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Investigating the interactions among benefits of information sharing in manufacturing supply chain

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C H R O N I C L E

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A B S T R A C T

Manufacturing organizations are under the pressure to give quality products at least cost within the possible minimum delivery time, even during unpredictable economic conditions. Due to competition like improved customer service and cost reduction, organizations are looking for innovative ways for creating competitive advantage. One such way is the effective information sharing among all the members of supply chain. To understand information sharing, we have to know the benefits of information sharing within the supply chain. In this study, on the basis of the relevant available literature and the suggestions of an expert team composed of managerial and technical experts of the manufacturing organization and academicians, eleven information sharing benefits have been diagnosed. An ISM-based model has been formed to study the understanding of the information sharing benefits in adopting the right information sharing within a manufacturing industry. We propose the ISM model, and a MICMAC investigation is applied. Its practical significance is to make use of the decision makers' knowledge to give a fundamental understanding of a complicated situation, followed by a course of actions for problem-solving.

1. Introduction

Manufacturing organizations are under the pressure to give quality products at least cost within the possible minimum delivery time, even during unpredictable economic conditions. Due to competition like improved customer service and cost reduction, firms are looking for innovative ways for creating competitive advantage, and one such way is Supply Chain Collaboration (SCC) (Salam, 2017). Globalization and competitive pressures have increased demands on firms to fulfill the customer needs all over the globe on time (Zaabi et al., 2013). Supply Chain Management (SCM) literature shows a growing interest in Supply Chain (SC) (Kaliani Sundram et al., 2016; Azadi et al., 2014). It has the requirement for more relationships among Supply Chain (SC) members (Zhao et al., 2011). The collaboration between supply chain members has become a common practice in many modern supply chains (Ramanathan et al., 2011). SCC is the relationship among supply chain members developed over a period of time to gain higher quality, lower cost, greater product innovation, enhance market value, and reduce risks (Gunasekaran et al., 2015). SCC largely depends on the Information Sharing (IS)

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among the supply chain partners, IS within SC is the effective strategy to increase SC performance (Montoya-Torres & Ortiz-Vargas, 2014). In current market conditions, the business environment has been defined as more as volatile and unpredictable due to faster-changing consumer demands, which results in more uncertainty in demand and supply (Roh et al., 2011). Right IS strategy collaborate the SC independent players, and prepare them to achieve a common goal in fast changing market conditions. Therefore organizations are adopting IS strategies time to time in order to effectively use their resources and proper sharing of knowledge throughout the supply chain (Caridi et al., 2005) (Verwaal & Hesselmans, 2004).

Organizations having practice IS strategies in their supply chain gain large benefits as compared with the firms which perform individually. The benefits from IS are in the form of efficiency and effectiveness like they have less cost of the overall supply chain as compared with, not IS supply chain organizations. Due to large benefits of sharing information in SC, very large numbers of organizations are going to apply more and more IS strategies to enhance the performance of their supply chain (Mathuramaytha, 2011). Therefore the study related with the IS in the supply chain is one of the emerging topics in this global environment (Barratt, 2004). IS made two or more firms sharing the responsibility of exchanging management, planning, execution, and performance measurement information, and acts as driving force behind SCM (Horvath, 2001). A large number of literatures supported that the information sharing (IS) plays a significant role in SC. The identified benefits of IS are a reduction in bullwhip effect, increase visibility, a reduction in cost and inventory etc. in spite of large numbers of benefits to sharing information within SC, but for a proper understanding of IS, and taking the right benefits from it, the benefits of IS is very important. In literature, the benefits of IS is ignored, so there is a large need to study benefits of IS in manufacturing organizations (Hudnurkar et al., 2014).

SCM is an important area of research for researchers and practitioners from a large number of disciplines. SCM has been starting from past seven decades, starts with the name traffic (Forrester 1961), then it becomes order management, and further came to warehousing departments. Then it would come under the name of the physical distribution. Then inventory management which further allowed by customer service then added a new term integrated logistics, and further production planning and procurement, then it became SCM, this is further embedded into the value chain, which ultimately accounts for the values related to demand and supply. IS benefits are the all related multiple advantages of the supply chain. Different members of SC cannot compete individually, so a continuous dynamic system of IS is required, through which all members become part of a unified system and come close and collaborate with other members of the SC to achieve a common goal, and sign all necessary documentation for SC activities so do according to the sign agreements and work to get the required supply chain performance. There is very less study, which discussed benefits of IS within SC in the manufacturing sector, as well as no study, discussed the interactions among these barriers.

In this study, on the basis of the relevant available literature and the suggestions of an expert team composed of managerial and technical experts of the manufacturing organization and academicians, eleven IS benefits have been diagnosed (Diabat et al., 2013). Analyzing the interactions among the benefits, and implementing the interpretive structural modeling (ISM) methodology, this work pursues to establish the following contributions:

- First, an ISM-based hierarchical model is built. The model provides the understanding of the IS benefits in adopting effective IS within SC in manufacturing organizations. Based on the understanding, decision makers can prepare the company to implement right IS in SC.
- Second, an impact matrix cross-reference multiplication tested to a classification (MICMAC) analysis is implemented. The analysis shows that there is no autonomous IS benefit. It indicates that all the identified benefits have an important role in the implementation of right IS in SC.

Thus, the ISM-based model and MICMAC analysis may be treated significant additions from this research work.

The rest of the paper is formulated as follows. Section 2 describes the review of the existing relevant literature. Section 3 describes the problem description. Section 4 describes the methodology. Section 5 describes the application of the proposed methodology. Section 6 describes results and discussion. Section 7 describes the managerial implications, and the conclusion is in Section 8.

2. Literature survey

Since the 1980s, SCM is the area of interest All of the academicians and practitioners are equally interested in this field (Stock et al., 2010; Wisner, 2003). SCM is the new area of interest by comparing with another area in the field of management studies (Pilbeam & Oboleviciute, 2012; Wilding et al., 2012; Larson & Halldorsson, 2004). Due to competition, there is a reduction in product life cycle, which builds pressure on supply chain members, which is tolerated by adding new strategies that increase directly and indirectly scale of economy and customer satisfaction (Mentzer et al., 2004). SC needs a strategic alliance, inventory control, cross-organizational logistics management, joint planning, and supplier-buyer relationships, and IS (Banomyong & Supatn, 2011). Inadequate IS in the SC does not give the optimal performance of the firm (Ding et al., 2011; Kaipia, 2009; Charan et al., 2008).

Therefore, adequate IS strategy of SC is a must for manufacturing organizations. The IS having large numbers of advantages throughout the SC. These advantages are known as benefits. By sharing information there is a better result for uncertainties in demand and supply (Xu & Beamon, 2006). Proper IS system in the supply chain is the requirement to construct more responsive and efficient chain to provide values to the customer (Gunasekaran & Ngai, 2012; Gunasekaran, 2001).

SCM has been a considerable component of a competitive strategy to increase organizational productivity and profitability (Gunasekaran et al., 2004). In spite of SCM has large literature, the concept of IS is still under study, but some companies have been using IS in different ways for several decades (Danese, 2007). Since last three decades, academics and practitioners have interested in various types of IS strategies in the supply chain (Danese, 2006). There are very large numbers of benefits of IS but the right observation regarding the benefits of IS and how to start sharing information and at where is the present situation is still challenging for supply chain partners (Fawcett et al., 2012; Soni & Kodali, 2012; Halldórsson et al., 2009). These are the various crucial benefits which made IS more successful in SC, these benefits accelerate the firms to enhance IS within the SC (Leeuw & Fransoo, 2009). IS between supply chain members make benefits, like inventory reduction, On time delivery service, and lesser product development Cycles (Fawcett et al., 2007).

It is a necessity that, Which are various IS benefits that reflect value in SC, and how to analyze these benefits in an organization to gain value from sharing information within SC (Kumar & Banerjee, 2012). IS supported the organizations to enhance their SC performance, it increases the connectivity within SC (Sanders & Wagner, 2011). Information Technology (IT) is one of the component of IS in SC (Ding et al., 2011). Hence, organizations have to have strong IT infrastructure to use technology to enhance IS in SC members (Benitez-Amado et al., 2010). The right SC depends upon the synchronization of the material flow and information flow within the SC (Lee et al., 2011). Effective SC is the long term relationships among all supply chain members and it is the output of effective IS within SC (Allesina et al., 2010)

3. Problem description

From the literature about sharing information in SC, the study of IS benefits in the SC is still under research. No study discussed interactions among the benefits. Therefore more research on IS benefits is required to understand and implementing IS in the supply chain. After a literature survey and

discussion with the expert team, eleven IS benefits to understanding and implementing right IS strategy within SC have been identified. The identified IS benefits are shown in Table 1.

Table 1
The identified information sharing benefits.

Sr. No	benefits	Description	Source
1	Increased productivity	SC productivity is generally a ratio of net profits to assets in an organization. The ratio is also known as return on invested capital. With the improvement of the education of employee, and improvement in services, products, and processes, the productivity of SC improved. Increased productivity is the principal benefit of improved sharing of information within SC.	Mourtzis, 2011; Yang & Maxwell, 2011; Lee & Whang, 2004; Bagchi & Skjøtt-Larsen, 2004; Attaran, 2004; Ferdows et al., 2004; Zahedirad & Shivaraj, 2011; Simatupang & Sridharan, 2004; Min et al., 2005; Lau et al., 2008; Flynn et al., 2010; Nyaga et al., 2010; Kache & Seuring, 2014; Kim, 2013; Yazar Soyadı & Ince, 2015; Tokman & Richey 2007
2	Inventory Reduction	Inventory plays a major role in SC; it makes the balance between supply and demand throughout the SC. To fulfill the demands of customers, which is very difficult to forecast, is possible only through inventory. At the same time, extra inventory becomes a burden for the chain and increase expenditure. Reduction in all types of inventory directly effects on the performance of the chain, and it is possible only by enhancing the share of information within all SC members.	Mourtzis, 2011; Lee et al., 2000; Lau et al., 2002; Lee & Whang, 2004; Gupta et al., 2001; Attaran, 2004; Min et al.; 2005; Ferdows et al., 2004; Leonard & Cronan, 2002; Min & Mentzer, 2000; Zahedirad & Shivaraj, 2011; Kim et al., 2005; Li et al., 2006; Lau et al., 2008; Flynn et al., 2010; Nyaga et al. 2010
3	Elimination of bullwhip effect	The bullwhip effect in SC is the distortion in demand, which moves upstream in SC because of the variation in orders which might be greater than a sale. Bullwhip effect piles the inventory at various levels in SC, which increase cost and reduce the performance of SC. By sharing more information about the actual consumer demand upstream in the chain, bullwhip effect diminishes.	Min et al., 2005; Lee & Whang, 2004; Li & Gao, 2011; Jauhari, 2009
4	Increase visibility	SC visibility is the quality of the chain, by which products and parts in transit have to be tracked by the specific members of the SC. It increases the value of the chain by readily available information to all stakeholders and customers. By increasing information sharing visibility of the SC also increases.	Fiala, 2005; Li, 2006; Min et al., 2005; Lee & Whang, 2004; Bagchi & Skjøtt-Larsen, 2004; Callioni et al., 2005; Jayaram et al., 2004; Lee, 2004; Min & Mentzer, 2000; Khan et al., 2006; Daugherty et al., 2006; Smirnova et al., 2011; Nyaga et al., 2010; Kim et al., 2005; Sheu et al., 2006; Li et al., 2006; Kache & Seuring, 2014
5	Improved resource utilization	Resource sharing is the process of sharing and investing in capabilities and assets within SC partners. Resources may be technology, facility, manufacturing equipment, and physical resources. Resource utilization enhances with increasing the flow of information in SC.	Mourtzis, 2011; Lee & Whang, 2004; Leonard & Cronan, 2002; Timme & Williams-Timme, 2000; Simatupang & Sridharan, 2004; Leonard & Cronan, 2002; Timme & Williams-Timme, 2000; Simatupang & Sridharan, 2004
6	SC cost reduction	Due to customer pressure and economic growth flattens, SC managers turn to reduce cost. SC cost represents a specific percentage of sale prices of a service or good. Cost reduction is a big achievement for an SC, it increases profit without increasing sales. Therefore SC cost reduces by sharing more information.	Mourtzis, 2011; Lee et al., 2000; Lau et al., 2002; Lee & Whang, 2004; Bagchi & Skjøtt-Larsen, 2004; Kaas & Ohl 2002; Leonard & Cronan, 2002; Rajib et al., 2002; Khan et al., 2006; Kim, 2013; Yazar Soyadı & Ince, 2015; Tokman & Richey, 2007)
7	Early problem detection	Effective sharing of information in SC reduces uncertainties in the chain. By enhancing the IS, the SC gains the ability to define the uncertain variations happening at an earlier stage. Sharing information makes SC managers capable of taking preventive actions to mitigate the problem.	Lee & Whang, 2004; Jauhari, 2009; Grabot et al., 2010; Min & Mentzer, 2000; Simatupang & Sridharan, 2004; Sheu et al., 2006; Lau et al., 2008; Flynn et al., 2010; Nyaga et al., 2010; Chen et al., 2013
8	Earlier time to market	Time to market is the time taken by a product, from the idea generation to its launch in the bazaar. It includes design, development, and delivery of new product to the bazaar. Right IS reduces this time up to certain extent.	(Lee & Whang 2004) (Attaran 2004) (Lee 2004) (Leonard & Cronan 2002)
9	Expended network	The SC is also known as supply network, it is a network of suppliers, manufacturers, wholesalers, distributors, and consumers. The effective IS increasing the supply network.	Lee & Whang, 2004; Bagchi & Skjøtt-Larsen, 2004; Marshall & Bly, 2004; Timme & Williams-Timme, 2000; Simatupang & Sridharan, 2004; Khan et al., 2006; Simatupang & Sridharan, 2002; Yazar Soyadı & Ince, 2015
10	Reduce cycle time	Cycle time is the time taken by a process from beginning to end, in SC it is the time period starts from an order placing and ends with an order received. It is also known as lead time. With IS increasing the cycle time reduces.	Bagchi & Skjøtt-Larsen, 2004; Lee, 2004; Min & Mentzer, 2000; Tyndall, 2000; Simatupang & Sridharan, 2004; Nooteboom & Haverbeke, 2007; Hult et al., 2004; Jayaram et al. 2004; Lee, 2004; Waller, 2000; Min & Mentzer, 2000; Simatupang & Sridharan, 2004; Khan et al., 2006; Daugherty et al., 2006; Smirnova et al., 2011; Nyaga et al., 2010; Kim, 2013
11	Quick response	Quick response is the reduction of internal and external lead time; it is the process of working with efficiency and effectiveness. It is the process to respond quickly to customer needs. It also lowers costs by reducing inventory and enhances the quality of the product by rapid replenishment. Quick IS gives a quick response to the needs of the customers.	Lau et al., 2002; Jauhari, 2009; Attaran, 2004; Lee, 2004; Leonard & Cronan, 2002; Gupta et al., 2001; Jayaram et al., 2004; Lee, 2004; Waller, 2000; Wagner et al., 2002; Simatupang & Sridharan, 2004; Min et al., 2005 Khan et al., 2006; Smirnova et al., 2011; Nyaga et al., 2010; Kim et al., 2005; Sheu et al., 2006; Li et al., 2006; Lau et al., 2008; Nyaga et al., 2010; Chen et al., 2013; Kim, 2013

4. ISM methodology

ISM methodology is mainly designed as a group learning process, but can also be used individually (Haq & Kannan, 2006). ISM methodology converts unclear models of systems into well-defined models, which is useful for many purposes. ISM methodology is used for a systematic and logical thinking approach, this gives order and direction for various complicated relationships among the variables (Jharkharia & Shankar, 2004; Singh et al., 2003). ISM methodology asks for grouping expert opinion by grouping various methods like nominal technique, brain-storming, and affinity diagramming in making contextual relationships among the variables (Ravi & Shankar, 2005). The ISM methodology has been proposed for modeling the barriers to implement green supply chain management in the Indian automobile industry (Balon et al., 2016). The ISM methodology has been used in Indian cement industry to model the variables of energy conservation by using direct and indirect interrelationships (Saxena et al., 1992). The ISM methodology was used to modeling the future objective variables of waste management (Sharma & Gupta, 1995). The ISM model was developed for supplier selection in manufacturing company, having the build-to-order type supply chain environment (Haq & Kannan, 2006). The ISM methodology was used for modeling the variables affecting in the green supply chain management (Diabat & Govindan, 2011).

The main drawback of ISM methodology is that of the unfairness of the expert who is deciding the variables, will affect the final model (Haq & Kannan, 2006). ISM methodology does not give any weight-age to the variables. In this study, we identify interactions of the IS benefits for SC in implementing an effective IS strategy in the manufacturing sector.

The procedure for ISM methodology (Haq & Kannan, 2006).

1. The IS benefits are listed.

2. Develop a contextual relationship for each benefit with respect to other benefits.

3. To show the pair-wise relationships between IS benefits develops structural self-interaction matrix (SSIM), which is based on step 2.

4. Develop and check transitivity of reachability matrix, which is based on SSIM. This matrix is confirmed for transitivity. Transitivity means if a variable ‘X’ is related to ‘Y’ and ‘Y’ is related to ‘Z’, then ‘X’ must be related with ‘Z’.

5. Differentiate the reachability matrix into different hierarchical levels.

6. Draw directed graph from the relationships in reachability matrix and delete transitive links.

7. Develop ISM model by replacing IS benefits nodes with statements.

8. Check conceptual inconsistency of the model and do modifications if necessary.

The flow chart for the ISM-based methodology is shown in Fig. 1.

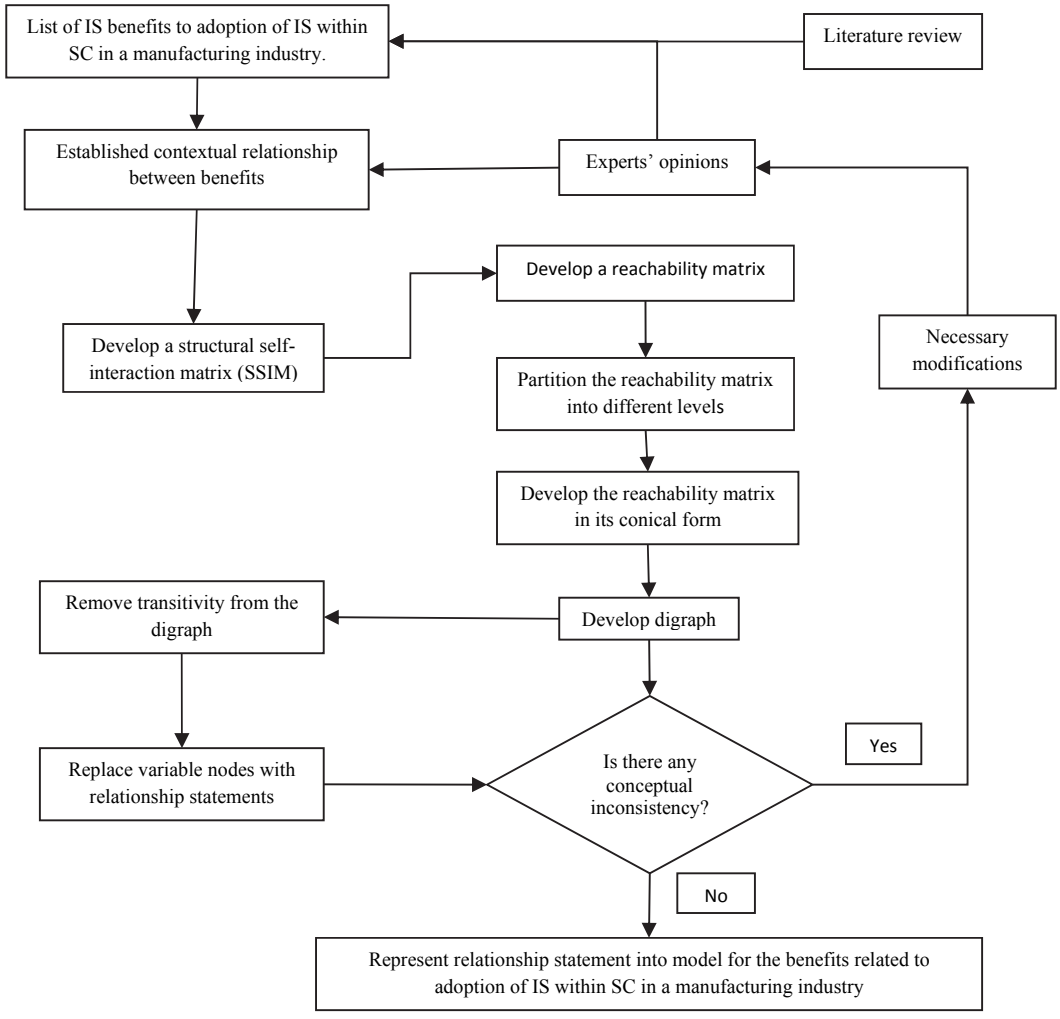

Fig. 1. Flow chart for the ISM-based methodology

5. Application of the ISM-based methodology for IS benefits to the implementation of effective IS within SC

In this section, the above-discussed methodology of ISM is used to model the various IS benefits for the right supply chain. Eleven IS benefits have been selected after discussion with the expert team and backed by existing available literature. The selected IS benefits are shown in Table 1. After the analysis of interactions among them, IS benefits, an ISM-based model is developed following the procedure discussed in section 4.

5.1 Overview of the manufacturing sector

Adding accounts in this competitive environment is not easy, companies increasing their efforts to retaining existing customers as well as remain competitive in the market and it is possible only by giving more values to the customers. Due to competition, there is a reduction in product life cycle, which builds pressure on supply chain members, which is tolerated by adding new strategies that increase directly and indirectly scale of economy and customer satisfaction (Mentzer et al., 2004).

The Manufacturing industry is a fundamental part of the economy (Bhanot et al., 2017). Supply chain growth is reasonable in developed economies and increasing in emerging economies (Subramanian &

Gunasekaran, 2015). This study, the manufacturing industry is considered to model the various IS benefits for the right IS implementation in SC. This work will helpful for SCM of the industry to analyze the interactions among them, and IS benefits while implementing right IS system in the industry. Firstly the process of implementation of right IS system in the manufacturing sector has been discussed with the expert team. Eleven benefits have been identified after several times discussion with the expert team and supported by existing available literature. The considered IS benefits, discussed above, and is tabulated in Table 1. After the process of interactions among the benefits, an ISM-based model is proposed following the procedure is given in section 4.

5.2 Structural Self-Interaction Matrix (SSIM)

Based upon the contextual relationships between IS benefits, the relation between those two benefits *i* and *j* and direction between these two are discussed. The four alphabets as a symbol have been used to relate directionally one benefit with another (*i* & *j*) (Warfield, 1974).
V - benefit *i* leads to benefit *j*.

A - benefit *j* leads to benefit *i*.

X - benefits *i* & *j* helps each other.

O - benefits *i* & *j* are not related.

In this study first benefit leads to fifth benefit so we use symbol 'V' in the (1, 5) cell; first benefit leads to the third benefit so we use symbol 'A' in the (1, 3) cell; first and seven benefits help each other so we use symbol 'X' in the (1, 7) cell; first and second benefits has no relation so we use symbol 'O' in the (1, 2) cell & so on. The relationships are made for the remaining IS benefit in Table 2.

Table 2
SSIM for the IS benefits

Self-Structured Interaction Matrix											
Sr No.	List of IS benefits	11	10	9	8	7	6	5	4	3	2
1	Increased productivity	A	A	V	O	X	V	V	O	A	O
2	Inventory Reduction	A	O	O	V	O	A	A	V	O	
3	Elimination of bullwhip effect	A	O	V	V	O	V	O	O		
4	Increase visibility	V	V	V	V	V	V	V			
5	Improved resource utilization	A	A	V	V	A	O				
6	SC cost reduction	A	V	O	O	O					
7	Early problem detection	A	A	V	A						
8	Earlier time to market	A	A	A							
9	Expended network	A	V								
10	Reduce cycle time	X									
11	Quick response										

5.3 Reachability Matrix

SSIM matrix is converted into a binary matrix, by substituting the sign '0' or '1' in place of O, X, A, V by the rule of substitution given below (Warfield, 1974).

- In the SSIM matrix, If (i, j) value is V, then in reachability matrix (i, j) value replace to '1' & (j, i) value replace to '0'; this means V (1, 5) in the matrix, '1' for (1, 5) cell & '0'for (5, 1) cell.

- If (i, j) cell value is A in SSIM matrix, then (i, j) cell value for reachability matrix is '0' & (j, i) cell value is '1'; this means A(1,3) in the matrix, '0' for (1,3) cell & '1' for (3,1) cell for reachability matrix.

- If (i, j) cell value in SSIM matrix is X, then (i, j) cell value for reachability matrix is '1' and (j, i) cell value is also '1'; this means X (1, 7) in the SSIM matrix, '1' is for (1, 7) cell & '1' for (7, 1) cell in the reachability matrix.

- If (i, j) cell value in SSIM matrix is O, (i, j) cell value for reachability matrix is '0' & (j, i) cell value is also '0'; this means O (1,4) in the SSIM matrix, '0' is in (1,4) cell & '0' in (4,1) cell in the reachability matrix

Following this rule, the initial reachability matrix for IS benefits is formed as shown in Table 3.

Table 3
Reachability matrix for the IS benefits.

Initial Reachability Matrix											
IS benefits	1	2	3	4	5	6	7	8	9	10	11
Increased productivity	1	0	0	0	1	1	1	0	1	0	0
Inventory Reduction	0	1	0	1	0	0	0	1	0	0	0
Elimination of bullwhip effect	1	0	1	0	0	1	0	1	1	0	0
Increase visibility	0	0	0	1	1	1	1	1	1	1	1
Improved resource utilization	0	1	0	0	1	0	0	1	1	0	0
SC cost reduction	0	1	0	0	0	1	0	0	0	1	0
Early problem detection	1	0	0	0	1	0	1	0	1	0	0
Earlier time to market	0	0	0	0	0	0	1	1	0	0	0
Expended network	0	0	0	0	0	0	0	1	1	1	0
Reduce cycle time	1	0	0	0	1	0	1	1	0	1	1
Quick response	1	1	1	0	1	1	1	1	1	1	1

The final reachability matrix for the IS benefits is formed by incorporating the transitivity rule as discussed in section4. The final reachability matrix for IS benefits is reached as shown in Table 4.

Table 4
Final reachability matrix for the IS benefits

Final Reachability Matrix											
IS benefits	1	2	3	4	5	6	7	8	9	10	11
Increased productivity	1	1	0	0	1	1	1	1	1	1	0
Inventory Reduction	0	1	0	1	1	1	1	1	1	1	1
Elimination of bullwhip effect	1	1	1	0	1	1	1	1	1	1	0
Increase visibility	1	1	1	1	1	1	1	1	1	1	1
Improved resource utilization	0	1	0	1	1	0	1	1	1	1	0
SC cost reduction	1	1	0	1	1	1	1	1	0	1	1
Early problem detection	1	1	0	0	1	1	1	1	1	1	0
Earlier time to market	1	0	0	0	1	0	1	1	1	0	0
Expended network	1	0	0	0	1	0	1	1	1	1	1
Reduce cycle time	1	1	1	0	1	1	1	1	1	1	1
Quick response	1	1	1	1	1	1	1	1	1	1	1

5.4 Level partitions

The antecedent set and reachability for each IS benefits are calculated from final reachability matrix. The reachability set for a benefit is the benefit itself and other, which it influences. The antecedent set for a benefit is the benefit itself and other benefits, which might influence it. After finding both sets, the intersections between these sets are derived from the benefits. Antecedent set, Reachability, and Intersection sets are derived for all IS benefits. benefits having same intersection set and reachability set is assigned top-level in the ISM hierarchy (Haq & Kannan, 2006) and say Level 1. This is the end of iteration 1 as shown in Table 5. The level 1 is discarded from the other remaining benefits and iteration 2 is done with the same procedure above. Continue this iterative procedure until the Levels of each benefit are found out. It is understood that the IS benefits 'trust', 'empowerment', 'culture', 'supply chain collaboration', 'profit sharing', and 'market responsiveness' is at level1. The collaborative drivers 'globalization' is at level 2. The collaborative drivers 'organization structure', 'financial strategy', 'strategic planning', 'information security', and 'information flow' is at level 3.

The collaborative driver 'motivation' is at level 4. The collaborative drivers 'technology and infrastructure', and 'training and education' is at level 5. The collaborative driver 'top management support' is at level 6.

Table 5
Partition matrix for the IS benefits:

	Level Partitioning			
IS benefits	**Reachability Set**	**Antecedent Set**	**Intersection Set**	**Level**
Increased productivity	1, 2, 5, 6, 7, 8, 9, 10	1, 3, 4, 6, 7, 8, 9, 10, 11	1, 6, 7, 8, 9, 10	III
Inventory Reduction	2, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 10, 11	2, 4, 5, 6, 7, 10, 11	II
Elimination of bullwhip effect	1, 2, 3, 5, 6, 7, 8, 9, 10	3, 4, 10, 11	3, 10	IV
Increase visibility	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2, 4, 5, 6, 11	2, 4, 5, 6, 11	V
Improved resource utilization	2, 4, 5, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2, 4, 5, 7, 8, 9, 10	I
SC cost reduction	1, 2, 4, 5, 6, 7, 8, 10, 11	1, 2, 3, 4, 6, 7, 10, 11	1, 2, 4, 6, 7, 10, 11	II
Early problem detection	1, 2, 5, 6, 7, 8, 9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 5, 6, 7, 8, 9, 10	I
Earlier time to market	1, 5, 7, 8, 9	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 5, 7, 8, 9	I
Expended network	1, 5, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 7, 8, 9, 10, 11	1, 5, 7, 8, 9, 10, 11	I
Reduce cycle time	1, 2, 3, 5, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 7, 9, 10, 11	1, 2, 3, 5, 6, 7, 9, 10, 11	II
Quick response	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	2, 4, 6, 9, 10, 11	2, 4, 6, 9, 10, 11	V

5.5 ISM-based model

Form the level partitions (Table 6) the ISM model is built as shown in Fig. 2. It is observed from the ISM-based model, that the collaborative driver 'top management support' at Level 7 is very significant driver in adopting SCC in the manufacturing industry as it becomes the base of the ISM- based hierarchy (Table 6).

Table 6
Levels partitions for all IS benefits

Sr. No.	Level Number	IS benefits
		Improved resource utilization
1	1st	Early problem detection
		Earlier time to market
		Expended network
		Inventory Reduction
2	2nd	SC cost reduction
		Reduce cycle time
3	3rd	Increased productivity
4	4th	Elimination of bullwhip effect
		Increase visibility
5	5th	Quick response

MICMAC analysis

With the help of the developed ISM-based model, a MICMAC analysis is done. Based on the driving and dependence power of the identified benefits under study. The driving power and dependence power are calculated from final reachability matrix, the numbers sum of all '1's in the corresponding row and column of that benefits are the driving and dependence power. Driving power means a benefit influencing other benefits, and dependence power means a benefit influenced by other benefits. The powers of all benefits are shown in Table 7.

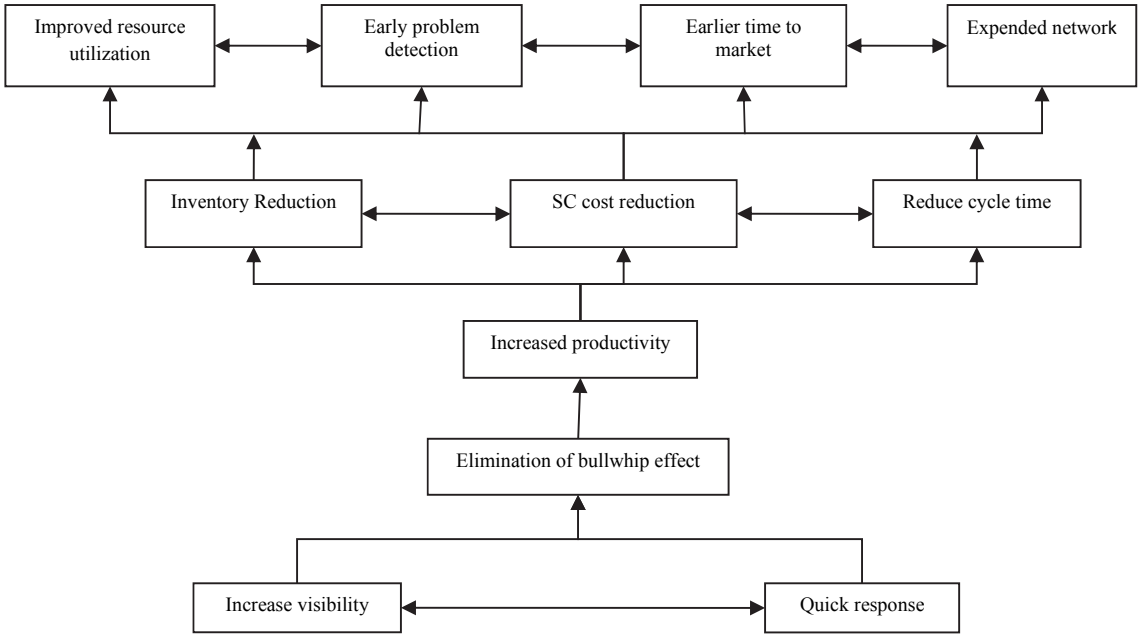

Fig. 2. ISM-based model.

Table 7
Power based ranks of identified benefits.

Sr no.	IS benefits	Driving power	Driving based rank	Dependence power	Dependence based rank
1	Increased productivity	8	**IV**	**9**	**III**
2	Inventory Reduction	9	**III**	**9**	**III**
3	Elimination of bullwhip effect	9	**III**	**4**	**VI**
4	Increase visibility	11	**I**	**5**	**V**
5	Improved resource utilization	7	**V**	**11**	**I**
6	SC cost reduction	9	**III**	**8**	
7	Early problem detection	8	**IV**	**11**	**I**
8	Earlier time to market	5	**VI**	**11**	**I**
9	Expended network	7	**V**	**10**	**II**
10	Reduce cycle time	10	**II**	**10**	**II**
11	Quick response	11	**I**	**6**	**IV**

The benefits can be partitioned into four quadrants, according to their driving and dependence power and their respective benefits are shown in Table 8.

Table 8
Grouping of benefits according to their driving power and dependence:

Quadrant no.	Name of elements	Driving power	Dependence power	IS benefits
I	Autonomous	weak	weak	
II	Dependent	weak	strong	Earlier time to market
III	Linkage	strong	strong	SC cost reduction, Inventory Reduction, Increased productivity, Reduce cycle time, Expended network, Early problem detection, Improved resource utilization
IV	Driver or independent	strong	weak	Elimination of bullwhip effect, Increase visibility, Quick response

In this study, there is no autonomous benefit. Linkage IS benefits having high driving and high dependence power, but are unstable in nature, because any action on these benefits will affect the others and also feedback on themselves. Using MICMAC analysis, a driving power and dependence power diagram for benefits is plotted in Fig. 3.

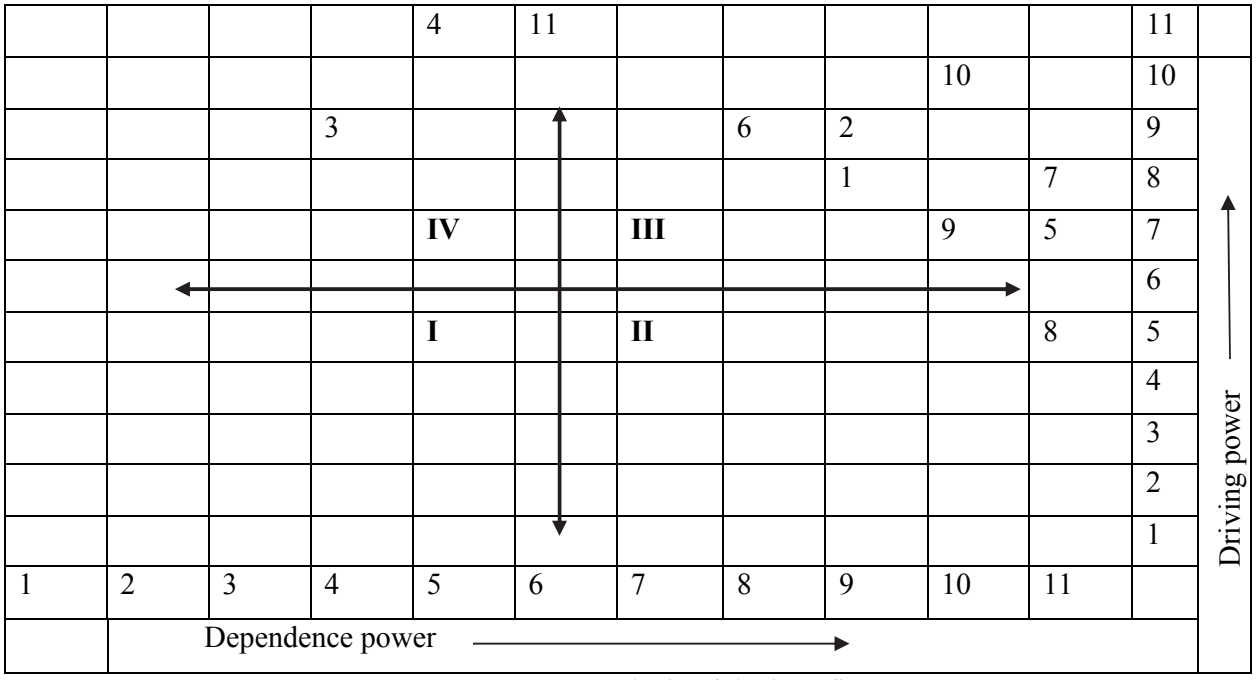

Fig. 3. MICMAC analysis of the benefits.

6. Results and Discussion

The aim of this work is to review and to analyze the interactions among the IS benefits for the implementation of effective SC in a manufacturing sector. An ISM-based model has been formed to study the understanding of the IS benefits in adopting SCC in a manufacturing industry. Propose the ISM model, and a MICMAC investigation is done. The ISM model gives a hierarchy of behaviors about IS benefits for the implementation of SCC. The supply chain decision makers can get an understanding of these IS benefits and observe their interdependencies and relative importance. The insights from the ISM-based model is that the IS benefits 'Improved resource utilization', 'Early problem detection', 'Earlier time to market', and 'Expended network' are at Level 1 and positioned at top of the ISM-based model. IS benefits have strong dependence power and weak driving power. The rest of the IS benefits are categorized on other levels as follows:

Level 2. IS benefits 'Inventory Reduction', 'SC cost reduction', and 'Reduce cycle time' is found.

Level 3. IS benefit such as 'Increased productivity' is found.

Level 4. IS benefit 'Elimination of bullwhip effect' is found.

Level 5. IS benefit 'Increase visibility', and 'Quick response' is found.

Finally, Level 5 forms the base of the ISM-based model and can be recognized a significant IS benefit in adopting right SC. This benefit has highest driving power and lowest dependence power. This implies that 'Increase visibility', and 'Quick response' plays an important role and work as the major driver in the implementation of right SC in the manufacturing industry.

By operating MICMAC analysis, the dependence-driver diagram is sketched which gives knowledge about the relative significance and the interdependencies among the IS benefit. From Figure 3, it is

found that in this work, there is no autonomous benefit. It is understood all the IS benefit examined in this work will impact the implementation of IS system in SC. Among the eleven benefits examined in this study one benefit are falling in the dependent quadrant in the dependence-driver diagram and it is acknowledged dependent benefit will depend on other IS benefit. The benefit like 'SC cost reduction', 'Inventory Reduction', 'Increased productivity', 'Reduce cycle time', 'Expended network', 'Early problem detection', and 'Improved resource utilization' fall under the linkage quadrant; they are unstable and possess high driving power and high dependence power. The remaining benefits 'Elimination of bullwhip effect', 'Increase visibility', and 'Quick response' falls under the Driver or independent quadrant, they possess high driving power and low dependence power. Hence, the proposed ISM model and MICMAC analysis will be helpful to supply chain decision makers to enhance the decision-making process. The study will contribute a clear picture about the importance of the various IS benefits.

7. Managerial Implications

ISM methodology is a technique that facilitates managers to establish a map of the complicated relationships between various elements in a decision-making process. The theoretical significance of this methodology is that it can clarify a complicated system into a hierarchical model having multiple levels. Its practical significance is to make use of the decision makers' knowledge to give a fundamental understanding of a complicated situation, followed by a course of action for problem-solving.

The ISM –based model formed in this work will give an insight to SCM decision makers about the IS benefits for the implementation of right information sharing in SC. Using this model, the supply chain decision makers can prioritize the IS benefits, take steps to maintain them, and reap the full benefits of SC. The MICMAC analysis shows that there is no autonomous benefit in the process of implementing right information sharing in SC. The autonomous benefit has weak dependence and weak driving power, and, hence, these benefits do not have much leverage on the system. This means that all the others considered IS benefits are important in the study. The ISM model and MICMAC analysis are the particular contributions of this study.

8. Conclusion

It is the necessity of every supply chain to remain competitive, for surviving in this globally competitive environment. This is possible only if all the members of supply chain collaborate with each other. Collaboration in the supply chain has become emerging part of the supply chain management. Based on the available literature and a consultation with the expert team, ten collaborative activities to the implementation of SCC in the manufacturing industry have been identified. The interaction between the IS benefit is analyzed and modeled by using ISM-based methodology.

The insights from the ISM-based model is that the IS benefit 'Improved resource utilization', 'Early problem detection', 'Earlier time to market', and 'Expended network' are at Level 1 and positioned at top of the ISM-based model. These benefits have strong dependence power and weak driving power. Similarly, the remaining benefits are found on different levels and, finally the 'Increase visibility', and 'Quick response' form the base of the ISM-based model, this benefit must be given important consideration by the decision makers in SC. Thus, the awareness about these IS benefit will help the firm to understand and implement information sharing in SC. The MICMAC analysis is carried out on the IS benefits using the dependence and driving power. The absence of autonomous benefit proves that the considered IS benefits have an important role in the implementing right IS system in SC in the manufacturing sector. Thus, ISM model and MICMAC analysis are considered as important contributions to the literature.

In this work, a relationship model among the IS benefit has been formulated using ISM-based methodology. The model is developed on the basis of the interactions among benefits as identified by the expert team having technical and managerial experts of the manufacturing sector and academicians. The limitation of this study is that the model does not give weights to the variables, so the proposed model needs to be validated using structural equation modeling, a scope for future work. Hence, a proposed model for the manufacturing sector implementing SCC may be built. The simulation modelling and analysis has also been used to measure the impact of information sharing on supply chain performance

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