AN EMPIRICAL COMPETENCE-CAPABILITY MODEL OF SUPPLY CHAIN INNOVATION

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Abstract: Supply chain innovation has become the new pre-requisite for the survival of firms in developing capabilities and strategies for sustaining their operations and performance in the market. This study investigates the influence of supply and demand competence on supply chain innovation and its influence on a firm's operational and relational performance. While the former competence refers to production and supply management related activities, the latter refers to distribution and demand management related activities. The current investigation further explores how well supply chain management processes are internally executed by the firm's employees i.e. process compliance is observed as an enabler (moderator) on the relationship between supply chain competences and supply chain innovation. Further the model also explores the moderating influence of environmental uncertainty on the linkage between supply chain innovation and firm performance. The model is empirically validated based on perceptual data collected from 166 supply chain professionals through web based survey. Implications for both managers as well as practitioners are also provided.

Keywords: supply chain innovation, supply side competence, demand side competence, firm performance, process compliance, operational performance, environmental uncertainty.

JEL Classification: C12, C42.

Introduction

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 (Fawcett, Waller 2011). The main aim of supply chains recently is to consolidate their footing through constant innovation in products, services and strategies of serving existing and newer markets profitably. Hence, the success of global manufacturing activities often depends upon a manufacturing firm's ability to innovate and adapt its supply chain to dynamic changes in customer needs and preferences. Now this capability to innovate for a supply chain is enhanced through efficient management of supply and demand side activities for the focal manufacturing firm. These supply and demand side competences are two fundamental building blocks of supply chain management (Blome *et al.* 2013) and would definitely contribute to developing a firm's supply chain innovation. While the former is defined as a firm's proficiency in managing its upstream (supply-related) activities (e.g. supplier and production management), the latter is defined as the firm's ability to effectively manage downstream (demand-related) aspects (e.g. demand and distribution management) (Blome *et al.* 2013; Handfield *et al.* 2004). However, their role in developing supply chain innovation was never explored. Using the tenets of resource-based view complemented with the dynamic capabilities perspective, the current study theorizes and explores the importance of both the competence for a firm's supply chain innovation.

And second, the study explores the role of process compliance as moderating the linkage between supply and demand side competences with supply chain innovation. Process compliance in the current context is defined as

appropriate execution and adherence to supply chain management principles and procedures (Blome *et al.* 2013). The rationale for this presumption rests on the understanding that suitable infrastructure is required for the associated competence to be appropriate in achieving their goals in the supply chain management. Hence the aims:

(1) To explore the influences of supply and demand side competences on supply chain innovation.

(2) To explore the influence of process compliance on the linkage between the above competencies and supply chain innovation.

(3) To explore the influence of supply chain innovation on operational and relational performance for the focal firm.

2. Theoretical background

2.1. 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; Chapman *et al.* 2003). 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. Wagner and Bode (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; Rogers 1995). More recently, Lee *et al.* (2011) in the Korean healthcare sector observed that supply chain innovation is necessary to improve the organizational performance. Arlbjørn and Paulraj (2013) reviewed the literature on innovations in supply chains and argued numerous research avenues. Their investigation also suggested that proper supply chain design and implementation has a tremendous influence on its performance. Hence innovation in supply chains has significant contribution in dominant areas like supplier selection and cooperation, entrepreneurship improvement. Further Innovation in supply chains also leads to improved organizational learning and knowledge development. This innovation urges all the entities in the supply chain to adhere to best practices. Using best practices lead to significant development in other processes for all participating firms for e.g. it leads to significant infrastructure development (Wagner, Bode

2008). Supply chain innovation can encompass several areas for application for e.g. implementing new technology (Stonebraker, Afifi 2004; Tang *et al.* 2003; Chesbrough 2003), supply chain networks (Srai, Gregory 2008), supply chain business process optimization (Holmstrom 2000; Cox 1999; Stundza 2009), 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; Kahn 2001) etc.

2.2. The resource-based view of the firm and the dynamic capabilities perspective

The study has utilized the resource-based view of the firm (RBV) augmented with the dynamic capabilities perspective for developing the proposed model. The extent to which a firm can gain a competitive advantage largely determined by its capacity to properly deploy its resources and capabilities which are often rare, valuable, not substitutable and difficult to imitate (Barney 1991; Wernerfelt 1984). Later, Teece *et al.* (1997) propounded the Dynamic Capabilities theory (DCT) that also advanced the resource based view. According to this theory, firms must build, develop, integrate and reconfigure their internal and external resources and competence for adapting to dynamic environments. A dynamic capability is defined as the capacity of a firm to create, extend and modify its resources so as to fulfill a desired purpose (Helfat *et al.* 2007; Ambrosini *et al.* 2009). Supply chain innovation can be conceptualized as a dynamic capability for several reasons including the following: it meets the criteria of being a higher level capability (Winter 2003), it is dedicated to the modification of operating routines (Zollo, Winter 2002), it facilitates resource reconfiguration, and it enables sensing and capitalizing on environmental threats and opportunities (Teece 2007; Dyer, Singh 1998). Now as a dynamic capability can be developed through the culmination of several competences (Blome *et al.* 2013); the current investigation argues that supply chain innovation can be developed through the culmination of the supply side and demand side competence. Further we view supply chain innovation as being capable of creating a comparative advantage through positively influencing firm performance. Figure 1 gives the framework.
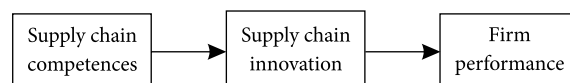
Fig. 1. Research model

3. Hypotheses development

The current investigation therefore deploys the above discussed theoretical foundations and extending the literature on supply chain innovation, develops formally the

proposed research model in more detail. In a first set of hypotheses, the study develops the linkage between supply and demand side competences with supply chain innovation. Next it develops the linkage of supply chain innovation with firm performance. Finally, it develops the argument for the moderating role of process compliance and environmental uncertainty.

3.1. Linking supply and demand side competence with supply chain innovation

The current investigation considers both supply and demand side competence as critical for enabling supply chain innovation, an important dynamic capability that can lead to competitive differentiation. Here we also distinguish between the terms capabilities and competence in line with strategic management literature. The study holds the argument that capabilities have evolved from competence (Prahalad, Hamel 1990; Zhang *et al.* 2002; Teece 2007) and accordingly we posit supply chain innovation as such a capability that has evolved from supply side and demand side competence. While competences are normally internally focused, capabilities concentrate rather on the environment external to the firm. Specifically, competence were described as expertise present at distinct points in the value chain, whereas capabilities were described to be more broad, externally visible and spanning the entire supply chain (Zhang *et al.* 2002; Caputo, Mininno 1998). Accordingly, the current investigation considers supply and demand side expertise as internal competence while supply chain innovation is viewed as a greater capability that incorporates both supply and demand side competence. Hence, supply and demand side competences form the building blocks of supply chain innovation. Supply side and demand side competence are of critical importance in recent dynamic environment (Gligor, Holcomb 2012; Yeung 2008; Jüttner, Maklan 2011) as firms are becoming more dependent on their value stream members and growing influence of customers (Choi, Krause 2006). Hence we argue both supply- and demand-side competences are mandatory in order to safe guard and sustain a firm's performance in today's dynamic environment, leading to the development of a dynamic capability under RBV.

Blome *et al.* (2013) argued in favor of combining competence in a dynamic manner so as to provide a proactive response to disruptions. This highlights the core tenet of RBV that highlights that resources and capabilities need to be combined in an appropriate manner for developing higher order capabilities. In line with Day (1994) who underscores capabilities as 'the glue that brings... assets together and enables them to be deployed advantageously' (Day 1994: 38). Hence this establishes supply chain innovation as a dynamic capability developed through suitable combination of supply and demand side competence. Accordingly, we frame our first set of hypotheses:

H1a: Supply-side competence positively influences the supply chain innovation of the firm.

H1b: Demand-side competence positively influences the supply chain innovation of the firm.

3.2. Linking supply chain innovation with firm performance

Supply chain innovation aims to enable a firm to sustain its position profitably in the marketplace through providing newer products and services and hence helps it sustain its performance (Lee *et al.* 2011) and therefore sustaining performance at an optimal level. Dynamic capabilities are such capabilities that are developed to for adapting to changing environmental conditions and sustain a decent level of performance (Teece *et al.* 1997). Supply chain innovation therefore helps a firm to gain competitive edge by helping it sustain a profitable performance level through satisfying the dynamic needs of its customers through providing new products and services. Extant research in supply chain management indicates a service perspective of measuring firm performance. Stank *et al.* (1999) propose a generic conceptualization of service performance using SERVQUAL: relational and operational. The authors view operational elements as "the activities per-formed by service providers that contribute to consistent quality, productivity, and efficiency" (Stank *et al.* 1999: 430). The relational elements are considered to focus on "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" (Stank *et al.* 1999: 430). Operational performance encompasses two dimensions: reliability (that indicates the dependability and accuracy of a service) and price/cost. Relational performance is observed as constituting responsiveness, assurance, and empathy. The above conceptualization of service performance is supported by Collier's (1991) two distinct dimension conceptualizations: an internal or operations-oriented dimension of service quality performance and an external or market-oriented performance. As our study posited supply chain innovation as a dynamic capability that is capable of sustaining a firm's performance in the face of its dynamic environment; we hypothesize supply chain innovation to have positive influences on both operational and relational performances of a firm (Gligor, Holcomb 2012). This leads us to our next set of hypotheses:

H2a: Supply chain innovation positively influences the operational performance of the firm.

H2b: Supply chain innovation positively influences the relational performance of the firm.

3.3. The moderating role of process compliance

Process compliance ensures that supply chain processes and procedures are well adhered by the firm employees. It assesses the degree to which adherence is made to prescribed norms and rules while executing the firm's processes. The running processes are assumed to be efficient as they represent optimized perspectives for executing the vital functions of a firm pertaining to its supply chain viz. supply management, production management, demand management, logistics and distribution etc. Therefore, if a firm follows the prescribed guidelines while executing these vital functions; should enhance the transformation of supply and demand side competence into supply chain innovation. Lee et al. (2011) in the Korean healthcare sector observed that innovative design of supply chain has a significant impact on selection of and cooperation with excellent suppliers, improved supply chain efficiency, and encouragement of quality management practices. Arlbjørn and Paulraj (2013) argued in favor of firm infrastructure and strategy implementation best practices for developing an innovative supply chain.

Under a theoretical perspective, the current investigation views process compliance as a combination of several building blocks, foundation or the right infrastructure with which the competence are suitably developed and evolved into supply chain innovation. In line with RBV complemented by the dynamic capabilities perspectives, process compliance is assumed to provide the infrastructure and guidelines in converting supply and demand side competence into supply chain innovation. Gunasekaran et al. (2008) argued that effective supply chain capabilities and efficient performance requires well-executed and controlled processes both in the supply and demand sides. Process compliance can help in developing the supply chain innovation so as to provide a proactive feedback to the need of the dynamic environment (Tan et al. 2015). A disciplined organization can focus its efforts and attention to developing strategies for encountering disruptions. This is a direct benefit of process compliance. Under the current context, process compliance helps to allocate resource planning in the optimal manner and hence will help in freeing up resources that can be used for meeting contingencies through the development of supply chain innovation.

From the absorptive capacity paradigm, process compliance can be viewed as a means to effectively absorb (recognize, evaluate, assimilate, and apply) aspects of supply- and demand-side competence for enhancing supply chain innovation (Cohen, Levinthal 1990). A firm with greater process compliance should thus be better able to utilize its competence for greater innovation, because through established rules, systems, procedures and cross-functional relations, company employees can more easily and effectively share and access the information (Schoenherr, Swink 2012; Blome et al. 2013). Further, with process compliance in place; firms in a supply chain will have relevant and required information being shared in the most effective manner (Swink et al. 2007). This will further help the supply chain firms to coordinate and prepare in a more effective way for maintaining alternate configurations. Based on these arguments, therefore we formulate our next set of hypotheses:

H3a: Process compliance moderates the relationship between supply-side competence and supply chain innovation, with the relationship being enhanced under greater levels of process compliance.

H3b: Process compliance moderates the relationship between demand-side competence and supply chain innovation, with the relationship being enhanced under greater levels of process compliance.

3.4. The moderating role of environmental uncertainty

Environmental uncertainty entails the changes in technology, consumer's taster and preferences, trade policies, physical weather conditions and other uncertainties in the allied environment (Srinivasan et al. 2011). Dynamic capabilities are developed to enable a firm to profitably sustain in these changing environmental scenarios. Hence dynamic capabilities hold a linkage of a firm's capability with its performance (Teece 2007; Blome et al. 2013; Gligor, Holcomb 2012).

Supply chain innovation, as a dynamic capability, is more targeted to meet environmental uncertainties in a profitable manner (this is because it can give the associated firm a competitive edge over others) (Teece 2007). The success of a firm's strategies depends on the environment in which their partners operate (Wong et al. 2011). A firm's strategies and their integration can be effective on performance only in certain suitable environments (because every strategy is devised considering certain environmental conditions).

The allied literature presents two contradicting viewpoints relating to environmental uncertainty. The first one highlight that firms will collaborate more to reduce uncertainty when it is high (Pfeffer, Salancik 1978). Based on transaction cost theory, the second one suggests that firms will make efforts to be more self-reliant in times of high uncertainty (Heide, Miner 1992). Perceived environmental uncertainty has significant impact on a firm's processes. Uncertain environment often mandates high information exchange between partners (Tushman, Nadler 1978). But transaction cost theory based literature indicates the difficulty in performance evaluation of partners in uncertain environments. Consequently, it may be difficult for firms to form exchange relationships in such environments (Williamson 2008; Martha, Subbakrishna 2002).
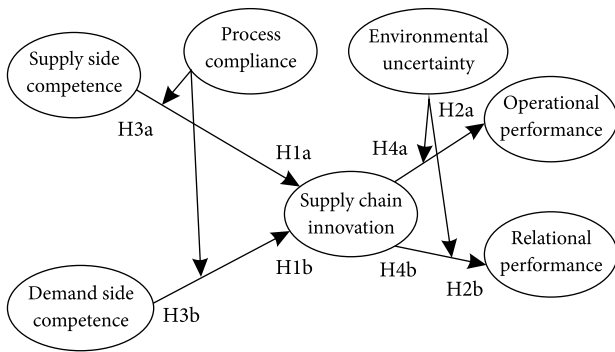
Fig. 2. Theoretical model

However, under RBV augmented with dynamic capabilities perspective, we posit that the relationship of supply chain innovation with a firm's performance will be stronger in an environment fraught with greater uncertainties. This is because supply chain innovation as a dynamic capability helps a firm to adapt to its changing environmental conditions (Teece 2007) while sustaining performance at the optimal levels (Lee *et al.* 2011; Tan *et al.* 2015). Based on these arguments, we formulate our next set of hypotheses:

H4a: Environmental uncertainty moderates the relationship between supply chain innovation and operational performance, with the relationship being enhanced under greater levels of environmental uncertainty.

H4b: Environmental uncertainty moderates the relationship between supply chain innovation and relational performance, with the relationship being enhanced under greater levels of environmental uncertainty.

Figure 2 summarizes the proposed hypotheses in a theoretical model.

4. Methodology

4.1. Data collection & sample demographics

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 (containing 1500 contacts of working professionals in various designations across different sectors in India) that was purchased from an Indian Marketing Research Firm (the firm wanted to remain anonymous). The list comprised of logistics, supply chain and purchasing managers working mostly in senior designations in the Indian subcontinent in different industries. Some of the measurement items were adapted to suit the context based on the feedback received during pretesting. The respondents for the survey were chosen from the aforementioned list based on two criteria: (1) the person is having at least 5 years of work experience in the logistics, purchasing or

allied decision making and (2) the candidate is working in his current designation for at least 2 years. This resulted in a final list of 755 supply chain professionals. The surveyed respondents were asked to respond based on their expertise in their respective firms. Table 1 shows the sample profile.

Table 1. Sample profile

Title	Number	Percentage
Annual Sales		
Revenue		
Undcr 1000 Cr	38	22.89
1100–2500 Cr	39	23.49
2600–5000 Cr	22	13.25
5100–10000 Cr	28	16.87
11000–25000 Cr	23	13.86
Over 25000 Cr	16	9.64
Totai	166	100.00
No of employees		
0–50	34	20.48
51–100	26	15.66
101–200	32	19.28
201–500	22	13.25
501–1000	31	18.67
1001 +	21	12.65
Totai	166	100.00
Industry Sector		
Automobiles	27	16.27
Electrical equipments	18	10.84
Textile	18	10.84
Paper Products	29	17.47
Wood Products	13	7.83
Chemicals	24	14.46
Furniture	8	4.82
Plastic Products	29	17.47
Totai	166	100.00

The first round of survey invitation was sent in the first week of September, 2014 via email. This was followed by two reminders, each within a gap of two weeks after the preceding survey invitation. A total of 755 emails were sent out. Out of these, 63 emails were returned as undeliverable. 173 partially complete responses were received, giving a response rate of 25% (173/692). However, for the final analysis we retained only complete responses. Thus, the final sample size was 166.

4.1.1. Non-response bias
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.

4.1.2. Common method bias

Since we collected from a single respondent per firm; common method may be a problem. Hence an assessment of common method bias was deemed necessary. Analysis of Harmon's single-factor test of common method bias (Podsakoff *et al.* 2003) showed six factors with Eigen values above one, explaining 59.2% of the total variance. The first factor explained 28.2% of the variance, which is not the majority of the total variance. Again we resort to a second test of common method bias; we applied confirmatory factor analysis to Harman's single-factor model (Flynn *et al.* 2010). The model's fit indices of chi-sq/df = 11.3; NNFI = 0.47; CFI= 0.52 and RMSEA = 0.15 were predominantly worse than those of the measurement model suggesting that single factor model is not acceptable; thus the common method bias is negligible.

4.2. 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 27 survey items (refer. Table 2) were used to measure independent and dependent variables in the study.

4.2.1. Supply-side competence, demand-side competence and process compliance

Supply side competence, demand side competence and process compliance scales were suitably adapted from Blome *et al.* (2013). Supply side competence reflects the degree to which a firm efficiently manages its procurement of raw materials, relationship with its key suppliers, ensures optimal supply of its raw materials and other relevant inputs. It was measured with four indicators that enquired from respondents if their supply management delivers the desired performance and operational needs of their business; if their production management delivers the expected performance and meets the operational needs of the

Table 2. Survey items

Constructs	Measurement Items *AB constructs were measured as l = Strongly Disagree; 4 = Neutral and 7 = Strongly Agree
Supply-side Competence Adapted from Blome *et al.* (2013)	Our supply/management provides the ejected performance within our supply chain Our supply management fulfills the operational requirements of our supply chain Our production management provides the expected performance within our supply chain Our distribution management fulfills the operational requirements of our supply chain
Demand-side Competence Adapted from Blome *et al.* (2013)	Our demand management provides the expected performance within our supply chain Our demand management fulfills the operational needs of our supply chain Our distribution management provides the expected performance within our supply chain Our distribution management fulfills the operational needs of our supply chain
Process Compliance Adapted from Blome *et al.* (2013)	Our demand management processes are 100% executed (as specified) by our employees Our supply management processes are 100% executed (as specified) by our employees Our production management processes are 100% executed (as specified) by our employees Our distribution management processes are 100% executed (as specified) by our employees
Supply Chain Innovation Adapted from Flint *et al.* (2008)	Our supply chain has formal new product and service development process Our supply chain monitors and documents new product and service ideas Our supply chain keeps track of successful product and service ideas Our supply chain focuses on process and technological innovation
Environmental Uncertainty Adapted from Wong *et al.* (2011)	Our customers frequently change their order Our suppliers performances unpredictable Competitors' actions regarding marketing promotions are unpredictable Our plant uses core production technologies that often change
Operational Performance Adapted from Stank *et al.* (1999); Gligor & Holcomb (2012)	Our firm delivers undamaged orders each time Our firm delivers accurate orders at all times. Our firm always meets deadlines as promised to supply chain partners
Relational Performance Adapted from Stank *et al.* (1999); Gligor & Holcomb (2012)	Our firm develops formal relationships with its supply chain partners Our firm exchanges recommendations for continuous improvement with its supply chain partners Our firm helps its supply chain partners successfully perform tasks Our firm knows its supply chain partners' needs well

business. Demand side competence was measured with four indicators after suitable modification from Blome *et al.* (2013). It enquired respondents if their demand management delivers the desired performance and meets the operational needs of their supply chain. It also enquired of the respondents if their distribution management delivers the desired performance and meets the operational needs of their business. Process compliance was measured with four indicators after suitable adaptation from Blome *et al.* (2013). It enquired respondents if their demand management processes are executed and followed by their employees to the extent of hundred percent. Further, they enquired the respondents if their supply management processes, production management processes and distribution management processes are hundred percent executed and followed by their employees. All the constructs were operationalised on 1 to 7 Likert scale where 1 = Strongly Disagree; 4 = Neutral and 7 = Strongly Agree (Autry, Griffis 2008).

4.2.2. Supply chain innovation, environmental uncertainty, operational and relational performance

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. Environmental uncertainty was measured with four items after suitable adaptation from Wong *et al.* (2011). Operational performance was measured with three items suitably adapted from Gligor and Holcomb (2012). Finally, relational performance were measured with four items suitably adapted from Gligor and Holcomb (2014). All the constructs were operationalised on 1 to 7 Likert scale where 1 = Strongly Disagree; 4 = Neutral and 7 = Strongly Agree.

4.2.3. Control variable

Like established studies in organizational research, we took firm size (natural logarithm of employee number) as control variable (Bulmer 1979).

4.3. Scale validation

The current study employed Partial Least Squares for scale validation and hypothesis testing. PLS is a structural equation modeling based methodology that deploys a component based approach for estimating the parameters. The benefit of using PLS extends from allowing the researcher to model formative constructs to estimating the required parameters with a minimal sample size. For PLS, the required sample size is ten times the no of indicators of the largest construct present in a theoretical model. As PLS does not provide a significance test or interval estimation, a bootstrapping analysis was conducted with 1000 sub-samples for calculating the path co-efficient, statistical significance and allied parameters. The procedure was executed in two steps. First, reliability and convergent validity was assessed. The second step assessed the discriminant validity.

The study first assessed reliability using the criterion, Cronbach's alpha larger than 0.7 (Chin 1998). Convergent validity was next assessed using multiple criteria: (1) item loading larger than 0.70 and statistical significance, (2) composite construct reliability larger than 0.80 and (3) average variance extracted (AVE) larger than 0.50 (Fornell, Larcker 1981). Further, discriminant validity was assessed using the criterion: the square root of AVE for each construct greater than its correlations with all other constructs (Fornell, Larcker 1981). As indicated in Table 3, standardized item loadings range from 0.74 to 0.92, composite reliabilities range from 0.86 to 0.94, and average variance extracted (AVEs) range from 0.62 to 0.8. In Table 4, the square root of AVE for each construct is larger than its correlations with all other constructs. Hence, these results show a highly acceptable level of reliability, convergent and discriminant validity.

Table 3. Convergent validity

Construct	Items	Item loadings	Composite reliability	AVE	Cronbach's Alpha
Supply-side Competence	4	0.84–0.90	0.927	0.761	0.916
Demand-side competence	4	0.77–0.85	0.886	0.661	0.877
Supply chain innovation	4	0.81–0.87	0.911	0.718	0.889
Process compliance	4	0.74–0.82	0.869	0.625	0.875
Environmental uncertainty	4	0.85–0.92	0.934	0.779	0.922
Operational performance	3	0.79–0.83	0.890	0.668	0.894
Relational performance	4	0.86–0.93	0.942	0.802	0.926

Table 4. Discriminant validity

	DSC	EU	OP	PC	RES	RP	SSC
Demand-side competence (DSC)	**0.813**						
Environmental uncertainty(EU)	0.4206	**0.883**					
Operational performance (OP)	0.3431	0.2124	**0.817**				
Process compliance (PC)	0.2703	0.4769	0.1722	**0.791**			
Supply chain innovation (SCI)	0.4396	0.5208	0.2647	0.4723	**0.847**		
Relational performance (RP)	0.3804	0.4251	0.1184	0.2981	0.3462	**0.896**	
Supply side competence (SSC)	0.2833	0.5036	0.2317	0.3579	0.4495	0.2013	**0.872**
Diagonal value: squared root of AVE, non-diagonal value: correlation							

5. Hypotheses testing

5.1. Main model

PLS was used to estimate the path coefficients in the structural model. The estimation was executed in two steps (Chin 1998). First, it was required to estimate the path coefficients and statistical significance for the dominant paths. Second, coefficient of determination (R-square) for endogenous variables was computed to assess their predictive power.

For the influence of supply-side competence on supply chain innovation; the corresponding path was found to be positive and statistically significant (0.243; t = 3.886). This showed support for our proposed hypothesis H1a. Again, H1b discussed a positive influence of demand-side competence on supply chain innovation. The corresponding path coefficient is positive and significant (0.255; t = 4.072). Hence H1b is supported.

H2a discussed a positive influence of supply chain innovation on operational performance. The corresponding path coefficient is positive and significant (0.317; t = 4.509). Hence H2a is supported. H2b discussed a positive influence of supply chain innovation on relational performance. The corresponding path coefficient is positive and significant (0.343; t = 4.291). Hence H2b is supported.

Hence the model established supply-side competence and demand-side competence as critical building blocks of supply chain innovation. Also, it established empirically that supply chain innovation does exert a positive influence on operational and relational performance of a firm. Both supply-side and demand-side competence explained around 35.3 percent of the variance in supply chain innovation. Supply chain innovation accounted for explaining 22.6 percent of the variance in operational performance and 28.1 percent of the variance in relational performance.

5.2. Moderating role of process compliance and environmental uncertainty

Several steps were followed to investigate the moderating role of process compliance in the supply-side competence and supply chain innovation linkage; and demand-side competence and supply chain innovation linkage. First, we examined the interaction between process compliance and supply-side competence. To reduce the threat of multicollinearity, the two variables were first centered (Aiken, West 1991). Next, supply chain innovation was regressed on supply-side competence, process compliance and supply-side competence*process compliance. The interaction term was significant (F = 37.3, Beta = 0.155, p = 0.029); so process compliance positively moderates the relationship between supply-side competence and supply chain innovation. As such, H3a is supported.

Identically, next we examined the interaction between process compliance and demand-side competence. Again the two variables were centered for reducing the threat of multicollinearity (Aiken, West 1991). Next, supply chain innovation was regressed on demand-side competence, process-compliance and demand-side competence*process compliance. The interaction term was significant (F = 26.7, Beta = 0.128, p = 0.04); so process compliance positively moderates the relationship between demand-side competence and supply chain innovation. As such, H3b is supported.

Similarly, we examined the moderating role of environmental uncertainty following the approach adopted in case of process compliance. For the moderating role of environmental uncertainty on supply chain innovation and operational performance linkage; the interaction term was significant (F = 43.5, Beta = 0.137, p = 0.037). As such, environmental uncertainty positively moderates the relationship between supply chain innovation and operational performance and H4a is supported. Finally, we examine the moderating role of environmental uncertainty on supply chain innovation and relational performance linkage; the corresponding interaction term too was found significant (F = 30.6, Beta = 0.111, p = 0.048). Hence, environmental uncertainty positively moderates the relationship between supply chain innovation and relational performance. Therefore, H4b is also supported. Table 5 summarizes the results of moderation.

Table 5. Moderation testing results

Moderation testing results				
Hypo-theses No	Relation-ship	Moderator	Std. weights	Sup-ported?
H3a	SSC ~> SCI	Process compliance	0.155	Yes; p = 0.029
H3b	DSC -> SCI	Process compliance	0.128	Yes; p = 0.04
H4a	SCI -> OP	Environmental uncertainty	0.137	Yes; p = 0.037
H4b	SCI ~> RP	Environmental uncertainty	0.111	Yes; p = 0.048

SSC = supply side competence.
DSC = demand side competence.
EU = environmental uncertainty.
PC = process compliance OP = operational performance.
RP = relational performance.
SCI = supply chain innovation.

6. Discussion and implications

The study sought to advance research in supply chain risk management through a focused investigation of supply chain innovation. Our model explored the antecedents (supply-side competence and demand-side competence) of supply chain innovation, its influence on firm performance (measured along operational and relational perspectives) and the moderating affect of process compliance and environmental uncertainty. Our study therefore exhibited the benefits of supply-side and demand-side competences for supply chain innovation. The empirical data provided support and suggest that supply and demand-side competence can be transformed via supply chain innovation into improved performance (Blome *et al.* 2013; Wu *et al.* 2014).

The findings contribute to past research by arguing that dynamic capabilities perspective is effective in explaining performance effects. For staying competitive, organizations have to adapt to their dynamic environments and supply chain innovation is a vehicle for achieving this objective. To sum up, we established supply chain innovation as the adaptive capability of a firm that can enable the firm to sustain its supply chain operations through providing an optimal feedback to the need of the situation and can be developed through a suitable culmination of supply and demand-side competences.

First, we have offered logical arguments (based on theoretical tenets of RBV complemented with the dynamic capabilities perspectives) differentiating supply and demand side competences after differentiating between capabilities and competences. The current investigation has achieved this based on theoretical support from strategic management and have argued capabilities to have emerged from a culmination of competences (Prahalad, Hamel 1990; Teece 2007). Further, the study have conceptualized

these competences as internal to a firm; while supply chain innovation as a dynamic capability is aimed to sustain firm performance through providing its customers with newer products and services. This also falls in line with literature arguing based on RBV that capabilities emerge from competences. The basic premise of positing supply and demand side competences as basic building blocks of supply chain innovation have been confirmed as demonstrated by the statistical significance of the corresponding paths (supply side competenceà supply chain innovation path: Beta = 0.243; t = 3.886; demand-side competenceà supply chain innovation path: Beta = 0.255; t = 4.072). This urged researchers and practitioners to incorporate these competences (supply and demand side) while considering the development of other critical supply chain capabilities e.g. supply chain resilience, supply chain flexibility, supply chain robustness (Swafford *et al.* 2006; Gunasekaran *et al.* 2008; Brandon-Jones *et al.* 2014). These findings are also in line with earlier studies that competencies can be the pillars of success for focal firms (Gonzalez-Benito 2007; Yeung 2008).

Second, our research has established supply chain innovation as the focal point of strategic planning for a firm through its positive influence on firm performance. As our study has noted; firm performance must be measured in both operational terms as well as relational parameters (Swafford *et al.* 2008). Empirically showcasing the positive influence of supply chain innovation on operational performance our study enriches the domain of dynamic capabilities and their positive implications on firm performance. Further, showcasing the positive influence of supply chain innovation on relational performance, our study proved that supply chain innovation improves the supply chain relationships too during a disruption as it helps a firm to restore its operations in collaboration with its supply chain members. This is due to increased cooperation and coordination being called for among the supply chain partners for greater benefit and sustenance of supply chain operations. The positive influence of supply chain innovation on operational performance is also manifested as building on such capabilities; a firm probably optimizes resource allocation and adheres to best practices.

Third, our study has established process compliance as a dominant infrastructural component influencing the evolution of the competences into supply chain innovation. This requests attention of supply chain managers and practitioners to ensure that their core processes e.g. distribution, production etc are well optimized and in line with a firm's overall business objectives. Frequent process checks should be conducted to ensure adherence to norms and procedures as the same will help in the effective evolvement of the competences into a dynamic capability e.g. supply chain innovation (in this case). With these, our study further confirms process compliance as a valuable ingredient under RBV that is able to guide through providing appropriate

infrastructure to supply and demand-side competences in their evolvement into supply chain innovation. Lastly, process compliance can be observed as a vehicle to effectively absorb (recognize, evaluate, assimilate and apply) paradigms of supply and demand-side competences for increased influence on supply innovation (Blome *et al.* 2013; Lee *et al.* 2011; Hazen *et al.* 2012; Tan *et al.* 2015).

Fourth, our study empirically established the appropriation of supply chain innovation as a dynamic capability through considering the moderating impact of environmental uncertainty on supply chain innovation and performance linkages. Innovation in supply chains indicates the ability of a firm's supply chain to satisfy its customer's requirements through developing and providing newer products and services. As dynamic capabilities are directed to enable a firm to adapt to the dynamic requirements of its allied environment (Teece 2007); our study has proved that supply chain innovation positively impacts both a firm's operational performance as well as its relational performance more strongly when environmental uncertainty is high. This implies that the positive relationship between supply chain innovation and a firm's operational and relational performances increases as environmental uncertainties enhances in magnitude. This calls the attention of supply chain managers and practitioners to focus their attention for executing strategies and plans for building supply chain innovation well in advance of a disruption. Hence our study provides empirical support to the conceptualization of supply chain innovation as a dynamic capability that ensures a strong performance for the firm in the presence of environmental uncertainty.

Conclusions

Little research has concentrated on the antecedents of supply chain innovation. Our study addressed this gap and investigated the relative importance of the precursors of supply chain innovation from a competence-capability perspective. Further, our study has provided a deeper understanding of supply chain innovation as a dynamic capability and undersigned its profound influence on a firm's operational and relational performance. Moreover, our study offered empirical evidence suggestive of the moderating influence of process compliance on the relationship between supply and demand-side competence and supply chain innovation. Lastly, the study has also empirically explored the validity of supply chain innovation as a dynamic capability through considering its influence on firm performance in the presence of environmental uncertainty. The empirical findings provided support suggestive of the fact that the influence of supply chain innovation on firm performance increases in the presence of environmental uncertainty. On a holistic note, through increasing our comprehension of supply chain innovation as a dynamic capability, with its

antecedents based on a competence-capability perspective, its performance implications along with performance enhancers, this empirical exploration makes a significant contribution to the field of supply chain management.

While our empirical exploration was successful in seeking answers to some of the interesting questions in the arena of supply chain responsiveness and supply chain management; it also has few limitations. The collected data (from a single respondent per firm) may not be representative of the actual picture. Although we have adopted empirical tests to examine and ensure the absence of common method bias; but even statistical tests have their own limitations. Hence future studies should attempt to gather perceptual responses from multiple respondents per firm. A second limitation refers to the generalization of the findings based on the representative sample in India. While it is expected that identical findings will hold good in countries with similar development characteristics; this cannot be guaranteed. Hence future studies should empirically test the proposed model in other demographic contexts.

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