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An empirical investigation of supply chain operations reference model practices and supply chain performance

Evidence from manufacturing sector

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Abstract

Purpose – The purpose of this paper is to develop and validate a scale measurement of supply chain operations reference (SCOR)-related performance indicators and proposed constructs, SCOR-related performance indicators as practices within the Indian manufacturing sector.

Design/methodology/approach – A literature-based model on SCOR processes with five constructs and respective performance indicators was empirically validated by using a structured questionnaire. A total of 155 respondents among Indian manufacturing sector participated in this research, and the returned questionnaires were analyzed by using structural equation modeling.

Findings – The study established a relationship among the SCOR-related performance indicators and overall supply chain performance indicators (OSCPI). The moderation effect of demographic characteristics, namely, employee size, company age and type of company showed significant differences between SCOR-related performance indicators and overall supply chain indicators.

Research limitations/implications – The scope of the study is limited to specific Indian manufacturing firms. The survey could not represent whole population of manufacturing sector.

Practical implications – The findings assist managers/supply chain practitioners in improving the performance measures identified using the standard framework, i.e., SCOR processes, overall supply chain performance measures as standard practices for Indian manufacturing sector for a profitable and sustainable business growth in global environment.

Originality/value – This research holds a value for suggested practices under SCOR processes and the proposed model for OSCPI, a path finder/performance measurement tool for supply chain professionals in the Indian context.

Keywords ANOVA, SEM, SCOR model, CFA, Multiple regression, Moderation effect

Paper type Research paper

1. Introduction

The supply chain operations reference (SCOR) model was developed by the Supply Chain Council (SCC) in the late 1990's and focuses on the operational aspects of supply chain management (SCM) (see Huang *et al.*, 2004). Today it is the most recognized and consistent SCM framework including seven core business processes, performance evaluation and the best practice (Figure 1).

SCOR also includes all customer interactions (order entry through invoice payment), all physical transactions (including equipment, suppliers, spare parts, bulk products, software, etc.), and all market interactions (from demand forecast to order fulfillment).

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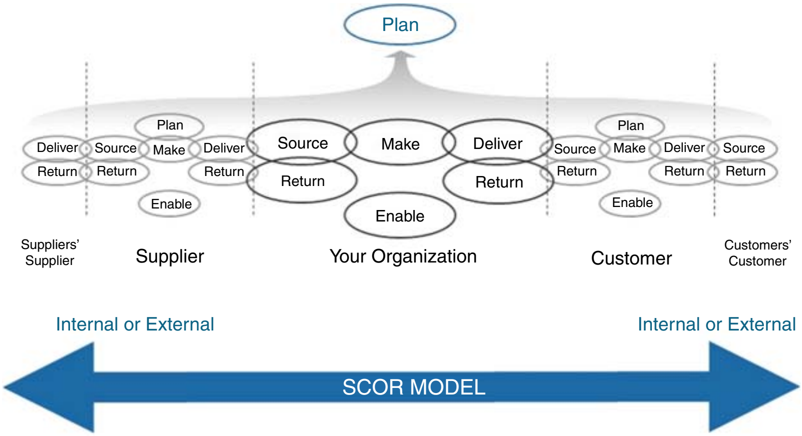

Source: Adapted from the supply chain operations reference model Version 7, Supply Chain Council (2005)

Figure 1.
Applying the SCOR model for Supply chain linkage

So far, a big number of leading companies and organizations have adopted the SCOR framework as knowledge is available on the empirical validity of the framework. One of the few works is by Zhou *et al.* (2011) who tested the power of the model for supply chain integration among 125 manufacturing companies in the USA. Furthermore, there is little work on examining the relationship between SCOR-related performance indicators and their influence on the overall supply chain performance (SCP).

In this paper, an empirical validation of the SCOR model as a performance measurement system is performed in two ways. First, we have validated the SCOR-specific performance indicators in an Indian manufacturing context. Second, we test the power of the model of being a SCP measurement system by finding out a positive influence of the different SCOR-related performance indicators performance measures on overall supply chain performance indicators (OSCPI). In order to complete our goals, a literature-based conceptual model was set up that was empirically tested with a survey among 155 Indian manufacturing companies. Our research is driven by these two research questions:

RQ1. What are the SCOR-based supply chain performance indicators (SCPI) for the Indian manufacturing sector?

RQ2. What is the influential effect between SCOR-related performance indicators and overall SCP measures for the Indian manufacturing sector?

By answering these questions we can close the identified research gaps as model development and case application for measuring SCOR as a performance system is scarce. Our literature review showed no records of prior research work on adaptation of the SCOR model for Indian manufacturing sector using empirical studies.

The paper comprises six sections. Section 2 sets the context of the research covering Indian manufacturing development sectorial view, the literature-based model and hypotheses development used by this research. Section 3 describes the research methodology covering questionnaire design, sample size and data collection approaches used. Section 4 analyses the field work data, reporting the results to assess the SCOR-related performance indicators as practices and overall SC performance indicators. Section 5 describes discussion with highlights of SCOR-related performance indicator practices prioritized by respondents as well as hypothesis testing. Last section summarizes conclusions drawn related to the SCOR-related performance indicator practices and OSCPI in the Indian manufacturing sector.

2. The Indian manufacturing development sectorial view

Studies like Dhawan *et al.* (2015), PWC (2017) and Deloitte (2017) have presented an exponential performance of the Indian manufacturing sector over the past few years. With the remarkable growth in the different segments of the manufacturing sector, all eyes are set on how the future of the industry will shape up the new policy “Make in India” promoted by government of India. A realistic assessment gives confidence that there is no dramatic decline in store for the sector – whether globally or in India.

In fact, there are opportunities to tap into certain sectors for both champions of productivity and participants in global value chains. But at the same time, churning is bound to happen on a large scale. There are success stories alongside closures. Winners and losers would get separated across sectors and within India becoming a base for export to third world countries.

For example, Hyundai Motors is using India as export base for foreign markets, currently exporting to eight countries and looking forward to expand the same to markets in the European Union and Latin America. The company has also set up an R&D center at its Chennai plant. India has world-class R&D facilities. It has come out as a global manufacturing hub with the presence of multinational companies (MNCs) such as LG, Samsung, Hyundai, Pepsi, GE, General Motors, Ford and Suzuki. India has increased implementation of state-of-the-art IT technologies, and presently, the IT usage is approximately 15 percent. The sectors showing high potential are automobiles, textiles, steel, aluminum, cement, auto ancillaries, forging and pharmaceuticals.

The manufacturing sector in India has been pioneering in SCM as well. Whether it is in automobiles or technology, a large number of MNCs see India as favorable destination for investment. For instance, various companies in automobile industry plan to set up plants in India and those having their base plan for major expansion of their existing units. The world’s leading auto part makers have relocated their product lines to India. Many leading car manufacturers are currently using India as a manufacturing and export base for their products.

According to 12th planning commission of India, an apex agency of Government of India presently restructured as National Institution for Transforming India (NITI AYOG). Combinations of different manufacturing sector classified as Group A covers strategic importance, i.e., defense equipment, aerospace, ship building and repair, commercial vehicles, electric motors, wagons, heavy locomotives. Second Group B covers basic input, namely, i.e., steel, mineral exploration, fertilizer and cement. Third Group C covers depth and value addition, i.e., automobile, electronics, pharmaceutical, chemical, paper and textile, and fourth Group D covers sector for employment: food processing, leather and leather goods, gems and jewelry. This classification was later used for our empirical study by labeling the responding companies as Group A, Group B, Group C and Group D of companies for our easiness to perform statistical analysis to accomplish the research objectives.

3. Model development

3.1 SCOR business processes as a supply chain performance view

Companies perform plenty of processes in shaping a final product and, as part of performance management, it is complex to understand/categorize these processes as key performance indicators based on different levels. Thus, SCOR model comprising of plan, source, make deliver and return are an essence, a horizontal, abstract process architecture and methodology for companies that want to develop supply chain applications from performance perspective. SCOR business processes can be categorically applied at different levels, namely, Level 1, Level 2, Level 3 and Level 4 mapping onto the management hierarchy, i.e., top, middle and lower or strategic, operational and tactical focus on performance measures of any manufacturing company.

Bolstorff (2006) classified balanced scored categories of supply chain for only Level 1 metrics for different process models covering SCOR, DCOR and CCOR. We made any attempt to view SCOR business processes from a SCP point of view in an empirical way among the Indian manufacturing sector. The SCOR reference model provides an overall architecture for supply chain systems, high-level processes and sub-processes, management goals and measures that companies can use and tailor to create their own individual supply chain systems from a performance perspective (see Table I).

Level 2 defines 26 core process categories that are possible components of a supply chain. Organizations can configure their ideal or actual operations using this process. Level 3 provides the information required for successfully planning and setting goals for supply chain improvements. This includes defining process element, setting target benchmarks, defining best practices and system software capabilities to enable best practices. Level 4 focuses on implementation, i.e., putting specific supply chain improvements into action. These are not defined within an industry standard model as implementation can be unique to each company.

In the context of SCOR, Table II presents a linkage of SCP measures to eight of the five SCOR processes as well as their foundation in the literature.

However, few researchers, namely, Georgise *et al.* (2017), argued that existing models are developed and tested based on the manufacturing sector of developed world. In developed countries, well-designed and admirable infrastructure leads to quality of information and physical goods flow among supply chain entities that is chaotic in Indian manufacturing sector. Most firms lack a clear vision to develop efficient performance metrics for SCP (Shepherd and Guenter, 2006). Sukati *et al.* (2012) argued that validating the SCP should include three different types of performance measurement – resources measurement (how well the resource is sourced), output measurement (how well it delivers value to the consumer), and flexibility (how flexible is the system to external uncertainties).

The manufacturing sector in emerging economies like India, and SCP measure using SCOR is complicated as majority of Indian companies have not implementing the concept of

Table I.
Level 1 SCOR processes

SCOR processes	Relevant activities impact on supply chain performance
Plan	Supply resources, aggregate and prioritize demand requirements, plan inventory, distribution requirements, production, material and rough-cut capacity, long-term capacity and resource planning, product phase-in/phase-out
Source	Infrastructure management, vendor certification and feedback, sourcing quality monitoring, vendor contracts receiving of material like: obtain, receive, inspect, hold and issue material
Make	Production, execution production execution activities like manufacturing, testing, packaging, holding and releasing of product, "make" infrastructure, engineering changes, facilities and equipment management, production status, production quality, shop scheduling/sequencing and short-term capacity
	Order management, warehouse management and transportation management, maintaining and entering orders, generating quotations, configuring products. Create and maintain customer database, maintain product and price database, managing receivables and credit management
Warehouse management	Pick-up, package, creating customer specific packaging/labeling, shipment of products
Transportation and delivery infrastructure management	Transportation management, traffic management, freight management

Measures/Variables	Source(s)
Overall supply chain performance indicators	
Quality of deliver goods	Li *et al.* (2005) and Chan (2003)
Cash to Cash cycle time	Chopra and Meindl (2013), Bragg (2011), Muller (2011), Hogus (2011), Law (2009), Hoffman (2004) and Wagner (2003)
Economic order quantity	Gunasekaran *et al.* (2005), Cheng (1991), Erlenkotter (1990), Lowe and Schwarz (1983), Schwarz (1972) and Harris (1913)
Delivery reliability	Chopra and Meindl (2013), Bragg (2011), Huang and Keskar (2007), Chunhua *et al.* (2003) and Kasilingam (1998)
Manufacturing lead-time	Facchin and Sellitto (2012), Tracey (2004) and Ahumda and Villalobas (2004)
Total cash flow time	Chopra and Meindl (2013), Bragg (2011), Shah (2009), Muchiri and Pintelon (2008), Stewart (1995) and Christopher (1992)
Inventory turnover ratio	Lapinskaite and Kuckailyte (2014), Muller (2011), Greasley (2008) and Sri Yogi (2015)
Warranty/returns processing cost	Mollenkopf *et al.* (2005), Rogers *et al.* (2002), Rogers and Tibben-Lembke (2001), Daugherty *et al.* (2001), Fleischmann *et al.* (2000), Carter and Ellram (1998) and Jahre (1995)
SCOR-related performance indicators	
Plan Information carrying cost Overhead cost Intangible cost Total supply chain response time Total supply chain cycle time Order lead-time Customer response time Total cash flow time Cash – cash cycle time Order entry methods Order flexibility	Fawcett *et al.* (2011), Narasimhan and Kim (2001), Gunasekaran *et al.* (2004), Makatsoris and Chang (2004), Lockamy and McCormack (2004), Hausman *et al.* (2002), Ferrari (2001), Mason-Jones and Towill (1997), Toni *et al.* (1994), Christopher (1992), Schonberger (1990), Womack *et al.* (1990) and Bower and Hout (1988)
Source Supplier cost-saving initiatives Supplier's booking-in procedures Purchase order cycle time Efficiency of purchase order cycle time Buyer–supplier partnership level Supplier rejection rate Mutual trust Satisfaction with knowledge transfer Satisfaction with supplier relationship Supplier assistance in solving technical problems Timely availability of accurate information Supplier ability to respond to quality problems	Benton (2011), Li *et al.* (2005), Chen and Paulraj (2004), Prahinski and Benton (2004), Ahmed and Schroeder (2001), Dong *et al.* (2001), Carr and Pearson (1999), Towill (1997), Maloni and Benton (1997), Thomas and Griffin (1996), Choi and Hartley (1996), New (1996), Landeros *et al.* (1995), Hill (1994), Hines (1994), Toni *et al.* (1994), MacBeth and Ferguson (1994), Graham *et al.* (1994), Stalk *et al.* (1992), Ellram (1991), Giffi *et al.* (1990), Treleven (1987), Hayes and Wright (1984) and Hahn *et al.* (1983)
Make Manufacturing cost Work in process Inventory cost Inventory turnover ratio Inventory days of supply Economic order quantity	Kaynak and Hartley (2008), Shah and Ward (2007), Nair (2006), Garcia *et al.* (2004), Fullerton *et al.* (2003), Dong and Xu (2002), Fullerton and McWatters (2001), McKone and Schroeder (2001), Cua *et al.* (2001), Pande *et al.* (2000), Benton and Shin (1998), Flynn *et al.* (1999), Fisher (1997), Levy (1997), Lee *et al.* (1997), Dobler and Burt (1996), MacDuffie *et al.* (1996), Harrington (1996), Slack *et al.* (1995), Powell (1995),Wild (1995),

(*continued*)

Table II.
Scale items and measures for performance indicators & SCOR processes

Measures/Variables	Source(s)
Warehouse costs Disposal costs Planned process cycle time Production flexibility Volume flexibility	Pyke and Cohen (1994), Henig and Levin (1992), Lee and Billington (1992), Blackburn (1991), Nakajima (1988) and Hahn *et al.* (1983)
Deliver Total logistics costs Distribution costs Delivery costs Transport costs Delivery efficiency Delivery lead-time Quality of delivered goods Quality of delivery documentation Frequency of delivery Delivery flexibility Transport flexibility	SCC (2010), Garcia *et al.* (2004), Makatsoris and Chang (2004), Ha *et al.* (2003), Dong and Xu (2002), Hausman *et al.* (2002), Ahmad and Schroeder (2001), Goldsby and Stank (2000), Gurin (2000), Mapes *et al.* (1997), Lee *et al.* (1997), Thomas and Griffin (1996), Slack *et al.* (1995), Stewart (1995), Gelders *et al.* (1994), Hill (1994), Neely *et al.* (1994), Cavinato (1992), Henig and Levin (1992), Stalk *et al.* (1992), Rushton and Oxley (1991) and Novich (1990)
Return Customer response time Level of customer perceived value of product Customer complaints Rate of complaint	Luo *et al.* (2009), Luo and Homburg (2008), Santos and Fernandes (2008), Landrum and Prybutok (2004), Grönroos (2004), Yang and Peterson (2004), Wang *et al.* (2004), Khatibi *et al.* (2002), Peter and Olson (1993), Patterson and Spreng (1997), Monroe (1991), Day (1990), Zeithaml (1988), Clawson and Donald (1978), Howard and Sheth (1969) and Kotler and Levy (1969)

Table II.

SCOR processes explicitly as PMS. However, some common processes of SCOR are being used as performance measures. Thus, we have made an attempt to suggest or prioritize the SCOR-based processes for enhancing the PMS among the Indian manufacturing sector for the ease of implementation and using it as an exemplar from our empirical study and also as a distinctive view from developed economy.

3.2 Supply chain performance

One of the major goals of SCM is the maximization of the effectiveness of a chain's outcome by providing superior service to the ultimate customer (e.g. Bowersox *et al.*, 2010). Consequently, SCP is the bottom line for supply chain strategies, but it is difficult to measure as this includes the observation of economic components like sales volumes and costs as well as qualitative components such as flexibility or delivery ability (e.g. Keeber *et al.*, 1999; Van Hoek, 1998). Every supply chain manager knows this dilemma of balancing costs, productivity, customer service and quality as well as financial benefits (see Brewer and Speh, 2000). However, supply chain performance measurement (SCPM) is recognized as an important tool for managing supply chain behavior and orientation (e.g. Karrer, 2003). Its purpose is to establish supply chain goals, evaluate SCP and determine future supply chain directions and activities (Gunasekaran *et al.*, 2001, 2004).

When measuring SCP, it is necessary to identify the SCPI that constitute the overall performance (see Lambert and Pohlen, 2001; Lebas, 1995). A SCPI is understood as an empirically observable numerical reference or illustration that is relevant for the supply chain success of an organization (see Neely, 2003; Lapide, 2000). SCPIs show regularly how well supply chain processes are executed and how well they can be expressed in absolute or in relative terms (see e.g. Keebler *et al.*, 1999).

For the measurement of SCPI, typically, the efficiency or the effectiveness of an outcome of a supply chain activity is analyzed (e.g. Fugate *et al.*, 2010). Efficiency describes an input/output relation, whereas effectiveness shows how well supply chain goals have been achieved (see e.g. Bowersox *et al.*, 2010). In this sense, SCP can be seen as a function of the utilization of supply chain resources or as a function of supply chain results as compared to supply chain targets. Gunasekaran *et al.* (2004) suggested further to measure SCP on strategic, tactical and operational levels and, thus, suggested adequate financial and non-financial SCPIs.

When it comes to our research, we considered those measures suggested by Shepherd and Guenter (2006) and categorized them according to the applicability of the five supply chain processes defined in the SCOR model. Whether the variables measure cost, time, quality, flexibility and innovativeness or they are quantitative or qualitative. Otto and Kotzab (2003) suggested six perspectives in SCP measurement based on their work, and we have considered two, i.e., first, logistics perspective issues: integration lead times, order cycle time, inventory level concept of flexibility for different measure under five processes of SCOR. Second, strategic perspective: time to network, time to mark and ROI of focal organization have relevancy to the measures considered in this study. Birhanu *et al.* (2018) argued that supply chain strategies are driven by respective companies and their supply chain measures. Manage environmental and sustainability expectations with profound effect on supply chain network configuration. GSCM dimensions are found to be related to at least one of the performance dimensions (Cankaya and Sezen, 2019). Among manufacturers, retailers and third party logistics companies (3PLs) in Asia pacific region financial category are dominating performance categories in managing warehouse operations (Laosirihongthong *et al.*, 2013). In Performance metrics of SCM economic value addition and SCOR are frequently used mechanism, companies focus more on cost oriented customer service; whereas social and environmental metrics are legally enslaved performance measures (Piotrowicz and Cuthbertson, 2015). As performance measures that includes all major links in a supply chain, as well as the three pillars of sustainability has a significant role in partnering supply chain (Abdullah *et al.*, 2014). Majority of researchers integrated the concept of TBL for SCP management as a framework (Taticchi *et al.*, 2013).

3.3 Hypotheses development

Structural contingency theory (SCT) posits that there should be a fit between organizational processes and the environment (Burns and Stalker, 1961; Lawrence and Lorsch, 1967). It further advocates that firms those match their configurations with environment requirement tend to perform better than those who do not match (Holmes, 2013). In the context of supply chain, the SCT advocates that each supply chain process or dimension should be aligned to achieve best performance (Flynn *et al.*, 2010). In the context of SCOR model, all five dimensions, plan, source, make, deliver and return, should be aligned to firm's requirement in order to match demand and supply. Needless to mention that all stakeholders are an important part of a firm's environment. Therefore, we believe that all the dimensions defined in the SCOR model influence overall performance of the supply chain of a firm.

3.3.1 Plan. Supply chain planning process happens at all three levels: strategic, tactical and operational levels. Planning is an integral element and is required in each of other four domains of SCOR model. For example, demand forecasting is required for source, make, deliver and return at all time frames: long, mid and short terms (Souza, 2014). Demand data forecasted during planning process improves the SCP (SCC, 2010). Next, information also plays an important role in planning various activities throughout supply chain. Real-time information sharing is used in balancing supply/demand, logistics, inventory management and return. Information sharing leads to improved SCP (Fawcett *et al.*, 2011). Information sharing also plays a vital role in supply chain collaboration and supply chain integration (Cao and Zhang, 2011; Zhou *et al.*, 2011). The extant literature suggests that supply chain collaboration and supply chain integration improve the SCP. The other activities of planning stage include supply resources, aggregate and prioritize demand requirements, plan inventory, distribution requirements, production, material and rough-cut capacity, long-term capacity and resource planning, product phase-in/phase-out. Based on above discussion, we hypothesize:

H1. Plan-based performance indicators positively influence OSCPI.

3.3.2 Source. Sourcing involves selecting best suppliers using an optimal combination of cost and lead-time, in order to meet demand. There are several sourcing best practices discussed in literature (Carr and Pearson, 1999; Prahinksi and Benton, 2004; Li *et al.*, 2005). For example, long-term relationship with suppliers, trust, real-time information sharing and collaboration with suppliers are some noted best practices (Zhou *et al.*, 2011). The literature on sourcing suggests that firms that collaborate with its suppliers tend to perform better (Cao and Zhang, 2011). Other studies show the positive impact of long-term relationship with suppliers, trust and real-time information sharing performance (Dyer and Singh, 1998; Kwon and Suh, 2004, 2005; Cai *et al.*, 2009; Hsu *et al.*, 2011; Nazim and Raja Yaacob, 2017; Özer and Zheng, 2017; Dadzie *et al.*, 2018). Based on above discussion, we hypothesize:

H2. Source-based performance indicators positively influences OSCPI.

3.3.3 Make. The make process is essentially a transformation process of converting raw material into finished goods. Therefore, researchers have developed several techniques over last few decades that improve transformation process. These improvements include reducing production and inventory costs, reducing production lead-time, reducing waste during production and improving quality. Some noted best practices that are developed during last few decades include just-in-time (JIT), total quality management (TQM), lean manufacturing, agile manufacturing, scheduling and push-pull manufacturing. Several studies in the literature have established the link between these best practices and SCP (e.g. Beamon, 1999; Gunasekaran *et al.*, 2001, 2004; Kannan and Tan, 2005; Li *et al.*, 2006; Koh *et al.*, 2007; Shepherd and Guenter, 2010; Green *et al.*, 2005; Govindan *et al.*, 2015; Prajogo *et al.*, 2016; Mani *et al.*, 2018). Therefore, we hypothesize:

H3. Make-based performance indicators positively influences OSCPI.

3.3.4 Deliver. Logistics has two parts: inbound logistics and outbound logistics. The deliver process of SCOR model discusses and evaluates the later part. Logistics becomes essential part of planning process of SCM as it completes the supply chain, that is, from supplier to customer (Gunasekaran and Kobu, 2007). In other words, logistics facilitates physical flow of goods from a supply node (supplier or manufacturer) to a demand node (customer). Research has shown that an effective logistics management can provide a sustainable competitive advantage to a firm (Christopher, 2016). However, firms face trade-off of time and cost in effectively managing the logistics function. For example, full truckload may provide cost advantage to a firm, but, in doing so, firm may have to compromise with the speed of delivery. Another example is that lower lead-time may not provide cost advantage to a firm. The literature shows that those firms that efficiently manage time and cost trade-off are likely to have better business performance (e.g. Lai *et al.*, 2002; Gunasekaran and Kobu, 2007; Coyle *et al.*, 2016; Christopher, 2016). Based on above discussion, we hypothesize:

H4. Deliver-based performance indicators positively influences OSCPI.

3.3.5 Return. The return process in the SCOR model is added in its 5.0 version onwards. The return process is defined as return defective products, return excess product, return maintenance, repair and overhaul products (Palma-Mendoza *et al.*, 2014). All the aforementioned returns are part of reverse logistics activities (Guide and Wassenhove, 2009). Firms, across the globe, are trying to reduce all kinds of returns as much as possible

(Kleindorfer *et al.*, 2005). Some noted best practices to reduce the returns include reduce defect at source, TQM, JIT, etc. The literature on reverse logistics suggests that those supply chains that are able to reduce the returns show better performance (Daugherty *et al.*, 2005; Govindan *et al.*, 2012; Agarwal *et al.*, 2016; Mahindroo *et al.*, 2018). Based on the above discussion, we hypothesize:

H5. Return-based performance indicators positively influences OSCPI.

Conceptual understanding of how SCOR-related performance indicators and the overall SCP are interrelated is shown in Figure 2, which also shows the proposed hypothetical model.

4. Research methodology

4.1 Questionnaire design/research instrument

The research instrument was based on a review of the literature exhibited in Table II. Various SCOR process versions along with discussions and interviews with both academicians and practicing supply chain managers were used. Relevant measures/variables have strong relevance with Indian manufacturing sector. The survey questions are grouped as plan (11) items, source (12) items, make (11) items, deliver (11) items and return (4).

4.2 Sample size and data collection

To acquire samples, 600 Indian manufacturing companies were contacted. Of which, only 155 companies responded. Targeted respondents of the research were drawn from functional areas like supply chain, manufacturing and distribution working in manufacturing industries. It is assumed that their job or designation enabled them to have a good working knowledge about their own organization. Most earmarked personnel to answer questions related to SCM, issues were chosen. Nominal and interval scales were used to get the responses from the targeted samples. The nominal scale/categorical scale was used to capture the demographics of the respondents. The interval scale was used for measurement of items deployed in this study.

The response rate was 25.83 percent Table III shows the breakdown of the respondents that are categorized by company size. About 23 percent of respondents had less than 99 employees and about 25 percent had employees in the range of 100–499. There were about 5 percent of respondents having employees in the range of 500–900 employees and 47 percent respondents having more than 1,000 employees.

4.3 Data analysis

4.3.1 Sample characteristics. From Table III, it can be seen that 64 percent of our respondents were from private limited company and 23 percent from public sector undertaking (PSU)

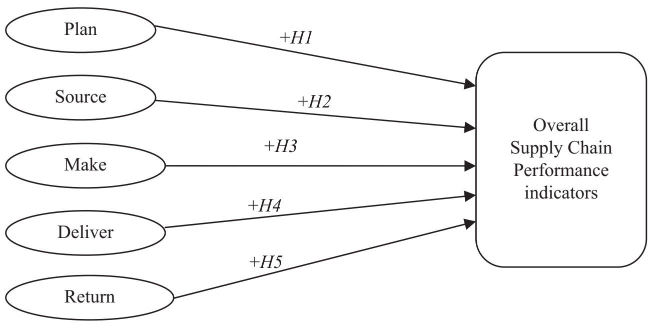

Figure 2. SCOR-related performance indicators and overall supply chain performance indicators for Indian manufacturing sector

	Respondents (in percentage)
Employee size range	
1–99	23
100–499	25
500–999	5
Greater than 1,000	47
Type of companies	
Private limited	64
Public sector undertaking	23
Public limited	7
Others	6
Firm characteristics	
Type of industry	
Engineering (A)	15
Automobiles(A)	13
Electronics (A)	11
Consumer (B)	8
Petroleum (B)	3
Fertilizer (B)	2
Power (B)	2
Steel (B)	3
Cement (B)	2
Pharmaceutical (C)	9
Agro-based(C)	8
Chemical (C)	8
Textile (D)	10
Food production (D)	7
Company's establishment in years	
Less than 5	10
5–10	9
11–20	29
21–30	11
31–40	10
41–50	8
Greater than 50	23
Respondent characteristics	
President	14
Director	10
General manager	14
Assistant general manager	15
Manager	26
Consultant	10
Practitioner	10

Table III.
Demographics

(i.e. the government-owned corporations are termed as PSU in India). In a PSU, majority (51 percent or more) of the paid up share capital is held by central government or by any state government or partly by the central governments and partly by one or more state governments in India; 7 percent of respondents were from public limited and 6 percent were from others (others mean which are neither private, government nor public limited companies category according to the Indian manufacturing sector).

The respondents were also asked about their company's prime business service to identify the industry; it has been observed from Table III that 15 percent of the respondents were from engineering industry, over 13 percent from automobile, 11 percent from electronics, consumer, 10 percent from textile, 7 percent from food production, 9 percent from pharmaceuticals, 8 percent from agro-based and chemical industry have, 3 percent from petroleum and steel and2 percent from fertilizer, power and cement. From Figure 3, it can be observed that Group A had 39 percent respondents, Group B 20 percent, Group C 25 percent and Group D 17 percent respondents. Regarding the age of company's participation in the questionnaire administered, it has been observed that 29 percent of respondents were from 11 to 20 years old establishment, 23 percent from more than 50 years old establsihment,11 percent from 21 to 23 years old establishment, 10 percent from less than 5 years old and 31–40 years old establishment, 9 percent from 5 to 10 year old establishment, and, least of all, 8 percent respondents from 41 to 50 years old establishment (see Table III). Descriptive statistics were also generated for the position/title of the respondent (see Table III). The respondents were asked about their position and knowledge of impacts of SCOR-related performance indicators and OSCPI in the company they are working. It has been observed that 26 percent of respondents had titles of Managers, 14 percent titles of president and general manager, 15 percent title of assistant general manager, 10 percent title of consultant and practitioners and 10 percent title of director.

Trend seems to continue in future among range of employee size of 100–499 and 500–900. There is a rising trend in private limited companies regarding participation in this kind of empirical survey. Group A showed highest participated respondents followed by Group B, Group C and Group D; however, Groups B and C followed a steady trend as participative respondents. Young companies of age between range of 5–11 years and 10–15 years followed a peak trend of participation as respondents in the survey. A valid upward trend shown by general managers, assistant general managers and manager participation in this survey indicates that mid-level managers in organization hierarchy have a more awareness level regarding SCOR model practices and its implications as a competitive tool of their business profits growth.

4.3.2 Test of reliability. The reliability of the survey instrument was tested using Cronbach's (1951) α as a test of internal consistency for the SCOR-related performance indicators under processes, i.e., plan, source, make, deliver and return. Cronbach's α tests the interrelationship among the items composing a construct to determine if the items are measuring a single construct. Cicchetti and Sparrow (1990) identified acceptable reliability guidelines $r < 0.70$ (unacceptable), between 0.70 and 0.80 (fair), 0.80–0.90 (good) and $r > 0.90$ (excellent).

Table IV presents the means, standard deviations and Cronbach's α for the SCOR-related performance indicators as practices in the Indian manufacturing sector.

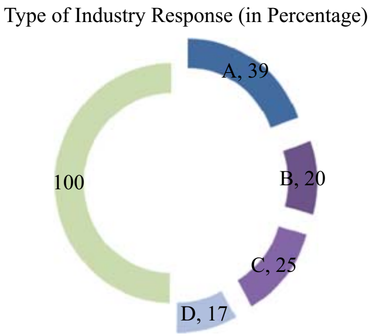

Figure 3.
Type of Industry (percentage) response

Table IV. Descriptive Statistics and Reliability measures for SCOR-related performance indicators (plan, source, make, deliver and return)

SCOR process	Item	Mean	SD	Corrected item-total correlation	Cronbach's α score	Factor loading
Plan	TSCRT	3.61	0.99	0.62	0.93	0.83
	TSCCT	3.74	1.07	0.59	0.93	0.79
	OFLEX	3.71	0.85	0.61	0.93	0.55
Source	POCC	3.74	0.86	0.63	0.93	0.78
	EOPOCC	3.86	0.83	0.60	0.93	0.75
	SASTRTQP	4.00	0.78	0.61	0.93	0.59
Make	WIP	3.86	0.84	0.59	0.93	0.73
	INVC	3.96	0.78	0.54	0.93	0.72
	INVDS	3.87	0.81	0.66	0.93	0.64
Deliver	DELEFF	3.82	0.95	0.71	0.93	0.77
	DELLT	3.73	0.94	0.67	0.93	0.79
	FOD	3.77	0.98	0.68	0.93	0.78
	DEFLEX	3.69	0.86	0.71	0.93	0.79
	TRANFLEX	3.72	0.93	0.67	0.93	0.77
Return	LCVP	3.88	0.86	0.61	0.93	0.72
	CC	4.08	0.98	0.51	0.93	0.81
	ROC	3.95	1.04	0.54	0.93	0.83

Notes: $n = 155$. Mean/SD of constructs measured along a five- point Likert scale (1 = strongly disagree; 5 = strongly agree). α = Cronbach's α test of internal consistency. Tests of model fit for confirmatory factor analysis (CFA) = $\chi^2 = 303.814$, df = 109, $p < 0.001$; RMSEA (90% CI) = 0.61; CFI = 0.859. All factor loadings are significant at $p < 0.05$

The results show that αs range is 0.93, indicating that proposed 17 performance indicators under SCOR processes, i.e., plan, source, make, deliver and return have acceptable reliability.

4.3.3 Test of validity. Convergent and discriminant validity. As part of test of measures and to assess the convergent validity, we examined the parameters such as factor loading of the item, average variance extracted (AVE), and composite reliability Hair *et al.* (2010).

All the estimates with respect to item loadings are presented in Table IV that shows that items are significantly related to their corresponding factors. Furthermore, the Table V indicates that the AVE and CR values exceed the threshold levels (AVE $\geqslant$ 0.50; CR $\geqslant$ 0.70). AVE is the primary indicator of convergence, and a CR value over 0.70 indicates the internal consistency of the latent construct analyzed (Hair *et al.*, 2010). These results suggest adequate fit with respect to convergent validity.

According to Churchill (1979) and Hair *et al.* (2010), discriminant validity can be evaluated based on three parameters that include the examination of factor correlations, maximum shared variance, average shared variance (ASE) and assessment of whether the square root of AVE is greater than inter-construct correlation values below 0.80, suggesting the discriminant validity of the scale (Bhattacherjee, 2002). Furthermore, MSV values are found to be less than the average shared variance of the factors. Additionally, average shared variance values are less than the AVE (ASV < AVE). The values presented in Table VIII suggest that the

Table V. Convergent and discriminant validity

	CR	AVE	MSV	ASV
Plan	0.773	1.570	0.422	0.361
Source	0.752	1.500	0.387	0.333
Make	0.739	1.500	0.473	0.381
Deliver	0.886	3.000	0.306	0.306
Return	0.800	2.400	0.306	0.280

square root of AVE is greater than inter-construct correlations. Therefore, all the latent constructs statistically passed discriminant validity.

Confirmatory factor analysis (CFA) loadings were used to determine the content and construct validity of SCOR process. Construct validity, also referred to as content validity, determines how accurately the survey items measure each of construct.

CFA was conducted using SPSS software to evaluate overall construct validities using structural equation modeling. The validity of the construct is based on fit of the structural equation model to the data using three measures of goodness of fit: ratio of χ^2 statistic and degrees of freedom (χ^2/df), ratio less than 2–1, a CFI value $\geqslant$0.90 and RMSEA $\leqslant$ 0.08. Table VI also shows that goodness of fit is acceptable for all the five constructs. The nomenclature for coding the variable used in the reliability testing, validity testing and hypothesis testing is presented in Appendix.

Table VI is the result of CFA; at first, we have conducted factor analysis using SPSS on the data collected, extraction method: principal component analysis, rotation method quartimax with Kaiser Normalization rotation converged in 19 iterations. From the total variance, explained 13 items were reduced satisfying the conditions, i.e., having eigenvalues greater than 1 as well as acceptable total variance explained on all 13 items. However, in order to make the proposed scale a valid, we have done CF using SEM and AMOS 24.0, in the process of further statistical analysis deleted items that have factor loading of less than 0.4 suggested by Brown (2015) and in this process initial 52 items reduced to 17 items. These 17 items have been named as five constructs relevant to core SCOR processes, thus accomplishing one of the research objectives of this work.

First construct as plan (three items): total supply chain response time (TSCRT), total supply chain cycle time (TSCCT) and order flexibility (OFLEX); second construct as source (three items): purchase order cycle time (POCC), efficiency of purchase order cycle time (EOPOCC) and supplier ability to respond to quality problems (SATRTQP); third construct as make (four items): work in process (WIP), inventory cost (INVC) and inventory days of supply (INVDS); fourth construct as deliver (five items): delivery efficiency (DELEFF), delivery lead-time (DELLT), frequency of delivery (FOD), delivery flexibility (DEFLEX) and transport flexibility (TRANFLEX) and fifth construct as return (three items): level of customer perceived value of product (LCVP), customer complaints (CC) and rate of complaint (ROC).

In this study, to validate our research objectives, GOF indices are presented first and later validity and reliability of measurement model are discussed. The initial measure of GOF is standardized root mean square (SRMS residual) that is an average difference between the predicted and observed variances and covariances in the model, based on standardized residuals. In the model, predicted SRMS is 0.018 that is in range of 0.05–0.08, hence, adequate fit Garson (2011). Other common goodness of fit indicators to assess a model are Normed fit Index (NFI), Non-Firmed Fit Index (NNFI also known as TLI) and

			Goodness of fit indices				
Scale	No. of items	Range of standardized regression weights	CFI 0–1.0*	NFI 0–1.0*	GFI 0–1.0*	RMR 0.05–0.08*	CMIN/DF Less than 3*
Plan	3	0.551–0.831	0.86	0.802	0.889	0.018	2.787
Source	3	0.592–0.784					
Make	3	0.642–0.720					
Deliver	5	0.765–0.793					
Return	3	0.719–0.830					

Note: *Acceptable range for model fit

Table VI. Confirmatory factor analysis: construct validity test of various scales for SCOR-related performance indicators

Incremental Fit Index, Comparative Fit Index (CFI) and root mean square error of approximation (RMSEA).

Hu and Bentler(1999) and Mac-Callum *et al.* (1996) argued that and acceptable model fit using different indices depend on sample sizes, type of data and range of acceptable scores as influencing factors. However, Schreiber *et al.* (2006) suggested that TLI, CFI and RMSEA for one time analyses are preferred to support the proposed SEM model. Current study reported (Table VI) most of goodness of fit measures found in model fit summary using AMOS 24.0.

5. Results

Based on the structural equation model, the results of the five hypotheses are shown in Table VII. According to the *t*-values in the table, all five hypotheses are supported at the 0.05 significance level. In addition to a good fit of the structural model, a good structural equation model needs to have a good measurement model (i.e. the path coefficients of all indicators to the related latent variables are significant at the 0.05 level).

According to the SEM results, all the path coefficients are significant at the 0.05 level and *t*-values are larger than 2.0. Thus, all our hypotheses are accepted. Similar research methodologies, statistical techniques: CFA, SEM and multiple regression are used by Degroote and Marx (2013), Li *et al.* (2011), Laia *et al.* (2004), Rodrigues *et al.* (2004), Zhou *et al.* (2011) and Kuo *et al.* (2009). Thus, plan, source, make, deliver and return processes have positive influence on SCPI: quality of goods, economic order quantity, cash to cash cycle time, delivery reliability, manufacturing lead-time, total cash flow time, inventory turnover ratio and warranty/returns processing cost.

Current study to understand differences among the identified four groups, i.e., Group A, Group B, Group C and Group D of Indian manufacturing sector found significant difference of SCOR processes practices as planning, sourcing, make, deliver and return processes strongly depend on different complex nature of manufacturing activities. These manufacturing activities are strongly linked with SCOR processes, but, in each group, these activities differ at large that has strong relation with SCPI (see Table VIII).

Using the SPSS, output table shows the results of multiple regression results using the stepwise method, *p*-value less than 0.01 SCOR processes as independent variables and

Table VII. SCOR-related performance indicators vs overall supply chain performance indicators

Path in the structural model	Path coefficient (*t*-value)	Outcome
Plan → OSCPI	0.217* (3.67)	*H1* accepted
Source → OSCPI	0.209* (3.83)	*H2* accepted
Make → OSCPI	0.446* (3.80)	*H3* accepted
Deliver → OSCIP	0.322* (3.78)	*H4* accepted
Return → OSCPI	0.262* (3.96)	*H5* accepted

Note: $^{*}p < 0.05$

Table VIII. Practices of SCOR processes based performance indicators among four groups of manufacturing industries

SCOR processes	*F*	*p*-value	*F* crit.
Plan	2.899	0.047	2.839
Source	2.591	0.065	2.616
Make	3.587	0.021	2.716
Deliver	8.843	0.000	2.816
Return	12.736	0.000	3.239

Note: Using ANOVA two-factor with replication overall SCP (eight indicators) as a dependent variable. The model R^2 (72.1 percent) the two-tail p-value for the significance of β (or the regression model itself), the slope β, standard error, t- and p-values are of satisfying conditions to predict the models. Durbin Watson for predicted models in the range, i.e. 1.766 that is in the range of 1.5–2.5; thus, analyzed data have not been auto-correlated. Suggested models use eight OSCPI (Table IX).

Validation of multiple regression satisfied the condition of multi-collinearity as the "tolerance" values greater than 0.10 and the variance inflation factor (VIF) value less than 10 are quite acceptable from coefficient values generated using SPSS. According to Hair *et al.* (1998) degree of multi-collinearity of proposed models addressed from collinearity diagnostics using the condition index, it has been observed that the condition index in range between 15 and 30 is acceptable. Hence, our model has no serious multi-collinearity problem:

$$\text{Overall supply chain performance indicators} = 1.067 + (0.122 \times \text{Plan} + 0.159 \times \text{Source} + 0.309 \times \text{Make} + 0.180 \times \text{Deliver} + 0.133 \times \text{Return})$$

The result of the multiple regression shows that SCOR-based performance indicator implementations have a positive influence on OSCPI in the Indian manufacturing sector.

From Table X, Model 1 (without the interaction term) is significant as $F(2, 152) = 179.290$, $p < 0.001$ and Model 2 (with interaction term) is significant as $F(1, 153) = 9.001$, $p < 0.001$; thus, the Model 2 interaction between employee size and SCOR performance indicators accounted for significantly more variance than employee size SCOR performance indicators level by themselves, R^2 change $= 0.649$, $p = 0.003$, indicating that there is potentially significant moderation between employee size and SCOR performance indicators on OSCPI (Table XI).

Model 1 (without the interaction term) is significant as $F(2, 153) = 179.476$, $p < 0.001$ and Model 2 (with interaction term) is significant as $F(1, 152) = 26.531$, $p < 0.001$; thus, the Model

Model	B	SE	β	t	p	95, 0% confidence interval for B Lower bound	Upper bound	Collinearity statistics Tolerance	VIF	Condition index
(Constant)	1.067	0.191		2.46	0.015	0.092	0.846			
Plan	0.122	0.066	0.315	4.70	0.000	0.179	0.439	0.405	2.470	18
Source	0.159	0.051	0.230	3.57	0.000	0.081	0.280	0.438	2.283	20
Make	0.309	0.039	0.188	3.42	0.001	0.056	0.211	0.600	1.666	21
Deliver	0.180	0.052	0.150	2.36	0.020	0.020	0.225	0.452	2.215	30
Return	0.133	0.067	0.148	2.36	0.020	0.026	0.292	0.465	2.151	33

Table IX. Results of multiple regression analysis

Model summary

Model	R	R^2	Adjusted R^2	SE of the estimates	Change statistics R^2 change	F change	df1	df2	Sig. F change
1	0.838[a]	0.702	0.698	0.291516657	0.702	179.290	2	152	0.000
2	0.236[b]	0.056	0.049	0.517531889	0.649	9.001	1	153	0.003

Notes: [a]Predictors: (Constant): employee Size, SCOR performance indicators; [b]Predictors: (Constant), employee size, SCOR performance indicators, EMPLR/SCOR; [c]Dependent variable: overall supply chain performance indicators

Table X. Moderation effect of employee size between SCOR performance indicators and overall supply chain performance indicators

2 interaction between company age and SCOR performance indicators accounted for significantly more variance than company age SCOR performance indicators level by themselves, R^2 change = 0.555, $p = 0.003$, indicating that there is potentially significant moderation between company age and SCOR performance indicators on OSCPI.

From Table XII, Model 1 (without the interaction term) is significant as $F(2, 153) = 26.531$, $p < 0.001$ and Model 2 (with interaction term) is significant as $F(1, 152) = 10.451$, $p < 0.001$; thus, the Model 2 interaction between type of company (private vs non-private) and SCOR performance indicators accounted for significantly more variance than company age SCOR performance indicators level by themselves, R^2 change = 0.084, $p = 0.003$, indicating that there is potentially significant moderation between type of company (private vs non-private) and SCOR performance indicators on OSCPI.

6. Discussion

Similar empirical studies by Zhou *et al.* (2011) and Jamehshooran *et al.* (2015) are supporting the results of the current work. Zhou *et al.* (2011) empirically proved that plan processes positively influences source, make and deliver processes and also source process positively influences make, make process positively influences deliver process and plan process influences make process, i.e., mediated by source process and influence of plan process on deliver process is mediated by make process based on 125 North American manufacturing firms respondents which suggested that the SCOR model shall help practitioners as a performance measurement system as well as a benchmarking tool for other companies and to optimize the supply chain investments.

6.1 Practical relevance

Supply chain managers are chosen as respondents in this study with reference to previous studies as majority of researchers have made significant contribution to the SCP measurement system among automobile, textile, pharmaceutical companies. However, a huge gap exists relating SCOR-based PMS covering different types of companies (based on ownership), firm characteristics covering 14 types of Indian manufacturing industries.

Table XI. Moderation effect of company age between SCOR performance indicators and overall supply chain performance indicators

Model summary									
					Change statistics				
Model	R	R^2	Adjusted R^2	SE of the estimates	R^2 change	F change	df1	df2	Sig. F change
1	0.838[a]	0.703	0.699	0.29141	0.703	179.476	2	153	0.000
2	0.384[b]	0.148	0.142	0.49162	0.555	26.531	1	152	0.000

Notes: [a]Predictors: (Constant), company age SCOR performance indicators; [b]Predictors: (Constant), company age, SCOR performance indicators, comp. age/SCORPI; [c]Dependent variable: overall supply chain performance indicators

Table XII. Moderation effect of type of company (private vs non-private) between SCOR performance indicators and overall supply chain performance indicators

Model summary									
					Change statistics				
Model	R	R^2	Adjusted R^2	SE of the estimates	R^2 change	F change	df1	df2	Sig. F change
1	0.384[a]	0.148	0.142	0.491615805	0.148	26.531	2	153	0.000
2	0.253[b]	0.064	0.058	0.515230348	0.084	10.451	1	153	0.003

Notes: [a]Predictors: (Constant), type of company (private vs non-private) SCOR performance indicators; [b]Predictors: (Constant), type of company, SCOR performance indicators, type of comp./SCORPI; [c]Dependent variable: overall supply chain performance indicators

Thus, this research shall be a pathfinder for SCM managers in the Indian manufacturing sector, i.e., the proposed SCOR-based model (see Figure 2) (processes to be prioritized for an effective and efficient practice or as a paradigm of SCP measurement system). SCOR-based processes to be designed in SCPMS are the quality of delivery of goods, quality of delivery documentation, CC, manufacturing cost, timely available of accurate information, SATRTQP, inventory costs and ROC supported by Jääskeläinen and Thitz (2018). Thus, by considering our proposed models (see Figure 2), this shall enhance the performance of organization with a sustainable business growth and profits. The generic manufacturing capabilities/priorities often mentioned in significant contribution such as Hayes and Wheelwright (1984), Hill (1987) and Gerwin (1993) have been cost, quality, dependability, flexibility and innovation. Hill (1987) introduced the concept of order winners and order qualifiers and differentiated between them. Order qualifiers are those criteria that a company must meet for a customer even to consider it as a potential supplier. Order winners are those criteria that could win the order. To provide qualifiers, companies need only to be as good as competitors but to provide order winners they need to be better than their competitors. Thus, our study also supported manufacturing companies that are mainly focused on quality, customer orientation and supplier integration with information sharing being most important parameters in manufacturing companies weaved with the concept of some critical process of proposed SCOR-based PMS.

Best practices as the results provide that under plan process the total cash flow time, cash to cash cycle time, OFLEX are dominant preference, under make respondents chosen manufacturing cost, inventory turnover ratio and inventory cost, as cost effective tools for sustainable business growth whereas in source the timely availability of accurate information, SATRTQP are considered as sourcing plays a crucial aspect in any manufacturing activity as a business process reliable vendors/supplier who can supply reliable information, promised time of delivery of materials helps in increasing the business growth as well as productivity of any firm. Subsequently, undelivered mutual trust, poor quality of delivery goods, poor quality of delivery documentation, delivery reliability that are priorities forfeited, erroneous delivery, protracted lead times lead to loss of business growth as well as loss of good will among customers, as respondents in this survey converged reliability issues of deliver process. Finally, in return, the CC, ROC, in India reverse logistics is emerging core business process of conventional logistics, in this survey respondents suggest to consider CC after sale of goods to improve the brand image among customers.

6.2 Academic contributions

Our study has identified and embedded a unique approach already being practiced by developed economies for SCPMS using the proposed SCOR-based processes to developing economy like India. By measuring the SCP using the proposed factors as well as SCT to understand the perceived levels of proposed SCOR-based processes, our findings also highlighted that organizations must first be integrated before they can have visibility of their SC partner's activities with reference to the proposed SCOR-based processes as a model reinforced by work of Ramish and Aslam (2016). Once there is visibility, organizations can integrate the PMS as a holistic approach between SC partners. Using this study, future research can propose or design customized information systems for the optimization of sourcing, manufacturing strategy and deliver as well as return strategic processes by a broader view of SCPMS using the SCOR-based process as a paradigm to Indian manufacturing sector distinct view of Elgazzar *et al.* (2019).

7. Conclusion

The study, at hand, attempts to verify the relationship between SCOR processes from a supply chain perspective in the Indian manufacturing sector. Our results show that SCOR decision areas are vital to supply chain processes. This study is one of the first attempts to empirically evaluate the SCOR model processes in the Indian manufacturing sector. Thus, the results of our study have several implications on SCM practitioners in terms of understanding the best practices to be chosen in line of SCOR processes. First, our study is supported by the literature that finds that SCOR processes play a critical role in improving the SCP. Our study found that quality, customer satisfaction and supplier integrity embedded into SCOR processes, i.e., plan, source, make, deliver and return. As suggested constructs, i.e., plan, source make, deliver and return performance indicators with respect to Indian manufacturing sector has close links with logistics drivers, distribution management, information, cash cycle, supplier relationship management, inventory management and purchasing operations. Similar studies by Delipinar and Kocaoglu (2016) suggested the need of research on implementation of SCOR model. Exploratory study by Lockamy and McCormack (2004) suggested important SCM practices as a planning prospective only, whereas our study made an effort to suggest other processes of the SCOR model covering source, make, deliver and return. Zhou *et al.* (2011) distinct view of this study but they validated only for Level 1 processes of SCOR model; however, our work focused relatively on all levels processes of SCOR model. Sri Yogi and Kotzab (2019) proposed a conceptual model using performance measures and SCM models association using organizational theories.

Our discussion and results reported infer that framed research objective, i.e., influential effect between SCOR-related performance indicators and OSCPI as measures to Indian manufacturing sector is accomplished. Second, our study provides empirical support for findings in the literature that OSCPI have to be considered as the proposed composite model comprising of perceived quality of goods, perceived economic order quantity, perceived cash to cash cycle time, perceived economic order quantity, perceived delivery reliability, perceived manufacturing lead-time, perceived total cash flow time, perceived inventory turnover ratio and perceived warranty/returns processing cost which should be used as the measure of SCPI in Indian manufacturing sector by practitioners.

Lastly, our study also supports that the literature's findings on some of the vital SCOR processes have not been prioritized by respondents, namely, order entry method, DEFLEX, volume flexibility, warehouse cost, overhead cost, TSCRT, information carrying cost, distribution cost, supplier rejection rate and intangible cost.

However, there are limitations to the study. First, our survey does not represent the whole population of the Indian manufacturing sector. Second, the study was limited to manufacturing firms. Service firms were not included because the majority of SCOR processes cannot be embedded in transformation processes of service firms. Thus, the generalization of these results to service firms is limited. Finally, the study focuses on Indian manufacturing sector, which may restrict the applicability of the findings to non-Indian manufacturing sector. Although few manufacturing companies that participated in the survey have global presence as they most likely do not operate under the same market and same supply chain, SCOR processes are same barring some companies that participated in the survey and do not have all processes under the SCOR framework due to different business processes.

Future researchers need to establish or develop the levels of the SCOR-based processes specifically to different types of Indian manufacturing Industries. This would give more prosperous information on levels to prioritize the SCOR-based SCPMS.

The limitations of our study refer to the chosen geographical setting as we focused on 14 types of Indian industries but excluded the service industry.

We used the perceived values of the proposed SCOR-based processes to adopt as a SCPMS paradigm. However, manufacturing companies lack a standardized approach in implementing SCPMS as compared to global standards established by developed economies. This proposed SCOR-based SCPMS should lead to more standardization specifically to different types of

Indian manufacturing Industries complemented by Ganeshkumar *et al.* (2014). This will enable Indian manufacturing industries to compare and benchmark their SCPMS and explore performance metrics based on SCOR processes. This will allow manufacturing industries to compare their own levels with those global standards.

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Appendix

The areas of supply chain performance measures linked with SCOR processes have significant contribution in your organization's supply chain PMS are listed below. Write your choice from 1 to 5 with respect to a particular area of supply chain PMS and concept of SCOR that are being practiced by your organization.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

S. No.	Plan					
1.	Information carrying cost	1	2	3	4	5
2.	Over head cost	1	2	3	4	5
3.	Intangible cost	1	2	3	4	5
4.	Total supply chain response time	1	2	3	4	5
5.	Total supply chain cycle time	1	2	3	4	5
6.	Order lead time	1	2	3	4	5
7.	Customer response time	1	2	3	4	5
8.	Order entry methods	1	2	3	4	5
9.	Order flexibility	1	2	3	4	5

	Source					
1.	Supplier cost-saving initiatives	1	2	3	4	5
2.	Supplier's booking-in procedures	1	2	3	4	5
3.	Purchase order cycle time	1	2	3	4	5
4.	Efficiency of purchase order cycle time	1	2	3	4	5
5.	Buyer-supplier partnership level	1	2	3	4	5
6.	Supplier rejection rate	1	2	3	4	5
7.	Mutual trust	1	2	3	4	5
8.	Satisfaction with knowledge transfer	1	2	3	4	5
9.	Satisfaction with supplier relationship	1	2	3	4	5
10.	Supplier assistance in solving technical problems	1	2	3	4	5
11.	Timely availability of accurate information	1	2	3	4	5
12.	Supplier ability to respond to quality problems	1	2	3	4	5

	Make					
1.	Manufacturing cost	1	2	3	4	5
2.	Work in process	1	2	3	4	5
3.	Inventory cost	1	2	3	4	5
4.	Inventory days of supply	1	2	3	4	5
5.	Warehouse costs	1	2	3	4	5
6.	Disposal costs	1	2	3	4	5
7.	Planned process cycle time	1	2	3	4	5
8.	Production flexibility	1	2	3	4	5
9.	Volume flexibility	1	2	3	4	5

	Deliver					
1.	Total logistics costs	1	2	3	4	5
2.	Distribution costs	1	2	3	4	5
3.	Delivery costs	1	2	3	4	5
4.	Transport costs	1	2	3	4	5
5.	Delivery efficiency	1	2	3	4	5
6.	Delivery lead time	1	2	3	4	5

7.	Quality of delivery documentation	1	2	3	4	5
8.	Frequency of delivery	1	2	3	4	5
9.	Delivery flexibility	1	2	3	4	5
10.	Transport flexibility	1	2	3	4	5

	Return					
1.	Customer response time	1	2	3	4	5
2.	Level of customer perceived value of product	1	2	3	4	5
3.	Customer complaints	1	2	3	4	5
4.	Rate of complaint	1	2	3	4	5

	Overall SCM Performance Indicators					
1.	Quality of delivery goods	1	2	3	4	5
2.	Cash – cash cycle time	1	2	3	4	5
3.	Economic order quantity	1	2	3	4	5
4.	Delivery reliability	1	2	3	4	5
5.	Manufacturing lead time	1	2	3	4	5
6.	Total cash flow time	1	2	3	4	5
7.	Inventory turnover ratio	1	2	3	4	5
8.	Warranty/returns processing costs	1	2	3	4	5

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