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Abstract

Purpose – Global supply chains are increasingly becoming more prone to high-impact disruptions, which has been fairly evident with the coronavirus disease 2019 (COVID-19) pandemic. The capacity to address disruptions is essential for the survival of any organization. Coping with increasing complexity and uncertainties requires a systemic view of supply chains. Furthermore, a comprehensive understanding of the governance structure and timely decision-making are critical in times of disruptions. Although several aspects of supply chain resilience (SCRES) are broadly studied in the literature, the relationship between supply chain orientation (SCO), decentralization in decision-making and SCRES is an understudied area.

Design/methodology/approach – This study takes a longitudinal approach to address this research gap with a comprehensive meta-analytic review to explore the relationships between the constructs of interest through the lenses of contingency and dynamic capability theories. Furthermore, 2 surveys with sample sizes of 250 and 200 were conducted with supply chain professionals to test the research framework before and after the pandemic to compare the findings.

Findings – Structural Equation Modeling (SEM) analysis indicates a positive relationship between SCO and decentralization and between decentralization and SCRES. The post-COVID-19 analysis further validates the influence of agility, collaboration and situational awareness related to decentralization and resilience. More importantly, capabilities have a higher impact on resilience during the pandemic than before.

Practical implications – The results entreat organizations to attain decentralized decision-making *vis-à-vis* dedicated functional teams charged with reacting timely to disruptions. The teams should be empowered to leverage their knowledge and experiences regardless of their position in the hierarchy.

Originality/value – Although SCRES is an active research stream, the structural aspects of SCRES and its relationship with SCO are understudied. Therefore, this research puts forth a research framework and empirically

tests hypotheses that frame the relationship between SCO, decentralization and resilience outcomes in pre- and post-COVID environments.

Keywords Supply chain orientation, Decentralization, Supply chain resilience, Agility, Collaboration, Situational awareness

Paper type Research paper

Introduction

The beginning of 2020 saw the advent of one of the most dramatic black swan events in supply chain history. The sudden supply shock that started in China rippled through every possible supply chain in all industries we can think of. The essential relationships between suppliers and buyers have witnessed significant strain and have resulted in supply and service shortages. Technology-enabled global connectivity invariably leads to highly complex supply chain networks that challenge responsiveness. Without agility, supply chains would become increasingly more vulnerable to economic, public health, technological and other disruptive forces (Gligor *et al.*, 2019). Along with the increased complexity and globalization, the frequency and types of disruptions have grown exponentially since the beginning of the 2000s (Christopher and Holweg, 2011; Richey, 2009). However, specifically in the last decade, the impact of these disruptions on the economy became even more disruptive with a high dependency level on globalization. The adoption of outsourcing strategies has further exacerbated the uncertainties in supply and demand (Resilinc, 2018) and has caused the loss of capabilities in the USA within critical industries, such as the semiconductor industry.

The damaging effects of disruptions, such as natural disasters, transportation failures, cyber-attacks or supplier bankruptcies, can have long-lasting impacts if not addressed immediately and appropriately (Pettit *et al.*, 2013). Whether man-made or natural, a single disruptive event can impact the value of a company tremendously within a short period, especially when it hits the news. For instance, following the tsunami and the earthquake in Japan in 2011, which caused an extended power disruption, the value of Toyota Motor Company diminished by 17% in a single day (Kachi and Takahashi, 2011). Most recently, we have observed the semiconductor chip shortage in the auto industry alone, causing a $110 billion loss globally (Forbes, 2021). The nature of dynamic and high-impact disruptive events has stimulated an increased interest in the topic of resilience in supply chains (Kochan and Nowicki, 2018; Machado *et al.*, 2018; Melnyk *et al.*, 2014; Juan *et al.*, 2022; Shishodia *et al.*, 2021). Extant research and anecdotal evidence suggest that companies should cultivate resilience practices in their supply chain activities to react to unanticipated disruptions (Jüttner and Maklan, 2011) by building a capacity to persist, adapt or transform in the face of change (Wieland and Durach, 2021).

Many evolving definitions of supply chain resilience (SCRES) exist in the literature (Sheffi and Rice, 2005; Al Naimi *et al.*, 2022). For the purpose of this study, we adopted the definition of Ponomorov and Holcomb (2009, p. 131) due to its particular focus on structure. They defined SCRES as "*the adaptive capability of the supply chain . . . by maintaining continuity of operations at the desired level of connectedness and control over structure and function.*" Organizations should view resilience capabilities holistically and invest in capabilities that increase abilities, robustness and flexibility that relate to before and after the disruption times. Otherwise, supply chains may experience recurrent interruptions (Ponis and Koronis, 2012). SCRES is critical for continuity in the short term and for gaining a competitive advantage in the long run (Polyviou *et al.*, 2019). Moreover, SCRES can positively influence supply chain performance measures, such as variability in on-time delivery, inventory levels and product quality (Pettit *et al.*, 2013).

The extant literature is increasingly expanding on SCRES strategies, practices, capabilities and elements that contribute to the capacity of an organization to respond to disruptions and return to normal conditions (Ali *et al.*, 2017). Nonetheless, there is limited research on the link between the structural characteristics of supply chains and the risk of disruptions. For example, Schmitt *et al.*

(2015) investigated the comparison of centralized and decentralized inventory policies and found that a decentralized inventory design contributes to risk diversification. Bode and Wagner (2015) focused on two organizational responses, buffering and bridging, to respond to supply chain disruptions. Kumar and Sharma *et al.* (2021) highlight the importance of decentralized decision making during the COVID-19 pandemic in a single case from the perspective of chaos theory. However, a holistic framework that integrates supply chain orientation (SCO) and relates it to the concept of SCRES through decentralization and capabilities (agility, collaboration and situational awareness) is missing. Specifically, this study examined how SCRES performance is influenced by decentralized decision-making and SCO using contingency theory and dynamic capability (DC) theory. Contingency theory helps frame the discussion on the alignment between the environmental uncertainty and contingencies and management responses (e.g. Flynn *et al.*, 2016; Ketokivi, 2006). DC theory helps frame the discussion on integrating and reconfiguring resources to survive and compete in turbulent environment (Barreto, 2010; Devi, 2021). The organizational structure enables quicker decision-making during disruptions by improving the ability to mobilize and manage resources (Kumar and Sharma, 2021). Overall, we argue that the extent of SCO increases decentralized decision-making, and this, in turn, increases SCRES capabilities (i.e. agility, situational awareness and collaboration), which translates into a higher SCRES performance.

This study has the following three objectives: (1) to develop a theoretical model of SCRES by integrating the constructs of SCO and decentralization (a specific aspect of organizational structure) within the extant literature on SCRES, particularly SCRES capabilities and SCRES outcomes; (2) to identify and test the relationships between decentralization and key SCRES capabilities; and (3) to determine and assess the relationships between SCRES capabilities and SCRES outcomes.

Literature review

During any disruption, a resilient supply chain would react quickly and efficiently due to its capabilities and capacities. Sheffi and Rice (2005) contended that decisions, primarily the ones made before the disruption more so than during the disruption, will define resilience. Nonetheless, while it may be argued that resilience depends on both, there is little doubt that resilience must be ingrained into the supply chain structure to maintain a stable state (Christopher and Peck, 2004). Supply chain structure is derived from the structure of an organization (Stock *et al.*, 2000), which is defined as "the design of the organization through which the enterprise is administered" (Chandler, 1962). Structure is the means through which integration occurs within the organization and among the supply chain members. This would encourage interaction, cross-functional initiatives, information sharing, and collaboration within the organization and supply chain (Defee and Stank, 2005). In addition, structure does not function in isolation. It starts within an organization but extends across the spectrum of multiple organizations (Chow *et al.*, 1995). Structure also has a cultural dimension, demonstrating itself with organizational procedures and policies (McAfee *et al.*, 2002). The literature of organizational structure can be categorized under three main constructs, namely, decentralization (centralization), formalization and specialization. Decentralization denotes the level that the decision-making authority is given to lower echelons in an organization (Daugherty, 2011). Formalization refers to the extent of how many rules and processes are written down (Jaworski and Kohli, 1993), whereas specialization is the degree of narrowness for the skill set that is required by an organization (Troy *et al.*, 2001). Considering that the majority of the literature focuses on decentralization as the focal construct (Olson *et al.*, 2005), we narrowed down our focus to decentralization for the scope of this study.

The decision-making process lies at the heart of all supply chain management activities (Manuj and Sahin, 2011; Haraguchi and Lall, 2015). Whether in responding to an ongoing

hurricane or a pandemic, such as COVID-19, organizations with appropriate and timely decision-making processes will always be one step ahead of others. The decision-making process of an organization is impacted by a multitude of factors (Davis-Sramek *et al.*, 2015). One of the more pronounced factors, as evidenced by its impact on the agility to respond, is organizational structure (Gligor and Holcomb, 2012). The structure of an organization and the decision-making process are inextricably linked in normal and disrupting times (Treiblmaier, 2018). One organization can possess all the necessary resources, but if the managers tasked with decision-making are not involved in the process of decision-making in a centralized structure, then the disruption could create greater impacts compared with an organization with more empowered employees. Inferior decision-making could also make an organization more vulnerable to future disruptions (Cantor *et al.*, 2014).

Supply chain orientation

One important factor that affects the impact of disruptions on supply chains is the level of supply chain integration (Świerczek, 2014). The underlying dynamic in all supply chain management flows is the integration between stakeholders that necessitates a systemic view. SCO can be described as the systemic awareness shared by organizations and employees of the consequences of coordinating the flows of products, cash, services and information within and across supply chains (Patel, 2013; Davis-Sramek *et al.*, 2015). Strategically managing the whole supply chain without a guiding philosophy would be fairly difficult and inefficient (Esper *et al.*, 2010). Accordingly, this guiding philosophy offers the characteristics of structures to have a well-rounded picture of supply chains. In classifying the structural part of SCO, Trent (2004) provided the following four categories: human resources, organizational measurement, information technology and organizational design. These characteristics apply within and across supply chains. Consequently, the structures adopted by a supply chain-oriented organization involve trust, leadership support and necessary information technology; it would foster more information sharing, cross-functional thinking and communication. Conversely, companies without an SCO approach may not generate similar structures (Esper *et al.*, 2010).

Mentzer (2001) first introduced the SCO phenomenon to the literature, which underlines a philosophical view to guide the relationships within supply chains. The structure between entities is crucial to executing this philosophical approach. It is through integration internally and externally; organizational capabilities emerge and create resilience. Mentzer (2001) defined SCO as "*the recognition by a company of the systemic, strategic implications of the activities and processes involved in managing the various flows in a supply chain.*" Hence, it differs from Supply Chain Management (SCM) in that the latter emphasizes exchange flows across tiers, while SCO underlines the importance of the strategic awareness of SCM within organizations. Organizations within supply chains must initially focus inward before engaging in external strategic activities (Min and Mentzer, 2007).

The literature categorizes SCO into two parts, namely, structural and strategic (Esper *et al.*, 2010). The strategic part involves approaching supply chains comprehensively as opposed to focusing on individual components and searching for incorporating, blending and synthesizing capabilities. The structural part emphasizes how the SCM philosophy is reflected in the decision-making of an organization, its coordinating mechanisms and its formal and informal interactions (Patel, 2013). Using the work of Esper *et al.* (2010) as a conceptual foundation, we employed organizational structure as an element of structural SCO. The current study aims to build upon the structural part of SCO. The organizational structure, which is influenced by the SCO of an organization, will cultivate an environment where integration, collaboration and information sharing would take place.

Supply chain resilience (SCRES)

Resilience involves the ability to plan proactively for disruptions, address them without losing control over structure and function and move to a better position prior to their occurrence (Ponis and Koronis, 2012). Supply chain disruptions can be defined as unexpected incidences that disturb the flow of products and services across supply chains (Kleindorfer and Saad, 2005). These disruptions can originate from natural catastrophes, such as earthquakes or man-made disasters, such as a fire, an electrical breakdown or a cyber-attack (Wagner and Nashat, 2010). Given that SCRES is still a developing area, there are numerous definitions for it. There are two main differing views on SCRES in the literature. One view looks at SCRES as an ability to recover from unforeseen disruptive situations and to return to where they were before the disruptions (Christopher and Peck, 2004). The other view looks beyond recovery to involve the generation of additional capabilities and an improved ability to utilize new opportunities (Ponomarov, 2012). The second perspective involves viewing resilience as a process (Cimellaro *et al.*, 2010) rather than as an outcome. As this paper deals with the processes within and outside organizations, the latter view of resilience is adopted.

Academics and industry members have emphasized the importance of organizational structure in supply chain management and marketing over the years (Olson *et al.*, 2005; Patel, 2013). The Marketing Science Institute has identified "organizational structure" as a crucial research area in its two biannual reports concentrating on the following essential question: "How do organizational structures influence business performance?" (Lee, 2015). An essential decision that must be made by an organization manager is the design of his or her organization. Once an organization recruits employees and creates policies for decision-making and reporting mechanisms, it develops a specific structure. In addition, as soon as an organization hires employees and establishes rules and reporting relationships, some kind of organizational structure develops. A design decision does not take place in a vacuum; it is a combination of external dynamics and specific choices. In the end, the result would be the designation of responsibilities, boundaries and coordination systems (Chaston, 1997).

The impact of the decentralization of decision-making can be illustrated in a supply chain disruption context by the classic Nokia vs. Ericsson case (Normann and Jansson, 2004). A thunderstorm caused a minor fire in a Philips plant on March 17, 2000. Nokia, one of Philips customers, instantly recognized the problem and acted quickly. It also identified a second supplier and worked actively with Philips to obtain the remaining quantity of products from other locations. Because of its quick response, Nokia suffered only from minor shipping delays. For Ericsson, another Philips customer, it took approximately four weeks to realize the extent of the problem; thus, the company lost 400 million in sales and eventually decided to quit the phone business (Diehl, 2012). The way Nokia structured its decision-making allowed it to be more responsive and ultimately gained a competitive advantage over Ericsson. The close monitoring of the critical parts and knowledge of the market due to the decentralization of the organization in decision-making allowed Nokia to detect the problem early and facilitated the mitigation of risk (Wallace, 2014).

Currently, we know that SCRES strategies, capabilities, elements and practices contribute to the capacity of an organization to address disruptions and return to normal conditions (Chopra and Sodhi, 2004). The effectiveness of these approaches is also demonstrated empirically (Pereira *et al.*, 2014). Nevertheless, there is limited attention given to the structure in which the aforementioned capabilities would be utilized. More specifically, if the decision-making does not take place at the right time in a disruption, then all the capabilities, such as flexibility, redundancy or agility, that lead to SCRES would basically equal to zero. Similarly, on the basis of a comprehensive literature review, Bhamra *et al.* (2011) concluded that topics such as organizational level resilience and how it extends to supply chains require further attention. This is because the extant literature is abundant with theories and definitions of resilience, but it lacks data on how organizations can achieve resilience. Accordingly, the present study addresses this issue by focusing on the question of how do organizational structure factors affect SCRES and how does SCO affect the structure?

Decentralization in decision-making

Organizational structure is described as establishing a set of relationships within an organization that defines hierarchical relationships and task flows (Jeanes, 2019). According to Underdown (2012), it is creating a reporting design that controls and motivates people and is geared toward the ultimate goals of an organization. It also refers to the responsibility and power allocation among members (Andrews, 2010). Additionally, organizational structure guides the quality of work, the ownership of employees and the synchronization within an organization (Herath, 2009). Although organizational structure has other attributes, such as specialization, leadership and culture, the scope of this study will include the decentralization of the decision-making process and its impact on SCRES through SCRES capabilities. These aspects are chosen because these are the main organizational structure dimensions that have their roots in organizational design (Robbins, 1990). Although centralization generates cost-effectiveness and standardization in large organizations, it also generates a non-inclusive culture that hinders communication, ownership and involvement in the tasks assigned.

In their book *Extreme Ownership*, US Navy SEAL Officers Jocko Willink and Leif Babin (2015) provided insights into decentralized structures and decision-making. They explain, "*Human beings are generally not capable of managing more than six to ten people, particularly when inevitable contingencies arise.*" Although the quote originates from a military setting, it has significant relevance for the business realm because underlying human dynamics and crisis situations are similar. The main message in this quote is to have a decentralized structure to respond effectively to contingencies. Further, this quote underlines the fact that it would be unrealistic to expect one or two managers to guide all the people and information in a large organization in times of crisis, thereby pointing to decentralization.

Decentralization does not automatically improve performance during and after disruptions. The quality of decisions is directly linked to the abilities of employees at lower levels. Those in lower levels should be vetted and trained properly to make important decisions that must be made in times of disruptions (Giannoccaro, 2018). Furthermore, local decisions can impact other functional or geographic areas and there would be unintended consequences. Therefore, constant lateral informal sharing is necessary to ensure that every stakeholder is in agreement (Davis-Sramek *et al.*, 2015). The external conditions of an organization are significant in designating authority and power because, in uncertain and dynamic market conditions, authority should be delegated to those at lower levels to respond quickly (Doll and Vonderembse, 1991). Centralization emphasizes improving efficiency, while decentralization highlights increasing agility and flexibility, which is more conducive to responding to crisis situations.

Theoretical background

Contingency theory's (CT) main tenet is that there needs to be a fit between the environmental conditions and organizational dynamics (Flynn *et al.*, 2010). Environmental conditions include uncertainty, technological dynamism and geographic dispersion. Organizational dynamics refers to processes and decision-making. The contingency theory lens has been used in SCM research in various contexts, such as last-mile delivery, inventory planning and innovation (Castillo *et al.*, 2018; Tenhiälä, 2011; Turkulainen and Swink, 2017). It highlights the dynamic nature of the environment where the company needs to adapt to align with changes in the business environment. Decades of lean and just-in-time practices along with extending global supply chains, have generated significant vulnerabilities in current supply chains and devastating disruptions. The speed, complexity and interconnected nature of supply chains over time, have created a mismatch between structure and the environment that resulted in financial, reputational and market losses, where organizations are forced to adapt to the changing environment. For example, leading companies like Johnson and

Johnson appoint "tiger teams" to sense, assess and act quickly on the disruption as it would be too late to go through up the chain to make a decision. These teams both collect data and take appropriate action (Sheffi, 2020). Also, the chief procurement and supply chain officer of Flex explains that, through these teams, they were able to understand the severity of the situation, and rather than going through the normal procurement channel, the tiger team immediately recommended securing Personal Protective Equipment (PPE) for two months, which was essential to continue their operations (Sheffi, 2020). Supply chains have historically relied on centralized processes and decision-making (Duan, 2013; Giannoccaro, 2011; Pertusa-Ortega *et al.*, 2010). This research argues that centralized decision-making does not fit with the dynamic nature of today's business environment. Companies need to adapt and adopt elements of decentralization in the planning and execution of supply chain processes to be responsive to frequent disruptions. Further, organizations must fundamentally adjust their supply chain strategies and reconfigure structural elements toward decentralization.

The second theory that helps explain SCRES is the DC theory. Dynamic capabilities theory posits that companies need to develop new or reconfigure and align their resources to respond to the arising uncertainties in their environments (Eisenhardt and Martin, 2000). In order to achieve this, firms must sense threats and opportunities and transform (Teece, 2007) supply chain processes to synchronize supply and demand and strengthen characteristics such as flexibility and adaptability (Fosso Wamba and Akter, 2019; Grawe *et al.*, 2011). This sensing and taking appropriate action will occur in a supply chain-oriented and decentralized structure. Barreto (2010) argues that DC involves having an awareness of opportunities and threats in the environment, viewing problems holistically and the ability to reconfigure resources and make appropriate decisions. This systemic view is essential for the execution of the SCO concept. Dynamic capabilities are highly responsive and relevant (Katkalo, 2010; Teece, 2012). The capabilities that we are investigating in this study, agility, situational awareness and collaboration capabilities, relate to the fundamentals of dynamic capability theory (Blome, 2013; Fawcett, 2011; Yu, 2019). These capabilities will assist in responding to the challenges in the uncertain environment by sensing, timely action and coordination for reconfiguring available resources.

We develop a conceptual framework and hypotheses (see Figure 1) that define the relationships between SCO, decentralization, capabilities and SCRES outcomes through the lenses of DC theory and contingency theory. In this study, we prefer contingency theory over the other structural theories as it highlights the fit between the environment and the decision-making, especially in the post-COVID world. Since proactive and reactive capabilities of SCRES can be expounded upon through DC lens (Teece *et al.*, 1997) and it sheds light on the situation-specific dynamic changes, it provides an appropriate theoretical context to analyze these relationships.

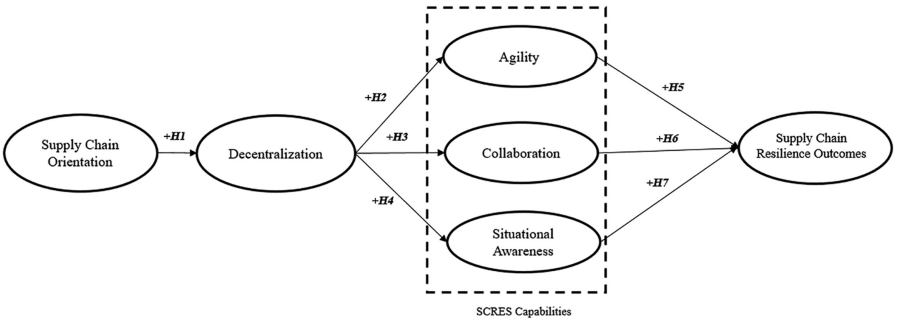

Figure 1.
Theoretical framework of SCRES

Model of supply chain resilience, decentralization and supply chain orientation

The topic of resilience has gained considerable attention in the supply chain discipline due to the widespread occurrence of disruptions around the world. Organizations are searching for ways to prevent or improve the recovery phase by investing in resilience (Melynk *et al.*, 2014). Consequently, the literature is abundant with capabilities that contribute to resilience against disruptions (Sheffi and Rice, 2005). However, the extant studies are limited in terms of addressing human aspects and, more specifically, decision-making processes during and after disruptions. We argue that as organizations achieve greater SCO levels, internally and externally, they will move toward more decentralization in decision-making and will demonstrate higher performance for establishing and maintaining SCRES.

Impact of supply chain orientation on decentralization

SCO provides shared organizational motivation and commitment to integrate and synchronize the supply chain (Davis-Sramek *et al.*, 2019; Gligor, 2022). The level of SCO impacts relationships not only within an organization but also the management of relationships with other organizations (Min *et al.*, 2007). Shared vision and practice of how companies approach their relationships strategically within and outside supply chains generate faster responses and establish appropriate behaviors (Koulikoff-Souviron and Harrison, 2008). Internal integration, collaboration and information exchange, all components of SCO, facilitate cross-functional and inter-organizational cooperation and the cross-pollination of ideas, thereby can ultimately lead to increased organizational responsiveness and supply chain agility (Mentzer *et al.*, 2008). SCO involves interacting within and outside the organization without any limitation, generating awareness, which would be possible with a decentralized decision-making structure. SCO necessitates a flat, empowering and continuous information-sharing decentralized system to exchange information freely without siloes in an organization and establish organization-wide awareness and commitment to a shared vision (Patel, 2013). This shared commitment also addresses the core agency problems of control and ownership by empowering and building trust within and outside of the organization. Coordination mechanisms under SCO would ensure decisions made by separate decentralized structures, which are aligned to a shared vision, act similarly in times of a disruption. These arguments suggest potential positive linkages between SCO orientation and decentralization. Therefore, we hypothesize the following:

H1. SCO is positively related to decentralization in decision-making.

Impact of decentralization on agility

Considering the highly dynamic and competitive markets and the potential for disruptions, employees need greater autonomy to respond to these challenges. Drucker (1992) validated that an organization should have a low degree of centralization to make fast decisions and gain creative solutions. Agility to react to disruptions depends on how organizations regulate their actions to cohesively and quickly work together in turbulent times (Gligor and Holcomb, 2012). Agility has been suggested as the capacity of a supply chain to quickly address variations in the industry and customer expectations (Sharp *et al.*, 1999). Wieland and Wallenburg (2013) determined that communication is an influential antecedent of supply chain agility. Additionally, Scholten and Schilder (2015) argued that cooperative decision-making, sharing information and resource and aligning incentives contribute to the capacity of a supply chain to address disruptive events. Visibility and velocity primarily comprise supply chain agility. Agility involves having a clear view of the whole supply chain (Christopher and Peck, 2004), which is instrumental in identifying indicators of potentially disruptive events and responding swiftly. Swiftness is essential in responding to the needs of customers while executing supply chain tasks.

Decentralization improves employee involvement and satisfaction because in decentralized settings, it is much easier to have 360 degrees of communication, and subject matter experts can influence decision-making as much as the top management (Burns and Stalker, 1961) and respond more efficiently to dynamic market conditions (Schminke *et al.*, 2000). In the same vein, Dynamic Capabilities Theory (DCT) would support the idea that capabilities resulting from a decentralized structure would be responsive to a changing environment. Polyviou *et al.* (2019) verified that due to their less complex decision-making systems and smaller echelons in the hierarchy, decentralized firms could avoid and respond to disruptions more effectively. The reason why firms delegate decision-making is that lower echelons can duly evaluate and apply their expertise quickly (Inkpen and Tsang, 2005). The majority of the characteristics of agility necessitate a structure that is conducive to information sharing, empowering and lateral coordination, which is a decentralized one. Thus, we hypothesize the following:

H2. Decentralization in decision-making is positively related to agility.

Impact of decentralization on collaboration

In the literature, collaboration is defined as cooperating with other supply chain units and sharing information and other critical resources to address disruptive events (Jüttner and Maklan, 2011). Christopher and Peck (2004) affirmed that the sense of creating a community where companies can share information is essential in developing a collaborative environment. Mandal (2012) demonstrated that unless each employee receives appropriate information, collaboration will not happen effectively and efficiently. In addition, Datta and Christopher (2011) asserted that decentralized structure, monitoring, flexibility and information sharing are the building blocks of SCRES. Christopher and Peck (2004) also highlighted the importance of communication by stating that supply chains are about the flow of information as much as the flow of goods. Centralized structures tend to direct decision-making and governance to a smaller group of people (Pertusa-Ortega *et al.*, 2010), thus potentially limiting the sharing of knowledge and information by restricting or enlarging the channels of communication. Centralized organizations generally operate with less information, since different functional areas tend to be siloed in how they operate and pass incomplete information. Technological developments have facilitated knowledge and information sharing at a reduced cost, allowing companies to locate factories and suppliers to overseas locations and increasing the capability to transfer information to more people and lower echelons in the organization seamlessly (Jensen and Meckling, 1995). Therefore, a decentralized organizational structure would be more conducive to communication and coordination between different entities (Pertusa-Ortega *et al.*, 2010; Tate, 2012). Hence, we hypothesize the following:

H3. Decentralization in decision-making is positively related to collaboration capability.

Impact of decentralization on situational awareness

The idea of situational awareness starts with mapping out the vulnerabilities of supply chains. Resulting critical elements help to detect and interpret potential negative events through early warning systems and to proactively develop plans for ensuring continuity of operations (Datta and Christopher, 2011). Through the help of these actions, avoiding, containing and controlling risks would be possible by identifying them in the system (Manuj and Mentzer, 2008; Stecke and Kumar, 2009). Nevertheless, the common denominators for all these practices are information exchange among supply chain members, coordination and initiative-taking approaches in predicting disruptive events (Vargo and Seville, 2011). Basically, if the detection of a supply chain disruption is done early and communicated to the right people, the supply chain would suffer much fewer negative effects (Craighead *et al.*, 2007).

In an organizational setting, the greater the decentralization, the greater the information sharing because organizations that welcome participation cultivate alertness, awareness and involvement (Germain, 1996). Facilitating risk awareness through seamless communication and information sharing before a potential disruption minimizes the vulnerability and the damage absorbed (Wieland and Wallenburg, 2013). Employees must be proactive and take the initiative to identify and monitor potential events. Therefore, in a decentralized structure, the furthest nodes will be warned of a potential disruption early, which will translate into a quick action to respond. Therefore, we hypothesize the following:

H4. Decentralization in decision-making is positively related to situational awareness and anticipation capability.

Impact of agility on resilience

Supply chain agility is conceptualized as a higher-order dynamic capability that would facilitate resource configuration and enable sensing and leveraging of opportunities and threats (Li *et al.*, 2009). Lee (2004) confirmed that the capacity to recover quickly from disruptions improves service and delivery performances. As mentioned earlier, visibility and speed comprise the core of the agility construct. Supply chain visibility is defined as the knowledge of the environment and the state of the processes and operations (Pettit *et al.*, 2013). Kleindorfer and Saad (2005) contended that to execute a risk management process, possessing supply chain-wide visibility is critical. A company with a high degree of visibility over its supply chain has more control over supply operations and interactions (Swift *et al.*, 2019). Visibility helps decision-makers to continue with operations when disruptions occur as well as to quickly detect potential indicators for disruptions and allow them to speedily come up with alternative plans and scenarios that can facilitate the recovery process (Braunscheidel and Suresh, 2009). Soni *et al.* (2014) also identified 14 enablers for resilience, among which agility ranks the highest, followed by collaboration, visibility and risk management culture. In addition, Blackhurst *et al.* (2011) in their study highlighted that quickly redesigning supply chains to minimize the effect of disruptions was noted by four out of seven companies. All these arguments lead to the following hypothesis:

H5. Supply chain agility is positively related to SCRES.

Impact of collaboration on resilience

Collaboration involves divergent entities in supply chains undertaking collaborative actions together, such as joint creating knowledge, sharing resources and information, aligning objectives and incentives and synchronizing decisions (Cao and Zhang, 2010). Furthermore, collaboration is an approach where several units work in an integrated manner to achieve common objectives. Supply chain visibility, through exchanging information and communication, generates the required transparency to sense and interpret disruptions in supply chains. Coordinating procedures, processes and operations of individual firms in a concerted way is essential to fully leverage the benefits of collaboration. Specifically, during a disruption, unless all companies in supply chains cooperate and respond harmoniously, resilience will not develop (Jüttner and Maklan, 2011). These dependencies show that supply chain collaboration is a requirement for SCRES. Thus, we hypothesize the following:

H6. Collaboration is positively related to SCRES.

Impact of situational awareness on resilience

As it was laid out in previous propositions, situational awareness requires a deep comprehension of weaknesses in supply chains, appropriate planning and the capacity to

recognize potential disruptions by timely identifying risks through detection systems (Sáenz and Revilla, 2014). This step is critical in having the time necessary to (re)configure the resources at hand. Hence, organizations should execute the contingency plan or the business continuity plan in due time and effectively respond to a disruption when there is an anticipation of potential disruption. Closs and McGarrell (2004) viewed resilient supply chains as proactive, that is, anticipating and establishing planned steps to prevent and respond to disruptions. Ambulkar *et al.* (2015) measured SCRES on the basis of four measurement items, one of which was situational awareness. In the same vein, Bode *et al.* (2011) argued that organizations emphasize that disruption orientation management is more resilient because it generates "awareness and seriousness" toward disruptions. In the comprehensive literature of SCRES by Ali (2017), anticipation comes out to be fifth in the list, which is conceptually and empirically linked to resilience outcomes in fourteen papers. Hence, we hypothesize the following:

H7. Situational awareness is positively related to SCRES.

Methodology

Considering that this research aimed at theoretically testing the proposed model, we used survey methodology using two separate set of respondents. Scale items based on the relevant literature were used for each construct (Chowdhury and Quaddus, 2017; Kotzab *et al.*, 2011; Treiblmaier, 2018; Li, 2009). After reviewing the SCRES literature and obtaining input from four academicians to assess the content validity of the scales for each item, we sent the items to doctoral students in a college of business at a research university and asked them to categorize the items into matching constructs. All students had significant work experience. Redundant and unclear items were removed or modified using as per the feedback of the respondents. As a final step in assessing the validity and reliability of the items, a pilot study was conducted. Subsequently, the scale items shown in Appendix A were retained for in this study. A five-point Likert scale was employed to indicate the extent to which the respondents agreed or disagreed with each statement.

Soon after we collected and analyzed data, and after the COVID-19 pandemic started, an unplanned opportunity arose to collect additional data on an abbreviated version of the survey. The COVID-19 pandemic became a stress test that shocked many organizations. Companies have had to deal with sharp spikes and declines in demand, manufacturing downtime and supply and transport delays. Supply chains continue to face stress and attention. We thought it was interesting to assess if the capabilities hypothesized in this study still hold after the most dramatic event in history. However, we could only include a limited number of questions. We decided to conduct this survey to obtain, at the least, preliminary longitudinal insights into a few constructs of interest.

The first set of data for our research model was collected through Mturk. Mturk platform offers an opportunity to improve the sample size, collect supply chain management survey responses on well-defined criteria (Knemeyer and Naylor, 2011) and collect enough data to employ statistical techniques affected by the sample size. Employing the survey strategies recommended by Schoenherr and Speier-Pero (2015), we screened the respondents' job functions and titles within the survey to protect against misrepresentation of qualifications and to improve the response quality. Additionally, an "attention filter" was utilized in the survey to assess the attentiveness of the respondents (Schoenherr and Speier-Pero, 2015).

A total of 302 respondents were received from Mturk workers. These were filtered on the basis of the time they spent and the attention questions directed to assess their focus level. After screening, the final sample for analysis comprised 250 respondents. Table 1 presents the demographics of the respondents.

		N (250)	%
Primary Job Function	Logistics Management	68	27
	Supply Chain Management	102	41
	Operations Management	80	32
Organization Size	Less than 250 employees	82	33
	Between 251 and 500 employees	85	34
	Between 501 and 1,000 employees	65	26
	Greater than 1,001 employees	18	7
Annual Revenue	Less than 10 million	121	48
	10 to 100 million	66	26
	101 to 200 million	34	14
	Greater than 200 million	29	12
Experience in SCM (in years)	1–5	127	51
	6–10	101	40
	11–15	15	6
	Greater than 16	7	3

Table 1. Demographics of research participants

For the second part of the study, we gathered data from companies right after the COVID-19 pandemic impacted the supply chains and tested H5, H6 and H7 (labeled as H5^, H6^ and H7^). Only a limited number of questions could be included in the survey. We chose to study the impact of capabilities on SCRES as this area lacks empirical investigation, and this survey presented a unique opportunity to test the capabilities impacting SCRES towards the tail end of the pandemic. The data were collected directly through the data collection company, Qualtrics. A total of 200 responses were received. This longitudinal data availability gave us a temporal perspective of the impact of one of the most dramatic disruptions in history.

Data analysis

We used a step-by-step method to analyze the data. First, exploratory factor analysis (EFA) using principal component analysis with a varimax rotation was conducted to unravel the underlying factor structure within the data. On the basis of the EFA results, 12 items with low factor loadings (below 0.5) and high cross-loadings were removed and 18 items remained. Second, confirmatory factor analysis (CFA) was performed, and a measurement model was developed to ensure construct reliability and validity. Third, a structural equation model was constructed to test the hypotheses using AMOS 27. All of the factor loadings exceeded 0.7; however, there was one construct whose items were kept because they exceeded 0.65 and because we utilized established scales from the literature and the theoretical underpinnings. The composite reliability (CR) for all latent constructs in our model were above the 0.7 thresholds, indicating acceptable reliability. Furthermore, the average variance extracted (AVE) exceeded the 0.5 threshold as well. On the basis of the reported CRs and Cronbach's alphas, we concluded that the reliability of the constructs of the model was acceptable. For discriminant validity, we employed the model of Fornell and Larcker (1981). Tables 2 and 3 display the evidence of discriminant validity and CFA results, respectively.

AMOS 27 was used to test the proposed hypothesis and the hypotheses were tested using covariance-based structural equations modeling. Table 3 presents the results of CFA and other important statistics. We utilized the same fit indices for the structural model, and overall, they similarly indicated a good fit to our model ($\chi 2 = 203.967$, IFI = 0.94, CFI = 0.94 and RMSEA = 0.05). Furthermore, heterotrait–monotrait (HTMT) report analysis was used to check for common method variance. Table 4 shows that the confidence interval calculated from 5,000 bootstrap samples supports the fact that HTMT values are lower than 0.9

(Henseler *et al.*, 2015), thereby substantiating discriminant validity. Furthermore, the variance inflation factor (VIF) values for all constructs remained less than 2.1 (the accepted threshold is 5), which eliminates the possibility of multicollinearity between items. To address common method biases (CMBs), we used two samples across time, and there was strong evidence that having a temporal separation reduces CMB (e.g. Lindell and Brandt, 2000). Finally, we used common latent factor (CLF) to check for common method variance. The square variance of CLF came out to be 13%, which cumulatively demonstrates that CMB is not an issue.

Study 2 (post-COVID-19 analysis)

In the second study, the constructs related to capabilities and SCRES were included as these most lacked empirical evidence. Using the same items for the aforementioned capabilities in the previous study, a survey with a sample of 200, composed of supply chain professionals who have experienced the impact of COVID-19, was conducted through the data collection company, Qualtrics. A similar structural equations model as in the first study was executed. The model fit indices for the second study indicated a good fit ($\chi 2 = 197.865$, IFI = 0.93, CFI = 0.93, RMSEA = 0.04).

Results

Table 5 shows, for the first study, the proposed relationships and the standard estimate for the path and identifies whether a relationship is supported or not. All hypotheses except H7 linking situational awareness to SCRES were supported. The link between SCO and decentralization, derived from the contingency theory and links between decentralization and capabilities (namely, agility, collaboration and situational awareness) supports or fundamental assertions about the role of SCO in impacting the extent of decentralization and decentralization impacting supply chain capabilities relevant to SCRES. Finally, the link between the three capabilities to SCRES provides empirical evidence for the roles of agility and collaboration in SCRES and calls to question the role of situation awareness in SCRES.

Table 6 shows, for the second study, the proposed subset of relationships and the standard estimate for the path and identifies whether a relationship is supported or not. All hypotheses with regard to capabilities and SCRES were retested in the second survey. All hypotheses were supported and with higher coefficients as compared to the first study. Most interestingly, situational awareness became significant in this new test and showed the highest coefficient (0.635). These stronger relationships in the second study provide additional support to our research model that was developed before the pandemic hit. The stronger relationships show that the three capabilities included in this research did indeed help companies improve their SCRES.

Table 2.
Evidence of reliability and construct validity

Factors	SCO	Dec	Agi	Coll	SA	SCRES
SCO	*0.81*					
Dec	0.19	*0.81*				
Agi	0.10	0.26	*0.84*			
Coll	0.31	0.31	0.14	*0.83*		
SA	0.37	0.17	0.02	0.28	*0.85*	
SCRES	0.23	0.04	0.17	0.25	0.24	*0.78*

Note(s): SCO: Supply Chain Orientation, Dec: Decentralization, Agi: Agility, SA: Situational Awareness, SCR; Supply Chain Resilience, Diagonal elements are $\sqrt{AVE}$ and the off-diagonal elements are ϕ estimates

Construct	Items	Loadings (λ)	*t*-value	CR	AVE
Supply Chain Orientation					
We believe that our supplier keeps our best interest in mind	SCO4	0.826	5.890	0.848	0.652
Our business unit's goals are consistent with those of our supply chain members	SCO2	0.749	5.641		
In my organization we believe it is important to develop strategies based on understanding of supply chain management	SCO3	0.844			
Decentralization					
Our regional offices are encouraged to make our own decisions	D1	0.838	7.096	0.845	0.648
The majority of our suppliers are scattered across various continents	D2	0.864	8.071		
Our regional offices can decide on how to go about doing our work	D4	0.703			
Agility					
My firm can quickly respond to changes in the business environment	A1	0.754		0.879	0.710
We always receive the information we demand from our suppliers	A2	0.854	11.893		
Our firm can promptly identify opportunities in its environment	A3	0.762	11.800		
When needed, we can adjust our supply chain operations to the extent necessary to execute our decisions	A4	0.804			
Collaboration					
We share information timely between departments in times of crisis	C1	0.836	8.951	0.866	0.683
We invest in knowledge transfer with external partners	C4	0.825	9.610		
We have long-term partnership with key customers	C5	0.819			
Situational Awareness					
We can predict negative upcoming events	SA1	0.879	4.752	0.887	0.724
We have IT systems available to give us a warning for a negative event	SA2	0.873	4.746		
We constantly monitor our processes	SA3	0.799			
SCRES					
Our company's supply chain can move to a new, more desirable state after being disrupted	SCRE2	0.663		0.822	0.611
Our company's supply chain is able to adequately respond to unexpected disruptions by quickly restoring its product flow	SCRE3	0.736	5.752		
We can reduce the occurrence of negative events	SCRE 4	0.555	6.785		
We can reduce impact of loss with the least cost	SCRE5	0.922	5.721		

Note(s): CFA global fit indices: $\chi 2 = 130.61$; df = 102 IFI = 0.98; NFI = 0.91; *CFI* = 0.98; RMSEA = 0.03

Table 3. Confirmatory factor analysis results

This combination of data collection from MTurk and Qualtrics further allowed the first-hand comparison of the comparability of both data sources as in previous studies (Schoenherr and Speier-Pero, 2015). Overall, the results provide support for all proposed hypotheses. The only hypothesis not supported in the first study linking situational awareness to SCRES was ultimately supported in the second study.

Discussion

The first objective of this research was to develop a theoretical model of SCRES by integrating the constructs of SCO and decentralization SCRES capabilities and SCRES outcomes. To achieve this, this study took an interdisciplinary approach to resilience by combining organizational structure and the resilience literature. We used contingency theory and DC theory to develop our research framework and hypotheses. The full model was tested first, and then because of an unplanned opportunity, part of the model was tested in a second study. Between the two studies, all hypotheses are supported. Overall, the results suggest that a supply chain-oriented organization helps cultivate a decentralized decision-making environment, which in turn enables organizational capabilities of agility, collaboration and situational awareness. These capabilities are linked to SCRES.

Consistent with contingency theory, results provide evidence that the changing business environment is calling for a more decentralized decision-making in supply chains. Adopting SCO enables decentralized decision-making which subsequently leads to higher resilience via capabilities.

The second objective of this paper was to identify and test the relationships between decentralization and key SCRES capabilities. In both studies, decentralization in decision-making impacted the collaboration capability. This makes sense intuitively because with decentralization managers at lower levels can take ownership of the processes and get involved in collaboration within and outside their organization (Peck, 2005; Sheffi and Rice, 2005).

Table 4. Discriminant validity test: Heterotrait-Monotrait (HTMT) criterion

Factors	SCO	Dec	Agi	Coll	SA	SCRES
SCO						
Dec	0.394					
Agi	0.142	0.173				
Coll	0.595	0.492	0.08			
SA	0.815	0.290	0.105	0.453		
SCRES	0.420	0.187	0.179	0.304	0.297	

Table 5. Results of hypothesis testing

Hypothesized relationships	Std.Est β =	p value	Supported status
H1: Supply Chain Orientation => Decentralization	0.086	0.0***	Supported
H2: Decentralization => Agility	0.122	0.0***	Supported
H3: Decentralization => Collaboration	0.576	0.0***	Supported
H4: Decentralization => Situational Awareness	0.232	0.040	Supported
H5: Agility => SCRES	0.070	0.043	Supported
H6: Collaboration => SCRES	0.191	0.035	Supported
H7: Situational Awareness => SCRES			Not Supported

Note(s): ***: $p < 0.001$

Table 6. Post-COVID results of hypothesis testing

Hypothesized relationships	Std.Est β =	p value	Supported status	*Study 1 Coefficient*
H5^: Agility => SCRES	0.358	0.0***	Supported	0.070
H6^: Collaboration => SCRES	0.356	0.0***	Supported	0.191
H7^: Situational Awareness => SCRES	0.635	0.0***	Supported	NS

Note(s): ***: $p < 0.001$

Decentralization also impacts agility because it allows the empowered people to act without being limited by bureaucracies and reduce delays in reaction as well as having the freedom to choose the response (Alavi, 2014). Decentralization impacted situational awareness in both studies. It is not surprising that if organizations have a relatively decentralized structure, they likely provide employees with tools that enable higher situational awareness levels to enable them to make decisions and be accountable for their decisions. Hence, decentralization makes it critical that employees are more proactive in watching out for potential upcoming disruptions.

The third objective of this research was to assess the relationships between SCRES capabilities and SCRES outcomes. Collaboration accounts for 19 and 35% changes in resilience outcomes in the first and second studies, respectively, thereby highlighting the importance of involving employees. Our finding confirms the empirical findings of Pettit *et al.* (2013) with regard to SCRES capabilities with a larger sample and reinforces them by validating those in a pre- and post-pandemic context. Collaboration could only be achieved through empowering employees. Agility accounts for 7% and 35 changes% in resilience outcomes in the two studies respectively. This finding is consistent with Jüttner and Maklan (2011). Surprisingly, situational awareness did not account for any change in resilience in the first study but accounted for almost 63% change in the resilience outcomes in the second study. Since the second study was carried out in the aftermath of the COVID-19 pandemic, it is possible that the stronger and more significant result is because of the investment that was already underway in situational awareness and the desire of the companies to avoid similar disruptions in the future by anticipating them.

From a longitudinal point of view and analyzing the second study, we observed agility and collaboration capabilities maintaining their significance and impact before and after COVID-19. Nonetheless, situational awareness came out to be the most significant factor after the pandemic. This result intuitively makes sense because as companies have experienced the devastating impacts on their supply chain, they have immediately shifted their attention and focus on improving situational awareness.

Implications, limitations and future research

As supply chains become more global and complex, they become much more susceptible to several types of disruptions due to a multitude of interdependencies. The scale and the outcomes of contemporary disruptions, such as COVID-19 pandemic, demonstrate that if an organization fails to invest in increasing SCRES, not only could it lose its competitiveness, but also its survival could be at stake. At the heart of responding to these interdependencies lies decision-making. Disruptions do not wait for organizations to make a decision; therefore, decision-making speed and the ability to choose the decision are imperative in adapting and reconfiguring their resources to respond to disruptions. To this end, this study several theoretical and managerial implications.

First, while the literature provides insights into the relationship between structure and performance in different contexts such as inventory (Chen and Lu, 2021), transportation (Muir *et al.*, 2019), it does not provide insights in the context of disruptions and SCRES. The main theoretical contribution of our paper is the development and empirical testing of a theoretical model that combines SCO, decentralization and SCRES capabilities and theorizes about the impact of capabilities on SCRES performance. Our findings contribute to theory by expanding extant resilience frameworks to include SCO and organizational structure. In doing so, it also responds to the literature calling for research for investigating relationships between organizational factors and SCRES (Fiksel, 2015).

Second, this study responds to Esper *et al.* (2010), who call for additional research on the structural element of SCO. Although the constructs of SCO and decentralization are not new *per se* (Davis-Sramek *et al.*, 2019; Treiblmaier, 2018) we extend the current knowledge by

combining the two in the context of SCRES and provide empirical evidence to support the relationships. The findings suggest that in addition to the strategy component of SCO, which is well established in literature (Esper, 2010), the less explored structural element of SCO positively influences SCRES.

Third, we ground our framework in two distinct theories. On one hand, contingency theory helps frame the discussion on the alignment between the environmental uncertainty and management (Arani *et al.*, 2016). On the other hand, dynamic capabilities theory helps frame the discussion on integrating and reconfiguring resources within the context of organizational structure and decision-making (Chowdhury and Quaddus, 2017), As the environment becomes increasingly uncertain and disruptive, the organizational structure and capabilities provide the mechanisms to deal with emergent supply chain challenges in face of disruptions.

Fourth, from a managerial perspective, to enhance SCRES, managers must understand the impact of the decentralization of decision-making on the resilience of supply chains, as shown empirically in this study. This research also helps to hone in on the three capabilities most relevant to SCRES from the perspective of decentralization: agility, collaboration and situational awareness. Companies, both big and small, should focus on adopting simpler and more agile internal structures by delegating authority and enabling their personnel with expertise to take charge despite their status in the reporting hierarchy. Such structures would also lead to better sensing and assessment of the disruptions and quicker actions to address these disruptions as compared to going through a hierarchy to make decisions. Further, an understanding of the origin of the decision-making authority and flow of decisions within an organization would allow managers to make more informed decisions and thus contribute to superior performance during disruptions.

Some study limitations must be noted. First, we did not specify the type of disruption. Different types of disruptions may have unique implications for the level of decision-making such as a pandemic like COVID-19 versus a fire at a supplier or a cyber-attack. Future research can capture the uniqueness of these disruptions and their implications on the specific capabilities and overall SCRES. Second, the first set of data was gathered through Mturk and the second set via Qualtrics. Although we observed increased usage and acceptance of online data collection platforms (Murfield, 2017), future studies can replicate the findings with other data sources. Third, we only focused on three capabilities because of their strong theoretical links to SCRES in the context of decentralization. There are several other capabilities related to SCRES, such as visibility and flexibility, that can be investigated with regard to decentralization and SCO. Finally, in this research, we integrated contingency theory and DC theory to investigate the phenomenon. In our research, we found other relevant theories and frameworks. For example, future studies could integrate complex adaptive systems and resource orchestration theory to provide additional insights into the phenomenon and integrate SCRES and decentralization with other supply chain constructs.

Future research could consider exploring managerial risk tendencies and how they impact the decentralization level of organizations. Furthermore, future research could conduct case studies and interviews to investigate internal and external dynamics that affect the decentralization level of an organization. Finally, future research could investigate how organizational capabilities other than agility, collaboration and situational awareness would be affected by decentralization.

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Appendix

Constructs	Survey items	Source
Supply Chain Orientation	We believe our supply chain members must work together to be successful	Gligor *et al.* (2016)
	Our organization recognizes the strategic importance of coordinating business functions across firms within the supply chain	Gligor *et al.* (2016)
	In my organization we believe it is important to develop strategies based on understanding of supply chain management	Thornton (2016)
	In my organization we believe establishing long-term relationships with our supply chain partners is critical to the organization's survival	Thornton (2016)
	Our business unit's goals are consistent with those of our supply chain members	Kotzab (2011)
Decentralization	Our regional offices are encouraged to make our own decisions	Treiblmaier (2018)
	The majority of our suppliers are scattered across various continents	Treiblmaier (2018)
	Our regional offices do not get precise directives from headquarters in case of a disruptive event	Treiblmaier (2018)
	Our regional offices can decide on how to go about doing our work	Treiblmaier (2018)
	Our subsidiaries and regional offices take the majority of purchasing decisions	Treiblmaier (2018)
Agility	My firm can quickly respond to changes in the business environment	Gligor *et al.* (2019)
	We always receive the information we demand from our suppliers	Gligor *et al.* (2019)
	Our firm can promptly identify opportunities in its environment	Li *et al.* (2009)
	When needed, we can adjust our supply chain operations to the extent necessary to execute our decisions	Gligor *et al.* (2019)
	Improving responsiveness to changing market needs is a high priority	Li *et al.* (2009)
Collaboration	We share information timely between departments in times of crisis	Cao (2010)
	We have long-term partnership with key suppliers	Cao (2010)
	We invest in internal knowledge transfer	Cao (2010)
	We invest in knowledge transfer with external partners	Cao (2010)
	We have long-term partnership with key customers	Cao (2010)
Situational Awareness	We can predict negative upcoming events	Chowdhury (2017)
	We have IT systems available to give us a warning for a negative event	Chowdhury (2017)
	We constantly monitor our processes	Chowdhury (2017)
	We constantly monitor our external environment	Chowdhury (2017)
	We have forecasting systems in place for meeting disruptions	Chowdhury (2017)
Supply Chain Resilience	We have a response team for mitigating crisis	Chowdhury (2017)
	Our company's supply chain can move to a new, more desirable state after being disrupted	Golgeci and Ponomarov (2013)
	Our company's supply chain is able to adequately respond to unexpected disruptions by quickly restoring its product flow	Golgeci and Ponomarov (2013)
	We can reduce the occurrence of negative events	Chowdhury (2017)
	We can reduce impact of loss with the least cost	Chowdhury (2017)

Table A1. Measurement of constructs