Responsiveness in the Face of Disruption – Exploring the Role of Collaborative Knowledge Management and Supply Chain Relational Capital

Prashanth Anekal
Saginaw Valley State University

The Covid pandemic has thrown light on the issue of resilience of the supply chain. Organizations and their supply chains are now exploring ways to increase resilience. Supply chain literature has largely defined resilience in terms of responding and reacting to disruptions. This study thus explores Supply Chain Responsiveness (SCR) as an aspect of resilience and examines the role of Collaborative Knowledge Management (CKM) and Supply Chain Relational Capital (SCRC) in improving responsiveness. Findings from a survey of manufacturing firms indicate that both CKM and SCRC have a positive impact on SCR. Implications for theory and practice are discussed.

Keywords: responsiveness, disruption, collaborative knowledge management, supply chain relational capital

INTRODUCTION

The Covid-19 pandemic and its aftereffects are forcing organizations to rethink their supply chains. Chief Supply Chain Officers are now thinking of the next possible disruption and how to make their supply chains less vulnerable to any future disruptive events. In late 2020, Gartner, Inc. conducted a global survey of more than 1,300 supply chain professionals and found that 87% of the respondents plan to make investments in supply chain resiliency over the next two years. Ever since the Covid-19 pandemic, resilience has become a key focus of organizations and management consulting firms (e.g., McKinsey, BCG, and Accenture). Academic literature has thus found a renewed interest in exploring topics related to supply chain resilience. However, resilience as a topic area is not new in supply chain literature. It has been discussed for over two decades. The renewed interest though makes absolute sense. Resilience as a topic area has its roots in the field of Ecology. Holling (1973) addresses the concept of resilience and defines it in terms of the ability of the system to absorb changes and persist. In the field of operations and supply chain management, resilience has generally been defined in terms of – (a) the ability of the system to return to its original state or a more desirable state (Christopher and Peck, 2004), (b) reacting to disruptions (Williams et al., 2009), (c) recovering from disruptions (Rice and Caniato, 2003; Ponomarov and Holcomb, 2009), and (d) increasing responsiveness (Chowdhury et al., 2018). Thus, Responsiveness has been a common theme in all these representations or interpretations of resilience. The responsiveness in question may be in anticipation of a possible future disruption or as a reaction to a disruptive event. No matter what, responsiveness is extremely crucial for the success of a firm in turbulent times. However, firms do not operate in a vacuum. A firm's business process extends beyond its organizational boundaries and a firm depends on its supply chain partners to achieve its organizational objectives, which is the essence of supply

chain management (Burke and Vakharia, 2002). Supply chain responsiveness and not merely firm responsiveness becomes a determinant of success in such circumstances. Supply Chain Responsiveness is thus the focus of this study.

A review of the literature shows that inter-firm collaboration is extremely important for achieving responsiveness within the supply chain. Information sharing between supply chain partners is said to be the most basic requirement for effective collaboration. Sharing of information could happen at the operational level or a strategic level or both. Studies have shown that information sharing has a positive impact on supply chain responsiveness (Li et al., 2006; Ramayah and Omar, 2010). The use of information technology tools to connect with supply chain partners and integrate business processes is said to be beneficial (Li et al., 2005). Multiple studies have explored the use of IT-based collaboration systems to facilitate inter-firm planning and forecasting activities to achieve responsiveness (Rai et al., 2006; Kim and Lee, 2010). One such system or practice that has been explored in previous studies is the use of Collaborative Knowledge Management. For instance, Li et al. (2012) found that the use of collaborative knowledge Management practices leads to better integration between supply chain partners and increased organizational knowledge quality. However, the question as to whether collaborative knowledge management facilitates improved responsiveness within the supply chain is still not addressed. Thus, the first research question of this study is - does collaborative knowledge management enhance supply chain responsiveness?

As addressed earlier in the section, achieving supply chain responsiveness requires the involvement of multiple supply chain partners. The relationship between those supply chain partners cannot be merely transactional. It calls for a more collaborative relationship that is based on a level of trust and mutual respect. Trust and social connections, which are constituents of the broader concept of social capital, are seen as critical resources for firms (Inkpen and Tsang, 2005; Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998). The benefits of social capital at the organizational and inter-organizational levels have been examined in the past. Social capital can facilitate the sharing of resources that are critical for inter-organizational processes and improve alliance outcomes (Dyer and Singh, 1998; Kogut and Zander, 1992; Szulanski, 1996; Inkpen and Tsang, 2005). The role of social capital has been highlighted in the context of disaster recovery and survival (Aldrich and Meyer, 2015). Even though the link between social capital and resilience has been examined, the results have been inconclusive (Golgeci and Kuivalainen, 2020). A more recent study by Ye et al., (2022) explored the relationship between social capital (and its three components – structural, cognitive, and relational capital) and supply chain performance. However, there are very few instances where the link between relational capital and supply chain responsiveness has been explicitly examined. Thus, the second research question of this study is - does supply chain relational capital improve supply chain responsiveness?

To address these research questions, this paper presents a research model that examines the relationships between (1) collaborative knowledge management and supply chain responsiveness, (2) supply chain relational capital and supply chain responsiveness, and (3) supply chain responsiveness and firm performance. Data collected from a survey of manufacturing firms in the US is used to empirically test the proposed relationships. The results of the study support all three proposed relationships. This study contributes to theory and practice in many ways. It highlights the importance of actively building relational capital with supply chain partners. At the same time, it shows that there is value in actively engaging in collaborative knowledge management and developing systems and processes that go with it. The results also highlight the importance of supply chain responsiveness in an organization's quest for building a more resilient system. It shows that having a responsive supply chain has positive impacts on the firm's performance. The rest of the paper is structured as follows. The next section presents a literature review, which is followed by hypotheses development, methodology, and empirical results. Finally, the implications of the study, limitations, and scope for future research are discussed.

LITERATURE REVIEW

Collaborative Knowledge Management

According to the resource-based view of organizations, resources that are valuable, rare, inimitable, and non-substitutable can be sources of competitive advantage (Barney, 1991). Knowledge is one such resource (Drucker, 1993; Penrose, 1959). In the context of a supply chain, knowledge is constantly generated, transferred, assimilated, and used due to the actions of various supply chain entities. However, in many cases this process is not carefully managed, thus resulting in a collective loss to the supply chain. It is therefore imperative that organizations have systems and processes in place to prevent the loss of knowledge. When these systems and processes are collectively devised and managed, it is known as collaborative knowledge management.

Knowledge in a supply chain is not a stand-alone entity. Supply chain knowledge is referred to as "a reservoir of collective insights, understandings, beliefs, behavioral routines, procedures and policies drawn from hard data as well as on viewpoints, beliefs, values, and intuitions, and owned by the supply chain regarding mutually interesting issues such as markets, products, technologies and processes" (Li et al., 2012). Knowledge management was initially studied at the organizational level. King (2001) defined knowledge management in terms of the acquisition, explication, and communication of individual expertise in a way that is relevant to organizational members. According to Marshall (1997), knowledge management is a way to harness intellectual capital. Most of the studies have conceptualized knowledge management in terms of some or all of the following – creation, assimilation, dissemination, storage, use, and leverage of organizational knowledge. Over time, knowledge management literature has expanded into the supply chain domain where it is conceptualized as a collaborative process involving suppliers and customers. Collaborative knowledge management refers to processes that enable firms to generate, store, access, disseminate and apply supply chain knowledge across organizational boundaries to achieve supply chain objectives (Li et al., 2012).

In the context of the supply chain, the interaction between supply chain partners forms the basis of knowledge creation. The formation of strategic alliances is an effective way to collaboratively create knowledge (Grant and Baden-Fuller, 2004). Strategic alliance formed for new product development is seen as an exploratory form of knowledge generation (Rothaermel and Deeds, 2004). Collaborative knowledge creation in the long term can lead to economic benefits and competitive advantage (Samaddar and Kadiyala, 2006).

Collaborative knowledge storage refers to the co-ownership of knowledge resources in a centralized location that is managed by all parties involved, thus leading to improved access (Nielsen, 2006). Knowledge from various sources can be pooled and stored in a centralized database thereby creating a knowledge warehouse.

Facilitating access to stored knowledge is an important part of collaborative knowledge management. Stored knowledge becomes useful only when it is accessible to the right people at the right time (Davenport and Prusak, 1998). However, since organizational knowledge may be proprietary in nature, it is important to have appropriate access controls in place.

Collaborative knowledge dissemination refers to the distribution of stored knowledge to all parties involved in a usable form. The process of knowledge dissemination is largely dependent on whether the knowledge being shared is tacit or explicit in nature. Tacit knowledge is the knowledge that is hard to codify. Explicit knowledge can be codified and transferred easily. Socialization and interaction processes are useful for the exchange of tacit knowledge (Thomke and Fujimoto, 2000).

Collaborative knowledge application refers to the act of knowledge utilization for purposes of decision-making, problem-solving, and goal attainment (Li et al., 2012). Collaborative knowledge application is a way for partners involved in strategic alliances to take advantage of complementary knowledge (Meier, 2011).

In this study, Collaborative knowledge management is thus defined as the extent to which the focal firm collectively creates, stores, and accesses knowledge with its supply chain partners.

The use of information technology (IT) / information systems (IS) is a common theme in many studies related to collaborative knowledge management. According to Mitchell (2003), information technology is a facilitator for effective knowledge management. Studies have shown that IS-based integration of knowledge management systems can create better access to stored knowledge and thus facilitate effective decision-making (Kebede, 2010). Multiple studies have addressed the performance impacts of collaborative knowledge management. Warren and Buke (2005) argue that CKM practices can lower costs and increase the effectiveness of knowledge management in the supply chain. Technology-enabled CKM is said to improve the overall performance of the supply chain by (a) providing a means to manage the large amounts of data generated by supply chain entities (Olson, 2018; Perez-Salazar et al., 2017; Dost et al., 2016), (b) improving the quality of knowledge captured in the supply chain by the use of data management and data analytics (Olson, 2018) and (c) providing timely access to the captured knowledge (Gunasekaran and Ngai, 2007).

Supply Chain Relational Capital

Supply chain transactions are not merely dependent on the usually talked about resources such as capital, labor, technology, or intellectual capital. They are also dependent on the extent to which there are social relationships among supply chain partners. According to the Social Capital Theory, social relationships and the resulting resource called social capital can be valuable resources or assets (Coleman, 1988). Social capital is a multidimensional concept that includes structural capital, cognitive capital, and relational capital (Nahapiet and Ghoshal, 1998). Structural capital is a result of the structural configuration of the supply chain and depends on boundary-spanning activities of peripheral entities (Krause et al., 2007). Cognitive capital represents shared meanings and interpretations of supply chain members. Relational capital refers to the personal relationships and social ties that exist between entities (Krause et al., 2007; Cousins et al., 2006).

Relational capital is a function of trust and mutual respect between transacting partners (Nahapiet and Ghoshal, 1998). Relational capital needs to be nurtured since it gradually builds over time. Socialization processes are generally responsible for increases in relational capital (Cousins et al., 2006). Relational capital stems from a strong sense of belonging and cooperation between partner firms (Capello and Faggian, 2005). Relational capital is also defined as the extent of trust, reciprocity, and strength of ties among members of a team. Kale et al., (2000) refer to relational capital as trust, respect, and friendship that is a result of close interactions between alliance partners. Cousins et al., (2006) define supply chain relational capital "as the configuration and social structure of the group through which resources are accessed". They determine the extent of supply chain relational capital by the degree of mutual trust, respect, and close interactions between supply chain partners. In this study, Supply chain relational capital is defined as the extent to which the focal firm has mutual trust, respect, and social interactions with its supply chain partners.

Relational capital has performance implications at both organizational and supply chain levels. In the supply chain, mutual trust and respect are seen as one of ways to reduce transaction costs (Kale et al., 2000). A lack of trust between transacting partners will mean increased monitoring costs since more resources must be allocated to monitor the actions of the partners. The fear of opportunism is amplified by the lack of trust between supply chain partners. The lack of trust is one of the main factors for the failure of supply chain partnerships (Forrest and Martin, 1990). Trust is seen as a key ingredient of success in many of the high-tech industries where supply chain collaboration is critical (Sahay, 2003). Trust-related benefits include the willingness to share information, reduced cost of transactions, reduced time for transactions, improved responsiveness, and increased innovativeness (Kale et al., 2000; Kothamaki et al., 2013; Yu and Huo, 2017). Social interactions between members of a supply chain contribute to the growth of relational capital and goodwill between partners (Liker and Choi, 2004). Social interaction between supply chain members also improves the extent of integration between supply chain partners (Wu et al., 2004). In the area of knowledge management, social interaction is seen as a way to acquire and disseminate tacit knowledge between members (Lang, 2004).

Supply Chain Responsiveness

The concept of responsiveness has its origins in "time-based competition" literature (Stalk, 1988; Bower and Hout, 1988). Quick Response Programs (QRP), Effective Customer Response (ECR), and Mass Customization are all concepts that are closely related to responsiveness (Holweg, 2005). All these concepts relate to the ability to react to external factors. According to Lee et al. (1997), supply chain responsiveness is the ability of the supply chain to respond quickly to changes in demand. As per this definition, responsiveness is not just about responding to changes in demand. It is also about how quickly a supply chain can respond to those changes (Swafford et al., 2006). These changes could be in terms of volumes, variety, customization, or new products (Christopher, 2000). There is some intersection in supply chain literature when it comes to the concepts of responsiveness and flexibility (Fisher 1997). Flexibility has generally been described in terms of volume flexibility, product mix flexibility, process flexibility, and machine flexibility (Slack, 1983; Browne et al., 1984; Sethi and Sethi, 1990; Gerwin, 1993; Parker and Wirth, 1999). These representations of flexibility are focused on internal operations, whereas responsiveness has an external focus. Responsiveness is more about the ability to respond to changes in the external marketplace. Based on these thoughts, supply chain responsiveness is defined as the extent to which the supply chain responds quickly to changes in demand and the external environment.

Firm Performance

Firm performance is the outcome variable that is most explored in operations management literature. Firm performance has been described in a variety of ways in management literature. Georgopoulos and Tannenbaum (1957) used productivity, flexibility, and inter-organizational tensions as was to assess performance. Porter (1985) described the firm performance in terms of its ability to create value for its customers. Firm performance has also been described in terms of efficiency and effectiveness. A well-performing firm is said to be both efficient and effective.

Studies in the past have used both operational measures and financial measures to capture firm performance. Commonly used operational indicators include cost, quality, delivery reliability, and flexibility (Li et al., 2005; Li et al., 2006; Koufteros 1995; Koufteros et al., 1997; Krause et al., 2007; Klassen and Whybark, 1999). Financial and market-based indicators such as profits, return on investment (ROI), market share, and stock price are also employed to assess firm performance (e.g., Holmberg, 2000; Tan et al., 1999; Huselid et al., 1997; Baker and Sinkula, 2005). Man (2006) identified four categories of performance measures – financial, non-financial, tangible, and intangible. Another way to assess firm performance is based on the firm's ability to create competitive advantage (e.g., Li et al., 2006). Organizations can achieve a competitive advantage by creating a defensible position over competitors (Li et al., 2006). Thus, gaining a competitive advantage and achieving competitive goals is a good indicator of a firm's performance. In this study, firm performance is thus defined as *the extent to which the firm meets its competitive goals*. Competitive goals are described in terms of the ability of the firm to provide value to the customer (Tu et al., 2001) and value to the firm itself to ensure growth and financial sustainability (Tracey and Tan, 2001).

HYPOTHESES DEVELOPMENT

Supply chain responsiveness can be seen as a dynamic capability where the supply chain can respond to a rapidly changing environment (Sher and Lee, 2004). Achieving this responsiveness at the supply chain level is not an easy task since it involves working with and coordinating with multiple supply chain partners. The basic requirement for achieving this coordination is the effective sharing of information between supply chain partners (Handfield and Nichols, 1999; Anekal, 2014 & 2018). Information sharing acts as the stepping stone in the quest for responsiveness. Responsiveness also calls for the synchronization of activities with suppliers. This could be in terms of making joint decisions related to production schedules, inventory positioning, and logistics. Being on the "same page" with suppliers and having a shared understanding of customer requirements and market trends are also helpful in achieving responsiveness. Collaborative knowledge management can be a facilitator for all of these. In this study, Collaborative

knowledge management refers to the routines in place to collectively create, store and access knowledge in the supply chain. (Li et al 2012). This is an inter-firm activity where partners rely on each other's knowledge and expertise to achieve organizational and supply chain goals. Studies in the past have shown that collaborative knowledge management activities have positive implications on the performance of the firms involved (Holland, 1995; Handfield and Nichols, 1999; Dustdar, 2005). Information Technology based CKM systems help in improving information transmission and increasing response speed (Sher and Lee, 2004). It is said to have a positive impact on information quality and knowledge quality by providing timely access to more accurate, relevant, and complete information (Li et al., 2012). CKM practices enable both internal functional integration and external integration with suppliers and customers (Li et al., 2012). It makes the negotiation process between supply chain partners less cumbersome, enables cooperation, and helps in the management of conflicts (Bonte, 2008). CKM practices enable supply chain participants to make joint strategic and operational decisions (Li, 2007; Bonte, 2008). A well-defined CKM process has been shown to improve logistics and overall supply chain performance (Fugate et al., 2009; Yang, 2013). It is also said to enhance the dynamic capabilities of the firms involved in the collaborative process (Sher and Lee, 2004) and thereby helping them become more responsive. Thus:

Hypothesis 1 (H1) *– Collaborative Knowledge Management has a positive relationship with Supply Chain Responsiveness.*

Relational capital plays an important role in the context of alliances between two firms. Relational capital is generally described in terms of value that is created by having and maintaining a good relationship. In the context of the supply chain, it is based on trust, social interaction, and mutual respect between partner firms (Kale et al 2000; Cousins et al 2006). The success of any strategic alliance depends heavily on trust (Narasimhan and Nair, 2003; Kale et al 2000). Trust, which is a component of relational capital, is said to enable the establishment of information-sharing structures between organizations and thus leading to improved coordination and improved responsiveness (Johnson et al., 2013). Trust is recognized as an informal mechanism to foster cooperation and coordination in a supply chain (Ballou et al., 2000).

Social capital theory suggests that the risk of opportunistic behavior can be reduced to a certain extent by developing relational capital (Kale et al., 2000). Relational capital has a positive impact on the willingness to cooperate with supply chain partners (Tsai, 2002). It also makes supply chain partners more willing to reconfigure resources and structures for mutual benefit (Atuahene-Gima and Murray, 2007). Relational capital motivates supply chain partners to work toward improving the flow of resources in their supply chain (Hite, 2003; Larson, 1992). Socialization is another way to develop relational capital. Socialization helps develop personal familiarity, improves communication, and eventually facilitates problem-solving (Gupta and Govindarajan, 2000). Wooldridge and Minsky (2002) propose socialization to improve inter-functional coordination. Thus:

Hypothesis 2 (H2) *– Supply Chain Relational Capital has a positive relationship with Supply Chain Responsiveness.*

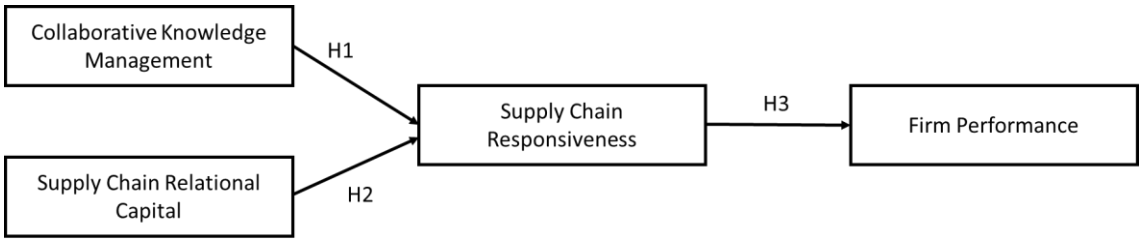
Firms do not operate in a vacuum. They are dependent on external entities for the supply of goods and services that are required for producing their end product. In many sectors of manufacturing, on average, 60 to 70% of the cost of manufacturing goes toward the purchase of raw materials and components. In such a scenario, the success of a firm depends on how well the firm can mobilize and manage these external entities, namely their suppliers. In the face of adversity and disruptions in the firm's external environment, a firm's success depends on how quickly it can respond to those changes. The response could be in the form of changing their product offerings, scaling up/down their production volumes, reconfiguring their supply network, rethinking their logistics, altering their delivery models, and many other things. However, since firms are greatly dependent on their suppliers, they must be able to get their suppliers on board and work with them to achieve these changes. Firms dealing with non-responsive suppliers will be forced to employ the use of buffer inventory and capacity to hedge against uncertainty. Buffering and the creation of

redundancies are common practices to hedge against uncertainty (Novak et al., 2021). But they are also expensive and may result in inefficiencies for the firm. In many situations, the inability to get the suppliers to respond in times of adversity may lead to lost sales and reduced market share. Previous studies have shown a positive relationship between supply chain performance and firm performance (e.g., Peterson et al., 2005; Li et al., 2006; Hendricks and Singhal, 2005). Thus:

Hypothesis 3 (H3): *Supply chain responsiveness has a positive relationship with firm performance.*

The proposed relationships are shown in the conceptual model below.

FIGURE 1
CONCEPTUAL MODEL



METHODOLOGY

Measures and Questionnaire Design

The measures for collaborative knowledge management and supply chain relational capital were developed based on existing literature. The measurement items were tested for content validity by consulting with subject matter experts (academicians and industry professionals). Content validity determines the extent to which the domain of a concept is captured by the measure (Churchill, 1979). The measurement instruments were then pilot-tested using Q-sort methodology and were further refined by modifying and/or deleting items based on the feedback of experts (Moore & Benbasat, 1991). Two rounds of Q-sort were conducted. The measures for supply chain responsiveness and firm performance were adopted from previous studies (Fisher, 1997; Vonderembse et al., 2006; Shah and Ward, 2003; Li et al., 2005; Li et al., 2006; Koufteros, 1995; Koufteros et al., 1997; Krause et al., 2007). An online questionnaire was designed with the indicators being measured on a five-point Likert scale (1 = strongly disagree and 5 = strongly agree).

Sampling and Data Collection

The data for this study was collected from manufacturing companies in the USA. To obtain a representative sample, prospective respondents were randomly selected from the Lexis Nexis Academic database. Prospective respondents included professionals in managerial roles in the areas of purchasing, supply chain, manufacturing, and operations. The following job titles were considered acceptable for this study - purchasing manager, supply chain manager, purchasing director, VP of manufacturing, VP of Purchasing, VP of the supply chain, VP of operations, CEO, and President. The sample was refined based on NAICS codes (31 to 33). The initial mailing list had 5000 names/e-mail addresses, out of which 3023 were invalid. The questionnaire was sent out to 1977 prospective respondents and 270 complete responses were received (13.66% response rate). The measures were then tested for convergent validity, reliability, and discriminant validity. Exploratory Factor Analysis (EFA) was used initially to assess convergent validity (Hair et. al., 2006; Raubenheimer, 2004). Reliability was assessed using Cronbach's alpha scores. Confirmatory factor analysis (CFA) was used to test for discriminant validity. Discriminant validity was assessed by evaluating the correlation coefficients of constructs (Hair et. al., 2006). Accordingly, a pair-wise comparison of the correlation coefficients to the square root of the average variance extracted (AVE)

was conducted. The square root of the AVE estimate was found to be greater than the correlation coefficient, which indicates discriminant validity (Fornell and Larcker, 1981; Koufteros, 1999; Koufteros et al., 2001).

RESULTS

AMOS package for Structural Equation Modeling (SEM) was used to test the proposed relationships. The overall model fit of the research model was assessed based on the following model fit indices – Goodness of Fit (GFI), Adjusted Goodness of Fit (AGFI), Root Mean Square Residual (RMR), Normed Fit Index (NFI), and Comparative Fit Index (CFI). The acceptable thresholds for the indices are – GFI > 0.85; AGFI > 0.8 and RMR < 0.1 (Hair et. al., 2006; Hadjistavropoulos et. al., 1999; MacCallum et. al., 1996). Individual relationships were then examined.

TABLE 1
HYPOTHESES TESTING RESULTS

Hypothesis	Regression Coefficient	t-value	Supported or Not
H 1	0.21	3.69***	Supported
H 2	0.35	6.13***	Supported
H 3	0.54	10.64***	Supported
GFI = 0.964; AGFI = 0.82; CFI = 0.91; RMR = 0.039 *** = p<0.01; **= p<0.05; *= p<0.1			

Hypothesis H1 was supported thus indicating that collaborative knowledge management is positively associated with supply chain responsiveness. This highlights the importance of creating processes and systems that enable the creation, storage, and assimilation of inter-organizational knowledge.

Hypothesis H2 was supported thus indicating that supply chain relational capital is positively associated with supply chain responsiveness. This showcases the benefit of trust between supply chain partners and shows that there is value in moving beyond mere transactional relationships with supply chain partners.

Hypothesis H3 was supported thus indicating that supply chain responsiveness is positively associated with firm performance. This emphasizes the importance of effectively managing the supply chain to achieve organizational performance objectives.

DISCUSSION AND CONCLUSION

This study comes at a time when resilience is being talked about extensively. Disruptions driven by external factors have heightened the need to have a responsive supply chain. The study thus builds on the conceptualization of responsiveness as an aspect of resilience and identifies two factors that could help an organization achieve responsiveness within its supply chain. Collaborative knowledge management and Supply chain relational capital are shown to have a positive association with supply chain responsiveness. The results of the study also highlight the positive relationship between supply chain responsiveness and firm performance, which reiterates the need for organizations to have a supply chain view of their operations. Supply chain pundits have often voiced the need to optimize the supply chain and move beyond sub-optimization at the organizational or even functional levels.

In terms of managerial implications, this study can be of relevance to firms that have experienced disruptions because of external factors. In the case of the Covid pandemic, all firms were invariably affected in one way or another. Even though the study is not entirely targeted at SMEs, a significant percentage of the respondent firms were SMEs. The results of the study can throw some light on what smaller firms with limited resources can do to make themselves more responsive and resilient. It is a given that large firms have better access to financial resources and are usually better placed in the market due to their dominant position in the supply chains in that they operate in. In contrast, smaller firms may be limited in their abilities to reconfigure their supply chain and reallocate resources when the need arises (Cohen and

Kaimenakis, 2007). Smaller firms thus need to rely on other mechanisms to achieve the desired responsiveness and hedge against uncertainty. The first factor identified in this study, collaborative knowledge management, can be helpful to smaller firms in their quest to achieve responsiveness. In the absence of existing processes, these smaller firms could start creating processes by which they could tap into the expertise of their supply chain partners and find collaborative means to capture the existing know-how (knowledge) and find ways to access it whenever required. The use of Information technology-based collaborative knowledge management systems is one route they could take to achieve that. Embarking on such an initiative may seem to be resource-intensive to some firms. Research has shown that SMEs perceive knowledge management projects to be long-term projects with an uncertain return on investment and thus hesitate to take them on (Nunes et al., 2006). In such a case, firms can take baby steps by laying the process foundation for a future initiative. For instance, they could start by creating processes that facilitate the sharing of information between supply chain partners. This could be in the form of sharing market trends, customer buying patterns, technology trends, etc. which would strengthen their supply chains. As they say, knowledge is power and any addition to a firm's knowledge base would be beneficial. Studies in the past have identified critical success factors in the context of organizational and inter-organizational knowledge management. Some of those success factors include the support of top leadership, a culture of sharing, creation of processes for knowledge management and technology infrastructure (Holsapple and Joshi, 2000; Liebowitz, 1999; Davenport et al., 1998). It might be worthwhile for SMEs to consider some of these factors as they engage in collaborative knowledge management practices.

Supply chain relational capital is the other factor that organizations could consider in their desire to become more responsive. The results of this study indicate that there is value in developing relational capital. Cousins et al. (2006) have shown that both formal and informal socialization processes can have a positive impact on supply chain relational capital. Trust, which is an important component of relational capital, can be developed by these socialization mechanisms (Kale et al., 2000). According to Peterson et al. (2008), socialization is said to promote relational capital or a "bank of goodwill", which enables collaboration and has other performance benefits. Some things like increasing the extent of face time with supply chain partners, developing close working relationships, and understanding how suppliers work are all beneficial in developing relational capital (Liker and Choi, 2004). Informal mechanisms to build relational capital include simple things like meeting with a supplier over lunch/dinner (Peterson et al., 2008). These mechanisms can be especially useful for SMEs since they do not call for any extensive investment of time or resources, yet they yield benefits for all the parties involved.

The study contributes to theory by building on previous empirical studies and by identifying two key factors that contribute to responsiveness at the supply chain level and overall performance at the firm level. The validated measures used in this study could be useful in future studies.

In terms of limitations, the data used in this study was cross-sectional and not longitudinal. Single-respondent bias could be seen as a limitation since a single respondent answers questions about the independent variables as well as the dependent variables. However, declining survey response rates makes it a challenge to get multiple respondents to respond from the same organization. Future studies could consider these limitations to build on the ideas proposed in this study.

REFERENCES

Aldrich, D.P., & Meyer, M.A. (2015). Social capital and community resilience. *American Behavioral Scientist, 59*(2), 254–269.

Anekal, P. (2014). The Effects of Product Complexity and Supply Base Complexity on Supply Chain Performance. Doctoral dissertation, University of Toledo.

Anekal, P. (2018). Supplier relational integration under conditions of product complexity. *American Journal of Management, 18*(1), 49.

Atuahene-Gima, K. (2005), Resolving the capability-rigidity paradox in new product innovation, *Journal of Marketing, 69*(4), 61–83.

Baker, W.E., & Sinkula, J.M. (2005). Market orientation and the new product paradox. *Journal of Product Innovation Management, 22*(6), 483–502.

Ballou, R.H., Gilbert, S.M., & Mukherjee, A. (2000). New Managerial Challenges from Supply Chain Opportunities. *Industrial Marketing Management, 29*(1), 7–18.

Barney, J.B. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17,* 99–120.

Bönte, W. (2008). Inter-firm trust in buyer–supplier relations: Are knowledge spillovers and geographical proximity relevant? *Journal of Economic Behavior & Organization, 67*(3–4), 855–870.

Bower, J.L., & Hout, T.M. (1988). Fast-cycle capability for competitive power. *Harvard Business Review*, pp. 110–118.

Browne, J., Dubois, D., Rathmill, K., Sethi, S.P., & Stecke, K.E. (1984). Classification of flexible manufacturing systems. *The FMS Magazine, 2*(2), 114–117.

Burke, G.J., & Vakharia, A.J. (2002). Supply chain management. In H. Bidgoli (Ed.), *Internet encyclopedia*. New York: John Wiley.

Caniato, F.F.A., & Rice, J. (2003). Building a secure and resilient supply chain. *Supply Chain Management Review, 7,* 22–30.

Capello, R., & Faggian, A. (2005). Collective learning and relational capital in local innovation processes. *Regional Studies, 39*(1), 75–87.

Chowdhury, M.M., Quaddus, M., & Agarwal, R. (2018). Supply chain resilience for performance: Role of relational practices and network complexities. *Supply Chain Management: An International Journal, 24*(5), 659–676.

Christopher, M. (2000). The agile supply chain: Competing in volatile markets. *Industrial Marketing Management, 29*(1), 37–44.

Christopher, M., & Peck, H. (2004). *Building the resilient supply chain*.

Churchill, Jr., G.A. (1979). A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, pp. 64–73.

Coleman, J.S. (1988). Social capital in the creation of human capital. *American Journal of Sociology, 94*, S95–S120.

Cousins, P.D., Handfield, R.B., Lawson, B., & Petersen, K.J. (2006). Creating supply chain relational capital: the impact of formal and informal socialization processes. *Journal of Operations Management, 24*(6), 851–863.

Davenport, T.H., & Prusak, L. (1998). *Working Knowledge: How Organizations Manage What They Know*. Harvard Business Press. Boston, MA.

Davenport, T.H., De Long, D.W., & Beers, M.C. (1998). Successful knowledge management projects. *Sloan Management Review, 39*(2), 43–57.

Dost, B., Rehman, C.A., Commer, P.J., Sci, S., & Khyzer, M., (2016). Significance of knowledge management practices effecting supply chain performance. *Pakistan Journal of Commerce and Social Sciences (PJCSS), 10*(3), 659–686

Drucker, P.F. (1993). The rise of the knowledge society. *The Wilson Quarterly, 17*(2), 52–72.

Dustdar, S. (2005). Reconciling Knowledge Management and Workflow Management Systems: The Activity-Based Knowledge Management Approach. *Journal of Universal Computer Science*, *11*(4), 589–604.
Dyer, J.H., & Singh, H. (1998). The relational view: cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review*, *23*(4), 660–679.
Fisher, M.L. (1997). What is the right supply chain for your product? *Harvard Business Review*, *75*, 105–117.
Fornell, C., & Larcker, D. (1981). Evaluating Structural Equations Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, *18*, 39–50.
Forrest, J.E., & Martin, M.J. (1990). Strategic alliances: Lessons from the new biotechnology industry. *Engineering Management Journal*, *2*(1), 13–22.
Fugate, B.S., Stank, T.P., & Mentzer, J.T. (2009). Linking improved knowledge management to operational and organizational performance. *Journal of Operations Management*, *27*, 247–264.
Georgopoulos, B.S., & Tannenbaum, A.S. (1957). A study of organizational effectiveness. *American Sociological Review*, *22*(5), 534–540.
Gerwin, D. (1993). Manufacturing flexibility: a strategic perspective. *Management Science*, *39*(4), 395–410.
Gölgeci, I., & Kuivalainen, O. (2020). Does social capital matter for supply chain resilience? The role of absorptive capacity and marketing-supply chain management alignment. *Industrial Marketing Management*, *84*, 63–74.
Grant, R.M., & Baden-Fuller, C. (2004). A knowledge accessing theory of strategic alliances. *Journal of Management Studies*, *41*(1), 61–84.
Gunasekaran, A., & Ngai, E.W.T. (2007). Knowledge management in 21st century manufacturing. *International Journal of Production Research*, *45*(11), 2391–2418.
Gupta, A.K., & Govindarajan, V. (2000). Knowledge flows within multinational corporations. *Strategic Management Journal*, *21*(4), 473–496.
Hadjistavropoulos, H.D., Frombach, I.K., & Asmundson, G.J.G. (1999). Exploratory and confirmatory factor analytic investigations of the Illness Attitudes Scale in a nonclinical sample. *Behavior Research and Therapy*, *37*, 671–684.
Hair, J.F., Tatham, R.L., Anderson, R.E., & Black, W. (2006). *Multivariate data analysis* (Vol. 6). Upper Saddle River, NJ: Pearson Prentice Hall.
Handfield, R., & Nichols, E. (1999). *Introduction to Supply Chain Management*. Prentice Hall, NJ.
Hendricks, K.B., & Singhal, V.R. (2005). An Empirical Analysis of the Effect of Supply Chain Disruptions on Long-Run Stock Price Performance and Equity Risk of the Firm. *Production and Operations Management*, *14*(1), 35–52.
Hite, J. (2003). Patterns of multidimensionality among embedded network ties: A typology of relational embeddedness in emerging entrepreneurial firms. *Strategic Organization*, *1*(1), 9–49.
Holland, J.H., (1995). *Hidden Order.* Addison-Wesley, Reading, MA.
Holling, C.S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, pp. 1–23.
Holmberg, S. (2000). A systems perspective on supply chain measurements. *International Journal of Physical Distribution & Logistics Management*, *30*(10), 847–868.
Holsapple, C.W., & Joshi, K.D. (2000). An investigation of factors that influence the management of knowledge in organizations. *Journal of Strategic Information Systems*, *9*(2/3), 235–61.
Holweg, M. (2005). An investigation into supplier responsiveness: Empirical evidence from the automotive Industry. *The International Journal of Logistics Management*, *16*(1), 96–119.
Huselid, M.A., Jackson, S.E., & Schuler, R.S. (1997). Technical and strategic human resources management effectiveness as determinants of firm performance. *Academy of Management Journal*, *40*(1), 171–188.
Inkpen, A.C., & Tsang, E.W. (2005). Social capital, networks, and knowledge transfer. *Academy of Management Review*, *30*(1), 146–165.

Johnson, N., Elliott, D., & Drake, P. (2013). Exploring the role of social capital in facilitating supply chain resilience. *Supply Chain Management, 18*(3), 324–336. https://doi.org/10.1108/SCM-06-2012-0203
Kale, P., Singh, H., & Perlmutter, H. (2000). Learning and protection of proprietary assets in strategic alliances: Building relational capital. *Strategic Management Journal, 21*, 217–237.
Kebede, G. (2010). Knowledge management: An information science perspective. *International Journal of Information Management, 30*(5), 416–424. https://doi.org/10.1016/j.ijinfomgt.2010.02.004
Kim, D., & Lee, R.P. (2010). Systems collaboration and strategic collaboration: Their impacts on supply chain responsiveness and market performance. *Decision Sciences, 41*(4), 955–981.
King, W.R. (2001). Strategies for creating a learning organization. *Information Systems Management, 18*(1), 12–20.
Klassen, R.D., & Whybark, D.C. (1999). The impact of environmental technologies on manufacturing performance. *Academy of Management Journal, 42*(6), 599–615.
Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science, 3*(3), 383–397.
Kohtamäki, M., Partanen, J., & Möller, K. (2013). Making a profit with R&D services—The critical role of relational capital. *Industrial Marketing Management, 42*(1), 71–81.
Koufteros, X. (1999). Testing a model of pull production: A paradigm for manufacturing research using structural equation modeling. *Journal of Operations Management, 17*, 467–488.
Koufteros, X., Vonderembse, M.A., & Doll, W. (2001). Concurrent engineering and its consequences. *Journal of Operations Management, 19*, 97–115.
Koufteros, X.A. (1995). Time-based competition: Developing a nomological network of constructs and instrument development. Doctoral dissertation, University of Toledo.
Koufteros, X.A., Vonderembse, M.A., Doll, W.J. (1997). Competitive capabilities: Measurement and relationships. In *National Proceedings of Decision Science Institute* (pp. 1067–1069).
Krause, D.R., Handfield, R.B., & Tyler, B.B. (2007). The relationships between supplier development, commitment, social capital accumulation and performance improvement. *Journal of Operations Management, 25*(2), 528–545. doi:10.1016/j.jom.2006.05.007
Lang, J.C. (2004). Social context and social capital as enablers of knowledge integration. *Journal of Knowledge Management, 8*(3), 89. doi:10.1108/13673270410541060
Larson, A. (1992). Network dyads in entrepreneurial settings: A study of governance of exchange relationships. *Administrative Science Quarterly, 37*, 76–104.
Lee, H.L., Padmanabhan, V., & Whang, S. (1997). The bullwhip effect in supply chains. *Sloan Management Review, 38*(3), 93–102.
Li, S., Ragu-Nathan, B., Ragu-Nathan, T.S., & Subba Rao, S. (2006). The impact of supply chain management practices on competitive advantage and organizational performance. *Omega, 34*(2), 107–124.
Li, S., Rao, S.S., Ragu-Nathan, T.S., & Ragu-Nathan, B. (2005). Development and validation of a measurement instrument for studying supply chain management practices. *Journal of Operations Management, 23*(6), 618–641.
Li, Y., Tarafdar, M., & Rao, S.S. (2012). Collaborative knowledge management practices: Theoretical development and empirical analysis. *International Journal of Operations & Production Management, 32*(4), 398–422.
Liebowitz, J. (1999). Key ingredients to the success of an organization's knowledge management strategy. *Knowledge and Process Management, 6*(1), 37–40.
Liker, J.K., & Choi, T.Y. (2004). Building deep supplier relationships. *Harvard Business Review, 82*(12), 104–113.
MacCallum, R.C., Browne, M.W., & Sugawara, H.M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods, 1*, 130–149.
Man, Y.S. (2006). Performance Measurement and Management of Third Party Logistics: An Organizational Theory Approach. Hong Kong Baptist University.

Marshall, L. (1997). Facilitating knowledge management and knowledge sharing: New opportunities for information professionals. *Online*, *21*, 92–98.
Meier, M. (2011). Knowledge management in strategic alliances: A review of empirical evidence. *International Journal of Management Reviews*, *13*(1), 1–23.
Mitchell, H.J. (2003). Technology and knowledge management: Is technology just an enabler or does it also add value? In *Knowledge management: Current issues and challenges* (pp. 66–78). IGI Global.
Moore, G.C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, *2*(3), 192–222.
Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review*, *23*(2), 242–266.
Narasimhan, R., & Nair, A. (2005). The antecedent role of quality, information sharing and supply chain proximity on strategic alliance formation and performance. *International Journal of Production Economics*, *96*(3), 301–313. doi:10.1016/j.ijpe.2003.06.004
Nielsen, A.P. (2006). Understanding dynamic capabilities through knowledge management. *Journal of Knowledge Management*, *10*(4), 59–71.
Novak, D.C., Wu, Z., & Dooley, K.J. (2021). Whose resilience matters? Addressing issues of scale in supply chain resilience. *Journal of Business Logistics*, *42*(3), 323–335.
Olson, D.L. (2018). View of IJPR contributions to knowledge management in supply chains. *Int. J. Prod. Res*., *56*(1–2), 733–742. https://doi.org/10.1080/00207543.2017.1398427
Parker, R.P., & Wirth, A. (1999). Manufacturing flexibility: Measures and relationships. *European Journal of Operational Research*, *118*(3), 429–449.
Penrose, E.T. (1959). *The Theory of the Growth of the Firm*. New York: John Wiley.
Penrose, E.T. (1959). *The Theory of the Growth of the Firm*. New York: John Wiley & Sons Inc. Penrose, E. T, 1, 1–23.
Pérez-Salazar, M., del R., Aguilar Lasserre, A.A., Cedillo-Campos, M.G., Hernández González, J.C., & González, J.C.H., (2017). The role of knowledge management in supply chain management: A literature review. *J. Ind. Eng. Management*, *10*(4), 711. https://doi.org/10.3926/jiem.2144
Petersen, K.J., Handfield, R.B., & Ragatz, G.L. (2005). Supplier integration into new product development: Coordinating product, process and supply chain design. *Journal of Operations Management*, *23*(3–4), 371–388. doi:10.1016/j.jom.2004.07.009
Petersen, K.J., Handfield, R.B., Lawson, B., & Cousins, P.D. (2008). Buyer dependency and relational capital formation: The mediating effects of socialization processes and supplier integration. *Journal of Supply Chain Management*, *44*(4), 53–65.
Ponomarov, S.Y., & Holcomb, M.C. (2009). Understanding the Concept of Supply Chain Resilience. *International Journal of Logistics Management*, *20*(1), 124–143.
Porter, M.E. (1985). *Competitive advantage*. New York: Free Press.
Rai, A., Patnayakuni, R., & Seth, N. (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS Quarterly*, pp. 225–246.
Ramayah, T., & Omar, R. (2010). Information exchange and supply chain performance. *International Journal of Information Technology*, *09*(01), 35. doi:10.1142/S0219622010003658
Rothaermel, F.T., & Deeds, D.L. (2004). Exploration and exploitation alliances in biotechnology: A system of new product development. *Strategic Management Journal*, *25*(3), 201–221.
Sahay, B. (2003). Understanding trust in supply chain relationships. *Industrial Management & Data Systems*, *103*(8), 553–563. doi:10.1108/02635570310497602
Samaddar, S., & Kadiyala, S.S. (2006). An analysis of interorganizational resource sharing decisions in collaborative knowledge creation. *European Journal of Operational Research*, *170*(1), 192–210.
Sethi, A.K., & Sethi, S.P. (1990). Flexibility in manufacturing: A survey. *International Journal of Flexible Manufacturing Systems*, *2*(4), 289–328.
Shah, R., & Ward, P.T. (2003). Lean manufacturing: Context, practice bundles, and performance. *Journal of Operations Management*, *21*(2), 129–149.

Sher, P.J., & Lee, V.C. (2004). Information technology as a facilitator for enhancing dynamic capabilities through knowledge management. *Information and Management, 41*(8), 933–945.
Slack, N. (1983). Flexibility as a manufacturing objective. *International Journal of Operations & Production Management, 3*(3), 4–13.
Stalk, G. (1988). Time--the next source of competitive advantage.
Swafford, P.M., Ghosh, S., & Murthy, N. (2006). The antecedents of supply chain agility of a firm: Scale development and model testing. *Journal of Operations Management, 24*(2), 170–188.
Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal, 17*(S2), 27–43.
Tan, K.C., Kannan, V.R., Handfield, R.B., & Ghosh, S. (1999). Supply chain management: An empirical study of its impact on performance. *International Journal of Operations & Production Management, 19*(10), 1034–1052.
Thomke, S., & Fujimoto, T. (2000). The effect of "front-loading" problem-solving on product development performance. *Journal of Product Innovation Management: An International Publication of the Product Development & Management Association, 17*(2), 128–142.
Tracey, M., & Tan, C.L. (2001). Empirical analysis of supplier selection and involvement, customer satisfaction, and firm performance. *Supply Chain Management: An International Journal, 6*(4), 174–188.
Tsai, W. (2002). Social structure of "coopetition" within a multiunit organization: Coordination, competition, and intraorganizational knowledge sharing. *Organization Science, 13*(2), 179–190.
Tsai, W., & Ghoshal, S. (1998). Social capital and value creation: The role of intrafirm networks. *Academy of Management Journal, 41*(4), 464–476.
Tu, Q., Vonderembse, M.A., & Ragu-Nathan, T.S. (2001). The impact of time-based manufacturing practices on mass customization and value to customer. *Journal of Operations Management, 19*(2), 201–217.
Vonderembse, M.A., Uppal, M., Huang, S.H., & Dismukes, J.P. (2006). Designing supply chains: Towards theory development. *International Journal of Production Economics, 100*(2), 223–238.
Williams, Z., Ponder, N., & Autry, C.W. (2009). Supply Chain Security Culture: Measure Development and Validation. *The International Journal of Logistics Management, 20*(2), 243–60.
Wooldridge, B.R., & Minsky, B.D. (2002). The role of climate and socialization in developing inter-functional coordination. *The Learning Organization, 9*(1), 29–38.
Wu, W.Y., Chiag, C.Y., Wu, Y.J., & Tu, H.J. (2004). The influencing factors of commitment and business integration on supply chain management. *Industrial Management & Data Systems, 104*(4), 322–333.
Yang, J. (2013). Harnessing value in knowledge management for performance in buyer–supplier collaboration. *International Journal of Production Research, 51*(7), 1984–1991. https://doi.org/10.1080/00207543.2012.701774
Ye, Y., Yang, L., Huo, B., & Zhao, X. (2022). The impact of supply chain social capital on supply chain performance: A longitudinal analysis. *Journal of Business & Industrial Marketing*, (ahead-of-print).
Yu, Y., & Huo, B. (2019). The impact of relational capital on supplier quality integration and operational performance. *Total Quality Management & Business Excellence, 30*(11–12), 1282–1301.