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AN INTEGRATED-EMPIRICAL LOGISTICS PERSPECTIVE ON SUPPLY CHAIN INNOVATION AND FIRM PERFORMANCE

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Abstract. Supply chains need to innovate constantly for maintaining their position in the marketplace and also to fight uncertainties. Hence firms are focusing on strategies for developing supply chain innovation. The current investigation adds to this emerging regime through investigating the influence of logistics capabilities viz. demand management capability, supply management capability, information management capability and coordination capability on supply chain innovation through logistics integration. Further, supply chain innovation helps a firm to sustain its position in the market place through generation and launching of new products and services. Accordingly, the influence of supply chain innovation on firm performance is also investigated. Data is collected from logistics, purchasing and supply chain professionals working in different industries in India. The findings based on 169 responses largely support our proposed relationships.

Keywords: supply chain innovation, logistics capabilities, demand management, supply management, logistics integration, firm performance, dynamic capability.

JEL Classification: C12, C42.

Introduction

Supply chains are more complex (Gunasekaran *et al.* 2008) and are becoming more prone to disruptions with increasing environmental uncertainties (Wagner, Bode 2008). In this context, firms are forced to contemplate on strategies and capabilities that can address these growing uncertainties. Thus today's supply chain has to respond proactively to these environmental conditions. Hence innovation in supply chains becomes a dire necessity not only to respond proactively to disruptions and uncertainties; but also to gain a competitive advantage in the market. Possibly, this may be the reason for identifying the most innovative organization by ACSCMP (American Council of Supply Chain Management Professionals) and rewarding the same with their "Supply Chain innovation Award". Arlbjørn, Haas and Munksgaard (2011) noted in this regard "… *among the nominees have been prestigious organizations such as the U.S. Air Force, Motorola, Kellogg's, and Blockbuster Inc. The list of award winners includes companies like Intel, Cisco Systems Inc., and Hewlett-Packard. The winner is selected out of 45–50 submissions each year, based upon criteria related to the degree of innovativeness, impact on overall supply chain, and sustainability in results (revenue, cost savings, etc.)".*

However, supply chain innovation is a must therefore for the following reasons: (a) for gaining competitive edge in the market (b) for managing the different types of risks prevailing in the supply chain (Wagner, Bode 2006) and (c) for meeting proactively the different forms of uncertainties in the adjoining environment. But for developing innovative supply chains, firms must ascertain its various logistics capabilities and align them in an appropriate manner. As logistics are an essential part of supply chain (Mentzer *et al.* 2004); firms cannot develop an innovative supply chain without integrating the dominant logistics

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capabilities viz. demand management interface capability, supply management interface capability, information management capability and coordination capability (Mentzer *et al.* 2004; Esper *et al.* 2007; Gligor, Holcomb 2012). Hence the current investigation attempts to address the growing influence of each of the above logistics capabilities on supply chain innovation in an empirical framework. Accordingly, the objectives of the current investigation are as follows:

(a) To investigate the influence of different logistics capabilities on logistics integration.
(b) To investigate the influence of logistics integration on supply chain innovation.
(c) To investigate the influence of supply chain innovation on supply chain performance?

The paper is arranged in the following manner. The next section discusses the theoretical backdrop and the research model. The subsequent section discusses the hypotheses followed by data collection and empirical testing. Finally, the study discusses the findings and concludes with managerial implications and scope for future research. Limitations of the study have also been addressed.

1. Theoretical background

1.1. Supply chain innovation

Supply chain innovation and logistics innovation have been dealt interchangeably. However the literature on supply chain innovation is highly fragmented (Grawe 2009) and multidisciplinary investigation has taken place (Flint *et al.* 2005). Supply chain innovation draws mainly from the definition of Innovation given by Rogers (1995: 11): "*Innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption*". Innovation in logistics need not be evolutionary but the same may result in providing a new service to its customers. For e.g. Flint *et al.* (2005) focused on innovation that is more helpful to customers for e.g. a better and enhanced service that is new. Though innovation emphasizes idea generation, but it's not beneficial or deemed important in a supply chain perspective unless it results in something valuable to the customers. For innovation to happen, only idea generation may not be enough (Chesbrough 2003); allied processes and technology must be emphasized for successful innovations (Christiansen 2000a, 2000b; Kahn 2001). Literature also cites how the innovation takes place in organizations and markets (Rogers 1995; Chesbrough 2003). Firms are constantly thriving to develop and test new ideas, products and services. Mainly for service industries, supply chain innovation is a compulsory for ensuring effective service delivery (Chapman *et al.* 2003). Drucker (1985) indicated innovation as a tool directed specifically for entrepreneurs. Afuah (1998) defined innovation as: *"a process of turning opportunity into new ideas and putting these into widely used practice. Innovation facilitates create new technical skills and knowledge that can help develop new products and/or services for customers*". The literature on supply chain innovation has just started evolving. Lin (2008) described supply chain innovation as certain set of tools that can improve firm processes directed for efficient supply chain management through seamless integration with suppliers, manufacturers, distributors and customers. A host of benefits are present with supply chain innovation like cost and lead-time reduction, generation of new operational strategies and flexibility development (Stundza 2009). Logistics innovation can be increased by using appropriate incentives like increased competition and capital shortage (Zinn 1996). Flint *et al.* (2005) interviewed several logistic executives and found a host of activities as indications of being innovative viz. setting the stage activities; customer clue gathering activities; negotiating, clarifying and reflecting activities; and inter-organizational learning. Later studies found that extent of innovation management and supply chain learning as having positive impact on supply chain innovation (Flint *et al.* 2008). Resources when combined, can lead to increased level of specialization and innovation (Hakansson, Persson 2004). Chapman *et al.* (2003) explored in a similar context relating to factors leading to innovation in logistics services and found that knowledge, technology and relationship networks as the relevant factors. Panayides and So (2005) empirically found organizational learning to mediate the relationship between relationship orientation and logistics innovation. Several studies have investigated performance under innovation. Gellman (1986) examined innovative performance of railroads under deregulation and found regulation, labor influence and lack of channel member innovation as barriers to innovation in the allied industry. Autry and Griffis (2008) using social network theory propounded structural capital, relational capital and supply chain knowledge development to be positively associated with innovation-oriented performance. Wagner (2008) proposed a model of logistics innovation consisting of several related activities like internal search and development, external search and development, investment in infrastructure and capital goods, acquisition of knowledge and training and education etc. that can lead to innovations in logistics. Supply chain innovation also indicates discovering and implementing new technologies with better efficiency and effectiveness (Bello *et al.* 2004). Supply chain innovation can encompass several areas for application for e.g. implementing new technology (Stonebraker, Afifi 2004; Tang *et al.* 2003), supply chain networks (Srai, Gregory 2008), supply chain business process optimization (Hines 1998; Holmstrom 2000; Cox 1999), new product and service introduction (Ettlie 1979; Flint *et al.* 2005), building new models and scenario for optimization (Bello *et al.* 2004; Calantone, Stanko 2007), etc.

1.2. Defining logistics capabilities

Mentzer *et al.* (2004) underscored logistics as an integral part of supply chain management; accordingly, logistics capabilities are required for developing supply chain capabilities. Morash *et al.* (1996) defined logistics capabilities as "those attributes, abilities, organizational processes, knowledge and skills that allow a firm to achieve superior performance and sustained competitive advantage over competitors". Logistic capabilities determine the extent to which a firm can manage its operations efficiently and effectively (Gligor, Holcomb 2012) and are a potential source of competitive advantage for a firm (Bowersox *et al.* 1999; Zhao *et al.* 2001).

In the logistics literature, there exists several related and yet different classifications of logistics capabilities. Morash *et al.* (1996) through an extensive review of logistics capabilities classified the same into two broad themes or "value disciplines". While the former value discipline, labeled "demand oriented" emphasizes interactions and interfaces with customer, fulfillment of allied goals and objectives, timeliness and being responsive to market needs; the latter, known as "supply oriented" stresses more on operational capabilities aimed at ensuring product availability, increasing convenience and minimizing total distribution cost. In contrast, Mentzer *et al.* (2004) classified logistics capabilities into: demand management interface capability (to manage and fulfill customer requirements; Zhao *et al.* 2001; Lynch *et al.* 2000; Bowersox *et al.* 1999), supply management interface capability (to efficiently manage inflow of raw materials; Morash *et al.* 1996; Lowson 2003), information management capability (to effectively manage information flow both in and out of an organization; Zhao *et al.* 2001; Closs *et al.* 1997) and coordination capability (to align the interests of the participating members; Mentzer *et al.* 2004; Gligor, Holcomb 2012).

Esper *et al.* (2007) categorized logistics capabilities into five broad labels: (a) customer focus capability(also known as demand management interface capability and aims for providing differentiated products and services to customers in a way exceeding their expectations), (b) supply management capability (aimed at reducing the cost of total manufacturing or service generating system, optimal utilization of resources and minimizing total distribution cost), (c) Integration capability (aims to achieve unification of effort among different activities both inside and outside the focal firm), (d) measurement capability (degree to which a firm monitors internal and external operations), and (e) information exchange capabilities (indicates the effectiveness with which a firm collects, stores and distributes tactical and strategic information both internally and externally).

Cho *et al.* (2008) empirically examined the relationship between firm's logistics capability, logistics outsourcing and its performance in an e-commerce market environment. The authors argued that e-commerce firms have a higher likelihood of creating a sustainable competitive advantage and improving performance if they have strong logistics capability. Their empirical findings suggested logistics capability to positively impact firm performance. However, logistics outsourcing shared a negative impact on firm performance. Studies have also explored the direct contribution of logistics capabilities to competitive advantage. Sandberg and Abrahamsson (2011) explored the link between operational and dynamic logistics capabilities and sustainable competitive advantage. Based on case study of two Swedish retail companies; the study concluded that logistics processes and IT systems are valuable, rare and inimitable resources for any firm and can contribute to competitive advantage for the same. Studies have also explored the interface of logistics capabilities and supply chain capabilities. As Mentzer *et al.* (2004) pointed logistics, as an integral of supply chain management; accordingly logistics capabilities must contribute for developing supply chain capabilities. Based on an extensive literature review of logistics capabilities and supply chain agility; Gligor and Holcomb (2012) argued that logistics capabilities of individual firms must be integrated at the supply chain level for developing supply chain agility.

Now in the current investigation, we adopt Mentzer's *et al.* (2004) classification of logistics capabilities as it is the most popular and acceptable classification in supply chain management studies and it covers the dominant logistics capabilities (Esper *et al.* 2007; Gligor, Holcomb 2012).

1.3. Logistics integration

Specific logistics process and practices need to be unified to ensure undisrupted flow of materials from suppliers to customers (Stock *et al.* 2000). These also ensures the availability of the right quantity of good at the required place at the appropriate hour; thereby enhancing the value proposition across each stage in the value stream (Caputo, Mininno 1998). Industrial firms often have time and space utilities made being available through efficient logistics integration (La Londe 1983; Flynn *et al.* 2010). The growing competition in the market place have urged firms to increase and improve their operational activities and processes. In addition, firms have felt the need to integrate their operations and dominant activities with those of their key suppliers and distributors within the supply chain. This is because suppliers contribute greatly in building and delivering the final value to the customer in the value chain through improved product quality, better inventory management and reduced delivery times. Therefore logistics integration is characterized with well-coordinated flow of materials from suppliers; this in turn results the focal firm to have a smooth production process (Frohlich, Westbrook 2001). A direct consequence of this is the elimination of the

intangible boundary existing between the focal firm and its suppliers (Stock *et al.* 2000; Flynn *et al.* 2010). Other direct benefits of effective logistics integration are also well recognized e.g. reduced bullwhip effect; firms adopting lean production systems etc. (Schonberger 2007). By and large, logistics integration allows companies and their supply chain partners to act as a single entity which would result in improved performance throughout the chain (Tan *et al.* 1998).

Logistics integration also enables the firm to have the probable gifts of vertical integration for e.g. quality, dependability, planning and control and lower costs. A plethora of operational benefits are incurred to the firm such as reduction in costs, lead time and risks (Liu *et al.* 2005) along with improvement in sales, distribution, customer services, and service levels (Seidmann, Sundararajan 1997) and customer satisfaction (Kim 2009).

1.4. Supply chain innovation: a dynamic capability perspective

The popularity of the resource based view (RBV) has been widely acknowledged in production and supply chain management (Allred *et al.* 2011). The RBV argues that a firm can attain sustained competitive advantage through suitably deploying its resources and capabilities that are often rare, valuable, not substitutable, and difficult to imitate (Barney 1991). Further these resources and capabilities are viewed as bundles of tangible and intangible assets that comprises for e.g. a firm's management skills, its organizational processes and routines, and the information and knowledge it controls (Barney *et al.* 2011).

Teece *et al.* (1997) proposed the dynamic capabilities theory as an extension of the resource based view. The theory aims to understand how firms use their dynamic capabilities to create and sustain a competitive advantage by reacting positively to environmental uncertainties (Teece 2007). Helfat *et al.* (2007) defined dynamic capability as "the capacity of an organization to purposefully, create, extend, and modify its resource base". The resource base of an organization includes its physical, human and organizational assets (Eisenhardt, Martin 2000; Ambrosini, Bowman 2009). For developing SC Innovation, a firm must align and realign its resources and capabilities in a suitable manner to match its environment. Hence SC innovation can be conceptualized as a dynamic capability as it is used for responding to environmental contingencies through developing other supply chain capabilities viz. agility, resilience etc. thereby providing an optimal performance.

Based on the above argument, the current study posits demand management interface capability (DMC), supply management interface capability (SMC), information management capability (IMC) and coordination capability as essential logistic capabilities that must be integrated to develop SC innovation. This is also essential as logistics is a part of supply chain as highlighted in the fairly accepted definition of logistics management, as offered by the Council of Logistics Management (2003):

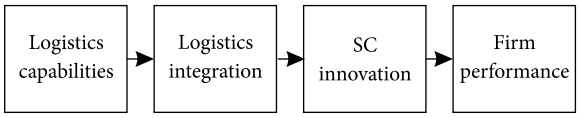

Fig. 1. Research model

"Logistics Management is that part of Supply Chain Management that plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customer requirements".

This suggests that the various logistics capabilities must be integrated suitably in order to develop any supply chain capability (for e.g. supply chain innovation in this case). Supply chain innovation (as the name implies), as a dynamic capability, extends beyond a single firm and includes entire supply chain as unit of analysis. Also as supply chain innovation imparts a firm the ability to address the uncertainties in its environment positive; it must have some positive performance implications. Figure 1 shows the proposed the research model.

In the above figures, it is proposed therefore that logistics capabilities influence logistics integration which in turn influences supply chain innovation. Lastly, supply chain innovation positively influences firm performance. In the above diagram, SC innovation represents supply chain innovation.

2. Hypotheses development

2.1. Demand management interface capability and logistics integration

Demand Management Interface Capability ensures that the firm and its supply chain are able to suitably manage the demands of its customers. Morash *et al.* (1996) underscored demand management interface capability as the ability of a firm to provide its customers with differentiated products and services. In recent times, it's the differentiated products and services that ensure the sustenance of a firm. Also, a firm must be able to provide value added products and services at the right time at the right place to its customers as the same, after integration, will ensure greater responsiveness to customer demands (Gligor, Holcomb 2012). However, the management of demand patterns of customers in the marketplace effectively portrays that the logistics activities are well integrated. Based on this we hypothesize that:

H1: Demand management interface capability is positively associated with logistics integration.

2.2. Supply management interface capability and logistics integration

Supply Management Interface Capability aims for efficient supply of raw materials from supplier to the manufacturer. Its main aim is to reduce the costs in several spheres of day to day operation for a firm. For e.g. it aims to minimize waste in inventory, enables the firm to respond to demand fluctuations with reduced distortion of the order cycle process and optimally utilizes resources for enabling postponement speculation, modularization and standardization (Esper *et al.* 2007). This portrays that supply management interface capability aims for increasing responsiveness when properly integrated. A higher level of supply management interface capability automatically results in integration of logistics activities through seamless connection between suppliers and the manufacturer. Accordingly we hypothesize:

H2: Supply management interface capability is positively associated with logistics integration.

A firm managing efficient and timely supply of its raw materials from its key suppliers will be in a much better position to manage ultimately its customer's demands in the market. Therefore, higher the supply management capability, greater is the demand management capability for a firm. Hence we posit that:

H3: Supply management interface capability is positively associated with demand management interface capability.

2.3. Information management capability and logistics integration

As pointed out by Closs *et al.* (1997) and Mentzer *et al.* (2004), this capability aims for effective collection, storage and distributing of routine and strategic information both internally and externally. Since managing demand effectively necessitates availability of demand information from the customers as well as the demand trend prevailing in the current market; hence information management capability is critical and affects demand management interface capability positively. Also a firm must have information about its supplier's inventory position, tentative delivery schedules and any change or problem in allied matters. Similarly, the supplier should also be in a position to obtain firsthand knowledge of production requirements. Hence, information management capability enhances the way a firm can manage its upstream operations. This concludes that information management capability must have a positive impact on demand management interface capability and supply management interface capability. Accordingly we hypothesize that:

H4: Information management capability is positively associated with demand management interface capability.

H5: Information management capability is positively associated with supply management interface capability.

Also a firm having effective information sharing capabilities both upstream and downstream portrays the optimal integration of several dominant logistics activities and capabilities. This indicated that information management capability must have a positive impact on logistics integration. Hence we hypothesize that:

H6: Information management capability is positively associated with logistics integration.

2.4. Moderating role of coordination capability

Coordination capability ensures that the different logistics activities in a supply chain are well synchronized (Gligor, Holcomb 2012). Different parties in a supply chain generally don't possess adequate knowledge of each other's skills, assets, strengths etc. Therefore this cognitive limitation prohibits supply chain members from effectively align their individual logistics capabilities with those of their focal firm. Hence, in line with Gligor, Holcomb (2012), we argue that the effectiveness of this logistics integration of individual logistics capabilities of supply chain members with their focal firm depends greatly on the ability of different entities to coordinate their activities and capabilities. Accordingly, we posit that coordination capability moderates the relationship between each logistic capability and logistics integration. This leads us to our next segment of hypotheses:

H7a: Coordination capability positively moderates the relationship between demand management interface capability and logistics integration.

H7b: Coordination capability positively moderates the relationship between information management capability and logistics integration.

H7c: Coordination capability positively moderates the relationship between supply management interface capability and logistics integration.

2.5. Logistics integration and supply chain innovation

Logistics integration results in well-coordinated flow of raw materials from a firm's key suppliers to its production site and then distributing finished goods to the final consumer. Supply chain innovation aims for efficient addressing of the environmental needs for e.g. responding to customer dynamic requirements profitably or mitigating a disruptive event (Khan *et al.* 2012). Therefore, a well-planned and coordinated flow of materials along the value chain will help the supply chain entities to prepare well for contingencies (Cao, Zhang 2011). Hence this increases the overall ability of the value chain to respond to threats and contingencies

(Kim, Lee 2010). Accordingly, we argue that improved logistics integration in a supply chain will increase its ability to address environmental dynamism more effectively. Therefore, we hypothesize that:

H8: Logistics integration is positively associated with supply chain innovation.

2.6. Supply chain innovation and firm performance

The main tenet of dynamic capabilities theory argued in favor of combining resources and capabilities owned by a firm in appropriate manner for developing special capabilities that can quickly adapt to environments (Teece 2007). Therefore within the context of dynamic capabilities, we are positing supply chain innovation as a dynamic capability developed through logistics integration of logistics capabilities. Dynamic capabilities are therefore built and not acquired; and this development is located in the efficient synchronization of organizational processes. Hence logistics integration of capabilities of firms within a supply chain suits the criteria of dynamic capabilities (Teece 2007); it is a higher-level capability, it is dedicated to the modification of operating routines, it facilitates resource reconfiguration and helps firms respond in a timely and effective manner to market volatility and supply uncertainties (Gligor, Holcomb 2012). Dynamic capabilities can result in competitive advantage because their quick adaptive ability to match their environment (Ponomarov, Holcomb 2009; Teece *et al.* 1997). This becomes possible through harnessing their resources and capabilities in a suitable manner so as to derive the optimal performance in a given environmental setting. Therefore, resource based view's dynamic capabilities perspective, logistics integration of capabilities can result in optimal performance for a firm.

Supply chain studies argued in favor of creating a sustained competitive advantage through integration of operations. For e.g. Cho *et al.* (2008) in their empirical exploration found a positive effect of logistics capability on firm performance. Flynn obtained a positive effect of integrating internal and external operations across the supply chain of a firm on its performance. In a similar context, Prajogo and Olhager's (2012) findings also empirically proved that logistics integration has a linkage with firm performance.

The current investigation explores firm performance from a service perspective. Stank *et al.* (2003) argued to measure service performance across two dimensions: operational and relational. The operational elements are indicated to be "the activities performed by service providers that contribute to consistent quality, productivity, and efficiency." The relational elements are captured as "activities that enhance the service firm's closeness to customers, so that firms can understand customer needs and expectations and develop processes to fulfill them" (p. 430). While operational performance emphasizes reliability and cost dimensions of service; relational performance reflects responsiveness, assurance and empathy. Thus in accordance with the dynamic capabilities agenda; we hypothesize that supply chain innovation (a dynamic capability) developed through logistics integration will result in positive firm performance. Therefore it is suggested that:

H9: Supply chain innovation is positively associated with operational performance.

H10: Supply chain innovation is positively associated with relational performance.

Figure 2 summarizes the above hypotheses in a theoretical model.

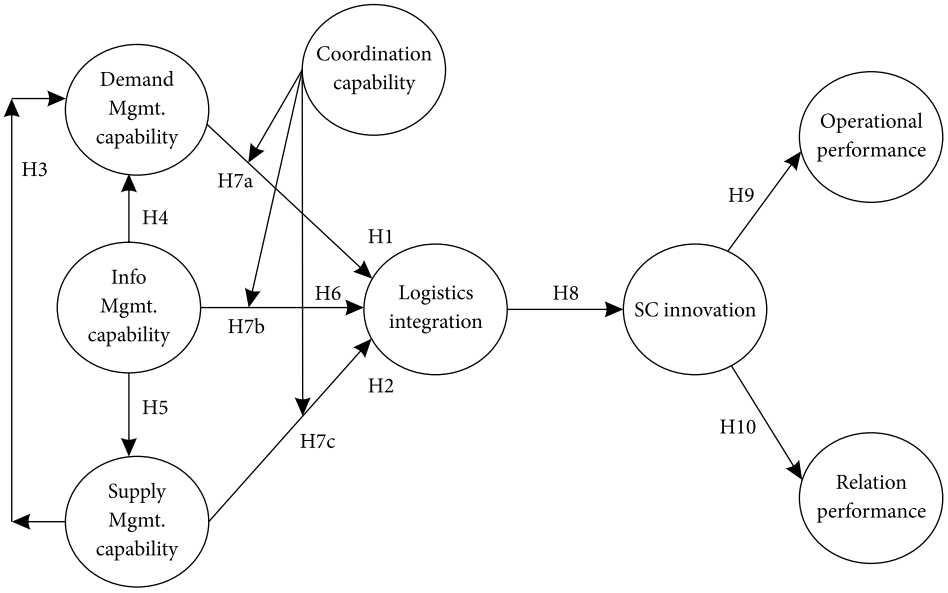

Fig. 2. Theoretical model

Thus the above theoretical model portrays the proposed hypotheses. As shown in the diagram, H1 portrays a positive influence of demand management capability on logistics integration; H2 shows a positive influence of supply management capability on logistics integration; H3 shows a positive influence of supply management capability on demand management capability; H4 & H5 posits a positive influence of information management capability on demand and supply management capabilities respectively. H6 shows the positive influence of information management capability on logistics integration. H7a, H7b and H7c show the moderating role of coordination capability on each of the proposed linkages. H8 shows the positive influence of logistics integration on supply chain innovation. Finally, H9 and H10 show the positive influence of supply chain innovation on operational performance and relational performance respectively. In the above diagram, SC innovation represents supply chain innovation. Further, in each of the logistics capabilities "mgmt." stands for "management".

3. Methodology

3.1. Sample and data collection

The data was collected through a web based electronic survey. The survey instrument was pretested by administering it to a small sample of supply chain managers drawn from a contact list that was purchased from an Indian Marketing Research Firm (the firm wanted to remain anonymous). A few of the measurement items were modified based on the feedback received from this sample in the pretesting phase. The final set of respondents was chosen randomly from the aforesaid contact list. The list comprised of logistics, supply chain and purchasing managers working mostly in senior designations in the Indian subcontinent in different industries. The unit of analysis was the firm and single respondent per firm was chosen. The surveyed respondents were asked to respond based on their expertise in their respective firms. The first round of survey invitation was sent in the first week of March via email. This was followed by two reminders, each within a gap of two weeks after the preceding survey invitation. A total of 714 emails were sent out. Out of these, 49 emails were returned as undeliverable. 182 partially complete responses were received, giving a response rate of 27.36% (182/665). However, for the final analysis we retained only complete responses. Thus, the final sample size was 169. We tested for the non-response bias by comparing the early and late respondents (Armstrong, Overton 1977). There were no significant mean differences between these two groups on key measures such as firm size and industry affiliation.

3.2. Survey instrument

All the constructs used in the model have established scales for measurement and hypothesis testing. The measures were suitably adapted (wherever needed) to suit the context. A total of 29 survey items (shown in Appendix-1) were used to measure independent, dependent and moderating variables in the study.

3.2.1. Independent & dependent variables

The study has a total of eight factors viz. demand management interface capability, information management capability, supply management interface capability, coordination capability, logistics integration, supply chain innovation, operational performance and relational performance. Demand management interface capability was measured using four items that enquired respondents if their firm can efficiently satisfy their customer needs; can provide differentiated products and services and can distribute its product as per customer needs. The items for measuring demand management interface capability were suitably adapted from Mentzer *et al.* (2004). Information management capability were measured with four items that enquired respondents if their firm can effectively share operational information among its various departments; maintains an integrated data base for information sharing; possess adequate systems and technology for detecting, capturing and maintaining timely data. The items for measuring information management capability were suitably adapted from Zhao *et al.* (2001) and Mentzer *et al.* (2004). Supply management capability was measured with four items that enquired the respondents if their firm has its logistics operations synchronized with that of its suppliers; if the firm pursues programs for developing its suppliers and if it has enhanced flexibility through collaboration with its suppliers. The items for measuring supply management interface capability were suitably adapted from Zhao *et al.* (2001) and Mentzer *et al.* (2004). Logistics integration was measured with four items that enquired respondents if their firm's internal logistics activities are closely coordinated; their logistics integration is efficiently supported with excellent distribution, transportation and warehousing facilities; if the inbound and outbound distribution of goods is well integrated. The items for measuring logistics integration were suitably adapted from Prajogo and Olhager (2012).

As supply chain innovation is relatively new, hence we thoroughly investigated the literature and develop our measurement items for supply chain Innovation. The measurement scale for supply chain innovation therefore resulted from a culmination of literature search and adaptation of innovation items from Flint *et al.* (2008) and Lee *et al.*

(2011). Supply chain innovation in line with its definition must encompass innovation of the core processes and technology. Accordingly, the supply chain innovation scale (thus developed) enquired executives if their supply chain have the formal new product or service development process. It further enquired if their supply chain monitors new idea generation and percentage of implemented new ideas that are successful in case of product and services. Finally, it asked if their supply chain focuses on new technological innovation and process innovation. Respondents were asked to indicate their choice on a Likert scale of 1–7 where "1" indicates "strongly disagree" and "7" indicates "strongly agree". Operational performance was measured with three items that enquired the respondents if their firm can deliver accurate, undamaged orders every time and able to meet its delivery deadlines successfully. The items for measuring operational performance was suitably adapted from Gligor and Holcomb (2014). Relational performance was measured with four items that enquired the respondents if their firm develops formal relationships with its suppliers; exchanges recommendations with its suppliers for continuous improvement; knows its supplier's needs and help its suppliers in executing important tasks. The items for measuring relational performance was suitably adapted from Gligor and Holcomb (2014). All the measurement items were operationalised on a 1 to 7 Likert scale (1 = Strongly Disagree; 4 = Neutral and 7 = Strongly Agree).

3.2.2. Moderating variable

In the proposed model, coordination capability was the moderating variable. Coordination capability was measured with three indicators that enquired respondents if their firm can effectively coordinate their activities and processes with that of its key suppliers. The items for measuring coordination capability were suitably adapted from Mentzer *et al.* (2004) and Gligor and Holcomb (2012). Respondents were asked to indicate their choice on a Likert scale of 1–7 where "1" indicates "strongly disagree" and "7" indicates "strongly agree".

4. Results of hypotheses testing

4.1. Scale reliability

The scale reliability of the measurement items were tested using Exploratory Factor Analysis (EFA) and Cronbach's alpha coefficients. The EFA on our data presented us with clean factors after we remove three problematic items SMC-2, LI3 and EU-4.The remaining items loaded on appropriate factors. EFA showed that one component was extracted for each variable based on Eigen values greater than one. The results portrayed high communalities showing that the majority of the measures variance was being explained by the constructs and indicated item appropriateness (Pedhazur, Schmelkin 2013). The Cronbach's alphas for the scales were as following: demand management capability (0.794), information management capability (0.823), supply management capability (0.866), coordination capability (0.817), and logistics integration (0.781), SC innovation (0.834), operational performance (0.765) and relational performance (0.819). Thus, all the Cronbach's alpha values are higher than the cutoff value of 0.70 as suggested by Nunnally (1978). The Cronbach's alpha values of the above scales demonstrate significant confidence regarding the scales' reliability. Table 1 shows the descriptive statistics and correlations.

As seen from Table 1, none of the correlations are high enough to signify the presence of multi-collinearity. Hence we can proceed for hypotheses testing.

4.2. OLS estimation results

Table II presents the results of our hypotheses testing. The hypotheses were tested using multiple regression analysis. In Table II, Model 1 represents the result of the hypotheses H1, H2 and H6. H1 posited a positive impact of demand management interface capability on logistics integration. The corresponding coefficient in Model-1 is positive and significant (0.247, $p < 0.01$) supporting H1. H2 predicted a positive influence of supply management interface capability on logistics integration. The corresponding coefficient in

Table 1. Descriptive statistics and correlations

Variable*	Mean	Std. Dev.	1	2	3	4	5	6	7	8
1 Demand Mgmt. capability	5.14	0.34	n. a.							
3 Information Mgmt. capability	4.96	0.29	0.41**	n.a.						
3 Supply Mgmt. capability	5.02	0.55	0.27*	0.23*	n.a.					
4 Coordination capability	4.88	0.82	0.33*	0.11**	0.19*	n.a.				
5 Logistics integration	5.36	0.47	0.17**	0.27*	0.08*	0.33*	n.a.			
6 SC Innovation	5.24	0.73	0.22*	0.09*	0.13**	0.37*	0.25*	n.a.		
7 Operational performance	5.07	0.38	0.14*	0.31*	0.24*	0.12**	0.14**	0.13*	n.a.	
8 Relational performance	4.91	0.27	0.28*	0.26*	0.32*	0.10*	0.21*	0.39*	0.16*	n.a.

Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Model-1 is positive and significant (0.112, $p < 0.05$) thereby supporting H2. H6 posited a positive influence of information management capability on logistics integration. The corresponding coefficient in Model-1 is positive and significant (0.179, $p < 0.01$) providing support for H6.

Model-2 represents the result of our hypotheses H7a, H7b and H7c. H7a predicted a positive interaction between coordination capability and demand management interface capability in affecting logistics integration. The corresponding coefficient in Model-2 is positive and significant (0.137, $p < 0.05$) thereby supporting H7a. Again, H7b posited a positive interaction between coordination capability and information management capability in influencing logistic integration. The corresponding coefficient in Model-2 is positive and significant (0.157, $p < 0.01$) thereby supporting H7b. Further, H7c predicted a positive interaction between coordination capability and supply management interface capability in affecting logistics integration. The corresponding coefficient in Model-2 is positive and significant (0.84, $p < 0.05$) thereby supporting H7c.

Model-3 represents the results for our hypotheses H3 and H4. H3 posited a positive influence of supply management capability on demand management capability. The corresponding coefficient in Model-3 is positive and significant (0.317, $p < 0.05$) supporting H3. H4 posited a positive influence of information management capability on demand management capability. The corresponding coefficient in Model-3 is positive and significant (0.249, $p < 0.05$) thereby providing support H4.

Model-4 represents the result for our hypothesis H5 that predicted a positive influence of information management capability on supply management interface capability. The corresponding coefficient in Model-4 is positive and significant (0.614, $p < 0.01$). Therefore, H5 is supported. Model-5 represents the result of our hypothesis H8 that predicted a positive influence of logistics integration on SC innovation. The corresponding coefficient in Model-5 is positive and significant (0.517, $p < 0.01$) thereby supporting H8. Model-6 represents the result of our hypothesis H9 that posited a positive influence of SC responsiveness on operational

Table 2. Results of OLS estimation

Model	Independent variables	Dependent variable	*B*	*t*-value	R^2	Adj. R^2	ΔR^2
1	Constant		4.27*	23.190	0.212	0.157	n. a.
	Demand Mgmt. capability	Logistics integration	0.247**	7.298			
	Information mgmt. capability	(Main effects model for logistics integration)	0.179**	7.112			
	Supply Mgmt. capability		0.112**	5.709			
	Coordination capability		0.376**	9.004			
2	Constant		3.031*	34.371	0.167	0.141	0.045*
	Demand Mgmt. capability	Logistics integration	0.219*	6.517			
	Information mgmt. capability	(Full model for logistics integration)	0.162*	6.321			
	Supply Mgmt. capability		0.104*	8.114			
	Coordination capability		0.323*	8.492			
	Coordination cap. * demand Mgmt. cap.		0.137*	6.552			
	Coordination cap. * info. Mgmt. cap.		0.157**	7.114			
	Coordination cap. * supply Mgmt. cap.		0.84*	6.204			
3	Constant		4.226*	24.198	0.334	0.291	
	Info Mgmt. capability	Demand Mgmt.	0.249*	3.141			
	Supply Mgmt. capability	Capability	0.317*	4.003			
4	Constant		5.904*	19.580	0.214	0.187	
	Info. Mgmt. capability	Supply Mgmt. capabiity	0.614**	8.674			
5	Constant		2.309*	26.173	0.159	0.103	
	Logistics integration	SC innovation	0.517**	6.142			
6	Constant		4.905*	24.001	0.276	0.249	
	SC innovation	Operational performance	0.541**	6.016			
7	Constant		4.369**	6.147	0.294	0.266	
	SC innovation	Relational performance	0.473**	4.018			

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ coefficients are standardized.

performance. The corresponding coefficient in Model-6 is positive and significant (0.541, $p < 0.01$) thereby supporting H9. Again, Model-7 represents the result of our hypothesis H10 that posited a positive influence of SC responsiveness on relational performance. The corresponding coefficient in Model-7 is positive and significant (0.473, $p < 0.01$) thereby supporting H10. Table 3 presents a summary of the hypotheses, model reference and findings.

5. Managerial implications

Our study has several implications for managers, practitioners and academicians. The study has investigated the importance of logistics capabilities in developing supply chain capability (e.g. supply chain innovation) and its impact on firm performance. Theoretically, the study has extended the usage of dynamic capability theory in testing logistics-supply chain relationships in terms of capabilities. Further the study have empirically underscored the dominant logistics capabilities and their respective importance (can be evaluated through path coefficients in the model) in generating supply chain innovation. Dynamic capabilities are such capabilities that can adjust themselves to situational needs and hence is the supply chain innovation; this helps a firm to gain new markets and wipe out competitive barriers through launching of new products and services (Teece *et al.* 1997).

The study suggests managers to invest resources for enhancing logistics capabilities as the same would develop dynamic capabilities e.g. supply chain innovation that would help them to sustain their position in the increasingly competitive marketplace. The study has underscored that a firm that is able to manage its demand side operations will be able to integrate its logistics capabilities more effectively; thereby helping in logistics integration (Gligor, Holcomb 2012).

Secondly, the study has urged managers to invest for newer technologies and invest simultaneously for latest hardware and software. This will lead to real-time and efficient information sharing among the supply chain entities leading to enhanced transparency and buyer-supplier relationships. Further, efficient information sharing leads to improved demand and supply management. Also managers should understand that if they can effectively manage their supply of raw materials; they will be more efficient and effective in meeting their regular demand and also demand fluctuations suitably (Mentzer *et al.* 2004).

Third, managers must understand that each firm in the supply chain should understand the importance of integration. This is required for mutual benefits. Unless every entity in the supply chain is collaborating with the other; effective integration of individual capabilities at the supply chain will not happen. Hence managers should organize frequent meetings and other informal sessions so as to interact with its partners and exchange knowledge. This will lead to enhanced idea exchange and will not only help in logistics integration; it will also prepare the platform for supply chain innovation to take place.

Finally, using a service perspective the study has shown that innovation in supply chains can effectively help a firm in improving its performance both in operational and relational terms. From the operational standpoint, supply chain innovation will lead to development and implementation

Table 3. Summary of hypotheses testing

Hypotheses	Statement	Referred Model	Result
HI	Demand management capability positively influences logistics integration	Model-1	Supported
H2	Supply management capability positively influences logistics integration	Model-1	Supported
H3	Supply management capability positively influences demand management capability	Model-3	Supported
H4	Information management capability positively influences demand management capability	Model-3	Supported
H5	Information management capability positively influences supply management capability	Model-1	Supported
H6	Information management capability positively influences logistics integration	Model-1	Supported
H7a	Coordination capability positively moderates relationship between demand management capability and logistics integration	Model-2	Supported
H7b	Coordination capability positively moderates relationship between information management capability and logistics integration	Model-2	Supported
H7c	Coordination capability positively moderates relationship between supply management capability and logistics integration	Model-2	Supported
H8	Logistics integration positively influences SC innovation	Model-5	Supported
H9	SC innovation positively influences operational performance	Model-6	Supported
H10	SC innovation positively influences relational performance	Model-7	Supported

of newer technologies in the manufacturing unit or production site. This will lead to training and up gradation of related skills of human resources. Further it will help in optimizing production process and smoothen out errors eliminating redundancies. This will overall help in streamlining different processes both inside and outside the firm. In relational term, supply chain innovation will help in improving transparency and relationship with its different downstream and upstream partners.

Lastly, the study has shown to both academicians and managers that logistics is a critical part of supply chain operations and for a firm that wants to develop essential supply chain capabilities; should concentrate its efforts in improving its logistics operations and capabilities. This will help ultimately to streamline the process thereby increasing transparency and sharing of know-how and ideas leading to supply chain innovation.

Conclusions

The empirical investigation sheds light on an important aspect: development of supply chain innovation through integration of logistics capabilities. Further, the influence of this supply chain innovation on firm performance is also measured. As firms are in constant search of newer strategies for gaining market share and winning customers over their competitors; supply chain innovation is a dynamic capability that helps a firm to organize its and resources and capabilities and adapt to its dynamic environments. Customers are constantly welcoming newer technologies and experimenting with the same. In this scenario, firms must adapt to these market needs through investing and developing its existing infrastructure. This can happen only when the focal firm (i.e. the manufacturing firm whose supply chain is being considered) coordinates and collaborates with its value stream partners for investing and implementing newer technologies, products and services. As shown by our study, this can happen when the focal firm integrates its individual logistics capabilities with those of its value chain partners at the supply chain level (Gligor, Holcomb 2012).

But for successful integration to happen; contribution is required from each of the dominant logistics capabilities viz. supply management capability, demand management capability, information management capability and coordination capability. There must be efficient and effective mechanisms of exchanging relevant information among the value stream partners for effective integration to take place. Further demand and supply management must take place in a proactive space so as to suggest different partners for effective collaboration. This will help in unification of individual efforts and logistics capabilities. Also, partners in a value chain must understand the importance of coordination. As shown by our study; effective integration of other logistics capabilities can be possible once the partners coordinate suitably with each other. Finally, using a service perspective for measuring firm performance; the study has empirically shown that supply chain innovation optimizes both operational and relational performance of the focal firm.

However, the current study suffers from few limitations like other survey based research. Firstly, like other supply chain survey studies, this one too gathers perception based data which may suffer from subjectivity. Secondly, there must be other factors and theories that can be used to explain the development of supply chain innovation in a more effective empirical way. Since every study has its own limitations; the contributions of this study too should not be ignored and investigated with greater rigor in further studies in different contexts.

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APPENDIX 1

Survey Instrument

Kindly indicate your agreement or disagreement with the following items as indicated: (1 = Strongly Disagree; 4 = Neutral and 7 = Strongly Agree)

Constructs & Source	Item Label	Measurement Items
Demand Mgmt. Capability (Mentzer *et al.* 2004)	DMC1	Our firm efficiently satisfies the demands of our customer.
	DMC2	Our firm has the ability to provide unique value added services to our customers.
	DMC3	Our firm has the ability to provide its customers with differentiated products/services.
	DMC4	Our firm has the ability to distribute its products according to customer requirements.
Information Manage-ment	IMC1	Our firm effectively shares operational information between departments.
Capability	IMC2	Our firm maintains an integrated database to facilitate information sharing.
(Zhao *et al.* 2001)	IMC3	Our firm's logistics information systems capture and maintain timely data.
(Mentzer *et al.* 2004)	IMC4	Our firm has invested in technology designed to facilitate cross-organizational data exchange.
Supply Mana-gement	SMC1	Our firm's logistical operations can be synchronized to integrate with supplier operations.
Capability (Zhao *et al.* 2001)	SMC2	Our firm actively pursues business relationships and programs targeted at maximizing supplier involvement.
(Mentzer *et al.* 2004)	SMC3	Our firm has increased operational flexibility through collaboration with suppliers.
Coordi-nation Capability	CC1	Our firm has the ability to coordinate the activities of different departments.
(Mentzer *et al.* 2004)	CC2	Our firm can coordinate the different processes within the firm.
(Gligor, Holcomb 2012)	CC3	Our firm has the ability to coordinate firm processes with that of key SC members.

Constructs & Source	Item Label	Measurement Items
Logistics Integration (Prajogo, Olhager 2012)	LI1	Our firm's internal logistic activities are closely coordinated.
	LI2	Our firm's logistics activities are well integrated with suppliers' logistics activities.
	LI3	Our logistics integration is characterized by excellent distribution, transportation, and/or warehousing facilities.
	LI4	The inbound and outbound distribution of goods with our suppliers is well integrated.
SC Innovation	INNOV1	Our supply chain has formal new product and service development process.
(Flint *et al.* 2008)	INNOV2	Our supply chain monitors and documents new product and service ideas.
(Lee *et al.* 2011)	INNOV3	Our supply chain keeps track of successful product and service ideas.
	INNOV4	Our supply chain focuses on process and technological innovation.
Operational perfor-mance	OP1	Our firm delivers undamaged orders each time.
(Gligor, Holcomb 2014)	OP2	Our firm delivers accurate orders at all times.
	OP3	Our firm always meets deadlines as promised to supply chain partners.
Relational perfor-mance (Gligor, Holcomb 2014)	RP1	Our firm develops formal relationships with its supply chain partners.
	RP2	Our firm exchanges recommen-dations for continuous improvement with its supply chain partners.
	RP3	Our firm helps its supply chain partners successfully perform tasks.
	RP4	Our firm knows its supply chain partners' needs well.

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