressures refers to any external force capable of beginning GSCM practices and finally the motivation to improve the purchasing process itself. Zhu and Sarkis [70] investigated the relationship between GSCM practice and environmental and economic performance with help of empirical results from 186 respondents of Chinese manufacturing enterprises using moderated hierarchical regression analysis. They also investigated how two primary types of management operations philosophies, quality management and just-in-time (or lean) manufacturing principles, influence relationship between GSCM practices and performance. Chien and Shih [11] measure the relationship between the extended supply chain performance in green supply chain, it also expends the collaboration and extended supply chain performance. Structural equation modeling was applied to test the ten hypothesis. Among those, seven hypothesis pass the test and three hypothesis failed. Sarkis and Tamarkin [51] pointed out that pressures on corporations to improve environmental performances are from globalization rather than localization.

Labonne [35] mentions that larger firms face more pressure from public/regulatory authorities to address environmental concerns compared to small/medium enterprises. Due to pressures from inadequate resources, every industry needs to set the environmental tasks in traditional activities to avoid loss of competitive benefits. Pressure of environmental safeguards is not solely from the demands of regulations; consumers and clients also exert pressure on companies [22]. Standards, regulations, and competition have together prompted organizations to become more aware of any consequences to the environment [11]. Based on the consumer expectations industries face more and more pressure to satisfy needs in terms of environmental issues. SMEs receive the greatest pressure from the legislation towards adopting GSCM to improve environmental performance. As per Holt and Ghobadian [26] view, least influential pressures are related to societal drivers and SC pressures from individual customers. Literature has documented a wide range of factors, like institutional/regulatory forces, stakeholder pressures [6], organizational resources, and cultural factors [5, 39] that drive firms to be environmentally oriented. Although environmental management researchers have long believed that a firm's increased level of environmental orientation will improve its strategic responses toward environmental issues, and consequently its performance, their belief has yet to be fully validated [10].

3 Research gap

Environmental regulations put pressure on manufacturing firms from different countries along a supply chain to work together to ensure the elimination of any hazardous substances [61]. Pressure on industries to reduce carbon emissions is a challenging issue needed to introduce the GSCM concept and their operations to control carbon emissions. imilarly industries understand they need to adopt GSCM concept without any option through normal procedure. Increasing the number of environmentally conscious customers also increases competition among firms to provide greener products and thus increase their market share [1]. From the available published literature sources, the topic of GSCM is summarized in Table 1. It is clearly evident that researchers are having tremendous awareness about GSCM. Almost researchers of all over the world focused extensive analysis of green manufacturing performances, green marketing, green products, and GSCM practices. However, there is a tremendous gap in research in analyzing pressure for GSCM adoption. There is also a gap for identifying the influential pressure among the recommended pressures. Due to these literature gap this research was taken up for fulfilling the abovementioned research gap. It is an initial research about pressure analysis in GSCM adoption in the Indian industrial scenario. This paper addresses the gap in collection of pressure from literature resources and determines the relationship between them for adoption of GSCM by two-phase research approach as follows. Phase 1 presents an initial survey to identify the pressures for the GSCM from available literature and phase 2 determines the relationship and identifies the influential pressures by ISM technique.

4 Problem description

In India, resource available is less but due to growth, industries need more resources. Due to resource scarcity most Indian industries depend on other countries for resources (raw materials). So, Indian industries need to reduce consuming of virgin resources by adopting reverse logistic concepts and also need to reduce environmental pollution through incubi utilization. Indian industries need to use fewer resources and improve environmental performance. Due to this reason industries must take up practices related to environmental sustainability [19]. Every industry has its own supply chain management and starts from procurement of raw material to finished products (industries to customer—forward supply chain management) and used products to industries (customers to industries— reverse supply chain management). If we adopt the good environmental systems in supply chain management we get notable

Table 1 Literature review of GSCM

Sl. no.	References	Area
1.	Muduli et al. [41]	Barriers GSCM in Indian mining industries, graph theoretic approach
2.	Azevedo et al. [4]	Ecosilient Index to assess the greenness, resilience of the upstream automotive supply chain
3.	Tseng and Chiu [60]	Evaluating firm's GSCM in linguistic preferences
4.	Nawrocka et al. [44]	ISO 14001 in environmental supply chain practices
5.	Hajmohammad et al. [21]	Lean management and supply management: their role in green practices and performance
6.	Wiengarten et al. [63]	ISO 14000 certification and investments in environmental supply chain management practices: identifying differences in motivation and adoption levels between Western European and North American companies
7.	Chien and Shih [11]	Electronics manufacturers, Taiwanese, GSCM practices, and performance
8.	Min and Galle [40]	Mixed sectors including manufacturing, USA, and green purchasing/ recycled packaging
9.	Rao [47]	Mixed sectors including manufacturing, SE Asia, and green supply chain management
10.	Zhu and Sarkis [70]	Manufacturing, Chinese, GSCM, and performance
11.	Zhu et al. [72]	Manufacturing, Chinese, and GSCM implementation
12.	Zhu et al. [71]	Manufacturing, Chinese, drivers, and GSCM practices and performance
13.	Abdallah et al. [1]	GSCM carbon trading and environmental sourcing, formulation, and life cycle assessment
14.	Zhang and Liu [67]	Coordination mechanism in three-level GSCM under non-cooperative game
15.	Liu et al. [36]	Multi-dimensional integration of green marketing and SSCM
16.	Hoejmose et al. [25]	GSCM, role of trust, and top management in B2B and B2C markets
17.	Chan et al. [10]	Environmental orientation and corporate performance, mediation mechanism of GSCM, and moderating effect of competitive intensity

improvements on environmental issues. GSCM practice is a tremendous solution for the above problem [12, 56]). Generally, industries are stubborn in adopting environmental supply chain management concepts (Green) in their TSCM. So, industries require some force to motivate adoption of GSCM concept. Only few industries adopt GSCM concept, but now almost all industries start to implement GSCM due to pressure from different directions (example: customer pressure, governmental regulations, etc.). Different industries face different pressures for GSCM adoption [71, 72]. As per industrial perspective, all pressures are not equal for enforcing adoption of GSCM. So, industries need to identify which pressure gives high impact. From literature we have taken 25 pressure variables for this study to identify the dominant pressure from recommended pressure. Pressure for GSCM is shown in Table 2. This study was conducted on 16 auto component units in Tamilnadu, India. These industries produce various types of commercial auto components and also each industry has more than ten manufacturing unit in and around India.

5 Solution methodology

ISM approach was used to analyze the inter-relationship between pressures and identified influential pressure in this research work. The methodology questionnaire and results are discussed in the following sections.

5.1 Interpretive structural modeling

It is normally felt that individuals or groups encounter complexities in commerce with complex issues or systems. The complexity of the issues/systems is due to a large number of elements and interactions among them [46]. ISM is a better tool to solve complexity of relationship in large number of elements. ISM is a multi-criteria decision-making methodology and an interactive learning process whereby a set of dissimilar directly and indirectly related elements are structured into a completed systemic model [17, 29]. It is also used to analyze the relations between elements and to understand dependence and driving power of each element with respect to other elements [3]. ISM was

Table 2 Pressures for GSCM from the literature review

Government policies and regulations	
P1	Central governmental environmental regulations (P1)
P2	Regional environmental regulations (P2)
P3	Special tax exemption for ISO 14001 certified firms (P3)
P4	High penalty for environmental pollution (P4)
Global competitiveness	
P5	Competitors' green environmental protection strategy (P5)
P6	World Trade Organization entry (P6)
P7	Lower market for current product (P7)
P8	Pressures in the process of selling products (P8)
P9	Foreign direct investment (FDI) interest in green products (P9)
Customer	
P10	Demand from customers for environmental protection requirements (P10)
P11	Increasing pressure to provide quality products (P11)
External factors	
P12	Need for establishing company's green image (P12)
P13	Carbon tax force fuel cost reduction (P13)
P14	Negative media attention by environmental action groups (P14)
P15	Corporate social responsibility (CSR) (P15)
P16	Increasing scarcity of resources in India (P16)
Financial factors	
P17	Cost of disposal of hazardous materials (P17)
P18	Increasing anticipated business benefits (P18)
P19	Long-term profits associated with the adoption of "green" strategies (P19)
P20	Pressure from new economic, energy savings (P20)
Production and operational factors	
P21	Company's environmental mission (P21)
P22	Reducing risks to business from current environmental, health, and safety factors (P22)
P23	Force to increasing cube utilization (P23)
P24	Awareness about investment recovery (P24)
P25	Reducing environmental accidents in organization (P25)

References: [1, 2, 8, 20, 34, 42, 54, 64, 65, 68, 69, 73, 74]

proposed for complex situations as a communication tool [12]. Philosophical basis for the development of this approach was presented by Warfield [62]. This technique transformed unclear and poorly articulated system models into visible and well-defined models [12, 50]. ISM is an influential approach, which can be applied in various fields [46]. Also this technique is well known to Indian researchers and academicians. They applied it in many industrial problems applications. Application of ISM in Indian perspective is given in Table 3. However, from the extensive literature and Table 2, there is no evidence of use of ISM technique to analyze dominant pressure during GSCM implementation.

Researchers suggested steps for ISM methodology, of which modified Kannan et al. [31] and Govindan et al. [17] ISM steps were used. The steps involved in the ISM methodology are as follows:

Step 1 Pressures considered for the system under consideration are listed.

Step 2 From the pressures identified in step 1, a contextual relationship is established among pressures to identify which pair of pressures should be examined.

Step 3 A structural self-interaction matrix (SSIM) is developed for pressure, which indicates pair-wise relationships among pressures of the system under consideration.

Step 4 Reachability matrix is developed from SSIM and checked for transitivity. The transitivity of the contextual relation is a basic assumption made in ISM. It states that if a pressure 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 of the above given reachability matrix, a directed graph is drawn and the transitive links are removed.

Step 7 The resultant digraph is converted into an ISM, by replacing variable nodes with statements.

Step 8 The ISM model developed in step 7 is reviewed to check for conceptual inconsistency and necessary modifications are made. The above steps are shown in the Fig. 1.

6 Questionnaires development

The study, considered 25 pressures for GSCM implementation taken from literature with five notable categories. The 25 pressures were grouped under five categories based on similarities. Initially 35 industries in and around Tamilnadu were visited for observing environmental management awareness with help of a common enquiry. In the visit executive engineers and managers of the each industry were met at their convenient time. Four months were spent for initial survey and research objectives explained. During the survey industries environmental improvement history and which had more interest to improve their environmental performance were observed. Finally, 16 industries gave permission for our research, based on our extensive explanations (power point presentation with managers and engineers of each department). We approached 16 industries with our pressure list (32 pressures) and asked for their feedback by a YES or NO question. After 10 days, 15 responses were received. Based on the industrial response less impact pressures were omitted and shortlisted 25 pressures from the 32 pressures. Research continued with 25 pressures and the framed questionnaire. Of 25 pressures,

Table 3 Application of ISM in India

Sl. no.	Application	Authors
1.	Analyzing barrier for GSCM in automotive industry	Mathiyazhagan et al. [38]
2.	Higher education program planning	Hawthorne and Sage [24]
3.	Energy conservation in Indian cement industry	Saxena et al. [52]
4.	Vendor selection criteria	Mandal and Deshmukh [37]
5.	Adoption of knowledge management in Indian industries	Singh et al. [55]
6.	Strategic decision making in managerial groups	Bolaños and Nenclares [9]
7.	Barriers for GSCM	Mudgal et al. [42]
8.	Drivers for GSCM	Diabat and Govindan [12]
9.	Barriers of reverse logistics	Ravi and Shankar [48]
10	Third party reverse logistic provider	Govindan et al. [17]
11.	Project management analysis	Ahuja et al. [3]
12.	Information sharing enablers	Khurana et al. [33]
13.	Flexible manufacturing system enablers in Indian companies	Raj et al. [45]
14.	Future objectives for waste management in India	Sharma et al. [53]
15.	Selection of green suppliers	Kannan et al. [30]
16.	Selection of reverse logistics provider	Kannan et al. [31]

influential pressure was found with help of ISM technique through expert's opinions. All industry individual responses were consolidated and sent to one expert in each industry asked for one final response. After receiving ten responses, finally one response was chosen based on expert discussions.

The approached industrial demographic profiles are illustrated based on their category, employee size, ownership, and turnover in Table 4. Sixteen auto component industries gave their response based on ISM questionnaire. Of 16 industries, five belong to engine parts manufacture (31.5 %), four are brakes manufacturer (25 %), three are steering manufacturer (18.75 %), and four are radiator manufacturers (25 %). Two industries has more than 1,501 employees; in four industries employee size is 1,001–1,500, in another three industries employee size is 751–1,000, similarly in another three industries 501–750 employees are employed, and 200–500 is the

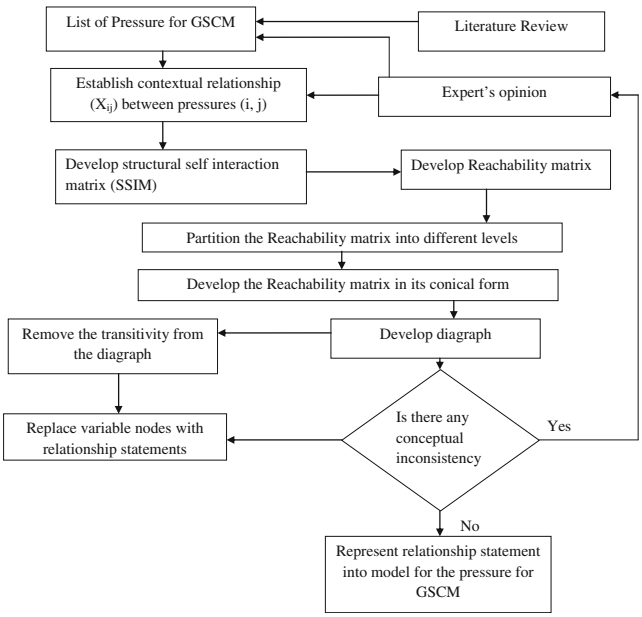

Fig. 1 Flow diagram for preparing the ISM model for GSCM pressure analysis (modified from [29, 31])

Table 4 Profile of the respondent auto components manufacturing industries

Industry	Total	Percentage
Engine parts manufacturer	05	31.25
Brakes manufacturer	04	25
Steering manufacturer	03	18.75
Radiator	04	25
Total	16	100
Size (employees)		
>1,500	02	12.5
1,001–1,500	04	25
751–1,000	03	18.75
501–750	03	18.75
200–500	04	25
<100	02	12.5
Total	16	100
Ownership		
Private	12	75
Foreign direct investment or joint venture	04	25
Total	16	100

employee size in four industries and less than 200 employees in the last two industries. According to ownership, majority ownership is in private industry (12) four industries belongs to Foreign Direct Investment or Joint Venture ownership.

7 Application of model to the case illustration

7.1 Data collection

The ISM technique suggests the utilization of the expert opinions based on various management techniques like brain storming, nominal technique, etc., in developing a contextual relationship among variables [17, 31]. Thus, in this research for identifying the contextual relationship among the pressures, two experts, one from the 16 auto components industries of Tamilnadu automobile sector and one from the academia, were consulted. For analyzing the pressures, a contextual relationship of "influential to" type is selected based on our questionnaire. This means that one variable leads to another. Based on this, a contextual relationship between variables is developed.

7.2 Structural self-interaction matrix

Keeping in mind the contextual relationship for each variable, the existence of a relationship between any two pressures (i and j) and the associated direction of the relationship is questioned. Generally, four symbols are recommended to experts to give their direction of relationship between the pressures (i and j). The symbols are given in below:

V Pressures i will help achieve pressure j
A Pressures j will help achieve pressure i
X Pressures i and j will help achieve each other
O Pressures i and j are unrelated

The SSIM for pressures in GSCM implementation is given in Table 5.

We received more than four individual responses in each industry. As per the ISM methodology rule, it is not possible to take average responses. We made one group from seven industrial experts from auto component industries with two academicians for the purpose of finalizing the one response. After 2 h they gave final SSIM matrix. Table 5 is the illustrated final SSIM matrix.

7.3 Initial reachability matrix

In this step, the reachability matrix is developed from SSIM. The SSIM format is initially converted into an initial reachability matrix format by transforming the information of each cell of SSIM into binary digits (i.e., ones or zeros) in the initial reachability matrix [17]. This transformation is done with the following rules:

- If the entry in the cell (i, j) in the SSIM is V, then the cell (i, j) the entry becomes 1 and the cell (j, i) entry becomes 0 in the initial reachability matrix.
- If the entry in the cell (i, j) in the SSIM is A, then the cell (i, j) entry becomes 0 and the cell (j, i) entry becomes 1 in the initial reachability matrix.
- If the entry in the cell (i, j) in the SSIM is X, then the entries in both the cells (i, j) and (j, i) become 1 in the initial reachability matrix.
- If the entry in the cell (i, j) in the SSIM is O, then the entries in both the cells (i, j) and (j, i) become 0 in the initial reachability matrix. Following these rules, the initial reachability matrix of pressure analysis was given in the Table 6.

The final reachability matrix is given in Table 7. It is obtained by incorporating the transitivities as enumerated in step 4 of the ISM methodology. The final reachability matrix will then consist of some entries from the pair-wise comparisons and some inferred entries.

7.4 Level partitions

The reachability and antecedent set [62] for each pressure is obtained from the final reachability matrix. The reachability set for a particular variable consists of the variable itself and other variables, which it helps achieve. The antecedent set consists of the variable itself and the other variables, which help in achieving them. Subsequently, the intersection of these sets is derived for all variables. The variable for which reachability and the intersection sets are the same is given the top-level variable in the ISM hierarchy, which would not help achieve any other variable above their own level. After identification of the top-level element, it is discarded from the other remaining variables. In this study, the 25 pressures, along with their reachability set, antecedent set, intersection set, and levels, are presented in Table 8. Level identification process of these pressures is completed in five iterations. This iteration is continued till the levels of each variable are obtained. The identified levels aid in building the digraph and the final ISM.

7.5 Formation of ISM-based model

From the final reachability matrix, a structural model is generated and is given in Fig. 2. The relationship between the pressure j and i is shown by an arrow pointing from i to j. The resulting graph is called a digraph. Removing the transitivities as described in the ISM methodology, the digraph is finally converted into the ISM model.

Table 5 SSIM matrix

Pressures	P25	P24	P23	P22	P21	P20	P19	P18	P17	P16	P15	P14	P13	P12	P11	P10	P9	P8	P7	P6	P5	P4	P3	P2
P1	A	V	A	V	V	V	V	V	V	A	V	V	V	V	V	V	V	V	V	V	V	V	O	A
P2	V	A	V	V	X	V	V	V	A	V	A	V	V	A	O	V	V	V	A	V	V	O	O	
P3	V	O	V	V	V	V	V	O	V	A	A	V	A	O	V	O	O	V	V	V	A	V		
P4	V	V	O	V	O	V	A	V	O	A	V	V	O	V	V	V	A	O	V	A	V			
P5	V	O	A	O	A	V	V	A	V	A	V	V	A	A	V	A	O	A	V	O				
P6	V	V	V	O	V	O	O	O	V	A	O	V	O	O	V	O	O	O	A					
P7	X	V	A	V	V	V	O	V	V	O	V	V	A	O	A	A	O	V						
P8	O	V	V	V	V	V	X	V	A	A	O	V	A	A	X	V	V							
P9	O	A	O	A	V	V	O	A	A	A	O	V	V	A	A	A								
P10	V	V	A	O	V	X	O	V	V	O	V	V	O	A	V									
P11	V	A	A	A	O	V	V	V	A	O	A	V	V	A										
P12	X	A	V	A	V	A	O	O	A	V	O	V	O											
P13	V	V	V	A	O	A	V	A	O	A	X	V												
P14	A	A	V	A	O	A	O	A	V	O	V													
P15	V	A	V	A	O	O	O	V	V	O														
P16	V	A	V	A	O	A	O	O	A															
P17	V	O	A	A	O	O	A	O																
P18	V	X	V	A	O	O	V																	
P19	V	V	A	O	O	O																		
P20	A	V	O	O	O																			
P21	A	V	V	O																				
P22	O	V	V																					
P23	A	A																						
P24	V																							

Table 6 Initial reachability matrix

Pressures	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
P1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P2	1	1	1	1	1	1	0	1	1	1	1	0	1	1	0	1	0	1	1	1	1	1	1	1	1
P3	0	0	1	1	0	1	0	1	0	0	1	0	0	0	1	0	1	1	1	1	1	1	1	1	1
P4	0	0	0	1	1	1	1	0	0	1	1	1	0	0	1	1	0	0	0	1	0	1	1	1	0
P5	0	0	1	0	1	0	1	0	0	0	1	0	0	1	1	0	1	0	0	1	0	0	0	0	1
P6	0	0	0	0	0	1	0	0	1	0	0	1	1	1	0	1	1	0	0	0	1	0	0	1	1
P7	0	0	1	0	0	1	1	1	0	1	1	0	0	1	1	0	1	0	0	1	1	1	1	1	0
P8	0	0	0	1	1	0	0	1	0	0	1	0	0	1	0	0	1	1	0	1	1	1	1	1	0
P9	0	0	0	1	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0
P10	0	0	0	0	1	0	1	1	0	1	0	0	0	1	1	0	0	1	0	1	1	0	0	1	0
P11	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0	1	1	0	0	0	1	0
P12	0	1	0	0	1	0	0	1	1	0	1	1	1	1	0	0	0	0	0	1	1	0	1	1	1
P13	0	0	1	0	1	0	1	1	0	1	0	0	1	1	0	0	1	1	1	1	0	1	1	1	1
P14	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	1	1	0	1
P15	0	1	0	0	0	0	0	1	1	0	1	0	1	0	1	0	0	1	0	0	1	1	0	0	0
P16	0	0	0	0	1	0	0	1	1	0	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0
P17	0	0	0	1	0	0	0	0	1	0	1	1	1	0	0	1	1	1	0	0	0	1	0	0	0
P18	0	0	0	1	1	0	1	0	1	0	1	0	0	1	0	0	0	1	1	0	1	1	1	1	0
P19	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	1	1	0
P20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0
P21	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0
P22	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	1	1	1	0
P23	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0
P24	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	1	0	0	0	0	1	0	1	1	1
P25	0	0	0	1	0	0	1	0	1	1	1	0	0	0	0	1	0	0	1	0	1	0	1	0	1

Table 7 Final reachability matrix

Pressures	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
P1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P3	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P4	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P5	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P6	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P7	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P8	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P9	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P10	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
P11	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1
P12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P13	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P14	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P16	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P17	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P18	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P19	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P20	0	0	0	0	1	0	1	1	1	0	0	1	1	1	1	1	0	0	0	1	1	0	1	1	1
P21	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1
P22	0	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1
P23	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
P24	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P25	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table 8 Level partitions for pressures: iteration I–iteration V

Pressures	Reachability set	Antecedent set	Intersection set	Iteration no. and level
P5	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	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	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	I
P7	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	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	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	I
P8	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	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	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	I
P9	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	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	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	I
P14	2 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	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	2 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	I
P15	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	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	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	I
P16	2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	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	2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	I
P20	5 7 8 9 12 13 14 15 16 20 21 23 24 25	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	5 7 8 9 12 13 14 15 16 20 21 23 24 25	I
P21	3 5 6 7 8 9 10 11 12 13 14 15 16 17 19 20 21 23 24 25	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	3 5 6 7 8 9 10 11 12 13 14 15 16 17 19 20 21 23 24 25	I
P23	3 4 5 6 7 8 9 10 11 14 15 16 17 18 19 20 21 22 23 24 25	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	3 4 5 6 7 8 9 10 11 14 15 16 17 18 19 20 21 22 23 24 25	I
P24	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	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	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	I
P25	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	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	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	I
P4	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 22 23 24 25	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 22 23 24 25	II
P10	2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18 19 20 21 22 23 24 25	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 21 22 23 24 25	2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18 19 21 22 23 24 25	II
P11	4 5 7 8 9 10 11 12 13 14 15 16 18 19 20 21 23 24 25	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 21 22 23 24 25	4 5 7 8 9 10 11 12 13 14 15 16 18 19 21 23 24 25	II
P13	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 24 25	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 24 25	II
P19	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 21 22 23 24 25	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 21 22 23 24 25	II
P12	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	1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 18 19 20 21 22 24 25	1 2 3 4 5 6 7 8 9 11 12 13 14 15 16 17 18 19 20 21 22 24 25	III
P22	2 4 5 7 8 9 10 11 12 13 14 15 16 19 20 21 22 23 24 25	1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19 22 23 24 25	2 4 5 7 8 9 10 12 13 14 15 16 19 22 23 24 25	III
P3	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	1 2 3 4 5 6 7 8 9 10 12 13 15 16 17 18 19 21 23 24 25	2 3 4 5 6 7 8 9 10 12 13 15 16 17 18 19 21 23 24 25	IV
P6	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	1 2 3 4 5 6 7 8 9 10 12 13 14 15 17 18 19 21 23 24 25	2 3 4 5 6 7 8 9 10 12 13 14 15 17 18 19 21 23 24 25	IV
P17	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19 21 23 24 25	2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19 21 23 24 25	IV
P18	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 23 24 25	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 23 24 25	IV
P1	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	1 2 12 15	1 2 12 15	V
P2	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	1 2 3 4 5 6 7 10 12 14 15 16 17 19 22 24	1 2 3 4 5 6 7 10 12 14 15 16 17 19 22 24	V

7.6 MICMAC analysis

Matriced'Impacts croises-multipication applique´ and classment (cross-impact matrix multiplication applied to classification) is abbreviated as MICMAC. The MICMAC principle is based on multiplication properties of matrices [53]. In this study, MICMAC analysis is used to identify influential pressures for GSCM adoption based on their driving power and dependence power. Based on their drive power and dependence power, pressures, in

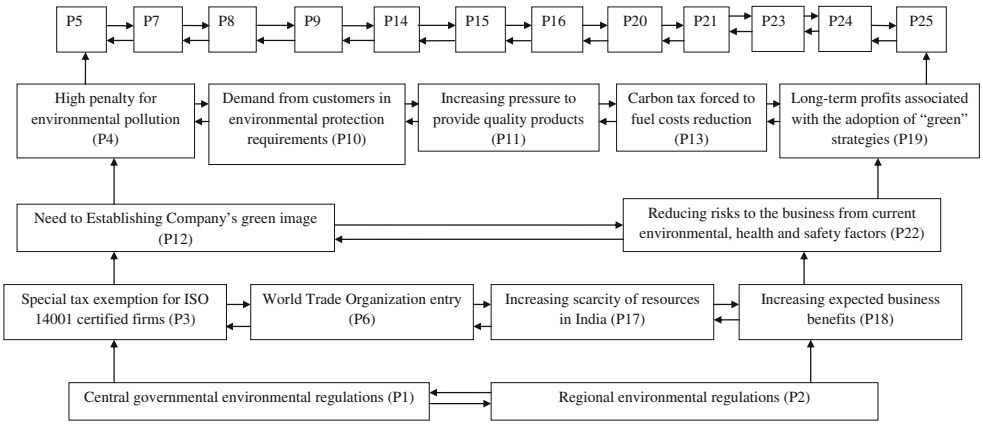

Fig. 2 ISM formation model

the present case, have been classified into four categories as follows:

1. Autonomous pressures: these pressures have weak driving power and weak dependence. They are relatively disconnected from the system, with which they have few links, which may be very strong. These pressures are represented in Quadrant-I.
2. Dependent pressures: this category includes those pressures which have weak drive power but strong dependence power and are placed in Quadrant-II.
3. Linkage pressures: these pressures have strong driving power as well as strong dependence and are placed in Quadrant-III. They are also unstable and so any action on them will have an effect on others and also provide a feedback effect on themselves.
4. Independent pressures: these pressures have strong driving power but weak dependence power. These are represented in Quadrant-IV.

It is observed that a variable with a very strong driving power, called key pressure, falls into the category of independent/linkage criteria. The driver power and dependence power of each of these pressures is shown in Table 9. Final full ISM framework model for pressure analysis was given in Fig. 2.

8 Results and discussions

Barari et al. [7] expressed that industries face more pressure as regard of environment degradation and have activated environmentally sound choices into supply chain management research and practices. Indian industrial environments have experienced drastic change and face competitive challenges in adoption of environmental concepts [12, 34, 41, 42]. Improvement of environmental performance of industries is a challenging process for managers based on the reasons of regulatory and contractual compliance, to public perception and competitive advantage [28, 58]. From literature, it is observed that many researchers have studied GSCM, which is a fashionable emerging corporate environmental management topic that arose in the past decade. All research has covered drivers, performance, and barriers but there is less research on pressures for GSCM. Pressures for the adoption of GSCM collected from literature have been put in to the ISM to determine the relationship between them. Based on the Table 7 values, driver-dependence power diagram obtained from MICMAC analysis gives a valuable insight into the relative importance and interdependencies between them. We get a clear visual interpretation of this research from Fig. 3. The results of this study are summarized in four categories:

- Autonomous pressures (Quadrant-I): Generally, autonomous pressures variable has weak driving and weak dependent power. This quadrant also does not have much influence on the GSCM adoption system. As per this paper's results, there are no autonomous pressures. It infers that all the collected pressure variables are acting as an excellent role to give notable pressure for GSCM adoption.
- Dependent pressure (Quadrant-II): In this quadrant pressure variable have very weak driving and strong dependent power on one another. Similar to autonomous pressure (Quadrant-I), there is no pressure variable in this quadrant. It is also inferred that all the pressure factors act a notable role.
- Regarding linkage pressure region (Quadrant-III): All pressure factors appeared except central governmental environmental regulations (P1). As a mentioned above in Section 6.6, this linkage pressures has strong driving and strong dependence power. According to Table 1, of 25 pressures, 24 pressures appeared; and are classified under seven categorizes namely Government Policies and Regulations, Global Competitiveness, Customer, External Factors, Financial Factors, and Production and Operational Factors. As per order of category, three

Table 9 Dependence and driving diagram

Pressures	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	Driving power
P1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
P2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
P3	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
P4	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
P5	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
P6	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
P7	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
P8	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
P9	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
P10	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	23
P11	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	19
P12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
P13	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
P14	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
P15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25
P16	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
P17	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
P18	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
P19	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
P20	0	0	0	0	1	0	1	1	1	0	0	1	1	1	1	1	0	0	0	1	1	0	1	1	1	14
P21	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	20
P22	0	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	20
P23	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	21
P24	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24
P25	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23
Dependence power	4	16	21	23	25	21	25	25	24	24	23	24	23	24	25	25	25	22	22	24	25	25	22	25	25	

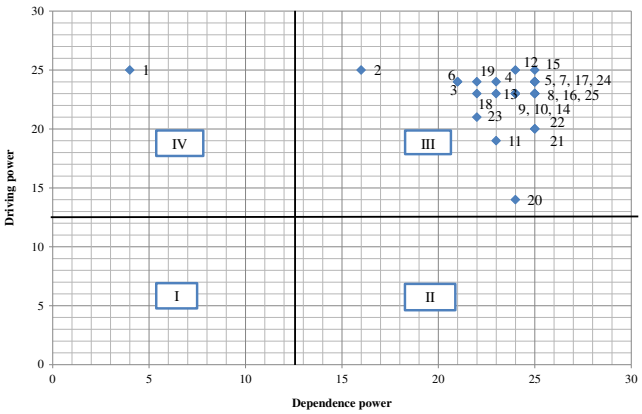

Fig. 3 Driving power and dependence power diagram

pressures appeared in this category including regional environmental regulations (P2), Special tax exemption for ISO 14001 certified firms (P3), and High penalty for environmental pollution (P4). This regulation pressures show a strong driving power compared to dependence power. Because without strict regulations industries will not adopt and maintain environmental concerns. That is why these pressures have more driving powers. Under Global Competitiveness category pressures are in this quadrant include competitors' green environmental protection strategy (P5), World Trade Organization entry (P6), lower market for current product (P7), pressures in the process of selling the products (P8), and foreign direct investment (FDI) interest in green products (P9). It is also understood that competitiveness of global market and shares of industrial products exerts the motivations towards GSCM adoption. This shows that Indian automotive industries has more competition in the global market for environmental friendly products. Demand from customers on environmental protection requirements (P10) and increasing pressure to provide quality products (P11) pressures are having excellent driving powers over dependence power. These two pressures appeared under customer's categories. Generally, industries are initially motivated by customers compared to other category motivations (regulations, global competition, etc.). Similarly, other 14 pressures under three categories (External Factors, Financial Factors, and Production and Operational Factors) appeared in the linkage pressure region. This also shows that, automotive industries in India are facing more pressure from all directions and not a particular category.

- According to independent pressure (Quadrant-IV), only one pressure appeared, i.e., central governmental environmental regulations (P1). This region pressures get more driving power and less dependent power. As a result of the driving and dependence diagram (Fig. 3) inferred that central governmental environmental regulations are influential in to motivating the GSCM adoption in Indian automotive industries among the 25 pressure variables. Mudgal et al. [42] and Diabat and Govindan [12] also inferred from their studies that environmental regulations are wonderful motivators for industries to ensure pollution-free environment in India.

9 Conclusions

Generally, modification/changes in supply chain regarding environmental concern is needed to find innovative items to minimize carbon emissions across the entire TSCM and are needed to implement environmental procurement to minimize carbon footprint. It will provide tremendous benefits like an increase in the market share and a reduction in green house emissions [1]. In India, automotive industries play a major role economically and environmentally. Presently, Indian automotive industries get global customers and have made a notable position globally. Due to this, Indian industries should necessarily adopt environmental concepts to improve TSCM performance. Analyzing pressure for GSCM adoption is a challenge for industrial managers. Twenty-five pressures are collected, based on the earlier articles from multiple media. Out of 25 pressures, we identified influential pressure during GSCM adoption with help of ISM in Indian automotive industries. Based on the experts opinions, SSIM matrix was formed and identified relationship between them. Then, 25 pressures were iterated in five levels. Based on the five iterations, ISM formation model was summarized in Fig. 2. In the top of the ISM model there were 12 pressures like P5, P7, P8, P9, P14, P15, P16, P20, P21, P23, P24, and P25, which play a less influential role compared to other 13 pressures. These pressures exert less motivations regarding GSCM adoption in Indian automotive industries. It is inferred that Indian industries feel that 12 pressure variables exert less and so there is no need to concentrate on them. In the second iteration level, there were five pressures; High penalty for environmental pollution (P4), demand from customers in environmental protection requirements (P10), increasing pressure to provide quality products (P11), carbon tax forced fuel cost reduction (P13), and long-term profits associated with the adoption of "green" strategies (P19). Compared to previous level pressures, these five pressures provide some motivation/pressure for GSCM adoption in Indian automotive industries. Next level (III) reducing risks to the business from current environmental, health, and safety factors (P22) and need to establish company's green image (P12) pressures exert notable pressure. Safety of human health and green image of industries are important factors to sell their products and ensure a good relationship with customers. This helps to improve both economic and environmental performance. Zhu et al. [72] and

Hsu and Hu [27] mention that green image is essential to get more customers in the competition for a global market. In fourth (IV) level, Special tax exemption for ISO 14001 certified firms (P3), World Trade Organization entry (P6), increasing scarcity of resources in India (P17), and increasing expected business benefits (P18) pressures appear. These five pressures provide more motivation compared to the abovementioned three levels. It infers that these pressures belong to external pressure not inside of the industry. It reveals that industries face pressures from outside, example: increasing scarcity of resources in India (P17) pressure is common factor given more pressure to reduce consumption of resources. P17 pressure comes from the regulation category and special tax exceptions are good motivations for industries to adopt the environmental concept because industries always give first priority to economic developments. At final level (V) there are two pressures; central governmental environmental regulations (P1) and regional environmental regulations (P2). These two pressures come under government policy and regulation. It shows that government regulation acts as a category and gives pressures to GSCM adoption. Generally, strict regulations are essential for a country to ensure a pollution-free environment, currently in India there is a tremendous industrial growth but many industries are not interested in maintaining and adopting the environmental policies. Due to these reasons strict environmental regulation is a must to ensure a pollution-free country. Many authors infer that government regulations are an important factor compared to other factors and it is the only way to force industries to move towards improved environmental performance. Zhu and Sarkis [70] and Diabat and Govindann [12] also inferred from their studies that industrialists feel regulations exert more motivation compared to other pressure variables. This analysis of the pressure study helps industries to identify which pressure factors are the key towards GSCM adoption. Also this study infers that other than the regulation category all other categories give less pressure.

10 Limitations of study and future scope

In this study, we conducted case study only in automotive industries. Future scope of this study can widen to identification of essential pressures in industries of different sectors for implementation of GSCM from the Indian perspective through multi-criteria decision-making techniques (ANP, VIKOR, and AHP). Also this study used only 25 pressure factors. Many pressures were not considered. Further analyzing more pressures will give tremendous results. This study does not validate our results. In future we can validate the ISM model structure, with structural equation modeling.

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