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RECYCL-3446; No. of Pages 22
ARTICLE IN PRESS
Resources, Conservation and Recycling xxx (2017) xxx–xxx
Contents lists available at ScienceDirect
Resources, Conservation and Recycling
journal homepage: www.elsevier.com/locate/resconrec

Full length article

Sustainable supply chain management practices in Indian automotive industry: A multi-stakeholder view

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ARTICLE INFO

Article history:
Received 28 June 2016
Received in revised form 5 January 2017
Accepted 5 January 2017
Available online xxx

Keywords:
Sustainable supply chain management
Automotive industries
Emerging economies
Sustainable supply chain management practices
Inter influences

ABSTRACT

As one of the largest manufacturing sectors, the automotive industry has a deep impact on the society and environment. Automotive products provide mobility to millions and create jobs, but also threaten the environment. Consumer pressure, government regulations, and stakeholder demands for a competitive edge have forced the automotive industry to consider their environmental and social impacts in addition to their economic status. These pressures have led many automotive industry businesses to adopt Sustainable Supply Chain Management (SSCM) practices. Specific practices that are adopted into the traditional supply chain and that help an industry shift towards a sustainable supply chain are called SSCM practices. Firms have difficulty identifying the most useful practices and learning how these practices impact each other. Unfortunately, no existing research has studied the interrelated influences among these practices in the automotive industry, nor from an Indian perspective. The current study aims to give a better understanding of the interrelated influences among SSCM practices with a particular look at the automotive industry. Our research presents views from multiple stakeholders, including managerial, environmental, societal, and governmental associations. We propose a framework model, using the Decision Making Trial and Evaluation Laboratory method, to evaluate automotive industry SSCM practices specifically situated in the emerging economy of India. Through a questionnaire survey with the above-mentioned stakeholders, we find interinfluences and the prominence of the identified practices. A prominence causal relationship diagram is obtained depicting the cause groups and the effect groups of the practices. The differences and similarities between individual perspectives and combined stakeholder perspectives are identified. The results reveal that management commitment towards sustainability and incorporating the triple bottom line approach in strategic decision making are the most influential practices for implementing the sustainable supply chain management. This study provides a foundation for industrial managers to understand the inter influences among the practices and increases the probability of successful implementation of SSCM practices within the automotive industry.

1. Introduction

The automotive industry plays a key role in the day to day activity of human life, not only by providing mobility but also by the enormous impact of the industry on economic, environmental, and social activities throughout the globe (Xia et al., 2015). As arguably the largest manufacturing sector worldwide, the industry faces high profile environmental challenges; they are held responsible for deteriorating air quality, contributing to global warming, and for ineffectively handling end of life automobiles (Orsato and Wells, 2007). These environmental challenges and governmental globalization policies have forced many automotive firms to shift towards using specific practices to help incorporate sustainability (Govindan et al., 2015a; Zhu et al., 2007). These practices, termed SSCM practices (Jayaraman et al., 2007; Linton et al., 2007; Carter and Rogers, 2008), help to reverse the well-known adverse effects of the industry, and the use of environmentally-friendly and socially beneficial practices may help to improve the profitability of the business. According to a report by the World Commission on Environment and Development (WCED) by Brundtland (1987), sustainability is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Sustainability creates balance between the economic, social, and environmental aims of organizations (Székely and Knirsch, 2005). Evidence indicates that to achieve sustainable performance, some practices in the traditional sup-

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http://dx.doi.org/10.1016/j.resconrec.2017.01.003
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ply chain must be incorporated (Govindan et al., 2016d; Gimenez and Tachizawa, 2012; Taticchi et al., 2013). Thus, the benefits of SSCM practices are well understood, but the challenges associated with their implementation and understandings are not as clearly identified especially in developing nations such as India (Epstein, 2008).

Since inception, the automotive industry has been a major contributor to the Indian economy. The AMP 2026 report by Auto Tech Review (Automotive Mission Plan 2016–2026 – A Curtain Raiser, 2015) estimated that automotive sectors will contribute more than 12% of the overall GDP of the country. Automotive industries also face environmental and societal pressures from customers, employees, and partners due to globalization (Zhu et al., 2007). In the present scenario, Indian automotive industries are at peak pressure to shift towards SSCM, due to continuous globalization pressures, rules and regulations framed by the government, and from daily increases in societal awareness and standards. Hence, Indian industries now consider the social and environmental issues more vital than ever (Kannan et al., 2016), and they face difficulty in identifying the prominent SSCM practices for improving their sustainable performance (Thanki et al., 2016). The increasing need for firms to adopt sustainability practices in order to achieve competitive advantages and, at the same time, not to compromise aspects of sustainability is the need of the hour (Smith and Ball, 2012). Indian automotive industries are also experiencing challenges in terms of global competition; well-known global giants seek to claim some of the local market. Indian industries understand that following the concepts of sustainability will not only help them to thrive in this healthy competition, but also may provide a competitive edge (Bouzon et al., 2016). Although the implementation of practices has been studied from different perspectives, no work has been done to find the prominent practices and the inter influences among the practices in a leading sector such as the automotive industry in an emerging economy like India. Once the prominent practices and their mutual influences with the other common practices are identified, the shift to SSCM is made easier and much effective. By Pareto 80/20 principle, it is believed that roughly 80% of the effects are only based on 20% of causes. Concentrating on the prominent practices first will automatically increase the chances for successful adoption of SSCM (Diabat and Govindan 2011). By identifying the inter influences between the practices one can develop a suitable mapping for thorough implementation of all the practices. Of late the multi-stake holder strategy has gained much importance in the field of sustainability since the strategy is cohesion of resources, market-based perspectives and ethical values, which in concurrence with the SSCM strategy. Hence, there is a need to investigate SSCM practices in these industries from a multi stakeholder perspective. For any firm, the three main stakeholders are (1) the government who pose the standards, rules and regulations, (2) the society on whose demand the goods are produced and who comprise the end consumers of the products, and (3) the internal stakeholders and managers who decide what is done within the organization. The views of all three categories of stakeholders are considered in the current study. Although their views may differ, the main motto of sustainability is a common function among them for assessing the real situation. Hence, the prominent practices based on their views are to be found for better understanding and easier implementation of SSCM.

The research questions we pursue include what are the SSCM practices that can be identified and incorporated in automotive firms to achieve sustainable performance?, what are the categories to which they belong?, and what are the inter influences and prominence among these practices? Identifying and categorizing these practices to build a framework model is just like building a theory towards sustainable supply chain management; proper evaluation of the model is necessary (Wacker, 2004). This work intends, first, to identify the various SSCM practices followed in automotive sectors by review of previous literatures from peer reviewed articles. We analyze practices from multiple stakeholder perspectives. Next we apply DEMATEL, a Multi Criteria Decision Making (MCDM) tool to evaluate the inter influences and prominences between the identified practices, and we include responses from governmental, management, and socially conscious staff. Fig. 1 shows the proposed framework for analyzing the SSCM practices in an Indian automotive industry.

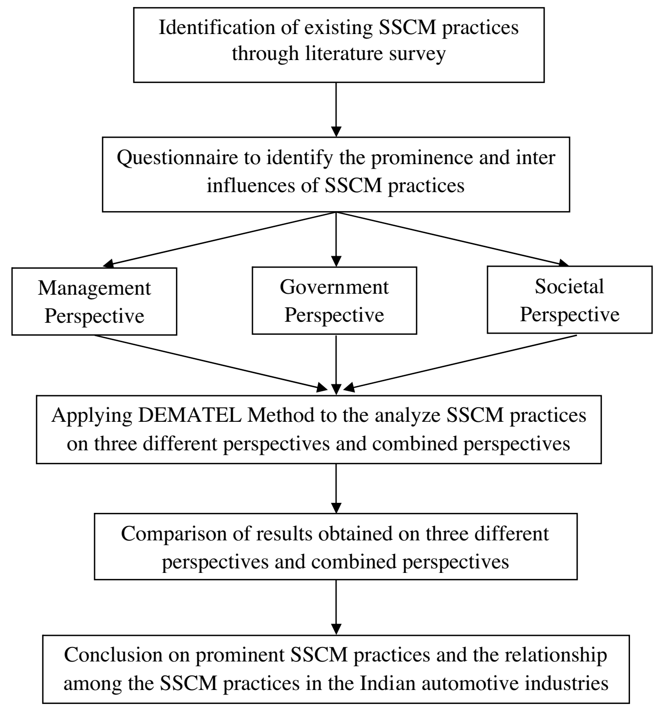

Fig. 1. Proposed research framework for identifying the prominent SSCM practices in Indian automotive industries.

The remaining paper is structured as follows. Section 2 summarizes the literature study. It also establishes the research gap addressed in the current study, followed by the problem description. An application of the proposed DEMATEL-based framework is described in Section 3, and we discuss the results obtained from multiple stakeholder perspectives in Section 4. Our conclusions and the managerial implications, along with limitations of the present study and future scope, are presented in Section 5 and Section 6 respectively.

2. Literature review

This literature review section is divided into three subsections. In the first sub section, we provide a brief understanding of what a SSCM is by trying to point out some of its various widely accepted definitions from previous publications. This will provide a brief introduction to what SSCM is and how it is understood by the academicians and the industrialists over the years. The next subsection gives an outline of the various investigations published in reference to the SSCM practices in accordance with automotive industries. This provides the base for identifying the research gap for the current study which is explained in the third sub section.

2.1. Sustainable supply chain management (SSCM)

SSCM is an area of research which has seen remarkable growth over the last few years, evidenced by a dramatic increase in the number of publications in this field (Seuring and Müller, 2008).

More than 300 research articles were published in the last 15 years or so on the topics of green and sustainable supply chain management (Seuring, 2013). Initial efforts focused on improving economic aspects of the supply chain, followed by introducing green/environmental practices into the supply chains, and resulting in an evolution of green supply chain management (Sarkis, 2003; Govindan et al., 2015c). According to Srivastava (2007), green supply chain management is “integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final products to the consumers, and end-of-life management of the product after its useful life.” Thus, green supply chains mainly focus on greening the supply chain and the associated benefits of doing so (Zhu and Sarkis, 2004). The concept of globalization and the evolution of corporate social responsibilities fueled the inclusion of social aspects into the more typical environmental concerns of supply chains (Govindan et al., 2014b). When supply chain management equally incorporates the three pillars of sustainability – economy, environment, and society – the term Sustainable Supply Chain Management (SSCM) is used (Elkington, 1998). Further, Seuring and Müller (2008) define SSCM as “the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, into account which are derived from customer and stakeholder requirements.”Various other definitions are found for SSCM in the previous literature and we highlight a few below. Lerberg Jorgensen and Steen Knudsen (2006) defined SSCM as a “means by which companies manage their social responsibilities across dislocated production processes spanning organizational and geographical boundaries.” Carter and Rogers (2008) defined SSCM based on the triple bottom line approach, risk management, transparency, strategy, and culture as “the strategic, transparent integration and achievement of an organization’s social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains.”Broadly, SSCM is one that adds sustainability to the existing SCM processes; it is a balanced and integrated consideration of the social, environmental, and economic impacts of business (Font et al., 2008). Teuteberg and Wittstruck (2010) gave a pictorial representation of “House of Sustainable Supply Chain Management” that depicts the three dimensions of sustainability as the pillars of SSCM which keep the house in balance. Wittstruck and Teuteberg (2012) stated that SSCM is nothing but the inclusion of environmental and social aspects into one’s traditional supply chain management. The conversion of a traditional economy-based supply chain management into SSCM involves the adoption of certain practices (Linton et al., 2007). Many definitions and explanations for SSCM co-exist in previous literature; the primary concurrences in SSCM research are the SSCM practices.

2.2. SSCM practices

How does one transform an existing supply chain into a sustainable one? How do firms attain a competitive edge over their competitors without compromising the environmental and societal aspects? How do firms achieve a high degree of social and environmental performance? What is the best way for a firm to deal with potentially catastrophic changes in market trends introduced by foreign investors? Automotive industries in India face all these questions due to modernization, globalization, and increased environmental awareness (Govindan et al., 2016a; Zailani et al., 2017). The answer to all these questions is the recommendation to adopt SSCM practices. SSCM practices, according to Markman and Krause (2016), are “a function of two inseparable principles: (1) they must enhance ecological health, follow ethical standards to further social justice, and improve economic vitality; and (2) they must prioritize the environment first, society second, and economics third.”

Over the last few years there is a steady growth in the number of research studies carried out in the area of SSCM (Beske and Seuring, 2014). Carter and Rogers (2008) proposed a framework summarizing SSCM practices and the pre-requisites for implementing those practices through case studies. Walker and Preuss (2008) identified different barriers to the practice of sustainability. Researchers investigated the affordability of SSCM practices and found that a firm’s lack of proper managerial time is a bigger factor than the lack of financial resources. Svensson (2007) classified supply chains as first, second, and n^{th}-order supply chains based on the practices implemented. Pagell and Wu (2009) constructed a case study model categorizing SSCM practices to discover the uniqueness of companies following SSCM practices in achieving competitive advantage. Vachon and Klassen (2008) classified the upstream and downstream collaboration activities among the supply chain partners using SSCM practices. Gold et al. (2010) proposed that when striving for sustainability, a firm and its supply chain should both possess all the requisite internal resources to implement SSCM practices. Ageron et al. (2012) proposed a conceptual model for SSCM explaining the reasons, characteristics, and barriers for adoption of SSCM through SSCM practices. Beske (2012) constructed a framework integrating SSCM practices and dynamic capabilities by a critical analysis of literature. Morali and Searcy (2013) focused on SSCM practices followed in Canadian industries and addressed the challenges faced during its implementation for achieving sustainability. Zailani et al. (2012) investigated the positive outcomes achieved by implementing SSCM practices on a firm’s economic and social performance through a factor analysis based on survey data obtained from over 400 manufacturing firms in Malaysia. Glover et al. (2014) examined the extent of SSCM practices implemented in the food industry based on Institutional Theory. Pressures that force the firms to adopt sustainable practices in their business strategies were also investigated. Govindan et al. (2014a) analyzed the impact of SSCM practices using a three-dimensional deductive research based approach; they considered the three dimensions of sustainability through lean, resilient, and green supply chain management paradigms. Beske et al. (2014) critically analyzed SSCM practices associated with the food industry and summarized how the practices allow companies to gain control over their supply chain and to achieve a competitive advantage. Jia et al. (2015a) analyzed and identified dominant SSCM practices in the mining and mineral industries using Interpretive Structural Modelling (ISM). Wu et al. (2016) proposed a comprehensive and quantitative method to understand the concept of SSCM and to assess its performance. Dubey et al. (2016) highlighted alternative methods research for SSCM by providing a conceptual framework that explores SSCM drivers and their relationships. Esfahbodi et al. (2016a) address the trade-offs between environmental and cost performance in SSCM especially in emerging economies. Ahmad et al. (2016a) reviewed corporate sustainability reporting practices in accordance to SSCM in the oil and gas industry. Ahmad et al. (2016b) focused on the challenges in relation to the SSCM practices in industries. Esfahbodi et al. (2016b) summarized the role of governance in the adoption of SSCM practices and investigated the performance gains of an organization with regard to both environment and economy. Hussain et al. (2016) provided a comprehensive framework on sustainability measurement with a practical approach for measuring and implementing SSCM practices in Arab countries.

It is thus clear that many researchers have focused on the need for implementation of SSCM in firms, the benefits of adopting SSCM practices, and the impact of those practices on a firm’s performance (Jia et al., 2015c; Luthra et al., 2017). Firms generally realize the importance of shifting from traditional supply chains to SSCM

Table 1
List of Sustainable Supply Chain Management practices in automotive industries.

Sl.No.	Practices	Explanation	Sources
		Management category	
1	Triple bottom-line approach (P1)	Equal importance to all three dimensions of sustainability in strategic decision making	Beske et al. (2014); Beske and Seuring (2014); Dyllick and Hockerts (2002); Zubir et al. (2012); Gimenez and Tachizawa (2012); Koplin et al. (2007); Linton et al. (2007); Matos and Hall (2007); Nikolaou et al. (2013); Pagell and Wu (2009); Seuring and Müller (2008); Zailani et al. (2012)
2	Supply Chain orientation (P2)	Considering the sustainability aspects in whole supply chain for decision making	Beske and Seuring (2014); Beske et al. (2014); Carter and Liane Easton (2011), Pagell and Wu (2009); Sarkis (2001); Seuring and Müller (2008)
3	Reverse logistics, using Product recovery techniques (P3)	reuse, recycle and remanufacturing	Brandenburg et al. (2014); Carter and Rogers (2008); Guide (2000); Inderfurth et al. (2001); Lin (2013); Nagalingam et al. (2013)
4	Management commitment (P4)	Commitment to SSCM from top and middle level managers	Jia et al. (2015a); Rostamzadeh et al. (2015); Shaharudin et al. (2015)
		Supplier category	
5	Environmental purchasing (P5)	Purchasing greener raw materials	Carter et al. (2000); Miemczyk et al. (2012); Walton and Handfield (1998); Zhu et al. (2013)
6	Standards and Certifications (P6)	Adhering to environmental and social standards of the society	Beske and Seuring (2014); Diabat et al. (2014); Giunipero et al. (2012); Jia et al. (2015a); Handfield et al. (2005); Walton et al. (1998)
7	Auditing suppliers (P7)	ensuring that sustainability standards are met in every order	Igarashi et al. (2013); Jia et al. (2015a,b,c); Handfield et al. (2005)
8	Green packaging (P8)	Minimum use of resources along with renewable raw materials used for packaging	Carter and Liane Easton (2011); El-Berishy et al. (2013); Faccio et al. (2014); Gupta and Kumar (2013); Jia et al. (2015a,b,c); Govindasamy (2010); Winkler (2011); Zailani et al. (2012)
		Collaboration category	
9	Long term relationships (P9)	Collaborative development of products and processes through long term relationships with the supply chain partners	Ashby et al. (2012); Beske and Seuring (2014); Beske et al. (2014); Gold et al. (2010); Miemczyk et al. (2012); Pagell and Wu (2009); Ziggers and Trienekens (1999)
10	Collaborating with suppliers (P10)	to produce environment friendly products	Attaran and Attaran (2007); Carter and Rogers (2008); Sacaluga and Froján (2014)
11	SC Partner Development (P11)	cooperation between suppliers and manufacturers in product development relationship	Bidault et al. (1998); Fossas-Olalla et al. (2010); Gold et al. (2010); Ziggers and Trienekens (1999)
12	Joint development (P12)	Improving sustainable performance through collaboration	Beske and Seuring (2014); Beske et al. (2014); Chen and Paulraj (2004); Burgess et al. (2006)
13	Logistical integration (P13)	direct involvement of a company with its suppliers and customers in planning and forecasting	Beske and Seuring (2014); Beske et al. (2014); Skjoett-Larsen et al. (2003); Vachon and Klassen (2008)
14	Technological integration (P14)	Collaboration to enhance sustainability performance	Beske and Seuring (2014); Beske et al. (2014); Croom et al. (2000); Power (2005)
		Design category	
15	Design of products to reduce waste and costs (P15)	Cost effective design produced by minimum use of resources	Ashby et al. (2012); Zubir et al. (2012); Govindan et al. (2013); Hasan (2013); Li et al. (2014); Guang Shi et al. (2012); Xia et al. (2015)
16	Redesigning processes for emissions reduction (P16)	Minimization of emission of harmful gases and waste produced during production	Ji et al. (2014); Renukappa et al. (2013); Handfield et al. (2005); Sacaluga and Froján (2014); Walton and Handfield (1998)
17	Innovation (P17)	Use of technology for increasing efficiency by interpreting shared knowledge on buyer behaviors and social trends	Beske and Seuring (2014); Carter and Rogers (2008); Zubir et al. (2012); Matos and Hall (2007); Svensson (2007)
		Internal practices category	
18	Life Cycle Analysis/Assessment (P18)	technique to assess environmental impacts associated with all the stages of a product's life from cradle to grave	Beske and Seuring (2014); Beske et al. (2014); Brandenburg et al. (2014); Egilmez et al. (2014); Gold et al. (2010); Ji et al. (2014); Matos and Hall (2007); Singh et al. (2014); Srivastava (2007)
19	Effective use of by-products (P19)	Use of the secondary products efficiently	Bansal and McKnight (2009); Carter and Rogers (2008); Edgeman (2013), Fiksel (2003); Moors (2006); Pagell and Wu (2009); Zhang et al. (2013)
20	Enhanced Communication (P20)	More transparent communication brings visibility and effectiveness in SSCM	Beske and Seuring (2014); Matos and Hall (2007)
21	Use of cleaner process technology (P21)	process involved in production is made pollution and waste free	Dubey et al. (2016); Zubir et al. (2012); Sangwan and Mittal (2016); Seuring and Müller (2008)
		Society Category	
22	Cooperation with customers (P22)	for eco design and green packaging	Bidault et al. (1998); Fossas-Olalla et al. (2010)
23	Environmental awareness training (P23)	Train management, employee and the community about sustainable environmental practices.	Igarashi et al. (2013); Jia et al. (2015a); Lozano (2013); Wei et al. (2007)
24	Measurement and reward systems linked to sustainability (P24)	Encouraging employees by proving incentives	Koplin et al. (2007); Pagell and Wu (2009)
25	Worker safety and human rights (P25)	Implementing and following the safety aspects and laws of the governments regarding employment	Carter and Rogers (2008); Kleindorfer et al. (2005)

Table 2
Initial Direct Relation Matrix – Management perspective.(For interpretation of the references to colour in the Table legend, the reader is referred to the web version of this article.)

Practice	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	0	2	3	2	2	3	3	3	2	2	3	1	2	2	2	2	2	2	2	2	2	3	3	2	2
P2	2	0	2	1	2	3	3	2	3	3	3	3	2	2	2	2	2	2	2	2	2	3	2	2	3
P3	0	0	0	0	0	2	0	0	2	2	2	0	3	3	0	0	3	3	3	3	0	3	3	2	2
P4	3	3	3	0	3	3	2	2	3	3	3	3	3	3	3	3	0	0	0	2	3	2	3	3	3
P5	2	2	2	0	0	3	3	3	0	2	0	0	0	0	0	0	0	2	3	2	3	0	0	0	2
P6	3	2	2	3	3	0	3	3	2	2	2	0	0	2	3	3	2	3	3	2	3	3	3	3	3
P7	0	0	0	0	3	3	0	0	2	2	2	2	0	0	0	0	0	3	0	2	0	0	0	0	2
P8	2	0	0	0	2	2	0	0	0	0	0	0	0	2	2	2	0	2	0	0	3	0	0	0	3
P9	2	2	3	2	0	0	2	2	0	3	3	3	3	3	0	0	0	0	0	3	0	3	2	2	0
P10	0	0	2	0	0	0	2	2	2	0	2	2	2	2	0	0	0	0	0	2	0	3	0	0	0
P11	2	2	3	0	2	2	3	2	3	3	0	3	4	4	2	2	3	1	2	3	2	3	3	2	0
P12	0	0	0	2	0	2	2	0	2	2	2	0	2	2	0	0	2	0	0	2	0	0	0	0	0
P13	0	2	3	2	3	2	2	0	2	2	2	2	0	0	0	0	0	0	0	2	0	0	0	0	0
P14	0	0	2	0	0	0	0	0	2	2	2	2	2	0	2	2	3	3	3	3	2	3	0	2	2
P15	0	2	0	0	3	2	2	2	0	0	2	0	0	2	0	2	3	2	3	0	3	0	0	0	0
P16	0	2	0	0	2	2	2	2	0	0	0	2	0	2	2	0	2	2	2	0	3	2	3	3	3
P17	0	0	3	0	0	0	0	0	0	1	1	1	2	2	3	3	0	3	3	3	3	0	0	0	0
P18	2	1	3	0	3	2	3	2	0	0	0	0	0	0	3	3	3	0	3	0	3	0	3	0	0
P19	0	0	2	0	0	2	2	0	0	0	0	0	0	3	3	3	1	3	0	0	3	0	0	0	0
P20	0	3	2	0	0	2	3	2	3	3	3	3	3	3	2	2	3	0	0	0	0	3	3	3	3
P21	0	0	2	0	3	3	3	3	0	0	0	0	0	3	3	3	0	3	3	0	0	3	2	2	2
P22	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
P23	2	0	3	2	3	3	3	3	0	0	0	2	2	3	3	3	3	3	3	0	3	0	0	3	3
P24	0	0	2	0	2	2	0	0	0	2	0	2	2	2	3	3	3	3	3	0	3	3	2	0	3
P25	2	2	0	2	2	3	0	0	0	0	0	0	0	0	0	3	3	2	0	2	3	2	2	0	0

Table 3
Initial Direct Relation Matrix – Government perspective.(For interpretation of the references to colour in the Table legend, the reader is referred to the web version of this article.)

Practice	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	0	2	2	2	2	3	3	3	2	2	3	2	2	2	2	2	2	2	2	2	2	3	3	2	2
P2	2	0	2	1	2	3	3	2	3	3	3	3	2	2	2	2	2	2	2	2	2	3	2	2	3
P3	0	0	0	0	0	2	0	0	2	2	2	0	3	3	0	0	3	3	3	3	0	3	3	2	2
P4	3	3	3	0	3	3	2	2	3	3	3	2	3	3	3	3	0	0	0	2	3	2	3	3	3
P5	2	2	2	0	0	2	3	3	0	2	0	0	0	0	0	0	0	2	3	2	3	0	0	0	2
P6	3	3	2	3	3	0	3	3	2	3	3	0	0	3	3	3	2	3	3	2	3	3	3	3	3
P7	0	0	0	0	3	3	0	0	2	2	2	2	0	0	0	0	0	3	0	2	0	0	0	0	2
P8	2	0	0	0	2	2	0	0	0	0	0	0	0	2	2	2	0	2	0	0	3	0	0	0	3
P9	2	2	3	2	0	0	2	2	0	3	2	2	3	3	0	0	0	0	0	3	0	3	2	2	0
P10	0	0	2	0	0	0	2	2	2	0	2	2	2	2	0	0	0	0	0	2	0	3	0	0	0
P11	2	2	3	0	2	2	3	2	3	3	0	3	4	4	2	2	3	1	2	3	2	3	3	2	0
P12	0	0	0	2	0	2	2	0	2	2	2	0	2	2	0	0	2	0	0	2	0	0	0	0	0
P13	0	2	3	2	2	2	2	0	2	2	2	2	0	0	0	0	0	0	0	2	0	0	0	0	0
P14	0	0	2	0	0	0	0	0	2	2	2	2	2	0	2	2	3	3	3	3	2	3	0	2	2
P15	0	2	0	0	3	2	2	2	0	0	2	0	0	2	0	2	3	2	3	0	3	0	0	0	0
P16	0	2	0	0	2	3	3	3	2	0	2	2	0	3	3	0	2	2	2	0	3	3	3	3	3
P17	0	0	3	0	0	0	0	0	0	1	1	1	2	2	3	3	0	3	3	3	3	0	0	0	0
P18	2	1	3	0	3	2	3	2	0	0	0	0	0	0	3	2	3	0	3	0	3	0	3	0	0
P19	0	0	2	0	0	2	2	0	0	0	0	0	0	3	3	2	1	3	0	0	0	0	0	0	0
P20	0	3	2	0	0	2	3	2	3	3	3	3	3	3	3	3	3	0	0	0	0	3	3	3	3
P21	0	3	2	0	3	3	3	3	0	0	0	0	0	3	3	3	0	3	3	0	0	3	2	2	3
P22	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
P23	2	0	3	2	3	3	3	3	0	0	0	2	2	3	3	2	3	3	3	0	3	0	0	3	3
P24	2	3	2	3	2	2	0	0	0	2	0	2	2	2	3	3	3	3	3	0	3	3	2	0	3
P25	2	2	0	2	2	3	0	0	0	0	0	0	0	0	0	3	3	2	0	2	3	2	2	0	0

by adopting SSCM practices and they understand the advantages gained by doing so. Industries have initiated various activities for implementing SSCM (Dehghanian et al., 2011). In a country like India, the automotive sector is one of the biggest contributors to the nation's GDP and economy. The sector has begun to address the need for improving environmental and the social performances by orienting themselves towards SSCM practices. Because these practices are correlated with one another, it is important to inspect

Table 4
Initial Direct Relation Matrix – Societal perspective.(For interpretation of the references to colour in the Table legend, the reader is referred to the web version of this article.)

Practice	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	0	2	2	2	2	3	2	3	2	2	2	1	2	2	2	2	2	2	2	2	2	3	2	2	2
P2	2	0	2	1	2	2	2	2	3	2	3	3	2	2	2	2	2	2	2	2	2	2	2	2	3
P3	0	0	0	0	0	2	0	0	2	2	2	0	3	3	0	0	3	3	3	3	0	3	3	2	2
P4	3	2	2	0	3	2	2	2	2	2	2	2	2	2	2	2	0	0	0	2	2	2	2	2	2
P5	2	2	2	0	0	3	3	3	0	2	0	0	0	0	0	0	0	2	3	2	3	0	0	0	2
P6	3	2	2	3	3	0	3	2	2	2	2	0	0	2	3	3	2	3	3	2	3	3	3	3	3
P7	0	0	0	0	3	3	0	0	2	2	2	2	0	0	0	0	0	3	0	2	0	0	0	0	2
P8	2	0	0	0	2	2	0	0	0	0	0	0	0	2	2	2	0	2	0	0	3	0	0	0	3
P9	2	2	3	2	0	0	2	2	0	3	3	3	3	3	0	0	0	0	0	3	0	3	2	2	0
P10	0	0	2	0	0	0	2	2	2	0	2	2	2	2	0	0	0	0	0	2	0	3	0	0	0
P11	2	2	3	0	2	2	3	2	3	3	0	3	3	3	2	2	2	1	2	3	2	3	3	2	0
P12	0	0	0	2	0	2	2	0	2	2	2	0	3	3	0	0	2	0	0	2	0	0	0	0	0
P13	0	2	2	2	2	2	2	0	2	2	2	2	0	0	0	0	0	0	0	2	0	0	0	0	0
P14	0	0	3	0	0	3	0	3	2	2	2	2	3	0	3	3	3	3	2	3	2	3	3	3	2
P15	0	2	0	0	3	2	2	2	0	0	2	0	0	2	0	2	3	2	3	0	3	0	0	0	0
P16	0	2	0	0	2	2	2	2	0	0	0	2	0	2	2	0	2	2	2	0	3	2	3	3	3
P17	0	0	3	0	0	0	0	0	0	1	1	1	2	2	3	3	0	3	3	3	3	0	0	0	0
P18	2	1	3	0	3	2	3	2	0	0	0	0	0	0	3	3	3	0	3	0	3	0	3	0	0
P19	0	0	2	0	0	2	2	0	0	0	0	0	0	3	3	3	1	3	0	0	3	0	0	0	0
P20	0	3	2	0	0	2	3	2	3	3	3	3	3	3	2	2	3	0	0	0	0	3	3	3	3
P21	0	0	2	0	3	3	3	3	0	0	0	0	0	3	3	3	0	3	3	0	0	3	2	2	2
P22	0	0	3	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
P23	2	0	3	2	3	3	3	3	0	0	0	2	2	3	3	3	3	3	3	0	3	0	0	3	3
P24	0	0	2	0	2	2	0	0	0	2	0	2	2	2	3	3	3	3	3	0	3	3	2	0	3
P25	2	3	0	2	3	3	2	2	0	0	0	0	0	0	2	3	3	2	2	2	3	2	2	3	0

the inter influences (Govindan and Chaudhuri, 2016; Govindan and Jepsen, 2016). There is no existing literature which analyses the inter influences between SSCM practices in an Indian automotive industry context with multiple stakeholder perspectives. The present study focuses on these voids by seeking a judicial plan for successful implementation of SSCM practices; we determine the practices that must be concentrated on in order to achieve competitive advantages through a multi stakeholder approach based MCDM technique. The study intends to identify the common SSCM practices followed in automotive sector through a literature survey and to understand the prominence relationship among the practices using DEMATEL method. The following Table 1.

Step 3: To find the Total Relation Matrix Eq. (4) is used and the resulting matrices for each case are shown in detail in Tables 8–10 shows the list of 25 SSCM practices along with their explanations identified from the existing literature. Keywords such as SSCM; SSCM practices; best practices; sustainable supply chain management; sustainable supply chain management practices; supply chain practices were used as data inputs in the scopus based search to identify these practices. The inter influences are analyzed from three perspectives; namely management; government; and societal stakeholders; they are the integral and core elements of any decision making in the industries. Including these stakeholders helps one to understand the commonalities and differences in their views and provides a multi-dimensional approach to address the current study.

2.3. Research gap

It is observed from the above literature study that SSCM practices play an important role in helping firms to achieve competitive advantages. Previous research has identified the various SSCM practices, explored their impact on the firm's performance, and provided necessary validating proofs of their advantages. But from an automotive industry perspective, specifically from an Indian scenario, the prominence and influences of each SSCM practice have not been explored. This paper seeks to bridge the gap by providing the prominence and influential relationship between SSCM practices and by evaluating them from multiple stakeholder perspectives. We utilized a questionnaire survey with respondents from South India who are industrial experts, academicians, social activists, and environmental scientists. The highlights of the research are as follows:

- Identifying the SSCM practices through literature survey of previous publications
- Proposing a framework to analyze SSCM practices in an Indian automotive sector on a multi stakeholder perspective using DEMATEL tool
- Validating prominent SSCM practices identified from the study through feedback from experts, industrial managers, and existing literature

3. Methodology

The first step is to identify the common SSCM practices through a literature review. The next step is to analyze SSCM practices from multi stakeholder perspectives using DEMATEL. The questionnaire was directed to multiple stakeholders of the automotive industry, and responses were collected from e-mail conversations, telephonic enquiries, and direct meetings. From the stakeholders' replies, an initial relationship matrix was constructed to evaluate the SSCM practices with the DEMATEL tool. Here, we analyze the SSCM practices for each stakeholder group individually to find the similarities and differences in the views of each group. Finally, to identify the mandatory practices from the full list, we provide a comparison between the combined stakeholder perspectives and the individual perspectives from the results obtained.

The solution methodology we apply to identify the prominences and the inter influences among the SSCM practices is DEMATEL, a Multi Criteria Decision Making (MCDM) tool. This tool analyses the inter influences among complex criteria (Jia et al., 2015b; Govindan et al., 2015b) by simplifying problems; it provides a map of the interrelationships based on the opinions of the respondents

Table 5
Normalized Relation Matrix – Management perspective.

Practice	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	0.000	0.034	0.051	0.034	0.034	0.051	0.051	0.051	0.034	0.034	0.051	0.017	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.051	0.051	0.034	0.034
P2	0.034	0.000	0.034	0.017	0.034	0.051	0.051	0.034	0.051	0.051	0.051	0.051	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.034	0.051	0.034	0.034	0.051
P3	0.000	0.000	0.000	0.000	0.000	0.034	0.000	0.000	0.034	0.034	0.034	0.000	0.051	0.051	0.000	0.000	0.051	0.051	0.051	0.051	0.000	0.051	0.051	0.034	0.034
P4	0.051	0.051	0.051	0.000	0.051	0.051	0.034	0.034	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.000	0.000	0.000	0.034	0.051	0.034	0.051	0.051	0.051
P5	0.034	0.034	0.034	0.000	0.000	0.051	0.051	0.051	0.000	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.034	0.051	0.034	0.051	0.000	0.000	0.000	0.034
P6	0.051	0.034	0.034	0.051	0.051	0.000	0.051	0.051	0.034	0.034	0.034	0.000	0.000	0.034	0.051	0.051	0.034	0.051	0.051	0.034	0.051	0.051	0.051	0.051	0.051
P7	0.000	0.000	0.000	0.000	0.051	0.051	0.000	0.000	0.034	0.034	0.034	0.034	0.000	0.000	0.000	0.000	0.000	0.051	0.000	0.034	0.000	0.000	0.000	0.000	0.034
P8	0.034	0.000	0.000	0.000	0.034	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.034	0.034	0.034	0.000	0.034	0.000	0.000	0.051	0.000	0.000	0.000	0.051
P9	0.034	0.034	0.051	0.034	0.000	0.000	0.034	0.034	0.000	0.051	0.051	0.051	0.051	0.051	0.000	0.000	0.000	0.000	0.000	0.051	0.000	0.051	0.034	0.034	0.000
P10	0.000	0.000	0.034	0.000	0.000	0.000	0.034	0.034	0.034	0.000	0.034	0.034	0.034	0.034	0.000	0.000	0.000	0.000	0.000	0.034	0.000	0.051	0.000	0.000	0.000
P11	0.034	0.034	0.051	0.000	0.034	0.034	0.051	0.034	0.051	0.051	0.000	0.051	0.068	0.068	0.034	0.034	0.051	0.017	0.034	0.051	0.034	0.051	0.051	0.034	0.000
P12	0.000	0.000	0.000	0.034	0.000	0.034	0.034	0.000	0.034	0.034	0.034	0.000	0.034	0.034	0.000	0.000	0.034	0.000	0.000	0.034	0.000	0.000	0.000	0.000	0.000
P13	0.000	0.034	0.051	0.034	0.051	0.034	0.034	0.000	0.034	0.034	0.034	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.034	0.000	0.000	0.000	0.000	0.000
P14	0.000	0.000	0.034	0.000	0.000	0.000	0.000	0.000	0.034	0.034	0.034	0.034	0.034	0.000	0.034	0.034	0.051	0.051	0.051	0.051	0.034	0.051	0.000	0.034	0.034
P15	0.000	0.034	0.000	0.000	0.051	0.034	0.034	0.034	0.000	0.000	0.034	0.000	0.000	0.034	0.000	0.034	0.051	0.034	0.051	0.000	0.051	0.000	0.000	0.000	0.000
P16	0.000	0.034	0.000	0.000	0.034	0.034	0.034	0.034	0.000	0.000	0.000	0.034	0.000	0.034	0.034	0.000	0.034	0.034	0.034	0.000	0.051	0.034	0.051	0.051	0.051
P17	0.000	0.000	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.017	0.017	0.017	0.034	0.034	0.051	0.051	0.000	0.051	0.051	0.051	0.051	0.000	0.000	0.000	0.000
P18	0.034	0.017	0.051	0.000	0.051	0.034	0.051	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.051	0.051	0.000	0.051	0.000	0.051	0.000	0.051	0.000	0.000
P19	0.000	0.000	0.034	0.000	0.000	0.034	0.034	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.051	0.051	0.017	0.051	0.000	0.000	0.051	0.000	0.000	0.000	0.000
P20	0.000	0.051	0.034	0.000	0.000	0.034	0.051	0.034	0.051	0.051	0.051	0.051	0.051	0.051	0.034	0.034	0.051	0.000	0.000	0.000	0.000	0.051	0.051	0.051	0.051
P21	0.000	0.000	0.034	0.000	0.051	0.051	0.051	0.051	0.000	0.000	0.000	0.000	0.000	0.051	0.051	0.051	0.000	0.051	0.051	0.000	0.000	0.051	0.034	0.034	0.034
P22	0.000	0.000	0.051	0.000	0.000	0.000	0.000	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P23	0.034	0.000	0.051	0.034	0.051	0.051	0.051	0.051	0.000	0.000	0.000	0.034	0.034	0.051	0.051	0.051	0.051	0.051	0.051	0.000	0.051	0.000	0.000	0.051	0.051
P24	0.000	0.000	0.034	0.000	0.034	0.034	0.000	0.000	0.000	0.034	0.000	0.034	0.034	0.034	0.051	0.051	0.051	0.051	0.051	0.000	0.051	0.051	0.034	0.000	0.051
P25	0.034	0.034	0.000	0.034	0.034	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.051	0.051	0.034	0.000	0.034	0.051	0.034	0.034	0.000	0.000

Table 6
Normalized Relation Matrix – Government perspective.

Practice	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	0.000	0.032	0.032	0.032	0.032	0.048	0.048	0.048	0.032	0.032	0.048	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.048	0.048	0.032	0.032
P2	0.032	0.000	0.032	0.016	0.032	0.048	0.048	0.032	0.048	0.048	0.048	0.048	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.048	0.032	0.032	0.048
P3	0.000	0.000	0.000	0.000	0.000	0.032	0.000	0.000	0.032	0.032	0.032	0.000	0.048	0.048	0.000	0.000	0.048	0.048	0.048	0.048	0.000	0.048	0.048	0.032	0.032
P4	0.048	0.048	0.048	0.000	0.048	0.048	0.032	0.032	0.048	0.048	0.048	0.032	0.048	0.048	0.048	0.048	0.000	0.000	0.000	0.032	0.048	0.032	0.048	0.048	0.048
P5	0.032	0.032	0.032	0.000	0.000	0.032	0.048	0.048	0.000	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.048	0.032	0.048	0.000	0.000	0.000	0.032
P6	0.048	0.048	0.032	0.048	0.048	0.000	0.048	0.048	0.032	0.048	0.048	0.000	0.000	0.048	0.048	0.048	0.032	0.048	0.048	0.032	0.048	0.048	0.048	0.048	0.048
P7	0.000	0.000	0.000	0.000	0.048	0.048	0.000	0.000	0.032	0.032	0.032	0.032	0.000	0.000	0.000	0.000	0.000	0.048	0.000	0.032	0.000	0.000	0.000	0.000	0.032
P8	0.032	0.000	0.000	0.000	0.032	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.032	0.032	0.000	0.032	0.000	0.000	0.048	0.000	0.000	0.000	0.048
P9	0.032	0.032	0.048	0.032	0.000	0.000	0.032	0.032	0.000	0.048	0.032	0.032	0.048	0.048	0.000	0.000	0.000	0.000	0.000	0.048	0.000	0.048	0.032	0.032	0.000
P10	0.000	0.000	0.032	0.000	0.000	0.000	0.032	0.032	0.032	0.000	0.032	0.032	0.032	0.032	0.000	0.000	0.000	0.000	0.000	0.032	0.000	0.048	0.000	0.000	0.000
P11	0.032	0.032	0.048	0.000	0.032	0.032	0.048	0.032	0.048	0.048	0.000	0.048	0.065	0.065	0.032	0.032	0.048	0.016	0.032	0.048	0.032	0.048	0.048	0.032	0.000
P12	0.000	0.000	0.000	0.032	0.000	0.032	0.032	0.000	0.032	0.032	0.032	0.000	0.032	0.032	0.000	0.000	0.032	0.000	0.000	0.032	0.000	0.000	0.000	0.000	0.000
P13	0.000	0.032	0.048	0.032	0.032	0.032	0.032	0.000	0.032	0.032	0.032	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.000	0.000	0.000	0.000	0.000
P14	0.000	0.000	0.032	0.000	0.000	0.000	0.000	0.000	0.032	0.032	0.032	0.032	0.032	0.000	0.032	0.032	0.048	0.048	0.048	0.048	0.032	0.048	0.000	0.032	0.032
P15	0.000	0.032	0.000	0.000	0.048	0.032	0.032	0.032	0.000	0.000	0.032	0.000	0.000	0.032	0.000	0.032	0.048	0.032	0.048	0.000	0.048	0.000	0.000	0.000	0.000
P16	0.000	0.032	0.000	0.000	0.032	0.048	0.048	0.048	0.032	0.000	0.032	0.032	0.000	0.048	0.048	0.000	0.032	0.032	0.032	0.000	0.048	0.048	0.048	0.048	0.048
P17	0.000	0.000	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.016	0.016	0.032	0.032	0.048	0.048	0.000	0.048	0.048	0.048	0.048	0.000	0.000	0.000	0.000
P18	0.032	0.016	0.048	0.000	0.048	0.032	0.048	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.032	0.048	0.000	0.048	0.000	0.048	0.000	0.048	0.000	0.000
P19	0.000	0.000	0.032	0.000	0.000	0.032	0.032	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.048	0.032	0.016	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P20	0.000	0.048	0.032	0.000	0.000	0.032	0.048	0.032	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.000	0.000	0.000	0.000	0.048	0.048	0.048	0.048
P21	0.000	0.048	0.032	0.000	0.048	0.048	0.048	0.048	0.000	0.000	0.000	0.000	0.000	0.048	0.048	0.048	0.000	0.048	0.048	0.000	0.000	0.048	0.032	0.032	0.048
P22	0.000	0.000	0.048	0.000	0.000	0.000	0.000	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P23	0.032	0.000	0.048	0.032	0.048	0.048	0.048	0.048	0.000	0.000	0.000	0.032	0.032	0.048	0.048	0.032	0.048	0.048	0.048	0.000	0.048	0.000	0.000	0.048	0.048
P24	0.032	0.048	0.032	0.048	0.032	0.032	0.000	0.000	0.000	0.032	0.000	0.032	0.032	0.032	0.048	0.048	0.048	0.048	0.048	0.000	0.048	0.048	0.032	0.000	0.048
P25	0.032	0.032	0.000	0.032	0.032	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.048	0.048	0.032	0.000	0.032	0.048	0.032	0.032	0.000	0.000

Table 7
Normalized Relation Matrix – Societal perspective.

Practice	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	0.000	0.035	0.035	0.035	0.035	0.053	0.035	0.053	0.035	0.035	0.035	0.018	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.053	0.035	0.035	0.035
P2	0.035	0.000	0.035	0.018	0.035	0.035	0.035	0.035	0.053	0.035	0.053	0.053	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.053
P3	0.000	0.000	0.000	0.000	0.000	0.035	0.000	0.000	0.035	0.035	0.035	0.000	0.053	0.053	0.000	0.000	0.053	0.053	0.053	0.053	0.000	0.053	0.053	0.035	0.035
P4	0.053	0.035	0.035	0.000	0.053	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.000	0.000	0.000	0.035	0.035	0.035	0.035	0.035	0.035
P5	0.035	0.035	0.035	0.000	0.000	0.053	0.053	0.053	0.000	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.035	0.053	0.035	0.053	0.000	0.000	0.000	0.035
P6	0.053	0.035	0.035	0.053	0.053	0.000	0.053	0.035	0.035	0.035	0.035	0.000	0.000	0.035	0.053	0.053	0.035	0.053	0.053	0.035	0.053	0.053	0.053	0.053	0.053
P7	0.000	0.000	0.000	0.000	0.053	0.053	0.000	0.000	0.035	0.035	0.035	0.035	0.000	0.000	0.000	0.000	0.000	0.053	0.000	0.035	0.000	0.000	0.000	0.000	0.035
P8	0.035	0.000	0.000	0.000	0.035	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.035	0.035	0.035	0.000	0.035	0.000	0.000	0.053	0.000	0.000	0.000	0.053
P9	0.035	0.035	0.053	0.035	0.000	0.000	0.035	0.035	0.000	0.053	0.053	0.053	0.053	0.053	0.000	0.000	0.000	0.000	0.000	0.053	0.000	0.053	0.035	0.035	0.000
P10	0.000	0.000	0.035	0.000	0.000	0.000	0.035	0.035	0.035	0.000	0.035	0.035	0.035	0.035	0.000	0.000	0.000	0.000	0.000	0.035	0.000	0.053	0.000	0.000	0.000
P11	0.035	0.035	0.053	0.000	0.035	0.035	0.053	0.035	0.053	0.053	0.000	0.053	0.053	0.053	0.035	0.035	0.035	0.018	0.035	0.053	0.035	0.053	0.053	0.035	0.000
P12	0.000	0.000	0.000	0.035	0.000	0.035	0.035	0.000	0.035	0.035	0.035	0.000	0.053	0.053	0.000	0.000	0.035	0.000	0.000	0.035	0.000	0.000	0.000	0.000	0.000
P13	0.000	0.035	0.035	0.035	0.035	0.035	0.035	0.000	0.035	0.035	0.035	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.035	0.000	0.000	0.000	0.000	0.000
P14	0.000	0.000	0.053	0.000	0.000	0.053	0.000	0.053	0.035	0.035	0.035	0.035	0.053	0.000	0.053	0.053	0.053	0.053	0.035	0.053	0.035	0.053	0.053	0.053	0.035
P15	0.000	0.035	0.000	0.000	0.053	0.035	0.035	0.035	0.000	0.000	0.035	0.000	0.000	0.035	0.000	0.035	0.053	0.035	0.053	0.000	0.053	0.000	0.000	0.000	0.000
P16	0.000	0.035	0.000	0.000	0.035	0.035	0.035	0.035	0.000	0.000	0.000	0.035	0.000	0.035	0.035	0.000	0.035	0.035	0.035	0.000	0.053	0.035	0.053	0.053	0.053
P17	0.000	0.000	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.018	0.018	0.035	0.035	0.053	0.053	0.000	0.053	0.053	0.053	0.053	0.000	0.000	0.000	0.000
P18	0.035	0.018	0.053	0.000	0.053	0.035	0.053	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.053	0.053	0.053	0.000	0.053	0.000	0.053	0.000	0.053	0.000	0.000
P19	0.000	0.000	0.035	0.000	0.000	0.035	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.053	0.053	0.053	0.018	0.053	0.000	0.000	0.053	0.000	0.000	0.000	0.000
P20	0.000	0.053	0.035	0.000	0.000	0.035	0.053	0.035	0.053	0.053	0.053	0.053	0.053	0.053	0.035	0.035	0.053	0.000	0.000	0.000	0.000	0.053	0.053	0.053	0.053
P21	0.000	0.000	0.035	0.000	0.053	0.053	0.053	0.053	0.000	0.000	0.000	0.000	0.000	0.053	0.053	0.053	0.000	0.053	0.053	0.000	0.000	0.053	0.035	0.035	0.035
P22	0.000	0.000	0.053	0.000	0.000	0.000	0.000	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
P23	0.035	0.000	0.053	0.035	0.053	0.053	0.053	0.053	0.000	0.000	0.000	0.035	0.035	0.053	0.053	0.053	0.053	0.053	0.053	0.000	0.053	0.000	0.000	0.053	0.053
P24	0.000	0.000	0.035	0.000	0.035	0.035	0.000	0.000	0.000	0.035	0.000	0.035	0.035	0.035	0.053	0.053	0.053	0.053	0.053	0.000	0.053	0.053	0.035	0.000	0.053
P25	0.035	0.053	0.000	0.035	0.053	0.053	0.035	0.035	0.000	0.000	0.000	0.000	0.000	0.000	0.035	0.053	0.053	0.035	0.035	0.035	0.053	0.035	0.035	0.053	0.000

Table 8
Total Relation Matrix – Management perspective.

Practice	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	0.033	0.069	0.116	0.056	0.091	0.118	0.113	0.104	0.073	0.081	0.094	0.060	0.078	0.100	0.091	0.096	0.097	0.101	0.094	0.085	0.101	0.107	0.100	0.077	0.088
P2	0.065	0.036	0.099	0.041	0.089	0.116	0.113	0.087	0.090	0.098	0.095	0.093	0.078	0.099	0.089	0.093	0.097	0.099	0.092	0.086	0.098	0.108	0.083	0.075	0.101
P3	0.020	0.023	0.049	0.015	0.034	0.073	0.040	0.034	0.059	0.064	0.062	0.030	0.081	0.093	0.040	0.043	0.095	0.092	0.090	0.084	0.043	0.087	0.082	0.061	0.064
P4	0.086	0.091	0.122	0.028	0.114	0.126	0.105	0.095	0.096	0.106	0.102	0.100	0.102	0.124	0.110	0.116	0.072	0.074	0.068	0.093	0.122	0.102	0.107	0.100	0.112
P5	0.052	0.052	0.067	0.013	0.033	0.090	0.086	0.080	0.022	0.058	0.024	0.020	0.020	0.036	0.033	0.037	0.032	0.073	0.082	0.060	0.086	0.033	0.030	0.023	0.066
P6	0.085	0.072	0.104	0.072	0.113	0.076	0.118	0.110	0.072	0.082	0.079	0.045	0.046	0.104	0.115	0.120	0.102	0.125	0.117	0.085	0.126	0.111	0.105	0.096	0.110
P7	0.017	0.018	0.028	0.011	0.072	0.077	0.030	0.025	0.051	0.055	0.053	0.051	0.019	0.026	0.022	0.024	0.026	0.074	0.024	0.057	0.027	0.025	0.023	0.017	0.053
P8	0.047	0.016	0.024	0.009	0.059	0.062	0.026	0.024	0.012	0.015	0.015	0.012	0.011	0.056	0.058	0.061	0.026	0.063	0.028	0.018	0.081	0.023	0.022	0.017	0.072
P9	0.054	0.057	0.099	0.050	0.037	0.046	0.076	0.069	0.036	0.090	0.087	0.087	0.090	0.098	0.037	0.039	0.047	0.042	0.037	0.091	0.039	0.094	0.068	0.065	0.038
P10	0.009	0.012	0.057	0.008	0.016	0.021	0.053	0.050	0.051	0.021	0.052	0.051	0.053	0.057	0.015	0.016	0.023	0.019	0.016	0.055	0.016	0.071	0.016	0.015	0.017
P11	0.061	0.066	0.117	0.023	0.086	0.098	0.112	0.085	0.091	0.100	0.048	0.095	0.113	0.132	0.088	0.091	0.112	0.083	0.093	0.104	0.094	0.107	0.095	0.075	0.053
P12	0.013	0.017	0.029	0.043	0.021	0.057	0.059	0.020	0.055	0.058	0.057	0.023	0.056	0.061	0.022	0.023	0.056	0.023	0.020	0.059	0.022	0.026	0.020	0.019	0.020
P13	0.018	0.053	0.082	0.045	0.075	0.066	0.066	0.027	0.059	0.064	0.061	0.058	0.027	0.034	0.023	0.025	0.028	0.029	0.026	0.064	0.027	0.031	0.026	0.023	0.027
P14	0.016	0.022	0.077	0.012	0.032	0.040	0.039	0.032	0.056	0.062	0.060	0.060	0.063	0.043	0.070	0.073	0.093	0.090	0.088	0.081	0.073	0.086	0.032	0.058	0.061
P15	0.017	0.050	0.034	0.009	0.081	0.069	0.068	0.062	0.018	0.023	0.053	0.019	0.018	0.067	0.035	0.069	0.080	0.074	0.086	0.026	0.090	0.027	0.025	0.021	0.029
P16	0.021	0.053	0.040	0.015	0.073	0.079	0.073	0.068	0.019	0.026	0.023	0.056	0.022	0.073	0.074	0.045	0.076	0.083	0.077	0.029	0.099	0.066	0.079	0.075	0.086
P17	0.011	0.018	0.082	0.008	0.028	0.034	0.034	0.026	0.019	0.038	0.039	0.037	0.054	0.069	0.081	0.082	0.035	0.085	0.084	0.073	0.083	0.029	0.027	0.022	0.025
P18	0.052	0.037	0.088	0.013	0.089	0.080	0.091	0.069	0.020	0.025	0.025	0.022	0.022	0.043	0.090	0.091	0.088	0.051	0.095	0.029	0.097	0.031	0.080	0.027	0.037
P19	0.011	0.013	0.057	0.007	0.026	0.061	0.059	0.022	0.013	0.016	0.017	0.014	0.013	0.076	0.076	0.078	0.044	0.082	0.032	0.019	0.080	0.023	0.022	0.018	0.023
P20	0.027	0.079	0.091	0.022	0.048	0.089	0.101	0.077	0.087	0.094	0.091	0.092	0.093	0.107	0.080	0.085	0.108	0.058	0.051	0.050	0.056	0.101	0.091	0.086	0.095
P21	0.022	0.022	0.072	0.013	0.090	0.096	0.089	0.085	0.019	0.025	0.023	0.021	0.020	0.089	0.090	0.093	0.045	0.101	0.095	0.028	0.051	0.083	0.064	0.059	0.071
P22	0.004	0.003	0.059	0.002	0.006	0.009	0.005	0.055	0.005	0.006	0.006	0.004	0.007	0.011	0.009	0.009	0.059	0.012	0.010	0.009	0.011	0.007	0.007	0.005	0.008
P23	0.062	0.032	0.105	0.053	0.105	0.114	0.105	0.095	0.031	0.040	0.037	0.066	0.067	0.107	0.106	0.111	0.106	0.118	0.110	0.045	0.117	0.048	0.045	0.086	0.101
P24	0.019	0.022	0.077	0.015	0.072	0.078	0.043	0.037	0.021	0.058	0.025	0.056	0.057	0.076	0.090	0.094	0.095	0.099	0.096	0.032	0.099	0.084	0.065	0.026	0.083
P25	0.054	0.056	0.040	0.047	0.069	0.090	0.040	0.037	0.021	0.026	0.024	0.024	0.023	0.038	0.039	0.090	0.086	0.074	0.039	0.060	0.092	0.067	0.066	0.029	0.036

Table 9
Total Relation Matrix – Government perspective.

Practice	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	0.032	0.072	0.089	0.055	0.081	0.107	0.104	0.096	0.070	0.076	0.090	0.069	0.071	0.093	0.085	0.083	0.087	0.090	0.084	0.077	0.086	0.098	0.091	0.069	0.081
P2	0.062	0.041	0.089	0.040	0.079	0.105	0.104	0.080	0.086	0.092	0.091	0.085	0.072	0.092	0.082	0.082	0.087	0.089	0.082	0.079	0.084	0.100	0.075	0.068	0.094
P3	0.019	0.025	0.043	0.016	0.028	0.066	0.036	0.030	0.055	0.060	0.058	0.026	0.075	0.087	0.037	0.035	0.087	0.084	0.082	0.078	0.034	0.081	0.075	0.056	0.059
P4	0.082	0.095	0.110	0.029	0.102	0.114	0.096	0.088	0.092	0.099	0.098	0.076	0.093	0.116	0.103	0.103	0.063	0.065	0.059	0.084	0.107	0.094	0.097	0.092	0.104
P5	0.048	0.052	0.059	0.011	0.027	0.065	0.078	0.072	0.019	0.053	0.022	0.017	0.017	0.031	0.029	0.028	0.027	0.065	0.073	0.054	0.074	0.028	0.024	0.019	0.059
P6	0.084	0.095	0.098	0.072	0.106	0.071	0.113	0.106	0.074	0.096	0.096	0.044	0.045	0.118	0.111	0.109	0.097	0.117	0.110	0.082	0.114	0.109	0.099	0.091	0.106
P7	0.015	0.019	0.024	0.011	0.066	0.070	0.026	0.022	0.048	0.052	0.050	0.046	0.017	0.024	0.020	0.020	0.022	0.068	0.020	0.052	0.022	0.022	0.020	0.015	0.049
P8	0.045	0.019	0.020	0.009	0.055	0.057	0.024	0.022	0.012	0.014	0.016	0.011	0.010	0.054	0.054	0.055	0.023	0.058	0.025	0.016	0.074	0.022	0.020	0.015	0.069
P9	0.050	0.057	0.087	0.048	0.029	0.038	0.067	0.062	0.031	0.081	0.064	0.062	0.080	0.088	0.032	0.031	0.038	0.035	0.031	0.081	0.031	0.085	0.060	0.058	0.033
P10	0.008	0.012	0.052	0.007	0.013	0.018	0.049	0.046	0.048	0.018	0.048	0.047	0.049	0.052	0.014	0.014	0.020	0.017	0.014	0.051	0.013	0.066	0.014	0.013	0.015
P11	0.058	0.069	0.105	0.024	0.076	0.088	0.103	0.078	0.087	0.093	0.046	0.087	0.105	0.123	0.082	0.079	0.102	0.073	0.083	0.095	0.081	0.099	0.087	0.069	0.047
P12	0.012	0.017	0.025	0.041	0.017	0.052	0.054	0.018	0.051	0.054	0.053	0.019	0.052	0.057	0.020	0.020	0.051	0.020	0.018	0.055	0.019	0.023	0.017	0.016	0.018
P13	0.015	0.051	0.074	0.043	0.052	0.058	0.059	0.022	0.055	0.059	0.056	0.052	0.024	0.030	0.021	0.020	0.024	0.023	0.021	0.058	0.021	0.027	0.022	0.020	0.023
P14	0.016	0.026	0.070	0.013	0.027	0.036	0.035	0.029	0.055	0.058	0.058	0.055	0.058	0.040	0.066	0.065	0.086	0.082	0.080	0.076	0.063	0.080	0.028	0.053	0.057
P15	0.016	0.052	0.029	0.009	0.074	0.063	0.063	0.057	0.018	0.021	0.052	0.017	0.016	0.063	0.032	0.061	0.074	0.067	0.079	0.023	0.079	0.025	0.022	0.019	0.027
P16	0.028	0.065	0.046	0.021	0.075	0.097	0.093	0.088	0.058	0.034	0.063	0.060	0.029	0.096	0.093	0.046	0.080	0.085	0.079	0.036	0.097	0.088	0.081	0.077	0.089
P17	0.011	0.021	0.075	0.008	0.024	0.031	0.031	0.024	0.020	0.036	0.038	0.034	0.051	0.065	0.077	0.074	0.031	0.078	0.077	0.068	0.073	0.027	0.024	0.020	0.023
P18	0.049	0.039	0.080	0.012	0.080	0.071	0.084	0.063	0.019	0.023	0.025	0.019	0.019	0.039	0.082	0.064	0.079	0.043	0.086	0.026	0.083	0.028	0.073	0.023	0.033
P19	0.009	0.013	0.049	0.006	0.018	0.051	0.050	0.016	0.012	0.013	0.016	0.011	0.011	0.067	0.067	0.049	0.037	0.070	0.023	0.015	0.021	0.017	0.015	0.013	0.016
P20	0.027	0.082	0.083	0.024	0.043	0.084	0.096	0.073	0.084	0.089	0.089	0.085	0.087	0.103	0.092	0.092	0.101	0.053	0.047	0.045	0.049	0.096	0.085	0.081	0.090
P21	0.025	0.076	0.071	0.017	0.088	0.094	0.089	0.085	0.025	0.029	0.029	0.024	0.022	0.090	0.089	0.088	0.045	0.098	0.091	0.030	0.046	0.084	0.064	0.058	0.087
P22	0.004	0.003	0.055	0.002	0.005	0.007	0.004	0.052	0.004	0.005	0.005	0.003	0.007	0.010	0.008	0.008	0.055	0.011	0.009	0.008	0.009	0.006	0.006	0.004	0.007
P23	0.059	0.038	0.095	0.053	0.094	0.103	0.096	0.088	0.030	0.037	0.037	0.060	0.062	0.100	0.097	0.081	0.096	0.106	0.099	0.040	0.101	0.043	0.039	0.078	0.093
P24	0.058	0.083	0.083	0.068	0.076	0.086	0.052	0.045	0.032	0.067	0.038	0.062	0.063	0.084	0.096	0.095	0.097	0.100	0.097	0.039	0.098	0.092	0.070	0.033	0.090
P25	0.051	0.058	0.035	0.045	0.063	0.084	0.037	0.034	0.022	0.025	0.026	0.021	0.021	0.037	0.037	0.081	0.080	0.067	0.035	0.056	0.083	0.063	0.061	0.026	0.033

Table 10
Total Relation Matrix – Societal perspective.

Practice	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	0.035	0.073	0.103	0.058	0.096	0.126	0.102	0.115	0.074	0.082	0.079	0.061	0.080	0.103	0.101	0.102	0.100	0.106	0.100	0.087	0.106	0.110	0.091	0.085	0.092
P2	0.069	0.040	0.104	0.043	0.096	0.111	0.104	0.099	0.093	0.085	0.098	0.097	0.084	0.106	0.101	0.102	0.102	0.106	0.101	0.091	0.106	0.095	0.092	0.087	0.107
P3	0.023	0.028	0.056	0.018	0.041	0.086	0.049	0.046	0.063	0.069	0.067	0.034	0.089	0.101	0.051	0.052	0.103	0.102	0.099	0.091	0.051	0.094	0.093	0.072	0.072
P4	0.083	0.071	0.094	0.024	0.107	0.104	0.096	0.094	0.073	0.080	0.077	0.076	0.078	0.096	0.091	0.092	0.060	0.064	0.059	0.084	0.096	0.091	0.085	0.082	0.088
P5	0.056	0.057	0.072	0.014	0.039	0.098	0.093	0.089	0.025	0.061	0.027	0.023	0.023	0.041	0.041	0.043	0.037	0.081	0.091	0.064	0.094	0.036	0.035	0.031	0.071
P6	0.091	0.079	0.112	0.076	0.125	0.089	0.129	0.111	0.076	0.086	0.083	0.049	0.051	0.113	0.130	0.132	0.111	0.137	0.130	0.093	0.137	0.119	0.117	0.110	0.119
P7	0.019	0.021	0.032	0.013	0.078	0.084	0.036	0.030	0.055	0.059	0.056	0.054	0.022	0.030	0.028	0.029	0.029	0.080	0.029	0.061	0.031	0.028	0.027	0.023	0.058
P8	0.051	0.020	0.028	0.011	0.067	0.071	0.033	0.033	0.014	0.017	0.016	0.014	0.015	0.062	0.067	0.069	0.030	0.070	0.035	0.021	0.088	0.027	0.028	0.025	0.079
P9	0.058	0.062	0.105	0.053	0.042	0.057	0.083	0.081	0.039	0.095	0.092	0.092	0.097	0.106	0.045	0.046	0.052	0.049	0.043	0.097	0.045	0.100	0.077	0.073	0.043
P10	0.011	0.014	0.062	0.009	0.019	0.028	0.058	0.058	0.055	0.023	0.056	0.055	0.058	0.061	0.020	0.020	0.026	0.023	0.019	0.059	0.020	0.076	0.021	0.019	0.020
P11	0.066	0.072	0.123	0.026	0.093	0.111	0.120	0.099	0.096	0.104	0.051	0.100	0.104	0.124	0.099	0.100	0.102	0.090	0.100	0.109	0.102	0.113	0.108	0.086	0.059
P12	0.016	0.020	0.035	0.047	0.026	0.067	0.066	0.028	0.060	0.063	0.062	0.027	0.079	0.084	0.028	0.029	0.062	0.029	0.025	0.066	0.028	0.031	0.027	0.025	0.024
P13	0.018	0.054	0.066	0.047	0.060	0.068	0.068	0.029	0.061	0.064	0.062	0.060	0.028	0.034	0.026	0.026	0.028	0.029	0.027	0.066	0.027	0.031	0.028	0.025	0.027
P14	0.031	0.037	0.118	0.024	0.060	0.123	0.066	0.111	0.070	0.078	0.076	0.076	0.097	0.070	0.118	0.119	0.120	0.122	0.101	0.100	0.105	0.108	0.107	0.101	0.088
P15	0.020	0.054	0.039	0.010	0.088	0.079	0.074	0.071	0.020	0.025	0.056	0.022	0.022	0.073	0.042	0.077	0.086	0.081	0.094	0.029	0.098	0.031	0.032	0.028	0.034
P16	0.025	0.059	0.047	0.017	0.083	0.092	0.083	0.081	0.023	0.029	0.027	0.061	0.028	0.082	0.087	0.055	0.084	0.093	0.088	0.034	0.109	0.072	0.090	0.087	0.094
P17	0.014	0.021	0.088	0.010	0.033	0.043	0.040	0.034	0.022	0.042	0.042	0.040	0.060	0.075	0.090	0.090	0.039	0.092	0.091	0.078	0.090	0.033	0.034	0.029	0.030
P18	0.056	0.041	0.094	0.014	0.097	0.089	0.098	0.077	0.022	0.028	0.027	0.024	0.026	0.048	0.099	0.100	0.094	0.058	0.104	0.033	0.106	0.035	0.087	0.034	0.042
P19	0.013	0.016	0.064	0.008	0.032	0.071	0.065	0.030	0.015	0.018	0.019	0.017	0.017	0.082	0.085	0.086	0.050	0.090	0.037	0.022	0.087	0.027	0.030	0.025	0.027
P20	0.032	0.087	0.100	0.026	0.057	0.105	0.113	0.093	0.093	0.101	0.098	0.100	0.102	0.118	0.095	0.097	0.117	0.068	0.062	0.057	0.065	0.109	0.104	0.101	0.104
P21	0.026	0.027	0.081	0.015	0.100	0.110	0.100	0.099	0.022	0.029	0.027	0.025	0.025	0.098	0.103	0.104	0.052	0.112	0.105	0.034	0.060	0.090	0.075	0.070	0.079
P22	0.005	0.004	0.062	0.002	0.007	0.011	0.006	0.059	0.005	0.007	0.007	0.005	0.009	0.013	0.011	0.011	0.062	0.014	0.012	0.010	0.012	0.008	0.008	0.007	0.009
P23	0.067	0.038	0.114	0.057	0.117	0.131	0.117	0.112	0.035	0.044	0.041	0.071	0.075	0.117	0.121	0.123	0.116	0.130	0.124	0.051	0.129	0.055	0.056	0.101	0.110
P24	0.023	0.028	0.085	0.017	0.081	0.091	0.052	0.049	0.024	0.064	0.029	0.061	0.064	0.085	0.104	0.105	0.104	0.109	0.107	0.037	0.109	0.092	0.075	0.037	0.091
P25	0.064	0.084	0.057	0.053	0.108	0.117	0.093	0.090	0.029	0.037	0.034	0.034	0.033	0.058	0.096	0.113	0.107	0.100	0.096	0.074	0.118	0.082	0.082	0.094	0.054

(Zhu et al., 2011). The DEMATEL method was first developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva; it was designed in 1973 by Fontela and Gabusto study the complex and interlinked group of problems (Tzeng et al., 2007; Wu and Lee, 2007). DEMATEL provides a structural model depicting the relationships between criteria under consideration. The method divides criteria into two groups – cause and effect – and visualizes the causal relationships through relationship matrices and diagraphs (Falatoonitoosi et al., 2013). The present aim is to explore the prominent SSCM practices in automotive industries. This objective has to be established while considering that a) these practices are not independent of each other and b) that the elements of sustainability are not mutually exclusive (Carter and Rogers, 2008). Hence, techniques such as Analytic Hierarchy Process can be eliminated because it assumes that the elements are independent of each other. The prominent practice is to be found from a group of practices, while keeping in mind that they are not independent of each other. For this purpose, we find DEMATEL as an apt tool for the analysis done in the current study. The procedural steps of this method are adopted from Tseng (2009) and are described below.

Step 1: Finding the Initial Direct Relation (Average) matrix, "A"

The experts provide their opinion regarding the influences of the practices in terms of numbers based on a 0–4 scalewith '0′ referring to no influence, '1' to low influence, '2' to medium influence, and '3′ and '4′ to high and very high influence, respectively.

If there are N number of experts and 'n' number of criteria considered, then each expert fills a matrix $Wk = [w_{ij}]_{nxn}$, k = 1 to N, then the average matrix is calculated as,

$$A = [a_{ij}]_{nxn} = \left(\sum W_k\right)/N \tag{1}$$

The matrix, A is also called the Initial Direct Relation Matrix, where, a_{ij} is denoted as the degree to which the criterion, 'i' affects the criterion. Hence, the Initial Direct Relation matrix indicates the initial direct effect each criterion exerts on and receives from other criteria.

Step 2: Obtaining the Normalized Relation Matrix, "X"

The Initial Direct Relation matrix is normalized using a value, S, which is calculated as follows.

$$S = \max\{\max \sum a_{ij}(j = 1, ., n), \max \sum a_{ij}(i = 1, ., n)\} \tag{2}$$

$$\text{Normalizedmatrix}, X = A/S \tag{3}$$

All the elements of the normalized matrix lie between 0 and 1.

Step 3: Obtaining the Total Relation Matrix, "M"

The Total Relation Matrix is calculated from the Normalized Relation Matrix as follows,

$$M = X(I{-}X)^{-1} \tag{4}$$

where"I" is an identity matrix of order, nxn.

Step 4: Obtaining the sum of rows and columns

D denotes the sum of the rows of the Total Relation Matrix.

$$D = \sum m_{ij}, j = 1, ., n \tag{5}$$

R denotes the sum of columns of the Total Relation Matrix.

$$R = \sum m_{ij}, i = 1, ., n \tag{6}$$

Di shows the net effects, both direct and indirect, given by criterion i to the other criteria $j = 1, 2, \ldots, n$. The total effects, direct and indirect, received by criterion j from the other criteria $i = 1, 2, \ldots, n$ is represented by R_j.

As a result, while i = j the sum (D + R) that is called "Prominence" depicts the degree of influence role of criterion 'i' in system. The index that shows the total effects both given and received by criterion i. The difference, (D-R) that is called "Relation" depicts the net effect that criterion i donates to the system. Criterion i with positive D-R values will go to the cause group and when (D-R) is negative, criterion i goes to the effect group.

Step 5: Obtain Causal and Effect Diagram

A causal and effect diagram is obtained by means of plotting the (D + R, D-R) values of all the criteria. Thus the procedure for DEMATEL has been explained and the subsequent section deals with the application of this procedure to the identified problem.

3.1. Application of the proposed framework

3.1.1. Questionnaire development and data collection

The SSCM practices as a whole were collected from the literature review and we identified that these practices can be categorized under specific groups on the basis of commonality in their orientations and functions. The six major categories identified for the classification are management, supplier, collaboration, design, internal, and society. Through discussions with industrial experts at managerial levels in the automotive sector, we validated the categorization of SSCM practices under these six major groups. A total tally of 50 experienced personnel from the automotive industries from Tamilnadu, Southern India were contacted through e-mails and face to face meetings to arrive at the conclusion of which practices fall under which category. These people are experts in the automotive field and have experience levels of more than 10–15 years. From various automotive industries, the respondents belonged to different departments, including product support technology, product manufacturing, Research and Design. We received responses from 33 units and, from these responses, we arrived with the categorization. The variations in responses created some havoc in the categorization process, but with further face to face personal meetings with the experts, all differences in the opinions were sorted out and we formulated the final classification and explanations through consensus, shown in Table 1.

Once we came up with the final list, a DEMATEL based questionnaire was prepared for the proposed 25 practices. In order to reach multi stakeholder perspectives, we contacted experts in all three groups in and around Tamilnadu, India, including industrial managers, government officials, and societal and environmental activists. A total of 88 individuals comprising all three stakeholder groups were contacted. Some neglected the survey due to busy work schedules and lack of interest. Finally, we had a sum of 65 units who responded to our survey. The SSCM practices were explained to them and they were asked to rate the influence of practices by pair-wise comparisons based on the 0–4 scale mentioned above.

3.1.2. Application of DEMATEL

The raw data is obtained from the three stakeholder groups in the form of relation matrices and DEMATEL method is applied as follows.

Step 1: Individual responses are combined accordingly into three stakeholder groups (management, government, and societal/environmental) using Eq. (1). The above par value for each single cell in the matrix is considered to obtain the Initial Direct Relation matrix for each of the three perspectives and is shown below in Tables 2–4.

Step 2: The Normalized value, S is calculated using Eq. (2), and the Initial Direct Relation matrix, A is divided throughout by S to obtain the Normalized Relation Matrix, X, using Eq. (3).The Normalized Relation Matrix for each of the three stakeholder perspectives is shown in Tables 5–7.

Step 4: The sums of rows and columns of the Total Relation Matrix are obtained using Eq. (5) and Eq. (6) and are shown in Tables 11–13. The sums of the row values calculate the sum of influence given and are denoted as D. The sums of column values give the sum of influence received and are denoted as R. A

Table 11
Sum of influences given and received for each criterion – Management Perspective.(For interpretation of the references to colour in the Table legend, the reader is referred to the web version of this article.)

Practice	D sum	R sum	D+R	D-R
P1	2.2252	0.8743	3.0995	1.3509
P2	2.2184	0.9877	3.2060	1.2307
P3	1.4594	1.8145	3.2739	-0.3551
P4	2.4738	0.6288	3.1026	1.8450
P5	1.2063	1.5618	2.7681	-0.3555
P6	2.3883	1.8661	4.2543	0.5222
P7	0.9040	1.7429	2.6469	-0.8388
P8	0.8579	1.4731	2.3310	-0.6152
P9	1.5725	1.0954	2.6679	0.4771
P10	0.7908	1.3298	2.1205	-0.5390
P11	2.2222	1.2529	3.4751	0.9694
P12	0.8784	1.1954	2.0738	-0.3169
P13	1.0646	1.2350	2.2996	-0.1704
P14	1.4192	1.8186	3.2377	-0.3994
P15	1.1482	1.5814	2.7295	-0.4332
P16	1.4291	1.7032	3.1323	-0.2741
P17	1.1206	1.7265	2.8471	-0.6059
P18	1.3915	1.8234	3.2149	-0.4318
P19	0.9014	1.6502	2.5516	-0.7488
P20	1.9579	1.4224	3.3803	0.5355
P21	1.4650	1.8306	3.2956	-0.3655
P22	0.3274	1.5766	1.9040	-1.2493
P23	2.0122	1.3778	3.3900	0.6344
P24	1.5185	1.1753	2.6938	0.3432
P25	1.2684	1.4778	2.7461	-0.2094

Table 12
Sum of influences given and received for each criterion – Government Perspective.(For interpretation of the references to colour in the Table legend, the reader is referred to the web version of this article.)

Practice	D sum	R sum	D+R	D-R
P1	2.0371	0.8827	2.9198	1.1544
P2	2.0397	1.1807	3.2204	0.8590
P3	1.3315	1.6466	2.9781	-0.3150
P4	2.2593	0.6837	2.9430	1.5756
P5	1.0503	1.4012	2.4516	-0.3509
P6	2.3622	1.7163	4.0785	0.6459
P7	0.8212	1.6441	2.4653	-0.8229
P8	0.8014	1.3953	2.1967	-0.5938
P9	1.3592	1.1077	2.4668	0.2515
P10	0.7170	1.2860	2.0030	-0.5691
P11	2.0415	1.2635	3.3051	0.7780
P12	0.7975	1.0902	1.8878	-0.2927
P13	0.9300	1.1550	2.0850	-0.2251
P14	1.3121	1.7581	3.0702	-0.4460
P15	1.0577	1.5256	2.5833	-0.4679
P16	1.7017	1.4831	3.1848	0.2187
P17	1.0380	1.5888	2.6268	-0.5508
P18	1.2401	1.6631	2.9032	-0.4231
P19	0.6823	1.5042	2.1865	-0.8219
P20	1.8832	1.3221	3.2054	0.5611
P21	1.5413	1.5612	3.1026	-0.0199
P22	0.2986	1.5007	1.7993	-1.2021
P23	1.8245	1.2685	3.0930	0.5560
P24	1.8039	1.0842	2.8881	0.7197
P25	1.1806	1.3992	2.5798	-0.2186

threshold value is set for the elements of Total Relation Matrix in order to find the relevant Causal Diagram. The value is taken as the (Mean + Standard Deviation) of the Total Relation Matrix. In the present case, the threshold values are calculated in each case and the values higher than this in the Total Relation Matrix were considered for further analysis of the relationships between practices. These values for each perspective are highlighted and shown in Total Relation Matrix (Tables 8–10).

Step 5: The final step is to obtain the Causal Diagram which is an X-Y plot with D + R values representing the prominences taking the x-axis and D-R values representing the relations taking the y-axis. By plotting D + R and D-R values in the plot we analyze the SSCM practices. Tables 11–13 show the D + R and D-R values for each perspective and Figs. 2–4 show the graphical plot, the Causal Diagram with the degree of prominences and relations. The combined results including all three perspectives are represented in Table 14 and Fig. 5 respectively.

4. Results and discussions

This section reveals the results obtained by using the DEMATEL method. The prominence and relations of the corresponding practices are summarized based on Tables 11–13 involving the individual perspectives. The combined perspective, the average of the results obtained of all the individual perspectives, is presented in Table 14. The positive D-R values highlighted in each of the above Tables 11–14 indicate that the practices associated with these values are the prominent ones. The values in the tables represent the horizontal axis point's values (D + R, the prominence values) and the vertical axis point's values (D-R, the relation values) for each of the practices, and are the base values on which the diagraphs are obtained. These diagraphs shown in Figs. 2–5 offer a pictorial representation of the causal and effect relationship among the practices. One can easily identify the prominent practices based on the cause and effect groups explained in the diagraphs. It is also described as an interrelationship diagram or Impact Relationship Map because it depicts the factors and presents the inter influences. The criteria having positive D-R values fall under the cause group and the rest form the effect group. The relation between these practices is

Table 13
Sum of influences given and received for each criterion – Societal Perspective.(For interpretation of the references to colour in the Table legend, the reader is referred to the web version of this article.)

Practice	D sum	R sum	D+R	D-R
P1	2.2664	0.9719	3.2383	1.2946
P2	2.3188	1.1050	3.4238	1.2139
P3	1.6530	1.9414	3.5945	-0.2884
P4	2.0469	0.6950	2.7419	1.3519
P5	1.3416	1.7507	3.0923	-0.4090
P6	2.6042	2.1606	4.7648	0.4436
P7	1.0126	1.9446	2.9571	-0.9320
P8	0.9911	1.8198	2.8109	-0.8287
P9	1.7306	1.1639	2.8945	0.5666
P10	0.8889	1.3901	2.2789	-0.5012
P11	2.3530	1.3077	3.6607	1.0453
P12	1.0538	1.2797	2.3336	-0.2259
P13	1.0600	1.3660	2.4260	-0.3060
P14	2.2272	1.9786	4.2058	0.2485
P15	1.2850	1.8773	3.1623	-0.5923
P16	1.6263	1.9218	3.5481	-0.2954
P17	1.2612	1.8712	3.1324	-0.6100
P18	1.5341	2.0354	3.5695	-0.5013
P19	1.0320	1.8768	2.9088	-0.8448
P20	2.2065	1.5502	3.7567	0.6564
P21	1.6688	2.0196	3.6884	-0.3508
P22	0.3634	1.6931	2.0565	-1.3296
P23	2.2535	1.6097	3.8632	0.6438
P24	1.7227	1.4551	3.1778	0.2676
P25	1.9055	1.6223	3.5278	0.2832

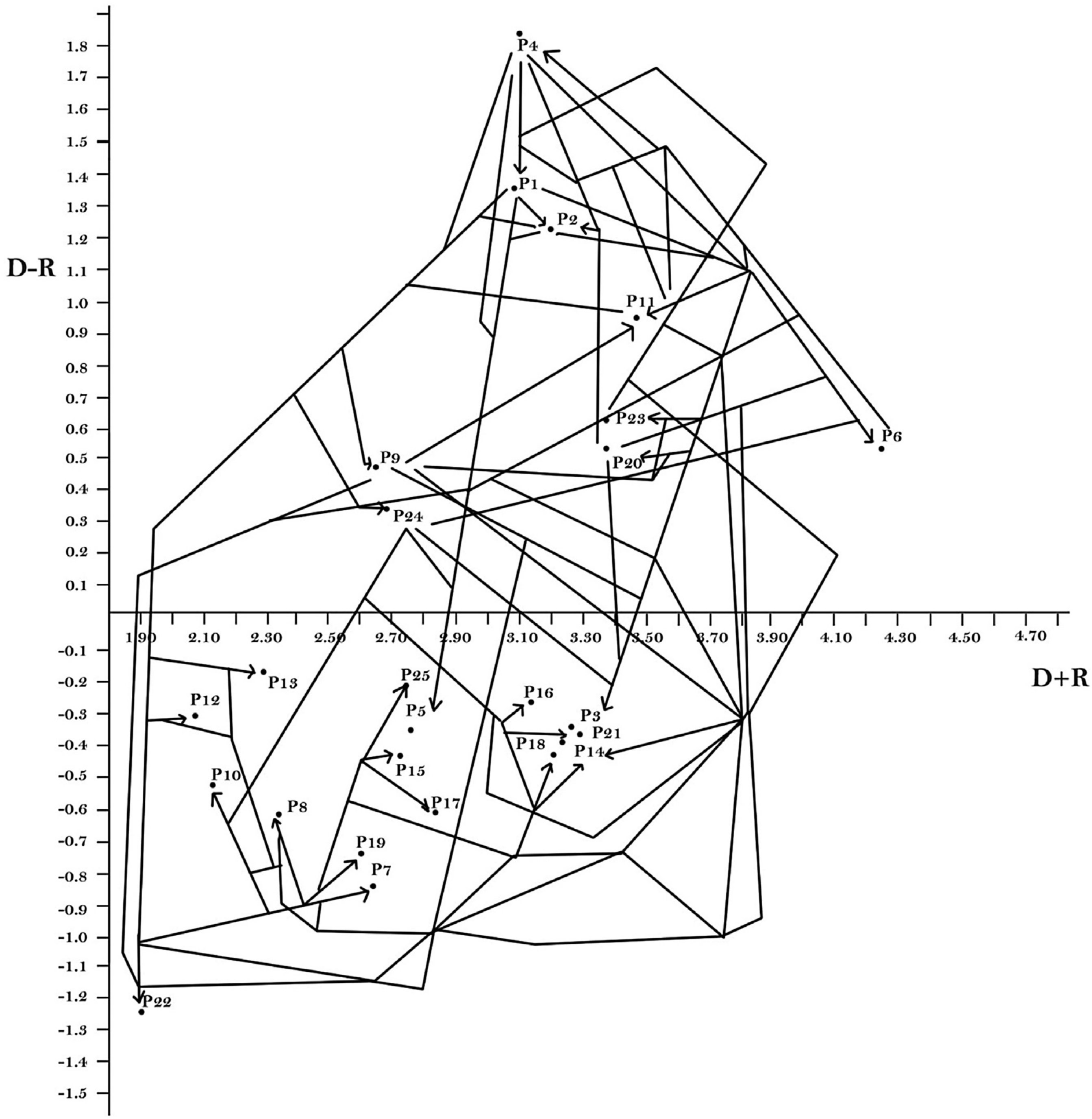

Fig. 2. Prominence and Relation between the SSCM practices—Management perspective.

depicted by means of arrows. The arrows in the figure represent the relationship between two practices. The tail of the arrow is generally at the practice that exerts influence on the other practice; the head of the arrow is at the practice that is the net receiver of the influence. The elements in the cause group are the influencing criteria and those in the effect group are the influenced criteria. In the following sections we discuss the results under two subsections: (1) the similarities and differences from the multi stakeholder perspectives, and (2) a comparison of individual results with combined perspective results.

4.1. Multi stakeholder perspective –Similarities and differences

Prominent practices with high influential effects over the other practices, as found in each category of perspectives, are summarized in Table 15 below. This table shows the most influential practices in each perspective and the combined results. It can be seen that practices P1, P2, P4, P6, P9, P11, P20, P23, and P24 fall in the cause group for all perspectives. In each of the perspectives,(P4), commitment from the management towards SSCM, gets the highest priority, proving that management commitment to move forward from old traditional systems and practices is the first sign of change. Other practices cannot be followed voluntarily without the commitment from the management. The second

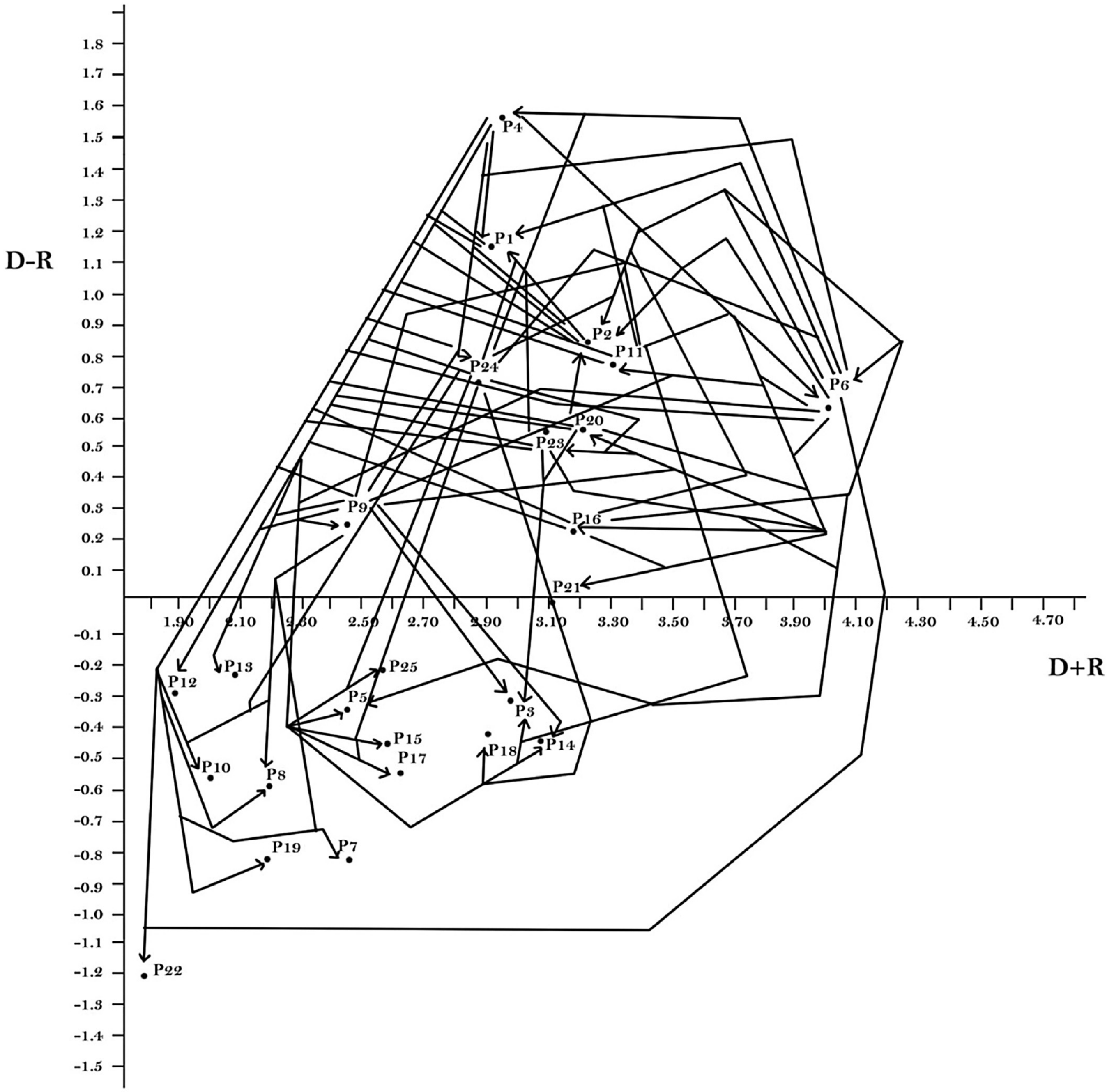

Fig. 3. Prominence and Relation between the SSCM practices—Government perspective.

item in the list of prioritized practices is (P1), the triple bottom line approach. The triple bottom line approach ensures that equal importance is given to all three dimensions of sustainability (social, environmental, and economic) in all strategic decisions to be made by the company, thereby incorporating sustainability into the foundation of the organization. Practice (P2), supply chain orientation, scores third in the list. All these three top prioritized practices are management-oriented practices. The other common influential practices are P6, P9, P11, P20, P23, and P24. The common practices which fall under the effect group make a slightly longer list. Those in the effect group are P3, P5, P7, P8, P10, P12, P13, P15, P17, P18, P19, and P21. These practices are technically the antecedents of the causal practices.

The causal group of practices in each perspective features the same practices as in the other perspectives, but there are a few uncommon practices noted. Those specific practices are highlighted in Table 15. The uncommon practices that fall in the causal group are (P16), Redesigning processes for emissions reduction-activities, which ranked as a higher priority in the governmental perspective, and (P14) and (P25), technological integration and worker safety and human rights, which earned higher priority in the societal perspective. These are the practices which failed to make the cut to the influential list in the combined perspective; apparently these practices did not catch the attention of management or government respondents as vital to the shift to SSCM. This result suggests that management and government stakeholders may prioritize economic benefits over human rights.

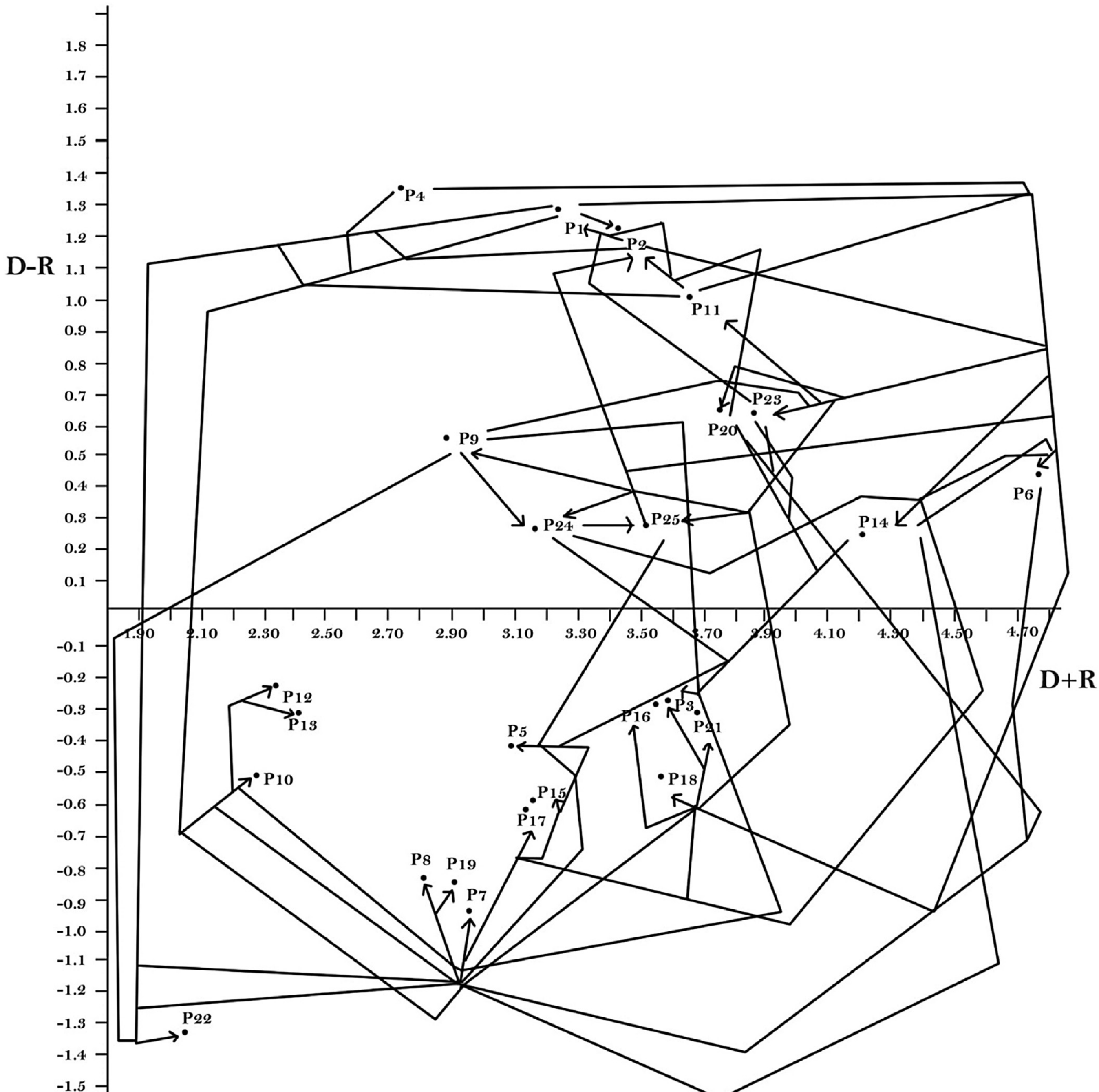

Fig. 4. Prominence and Relation between the SSCM practices—Societal perspective.

4.2. Comparison of individual perspectives with the combined stakeholder perspectives

Combined stakeholder perspectives are nothing but the average of the responses obtained from individual perspectives. From the combined perspective, practices P1, P2, P4, P6, P9, P11, P20, P23,and P24 form the nine elements of the cause group that are similar to the individual perspectives. The most influential practice is (P1), commitment from management towards sustainable development, and the least influential practice is (P22), cooperation with customers, which coincides among all three perspectives.

From this study we infer that although pressures from external stakeholders exert influence, change has to come from within the organization to adopt SSCM practices. In a country like India, one of the leading producers of automobiles tries to move towards SSCM from their own initiative to attain a competitive edge over other firms. Whereas compliance with mandatory practices, such as regulations and certifications imposed by the government and by human rights, provides motivation to adopt SSCM practices, ultimately internal practices imposed by the management hold the key to change. Practices such as employing the triple bottom line approach and incorporating supply chain considerations throughout all decision making aspects play a pivotal role in influencing the other practices. Hence, these are mandatory practices which are prerequisites for the successful implementation of other practices.

Table 14
Sum of influences given and received for each criterion – Combined Perspective.

Practice	D sum	R sum	D + R	D-R
P1	2.2223	0.9584	3.1807	1.2639
P2	2.2798	1.1475	3.4272	1.1323
P3	1.5265	1.8846	3.4111	−0.3581
P4	2.4155	0.6861	3.1017	1.7294
P5	1.2942	1.6252	2.9194	−0.3309
P6	2.5155	1.9623	4.4777	0.5532
P7	0.9442	1.8160	2.7602	−0.8718
P8	0.9097	1.5875	2.4973	−0.6778
P9	1.6092	1.1514	2.7607	0.4578
P10	0.8214	1.3761	2.1975	−0.5547
P11	2.2378	1.3134	3.5512	0.9244
P12	0.9292	1.2338	2.1629	−0.3046
P13	1.0701	1.2740	2.3441	−0.2039
P14	1.6146	1.9132	3.5278	−0.2987
P15	1.2168	1.6890	2.9058	−0.4723
P16	1.6151	1.7622	3.3774	−0.1471
P17	1.1760	1.7821	2.9582	−0.6061
P18	1.4439	1.9155	3.3594	−0.4716
P19	0.9101	1.7097	2.6198	−0.7997
P20	2.0716	1.4707	3.5423	0.6010
P21	1.5982	1.8741	3.4722	−0.2759
P22	0.3405	1.6414	1.9820	−1.3009
P23	2.1151	1.4484	3.5635	0.6667
P24	1.7109	1.2651	2.9760	0.4458
P25	1.4506	1.5510	3.0016	−0.1004

Table 15
Prominent SSCM practices under each perspective.(For interpretation of the references to colour in the Table legend, the reader is referred to the web version of this article.)

Combined perspective	Management perspective	Government perspective	Societal perspective
P1	P1	P1	P1
P2	P2	P2	P2
P4	P4	P4	P4
P6	P6	P6	P6
P9	P9	P9	P9
P11	P11	P11	P11
P20	P20	P16	P14
P23	P23	P20	P20
P24	P24	P23	P23
		P24	P24
			P25

5. Conclusion

SSCM practices are implemented by automotive industries in order to achieve sustainability. While stringent policies and government regulations of developed nations easily allow firms to adopt SSCM practices, industries in an emerging nation like India struggle to do the same. They find it difficult to identify the prominent practices that have high influence over other practices to adopt SSCM. Once those prominent practices are identified and effectively implemented, they act as enablers for many other practices; the firm can then follow all the necessary SSCM practices. DEMATEL, a well-known MCDM technique, suits this kind of problems where there are inter relationships within the criteria (Jia et al., 2015b). This method classifies the relationships between criteria as influencing and being influenced. DEMATEL is a novel approach used both to form and to analyze the cause and effect relationship between criteria (Yang et al., 2008) and/or to infer the inter relationship among criteria considered (Lin and Tzeng, 2009). From the results obtained from our analysis, we present the following conclusions. 25 SSCM practices followed in the automotive industries were identified from the existing literature; all practices aid the firm in achieving a sustainable supply chain through which they may gain a competitive advantage over other firms. But concentrating effectively on all SSCM practices is practically impossible. Hence, it is important to find the most prominent SSCM practices, especially those that positively influence other practices. The prominence and the influences of the 25 practices were studied using DEMATEL from multi stakeholder perspectives. The multi stakeholder collaboration is a majorly incorporated element across the globe and, hence, more attention is based on collaboration between the various stakeholders for sustained success (McComb et al., 2016). Due to the complexity of the data and due to the availability of only qualitative data, experts from relevant fields in south India were targeted and their opinions were collected through questionnaire surveys. This study explored the views of management, government, and societal stakeholders on SSCM implementation. Although the stakeholders have a difference in their preferences towards practices, the top practices ranked in each perspective were the same. The study revealed that for automotive sectors of India, management commitment, including supply chain orientation and the triple bottom line approach in all aspects of the supply chain, are the most prominent practices. These three factors act as driving forces for the remaining practices to improve sustainability of the firm. By improving the cause group, the effect group will also be easily improved (Falatoonitoosi et al., 2013). Hence, these prominent practices should be focused upon and maintained accordingly for better implementation of other practices and for sustainability. All the top practices identified are management-related practices in each of the three stakeholder perspectives and also in the combined perspectives. This finding reveals that in emerging nations such as India, the internal commitment from the management (P4) plays a larger role in identifying the way forward towards sustainability than governmental rules and regulations. The study was mainly focused on the extreme case, considering the private sectors where management is completely responsible for the firm's action of implementing the rules and regulations proposed by the government, but our results are also applicable for general public automotive sectors. In a country like India, the majority of the automotive sectors are owned by private organizations, and hence it is evident that the results of the current study can be applied generally to all Indian automotive sec-

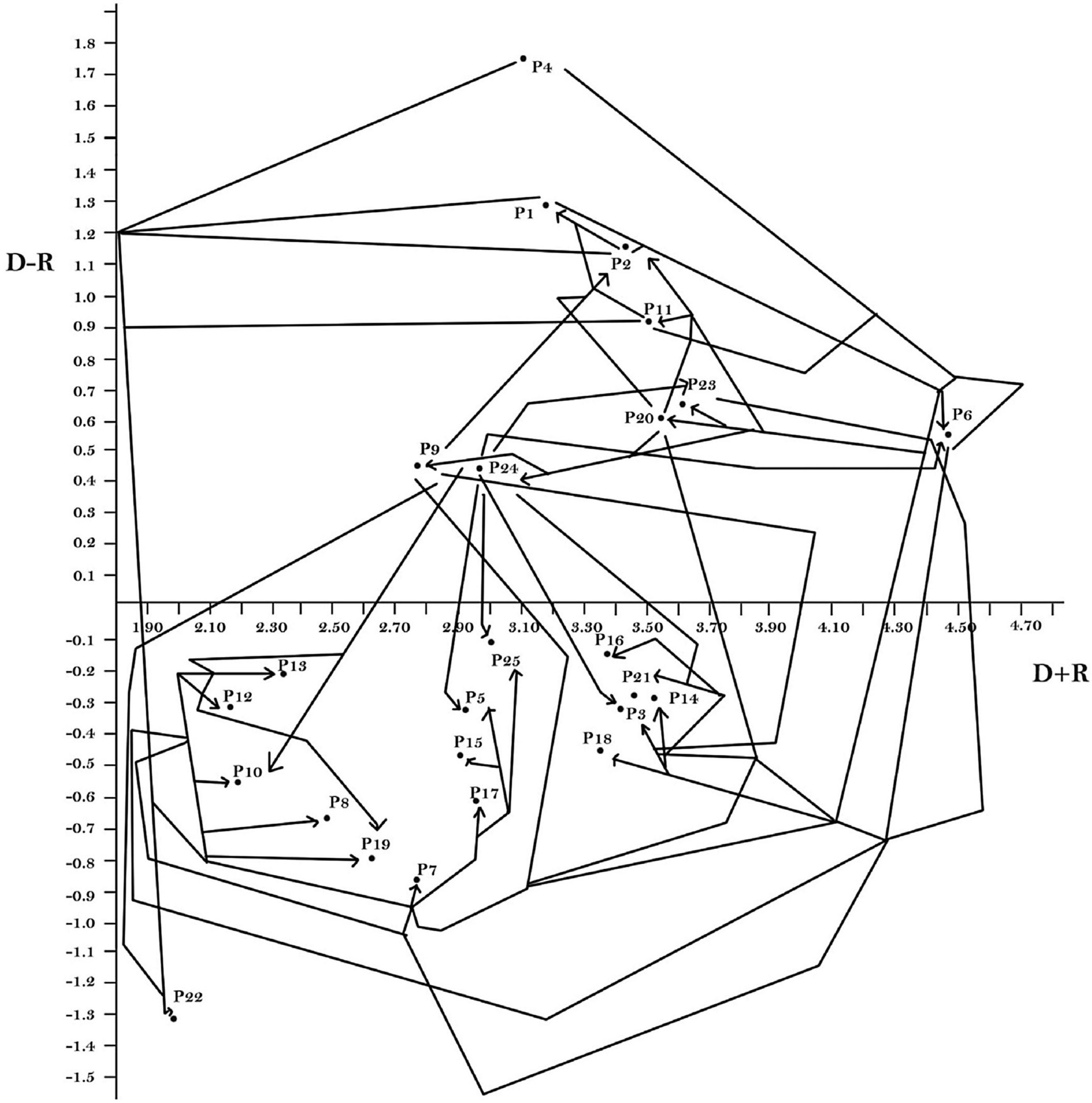

Fig. 5. Prominence and Relation between the SSCM practices—Combined perspective.

tors. The managerial implications, limitations, and future scope of the study are discussed in the following section.

6. Managerial implications

The current study includes managerial level implications by exploring dominant SSCM practices in automotive industries in an Indian scenario; it also provides a scientific approach that identifies and evaluates the inter influences among the SSCM practices. The outcome of the study helps managers of automotive industries to identify, prioritize, and adopt appropriate practices for the shift towards SSCM. The current work classified 25 SSCM practices into six main categories and provided insights on their nature. One of the implications is identifying the categories under which the practices fall. Once the categories are identified, it helps the managers to easily identify the performance-based practices which should be emphasized. DEMATEL, a method to study the relationships among the practices, helps the managers to understand the cause and effect type of relationships among the SSCM practices. Through this study, the inter influences between practices for implementation of SSCM are explored, which will help industrial managers to effectively implement SSCM by concentrating on the most effective practices. The multi stakeholder view helps to identify what each stakeholder emphasizes, and the collective analysis of all stakeholders' views provides an in-depth understanding of their views while still respecting their varied importance. This study can help as a valuable tool to provide useful interpretational information both for researchers and practitioners and to provide a basis for companies trying to introduce and implement SSCM through a wide range of practices, especially in a country like India which faces domestic and international pressure in moving towards SSCM. The approach used in the study provides a kick- start guidance on the effective implementation of SSCM considering the relationships among the practices. Organizations can identify the set of influential practices and implement them first, and then, introduce the other practices in a sequential, step-by-step basis, utilizing the causal and effect relationship for the best performance.

7. Limitations and future scope

In the present study, the inter relationships between SSCM practices of automotive industries have been studied from multi stakeholder perspectives with the background of an emerging economy, India. Future research may wish to pursue other emerging nations such as Brazil or China, who have not been considered in the present study. This study is based on experts' opinions. Its limitations may include that practical implementation has not been focused upon, and that this study builds on empirical insights from the judgment of automotive industry experts. There may be some scale of error in judgment. The other limitation is that the present study evaluates the importance of any practice based on its influence over the other practices. Practices which do not possess inter influences with other practices may also be vital practices, so incorporating a networking approach such as ANP and other advanced techniques can overcome such limitations (Govindan et al., 2016b,c; Hong et al., 2017; Shen et al., 2013).

The present study is done on sustainability implementation in automotive industries. Future studies may be extended to other industries in general. The practices implemented in other industry sectors may vary in importance and influence. Hence, other specific industry sectors, such as service, food etc., can be focused upon. Another extension could compare diverse scenarios by conducting the same study in different countries, which may provide better insights into their organizational cultures. Because the present study is based on experts' opinions, research by conducting case studies of the practices in relevant industries might be done. In that case, real scenario influences can be studied and verified.

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