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A resource-based perspective of the interplay between organizational learning and supply chain resilience

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Abstract

Purpose – The aim of this article is to shed light on the impact of intangible resources, such as organizational learning (OL), organizational agility (OA) and organizational innovativeness (OI), on supply chain resilience (SCR). For this, a theoretical model is developed to analyze the development of relationships between chosen resource variables.

Design/methodology/approach – This study is based on a cross-sectional questionnaire. Survey data were collected from 180 businesses including only medium to senior level managers to ensure a thorough understanding about the company's inner workings and supply chain (SC). The validity of the model is determined using structural equation modeling (SEM) and tested using lavaan package in R.

Findings – The findings indicate a statistically significant relationship between OL and SCR. Two organizational resource constructs, OI and OA, are found to have a strong mediating effect on this relationship. OL ability mediated by OA and OI results in increased SCR.

Research limitations/implications – The data cover multiple sectors but are collected from one country. The dataset is also limited in that it is collected from mid- to high-level managers working on manufacturing and supply chain-related departments.

Practical implications – The authors believe that the results of this study will guide both managers and academics in developing effective measures to avoid SC disruptions due to the Covid-19 pandemic or other comparable risks.

Originality/value – This is the first study that examines the relationship between OL and SCR. Prior studies have examined the relationship between OA and SCR. However, OL and OI, in particular, have not featured frequently in SCR-related studies. In this regard, this research is also unique in that it examines the mediating role of OA and OI in the relationship between OL and SCR.

Keywords Supply chain resilience, Organizational learning, Innovativeness, Agility

Paper type Research paper

1. Introduction

Firms often face risks and uncertainties in business operations, which may have a detrimental effect on their operational performance. While the complexity of supply chains (SCs) increases their susceptibility to failures and outages, they are also required to be more flexible, adaptive and resilient in order to respond to constantly changing market conditions. They must plan for potential SC interruptions by considering inventory stockpiling and manufacturing automation (Kumar *et al.*, 2020; Sarkis *et al.*, 2020) and work on their supply chain resilience (SCR) (Kumar and Managi, 2020).

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To achieve operational resilience, organizations should engage in a continual learning process (Norman, 2004). The ability to react swiftly to changes is a key characteristic of organizational learning (OL) that enables SCs improve their performance (Bell *et al.*, 2010) by becoming more proactive in production planning. OL also benefits them in achieving sustainability (Spicer and Smith, 2006) by enabling businesses to better predict changes in client demand (Santos-Vijande *et al.*, 2012). Hamada and Yozgat (2017) suggest that the wealth of knowledge acquired via OL enhances the agility and flexibility of SCs.

Technological advancements and shorter product life cycles require organizations to operate quickly (Swafford *et al.*, 2006), which is referred to as agility. Agility is a competency that provides benefits such as increasing competitiveness (van Hoek *et al.*, 2001) among others (Swafford *et al.*, 2006; Gligor *et al.*, 2019). One of the primary criteria for organizational agility (OA) is SC agility, which allows SC participants to respond rapidly and effectively to market fluctuations and uncertainties gaining them a competitive advantage (van Hoek *et al.*, 2001). Another characteristic that businesses must possess to thrive in a highly competitive market is their ability to innovate (Chen, 2019). Innovativeness brings sustainable competencies to the organization (Calantone *et al.*, 2002), helping them build a competitive advantage (Kuncoro and Suriani, 2017; Battor and Battor, 2010). Barreto (2010) itemizes the benefits of innovativeness to organizations as (1) sensing competitive opportunities and threats, (2) making fast and customer-oriented decisions, (3) developing new products to meet market needs and (4) meeting customer expectations. The ability to innovate may be seen as a critical element in an organization's sustainability (Maury, 2017; Wang and Ahmed, 2004).

This study contributes to the literature by studying the importance of OL, OA and organizational innovativeness (OI) for SCR. Similar to prepandemic studies regarding SCR (Norman, 2004; Purushothaman, 2015), we anticipate OL having a positive impact on SCR in the postpandemic period as well. Therefore, the research questions addressed by this study are as follows (1) what is the importance of organizational intangible resources to improve SCR for organizations? and (2) what is the relationship between SCR and the suggested organizational characteristics? In this study, research questions were posed through cross-sectional questionnaires. The survey items were adapted from the literature. The responses of 180 business administrations offered a complete grasp of the inner workings and SCs of their respective firms. The theoretical model for this research was tested with variance-based SEM. Our results, we believe, will assist decision-makers to develop effective resilience strategies and to establish effective measures to avoid SC disruptions during Covid-19 pandemic or other high-risk situations.

2. Literature review and theoretical background

2.1 Literature review

SC risk management has been a major challenge that impacts organizational performance within its environment (Altay and Ramirez, 2010). SC disruptions, in particular, can have long-term consequences (Adobor and McMullen, 2018) and can lead to significant financial and operational problems for organizations (Ponis and Koronis, 2012). Even the most successful SCs are susceptible to losing their competitiveness if they do not adapt to the changing environment (Lee, 2004). The recent Covid-19 crisis has resulted in severe effects on SCs (Sarkis, 2021) by causing supply and demand shocks, unprecedented demand volatility and amplified swings in inventories and transportation requirements (Zhu *et al.*, 2020). To avoid similar crises, organizations need to better prepare for both foreseeable and unforeseeable disruptions. These preparations work towards building resilience, a critical issue in SCs (Fiksel, 2006).

SCR is defined as the ability to absorb changes and maintain the predisturbance conditions within SC (Hendry *et al.*, 2019). SCR serves to develop readiness, response and

recovery to manage risks and uncertainties and get back to even a better state following disruptions (Chowdhury and Quaddus, 2017). The pandemic environment is considered turbulent and uncertain, specifically for organizations that rely heavily on their suppliers (Tanner, 2021).

The restructuring of technological and human resources is crucial for addressing the disruptions to the SC (Aman and Seuring, 2021). In our research, we aim to study several antecedents contributing to the SCR. The present study takes a different tack by exploring a wider selection of organizational variables than the extant literature, including learning, agility and innovativeness, serving as antecedents of SCR. Considering the three aspects of SCR, readiness, response and recovery, as proposed by Ali *et al.* (2022), we posit that this study concentrates on the readiness aspect. Accordingly, this study adopts an *ex ante* (before the disruptive event) perspective to resilience (Iftikhar *et al.*, 2021), emphasizing on the resources of an organization needs to possess to be well-prepared for any prospective disruption.

2.2 Theoretical background

The resource-based view (RBV) mainly provides assumptions to discover the relationships between resources and competitive advantage (Penrose, 1959). It contends that organizations can achieve a competitive advantage through the acquisition of strategic resources (Dubey *et al.*, 2018) that are unique, costly-to-copy and rare (Barney, 1991). One of the major objectives of the RBV is to explore the determinants of competitive advantage (Hassan *et al.*, 2013). Within SC, the core capabilities of an organization involve an organizations' ability to manage its SC to gain advantage within the market during periods of change (Chen, 2019). In the current study, SCR is viewed as a capability. Similar to the study by Dubey *et al.* (2018), this current study draws on the RBV to explain the proposed research model and hypotheses as the RBV yields insightful results that are applicable in this context. It is critical to distinguish resources from capabilities, as resources refer to available factors that are owned by the organization, whereas capabilities are organizational capacity to deploy resources, for a desired end (Amit and Schoemaker, 1993). In this regard, we consider OL, OI and OA as strategic and intangible resources contributing to the SCR capability adding to survival and competitiveness.

According to Andreou *et al.* (2016), OL improves strategic decision-making and related to firm performance. Plentiful studies accept OL as an intangible asset and support the idea that OL is a "valuable, rare, inimitable and non-substitutable" resource (Santos-Vijande *et al.*, 2012) satisfying the RBV's main criterion. In their study, Hassan *et al.* (2013) also considered OL as a resource contributing to competitive advantage. In addition, innovativeness has also been regarded as critical for organizational survival in a volatile environment (Rogers, 2010). Following the previous literature, this current study considers OL as a resource and SCR as an outcome yielding competitive advantage.

Yusuf *et al.* (1999) defined agility as the integrated use of new technologies and manufacturing practices, and as a result, we consider it to be a resource that contributes to the competitiveness of an organization. Other studies, following RBV, also regard agility as a resource (Alvarez and Barney, 2000).

In their recent study, Zhao and Kim (2021) suggested that the RBV provides insights for identifying which resources to have during and after the pandemic. Being informed on the related literature, this study draws on the RBV by regarding SCR as a desired outcome and evaluates the effects of the OL on its understanding, particularly through the mediating roles of innovativeness and agility.

In this study, we also posit that OI is an intangible resource. OI enables the achievement of competitive advantage and desirable performance outcomes (Salomo *et al.*, 2008). In their study, Tsai and Yang (2014) regarded firm innovativeness as a strategic resource. We posit

that both OI and OA as intangible resources can mediate the relationship between OL as a resource and SCR as a capability as resources in fact include three main constructs as resources, capabilities and competencies (Carmeli and Tishler, 2004). Organizational capabilities are about the ability to combine and configure organizational resources (Bhatt, 2000).

3. Development of hypotheses

This research is primarily concerned with the antecedents of SCR, offering interpretations for the links between the OL, OI and OA. The literature identifies a variety of antecedents that contribute to SCR. Ponomarov (2012), for example, emphasized logistical capabilities as antecedents via the use of RBV. Similarly, following the RBV, Dubey *et al.* (2017) contended that SC visibility, trust and collaboration all contribute to SCR. Additionally, Kochan and Nowicki (2018) cited agility as a forerunner to SCR. Reinmoeller and Van Baardwijk (2005) recognized SC innovation as an SCR driver. In their study on SCR research, Ali and Gölgeci (2019) grouped SCR drivers under three categories as "preparedness, resistance and rebound" and identified agility, innovativeness and employees' training and development among key SCR drivers. Simultaneously, we propose OL, OA and OI as antecedents of SCR and demonstrate how the interplay of these enablers contributes to SCR.

3.1 OL-SCR

OL involves integrating the acquisition, interpretation and use of knowledge in order to be prepared to perceive, respond and adapt to changes within the organization's environment (Berthoin Antal and Friedman, 2004). Purushothaman (2015) argues that organization-wide information sharing adds to employees' necessary capabilities and enhances resilience. At this point, OL can be regarded as promoting information sharing across the organization. For this adaptation, they must have a detailed knowledge of their environment and internal processes (Liao *et al.*, 2011). Information sharing within OL helps organizations anticipate disruptions (Barratt and Oke, 2007) and maintain resilience (Ponomarov, 2012). SCs, in particular, require timely information during disruption in order to develop strategic responses (Sarkis, 2021). OL helps organizations improve information processing and contributes to more effective change management (Dickson *et al.*, 2001). In addition, Ali *et al.* (2022) emphasized that regular staff training and employee development is considered readiness, which leads to SCR. In this regard, the organization-wide dissemination of learning may be regarded as a vital resource for organizations.

According to Norman (2004), having integrated learning increases the organization's survival capability and thus contributes to its resilience. Agreeing with the literature on OL, Azadegan *et al.* (2019) argued that organizations can learn from the close-call events in order to be prepared for and protect from the potential effects of larger size disruptions. Ali *et al.* (2021) emphasized the importance of knowledge management on SCR in terms of knowledge acquisition, assimilation and application. In this study, we consider learning as a catalyst for raising awareness of the need for change and that awareness helps develop a determination to build resilience. Consequently, this study posits that OL contributes to and promotes the adaptive behavior leading to SCR, and the following hypothesis is accordingly proposed:

H1. There is a significant and positive direct relationship between OL and SCR.

3.2 OL-OI-SCR

According to the RBV, the efficient use of resources would help organizations to achieve competitive advantage (Hassan *et al.*, 2013). Innovation is highly associated with OL (Calantone *et al.*, 2002). There are many studies focusing on the relevance of learning for

innovation (e.g. Verona, 1999). An organization having integrated learning can develop greater innovation capacity than others (Damanpour, 1991) as innovation assumes exploiting OL capabilities (Olaleye *et al.*, 2021). Accordingly, we posit that continuous learning may help an organization become more receptive to new knowledge and advancements in their industry, and this receptivity can trigger innovativeness.

Organizations need to be innovative in order to survive in turbulent environments (Calantone *et al.*, 2002). In their study, Akgün and Keskin (2014) reported a high association between organizational innovation and resilience capacity. Resilience involves "continuous redistribution of innovation strategies" (Olaleye *et al.*, 2021), and innovativeness helps organizations see threats, make their decisions promptly and meet customer expectations (Barreto, 2010). Accordingly, OI can be leveraged against disruptive events affecting SCs (Gölgeci and Ponomarov, 2015). The literature suggests that innovative organizations are more successful in effectively responding to environmental uncertainties (Stevens and Dimitriadis, 2004) by avoiding mundane practices and providing innovative ideas (Teece, 2007). We consider innovativeness as a resource for adapting to new conditions to mitigate adverse effects. As organizations with innovative strategies are more likely to discover new opportunities that enable them to effectively adapt to environmental changes or needs (Hult *et al.*, 2005), innovativeness can be critical amid disturbances in SCs, with the ability to devise creative safeguards against risks (Mitroff and Alpaslan, 2003). Inadequate investment in research and development (R&D) is regarded as a barrier to build SCR (Ali *et al.*, 2017).

While SCR has been identified as an SC's ability to respond, recover and transform, there is little knowledge on how to manage this transformation (Adobor and McMullen, 2018). For this reason, this study suggests that OI, triggered by continuous learning, would help organizations develop resilience. Innovative behavior may act as a catalyst to quickly find alternative suppliers and swiftly generate new sales leads when necessary. Crisis times necessitate having resilience. In this regard, OL can be regarded as a mechanism contributing to innovative behavior, which in turn leads to SCR. To the best of our knowledge, no study has investigated the suggested relationship between OL and SCR with the explanatory role of innovativeness. In line with the RBV, we propose the corresponding hypotheses as follows:

H2. There is a significant and positive relationship between OL and OI.

H3. There is a significant and positive relationship between OI and SCR.

H4a. OI mediates the relationship between OL and SCR.

3.3 OL-OA-SCR

While there are a plethora of studies on the association between SCR and SC agility (e.g. Dubey *et al.*, 2014; Mandal, 2012), there has been little research into a broader view of OA and its relationship to SCR. Both learning and agility, according to Hamada and Yozgat (2017), are critical elements for organizational survival and success during disruptions. OA largely follows OL (Braunscheidel and Suresh, 2009), and both continuous (Grossan *et al.*, 1999) and dynamic learning (Antonacopoulou and Chiva, 2007) are essential for OA. In their study, Ponis and Koronis (2012) identified agility as an antecedent of SCR. An agile organization can reduce costs, better meet customer demands and continuously evaluate its activities for competitive advantage (Shahrabi, 2012). With respect to the partnering agility, Liu *et al.* (2016) argued that it is an ability to leverage the knowledge and competencies of SC parties through partnerships. We contend that this ability to grasp new and necessary knowledge can explain how OL contributes to SCR as an integrated learning can help an organization to strengthen knowledge-based interactions with the SC partners.

In light of the foregoing discussion, we argue that the relationship between OL and SCR can be explained by increasing OA. Through continuous integration of OL, organizations can

improve their ability to respond to change quickly, which can contribute to the resilience of their SCs in dealing with fluctuations successfully. This agility can be seen in a timely and responsive switch to alternative materials to allow production to continue, in the replacement of a supplier who is experiencing difficulties or in the addition of new suppliers to the SC in response to a need to increase production capacity. In this regard, we depict the model in Figure 1 and suggest the corresponding hypotheses of this study as follows:

H5. There is a significant and positive relationship between OL and OA

H6. There is a significant and positive relationship between OA and SCR.

H4b. OA mediates the relationship between OL and SCR.

4. Research methodology

4.1 Sample and data collection

A self-administered survey was designed. The survey was piloted iteratively to ensure the content validity and to improve the language, structure and sequencing. Then a panel of four business professionals and four academics with appropriate expertise and experience in SC

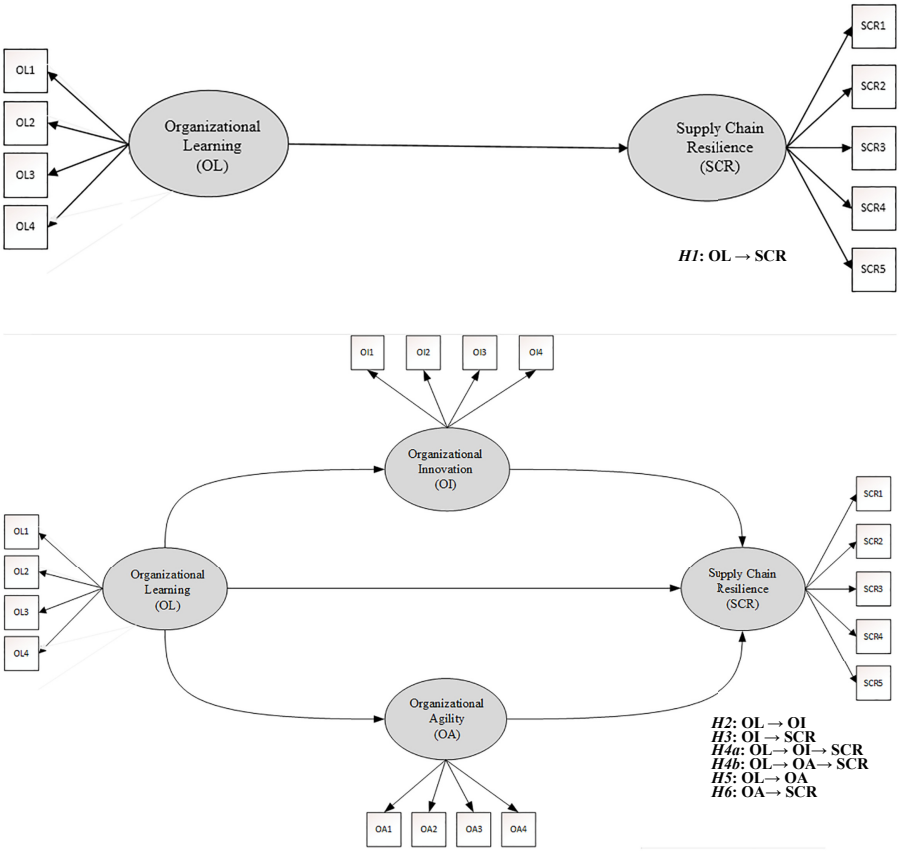


Figure 1.
Research models 1 (above) and 2 (below)

operations examined the survey and gave its final form. Based on the literature and frequently used scales, the questionnaire was developed to measure the constructs of the research model as OL, OA, OI and SCR with seven-point Likert scales (1: strongly disagree and 7: strongly agree). In order to have a homogeneous data, only manufacturing companies were considered in this research. We relied on the database obtained from the Izmir Chamber of Industry, which included around 2,500 registered manufacturing firms operating in a wide range of industries. We randomly selected 1,000 member firms to mail out our survey. Professional online networks were used to contact the managers of these firms. The identified respondents were from different but related departments, such as the SC, manufacturing, procurement, marketing and information technology. With a detailed explanation attached, we were able to reach and email our survey to 521 managers; of which, 248 responded, expressing their willingness to fill-out the questionnaire. A total of 187 complete questionnaires were actually returned. The survey by design contained no missing values. However, after checking for improper respondents and double respondents, 180 questionnaires were kept and subsequently used in the statistical analysis. The distribution for the ranks of respondents is provided in Table 1. Survey data were collected via e-mail using an online questionnaire during Covid-19 pandemic (March–June 2021). During the data analysis, it was discovered that several variables did not follow a normal distribution. These variables were transformed to follow a normal distribution using Templeton's two-step transformation method to ensure acceptable levels of normality (Templeton, 2011).

While our study focuses on SCR in SC networks, we use single key respondents for each organization in their respective supplier chain as our unit of analysis. Although some studies have remarked on the potential issues of relying on single key respondents, using several respondents from each SC might not be a solution (Krause *et al.*, 2018). Their study points that

Characteristics		Number	%
Industry sector	Metals industry, machinery and equipment	52	28.9
	Automotive and electronics	24	13.3
	Food and agriculture	19	10.6
	Chemicals and pharmaceuticals	17	9.4
	Construction, wood, furniture and paper	13	7.2
	Aerospace and defense	13	7.2
	Textile	12	6.7
	Energy and mining	8	4.4
	Others	22	12.2
Firm size (number of employees)	SMEs (less than 250)	79	39
	White collar (Engineer)	18	
	Supervisor	19	
	Management	42	
	Large size (greater than or equal to 250)	101	61
	White collar (Engineer)	41	
	Supervisor	19	
	Management	41	
Firm age (years of operation)	Young and middle-aged (firms less than 30 years)	90	50
	Mature (firms older than 30 years)	90	50
Type of ownership	Locally owned	144	80
	Foreign-owned	19	10.5
	Foreign/local partnership	17	9.5
N		*180*	

Table 1.
Characteristics of sample firms

having the right respondent informed about the SC is a better approach than having to treat the disagreements among several respondents from each SC. Following our decision to work with single key respondents for each organization, we, therefore, included only supply chain informed-white-collars or high-level managers in our sample.

Based on the extant literature, we developed the survey to assess the fundamentals of SCR using OI, OA and OL as constructs. Table 1 shows the main characteristics of the sample. The sample consists of firms from a wide variety of industries, including metals industry, machine and equipment (28.89%); automotive and electronics (13.33%); food and agriculture (10.55%); chemicals and pharmaceuticals (9.44%); construction, wood, furniture and paper (7.22%); aerospace and defense (7.22%); textile (6.67%), energy and mining (4.44%). The sample comprises large-sized enterprises (61%), while the rest includes small- and medium-sized enterprises (SMEs). Most of the sample comprises locally owned firms (80%), with the remaining firms having some foreign ownership at varying levels. In the sample, young and middle age firms (50%) and mature firms (50%) are equal in numbers.

4.2 Measurement of variables

Our study consists of four main constructs. All items were measured using seven-point Likert-type scale items ranging from 1 (strongly disagree) to 7 (strongly agree). The brief descriptions of the measures used in this study are provided in the ensuing subsections.

OL: The instrument used in this study was developed by Baker and Sinkula (1999).

OI: The items for OI are drawn from the previous research by Gölgeci and Ponomarov (2015).

OA: The instrument used in this study was developed by Felipe *et al.* (2017) for partnering agility of the larger OA scale.

SCR: SCR is the dependent variable. To measure SCR, we employ scales adapted from previous research by Brandon-Jones *et al.* (2014), Brusset and Teller (2017) and Ambulkar *et al.* (2015).

5. Analyses and findings

In order to test our proposed research model (Figure 1), we used R language and processed our data and model using lavaan package. First, we conducted a confirmatory factor analysis (CFA) to verify the reflective constructs. Then, we conducted reliability tests on each of the constructs. We checked convergent and discriminant validity for data validation. The validity of the model was determined using SEM (Byrne, 2013), which determined whether the model fit our dataset while also taking our moderators into account. The correlations are provided in Table 2. In order to assess the level of collinearity, we have also evaluated the variance inflation factor (VIF) values (Table 3). Typical threshold values for VIF are 5 (Hair *et al.*, 2010) and 10 (Chatterjee and Hadi, 2012). Thus, we concluded that there were no multicollinearity issues present.

5.1 Reliability and validity

5.1.1 Construct validity. For unidimensionality and construct validity, CFA was used in place of exploratory factor analysis (EFA). The literature favors performing CFA over pure EFA as interpreting the factors via pure EFA is difficult. Venkatraman (1989) suggests that using CFA allows for "the specification of measurement errors within a broader context of assessing measurement properties and describes a causal indicator model where the

Table 2.
Correlation matrix

	OI1	OI2	OI3	OI4	OL1	OL2	OL3	OL4	OA1	OA2	OA3	OA4	SCR1	SCR2	SCR3	SCR4	SCR5
μ	5.46	5.40	5.31	5.27	4.01	4.18	3.96	3.96	5.77	5.68	5.54	5.81	5.26	5.35	5.42	5.36	5.49
σ	1.38	1.52	1.46	1.48	1.05	0.98	1.15	1.04	1.18	1.21	1.26	1.06	1.30	1.36	1.23	1.25	1.25
OI1		0.58	0.58	0.61	0.51	0.49	0.51	0.53	0.42	0.49	0.35	0.29	0.42	0.33	0.38	0.44	0.48
OI2			0.64	0.66	0.48	0.49	0.45	0.54	0.32	0.34	0.28	0.33	0.4	0.33	0.35	0.42	0.43
OI3				0.73	0.51	0.5	0.51	0.56	0.38	0.46	0.51	0.46	0.39	0.41	0.46	0.47	0.46
OI4					0.53	0.53	0.55	0.57	0.3	0.33	0.34	0.39	0.33	0.31	0.36	0.41	0.34
OL1						0.65	0.67	0.68	0.34	0.39	0.3	0.41	0.26	0.31	0.3	0.31	0.48
OL2							0.63	0.76	0.41	0.48	0.42	0.42	0.41	0.47	0.45	0.48	0.49
OL3								0.74	0.42	0.44	0.35	0.3	0.4	0.38	0.38	0.42	0.45
OL4									0.36	0.42	0.44	0.4	0.34	0.39	0.39	0.38	0.48
OA1										0.65	0.47	0.42	0.63	0.55	0.61	0.65	0.59
OA2											0.66	0.5	0.61	0.53	0.6	0.6	0.58
OA3												0.51	0.47	0.52	0.51	0.52	0.52
OA4													0.41	0.49	0.44	0.53	0.45
SCR1														0.63	0.71	0.8	0.59
SCR2															0.81	0.8	0.6
SCR3																0.84	0.56
SCR4																	0.66

Construct	Items	VIF values	Model SRW[a]	AVE[b]	Cr. α	CR[c]
Organizational learning (OL)	*OL*			*0.690*	*0.899*	*0.899*
Managers basically agree that our business unit's ability to learn is the key to our competitive advantage	OL1	2.29	0.78			
The basic values of this business unit include learning as a key to improvement	OL2	2.70	0.83			
The sense around here is that employee learning is an investment, not an expense	OL3	2.36	0.81			
Learning in my organization is seen as a key commodity necessary to guarantee organizational survival	OL4	3.46	0.90			
Organizational innovation (OI)	*OI*			*0.638*	*0.875*	*0.875*
Our firm's management actively seeks innovative technologies, processes, techniques, and/or product ideas	OI1	1.94	0.73			
Our firm is known as an innovator among firms in our area	OI2	2.04	0.78			
Our firm investigates and secures funds needed to implement new ideas	OI3	2.66	0.83			
Our firm constantly experiments with new ideas	OI4	2.85	0.85			
Organizational agility (OA)	*OA*			0.547	*0.827*	0.827
Whenever there is a disruption in supply from our suppliers we can quickly make necessary alternative arrangements and internal adjustments	OA1	1.79	0.76			
We collect detailed information about our suppliers and service providers	OA2	2.46	0.83			
We are able to exploit the resources and capabilities of suppliers to enhance the quality and quantity of products and services	OA3	1.92	0.72			
We are able to manage relationships with outsourcing partners	OA4	1.45	0.63			
Supply chain resilience (SCR)	*SCR*			*0.714*	*0.925*	*0.925*
Material flow would be quickly restored	SCR1	3.07	0.83			
It would not take long to recover normal operating performance	SCR2	3.62	0.82			
The supply chain would easily recover to its original state	SCR3	4.2	0.86			
Disruptions would be dealt with quickly	SCR4	4.90	0.95			
We are able to maintain high situational awareness at all times	SCR5	1.82	0.70			

Note(s): [a]Model standardized regression weights are significant at $p < 0.01$; [b]Average variance extracted; [c]Composite reliability

Table 3.
Assessment of the measurement model

operational indicators are reflective of the unobserved theoretical construct". In this study, four factors were established: OL, OI, OA and SCR.

To exemplify, four items constituting the OL dimension were subjected to CFA using R lavaan package (Rosseel, 2012). We used maximum likelihood estimations when computing the model parameters. The χ^2 statistic was 248.82 (degrees of freedom = 113, $p < 0.05$), with the χ^2/df ratio having a value of 2.2 that is less than 3.0 (between 0 and 3 with lower values indicating a better fit). The other indices goodness of fit index (GFI) is 0.86 and adjustment goodness of fit index (AGFI) is 0.82. These scores are very close to 1.0 (a value of 1.0 indicates

perfect fit). CFI = 0.94, TLI = 0.93 and RMSA = 0.079. All indices indicate the measurement model satisfied the required threshold values. Similar analysis was performed for the other three dimensions as well. The findings show that the measurement models for all four domains demonstrated construct validity.

5.1.1.1 Reliability. We computed the Cronbach's alpha (CA) values for each of the constructs. The CA values of reliability for OL, OI, OA and SCR constructs were computed as 0.899, 0.875, 0.827 and 0.925 respectively. Table 3 shows the assessment of the measurement model.

As indicated in Table 3, the standardized regression weights (SRWs) for all variables are greater than 0.60 and significant ($p < 0.01$) (Hair *et al.*, 2010). We used the method of maximum likelihood to estimate the model parameters. Table 3 also provides CA and composite reliability (CR) values to measure the constructs' internal consistency. Both CA and CR values exceed 0.80, indicating satisfactory construct *reliability levels* (Bagozzi and Yi, 1988).

5.1.1.2 Convergent validity. Convergent validity was checked using the average variance extracted (AVE) values. AVE values higher than 0.50 suggest an acceptable level of *convergent validity* for constructs (Fornell and Larcker, 1981). Furthermore, statistically significant SRWs for individual variables (as shown in Table 3) also confirm convergent validity.

5.1.1.3 Discriminant validity. We checked the discriminant validity using three methods. First, the *discriminant validity* was checked by the square root of AVE as suggested by Fornell and Larcker (1981). Table 4 shows that the AVE's square root for each construct is higher than the interconstruct correlation values, indicating a satisfactory level of discriminant validity. Second, we checked for discriminant validity following Venkatraman (1989). The term refers to the degree to which various dimensions' measurements are distinct from one another. The model's discriminant validity is statistically supported by significantly lower χ^2 scores for the unconstrained model. According to Venkatraman (1989), a χ^2 difference value with an associated p-value less than 0.05 is generally chosen to indicate the support for the discriminant validity criterion. Table 5

Table 4.
Discriminant validity using average variance extracted (AVE)[a] and heterotrait monotrait (HTMT) values

[AVE] · *[HTMT]*	OA	OI	OL	SCR
OA	[0.740] · *[n/a]*			
OI	[0.620] · *[0.585]*	[0.799] · *[n/a]*		
OL	[0.630] · *[0.632]*	[0.771] · *[0.783]*	[0.831] · *[n/a]*	
SCR	[0.720] · *[0.884]*	[0.564] · *[0.495]*	[0.525] · *[0.519]*	[0.845] · *[n/a]*

Note(s): [a]Italicized values on the diagonal are the square root of the AVE values

Table 5.
Assessment of discriminant validity

Test #	Description	Chi-squared Constrained Model (df)	Chi-squared Unconstrained Model (df)	Difference
1	OL–OI	121.218, df = 20	16.211, df = 19	105.007*
2	OL–OA	176.958, df = 20	42.518, df = 19	134.44*
3	OL–SCR	395.974, df = 27	80.408, df = 26	315.566*
4	OI–OA	182.017, df = 20	56.751, df = 19	125.266*
5	OI–SCR	303.452, df = 27	64.258, df = 26	239.194*
6	OA–SCR	134.47, df = 27	86.45, df = 26	48.02*

Note(s): *$p < 0.001$

reports the results of six pair-wise tests for discriminant validity. All of the pair-wise tests indicate strong support for the discriminant validity criterion. Third, discriminant validity can be established if heterotrait monotrait (HTMT) values are less than or equal to 0.9 (Franke and Sarstedt, 2019). According to the results, respondents understood that there were four distinct constructs. The results are given in Table 4.

5.1.1.4 Nonresponse bias. Nonresponse bias, also known as participation bias, arises when individuals display certain qualities that have a disproportionate influence on the results. A possible nonresponse bias may be measured by comparing the outcomes of the early and late responders, according to Armstrong and Overton (1977). We designated individuals who reacted late to our reminders (beyond the second reminder) as "late," and those who responded earlier as "early" (85 early, and 95 late respondents). We considered that early respondents were representative of the typical responder and that late respondents were representative of the average nonrespondent and tested all our variables using an independent *t*-test. The *t*-test indicates that only one of the variables might suffer from nonresponse at $p = 0.05$ (OI4, at $p = 0.04$). Otherwise, there is no discernible difference between the two respondent groups (at $p = 0.05$ level). As a result, we concluded that nonresponse bias is not a significant concern throughout our study.

5.1.1.5 Common method bias (CMB). In this study, we checked for common method bias (CMB) following three approaches. One option for implementing Harmon's single-factor test is to use CFA according to Malhotra *et al.* (2006). According to the CFA approach, all observed variables are linked to a single factor reflecting method effects. CMB is significant if the hypothesized model fits the data. Following Malhotra *et al.* (2006), in order to examine whether a single factor might explain the majority of the variance, we used Harman's single factor test by including all of the items in the study in CFA approach (Podsakoff and Organ, 1986; Malhotra *et al.*, 2006). First, the number of factors in CFA is forced to one to check the significance of common variance. If the majority of the total covariance is generated by a single factor among all factors, then CMB exists. Our findings indicated that 13.7% (0.37^2 = 0.137) of the variation was accounted by the common method variance. As a result, the CMB is not regarded statistically significant since it is below than 0.50 (Podsakoff and Organ, 1986; Malhotra *et al.*, 2006). Finally, we also implemented multi-trait multi-method (MTMM) approach outlined by Podsakoff *et al.* (2003) and Byrne (2013) to check if a systematic covariation beyond the true relationship among the scale items exists. We created two models: one with freely correlated traits and methods and another with no traits, correlated methods. Our analysis yielded a significant difference in χ^2 supporting convergent validity.

We also evaluated CMB using marker variables (Lindell and Whitney, 2001). We used organizational resistance (OR) construct that we had formed for our earlier analyses. While the construct was not designed to be used as a marker variable, its removal from the study allowed us to utilize it as one. Our marker variable assessed respondents' perceptions of OR using the same seven-point scale format. We computed raw correlations among constructs as well as adjusted correlations after partial out the marker variable's effect. Following Cote and Buckley (1987), we formed three competing models. The first model included the original confirmatory factor model. The second model, on the other hand, employed a common latent factor which links all the indicators (Harman single factor with CFA). The third model, involved Harman single factor CFA model with the marker construct. Comparing these models (Model 1: $\chi^2/df = 2.20$, $NFI = 0.90$, $CFI = 0.94$, RMSA = 0.08, Model 2: $\chi^2/df = 1.95$, $NFI = 0.90$, $CFI = 0.95$, RMSA = 0.072, Model 3: $\chi^2/df = 1.87$, $NFI = 0.89$, $CFI = 0.95$, RMSA = 0.069) indicated no significant difference in model fit (Table 6). Thus, we conclude that CMB is not an issue in this study. We also found that these three

models yielded similar correlations (see above model fit indices and Table 2 for correlations). This indicates that CMB is not an issue.

5.1.1.6 Endogeneity. We also considered vital to assess whether endogeneity was a serious concern due to reverse causality (Lu *et al.*, 2018) between OI/OA and OL. As a result, we ran a series of tests to see whether endogeneity is likely to constitute a severe risk. As a result, we ran a series of tests on two models with instrument construct. Therefore, we conducted a number of tests with instrument variables and without instrument variables to determine whether endogeneity is likely to pose a serious threat. We used OR construct comprising three items as our instrument construct. The details of all constructs are provided in Appendix 1. To check the endogeneity of our exogenous variables, we performed the Durbin–Wu–Hausman and Sargan endogeneity test. The null hypothesis in Durbin–Wu–Hausman is that the estimator of the true population parameter is an efficient (and consistent) estimator of the true population parameters. An appropriate instrumental variable should be uncorrelated with the errors, but strongly correlated with explanatory factor(s). It is problematic to precisely compute rely on the corresponding coefficient if relationship between the instrumental variable and endogenous regressor is weak. We therefore hope a large p-value in the diagnostic test for weak instruments. The p-values for OI-SCR and OA-SCR are 0.051 and 0.499, respectively. Sargan test is used to address the issue that in an overidentified regression equation with more instrumental variables than coefficients to estimate, it is possible that the instrumental variables cause coefficient values to be incorrect. A small p-value suggests that the model is misspecified. The Sargan test p-values are 0.72 and 0.19 for OA-SCR and OI-SCR, respectively. Both of the tests confirmed the validity of our instruments and that our results are not likely to be influenced by endogeneity at $p < 0.05$ level.

5.2 Hypothesis testing

SEM analysis was conducted to test the study's hypotheses. Figure 2 presents the results of the structural model. Model fit indices are within the accepted ranges, indicating a good fit with the data [χ^2 statistic = 237.083, $p < 0.01$; *d.f.* = 113, $\chi^2/d.f.$ = 2.09, *GFI* = *0.87*, *AGFI* = *0.82*, *CFI* = 0.94, *TLI* = 0.93, *IFI* = *0.94*, *RFI* = *0.88*, *RMSEA* = *0.08*] (Schumacker and Lomax, 2016).

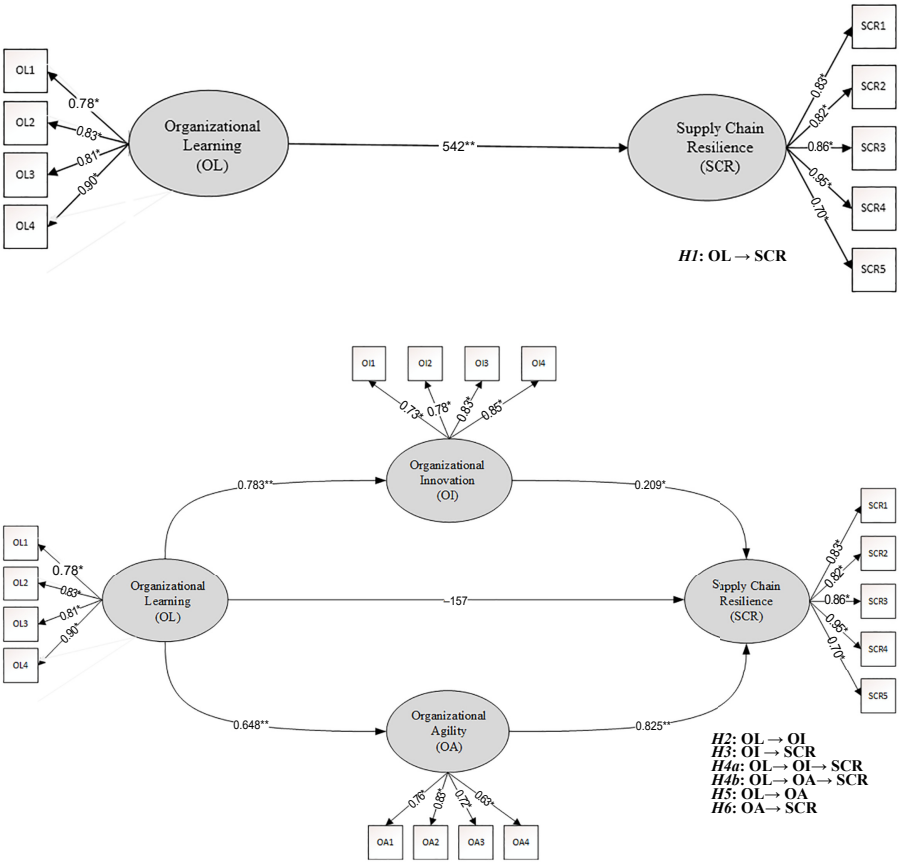
As shown in Table 7, the direct relationships in the model underlying H1, H2 H4, and H5 are statistically significant. The links between OL and OI (H1), OI and SCR (H2), OL and OA (H4), OA and SCR (H5) have SRWs of 0.783, 0.209, 0.648 and 0.825, respectively.

As for the mediation hypotheses (H3a and H3b), the traditional Sobel test approach (Baron and Kenny, 1986) was first applied to check the mediation effects of OI and OA on the relationship between OL and SCR. The test results indicate that OI fully mediates the link between OL and SCR (Sobel test statistics = 0.59; $p < 0.05$). Also, OI is found to have a full

Table 6.
Common method bias tests using marker variable

Correlation between	Original corrected correlation (first model)	Harman single factor with CFA (second model)	Marker-variable correlation (third model)
OI-OL	0.77***	0.75***	0.76***
OI-OA	0.54***	0.48***	0.50***
OI-SCR	0.45***	0.40***	0.42*
OL-OA	0.60***	0.52***	0.54***
OL-SCR	0.47***	0.40***	0.43***
OA-SCR	0.84***	0.82***	0.83***

Note(s): Table includes correlations before and after partial out the variance of the marker variable; ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$



Note(s): *$p < 0.05$; **$p < 0.01$

Figure 2.
Results of the model without (above) and with (below) mediation

Hypotheses	Total effect	Direct effect	Indirect effect (CI)	Level of support
Direct effects				
H1: OL → SCR	0.542		–	Supported
H2: OL → OI	–	0.783**	–	Supported
H3: OI → SCR	–	0.209*	–	Supported
H5: OL → OA	–	0.648**	–	Supported
H6: OA → SCR	–	0.825**	–	Supported
Indirect effects				
H4a: OL → OI → SCR	0.542	−0.157	0.164* (0.080–0.484)	Supported
H4b: OL → OA → SCR	0.542	−0.157	0.534** (0.386–0.793)	Supported

Note(s): *$p < 0.05$; **$p < 0.01$ (two-tailed); Bootstrapping $N = 5{,}000$

Table 7.
Hypothesis testing results

mediating effect on the relationship between OL and SCR (Sobel test statistics = 1.29; $p < 0.05$). These results validate the full mediation effects of OI and OA. They indicate that the effect of OL and SCR is fully mediated by OI and OA, confirming both H3a (OL → OI → SCR) and H3b (OL → OA→ SCR).

To run the bias-corrected bootstrapping method, 5,000 resamples were generated to check whether the indirect effects differ significantly from zero. Bias corrected bootstrapping analysis shows that the standardized estimates for indirect effects of OL on SCR, through OI, are calculated as 0.164, 95% bias-corrected confidence interval (CI) [0.80, 0.484] and significant at 0.05 level. On the other hand, the standardized estimates for indirect effects of OL on SCR, through OA, are calculated as 0.534, 99% bias-corrected CI [0.386, 0.793] and significant at 0.01 level. Both hypotheses, H4a (OL → OI → SCR) and H4b (OL → OA→ SCR), regarding the mediating effects of OI and OA, are fully supported.

6. Discussion

While the impact of OA on resilience has been repeatedly highlighted in several studies within the SC literature (Swafford *et al.*, 2006, 2008), the roles of OL and OI have attracted scant attention. To the best of our knowledge, this is the first empirical research linking OL to SCR and investigating the mediating roles of OI and OA in this relationship. Consistent with the RBV's claim that the effective usage of organizational resources enhances firm performance, our findings point the significantly positive relationship for OL-SCR and the full mediating role of OA and OI in this link.

6.1 Theoretical implications

The present study makes a series of theoretical contributions to SCR literature. The literature suggests that having integrated learning within an organization increases the organization's survival capability and thus contributes to its resilience (Norman, 2004). Similarly, in this study, we show the importance of OL to strengthen resilience within SCs. In addition, agility and resilience are complementary to build sustainability in SC operations (Ponomarov and Holcomb, 2009). The study shows that agility is a consequence of OL process.

While the extant literature views innovativeness as a critical driver in risk management to prevent disruptions (Sabahi and Parast, 2020), literature linking innovativeness to SCR is lacking. Thus, the study bridges the gap by including OI as an antecedent in the theoretical model. By investigating the link between OI and SCR experimentally, this study provides a better understanding of the influence of innovativeness on SC resilience. Our finding is consistent with the extant SC literature (Gölgeci and Ponomarov, 2015; Ponomarov and Holcomb, 2009). Because innovativeness is the ability to respond the expectations of market, it cannot be achieved without processing of knowledge. Hereby, the study helps better understand how innovativeness has a mediating effect on the link between OL and SCR. Furthermore, the current study highlights some of the underexplored constructs and their interrelationships in the extant literature. The study also expands the literature by providing a unique perspective that combines these constructs in a single theoretical framework in the aftermath of Covid-19 pandemic using RBV.

6.2 Practical implications

It is a fact that collective learning within the organization contributes to the organization's resilience (Norman, 2004). In this regard, our results fit with the literature that learning patterns within an organization helps collective learning, including mutual learning within the SC, and this adds to the adaptive behavior leading to SCR. By doing this, OL may act as a guide to ensure short- and long-term organizational problems.

Our results are consistent with the literature that learning patterns within an organization helps collective learning which builds resilience. While learning plays a critical role in ensuring short- and long-term organizational problems, this is mechanism is influenced by innovativeness and agility of organizations.

While some companies were severely impacted by the pandemic, others were able to rapidly adjust their supply networks (Kumar *et al.*, 2020). For instance, airlines have reported record losses, but General Motors and Ford expanded their primary manufacturing and began producing ventilators and other medicinal goods in response to reshaped consumer demand. UPS invested heavily in strengthening their SC for vaccine delivery (Weforum, 2021). These transformations and adjustments have been made possible thanks to their nimble manufacturing processes (agility) and their willingness to search for, embrace and promote change (innovativeness). Our research highlights that this agility relies on the groundwork that involves OL. Buttressed by OA and pillared by OI, OL culminates in increased resilience. While companies need to cultivate learning to enhance SCR, this does not take place overnight. Developing a learning organization provides a basis for developing resilience in the long term and catalyzed or mediated by other resources. The study highlights that learning, in fact, is linked to the development of OA and OI. For a company that values learning it becomes easier to attain innovativeness and agility. The results indicate that combining all these is vital, especially in times of crises.

7. Conclusion

In uncertain and volatile business environments, operationalizing the right set of resources is the key to success and survival of corporations. During unavoidable SC disruptions, firms need to combine the right set of organizational capabilities in their strategies. This research investigates the effects of key institutional factors on SC resilience. In this study, OL, OA and OI are considered antecedents of SCR. We empirically tested the relationships and found that all trigger the resilience capability for organizations. Furthermore, OA and OI play mediating roles between OL and SCR relationship. Through agility, SCs are expected to make faster decisions in the face of risks and unexpected shocks. Our results show that this agility, along with learning, is crucial to build resilience. Similarly, innovativeness encourages the development of new ideas and products and expected to result in improved SC performance in times of crises. We found that OI is an important factor to survive during risky environment and therefore it significantly affects the firm's SCR level. In line with the literature (Panayides and Lun, 2009; Swafford *et al.*, 2008; Chen, 2019), using RBV, our findings show that SCs fostering agile and innovative culture are more likely to deal with unexpected risks.

Our findings echo the known and establish newly identified effects of key intangible internal resources on SCR. While our results show that OI and OA fully mediate the relationship between OL and SCR, in future studies, other organizational resources could be added to the model. In particular, the effect of "information sharing" as the intangible resource (Brandon-Jones *et al.*, 2014) can be investigated. Furthermore, this study guides different research questions, such as "does decentralization trigger SCR?" and "are there any organizational resources that might have a negative impact on SCR?". We believe that some of these issues can be explored empirically using a survey-based methodology or in-depth interviews with professionals. Additionally, to achieve a certain level of homogeneity, we limited our study to manufacturing companies only. Future research can include organizations that operate in the service sector to compare the findings to those found in this study for the manufacturing sector. Lastly, the research shows that OA and OI trigger the resilience; nevertheless, the "how" question remains unanswered and requires further explorative investigation. Additionally, different moderators, such as decentralization within

company and commitment to suppliers, can be included as moderators to enrich the conceptual model.

As with all studies, this study also has some limitations. First, the number of participants and number of regions included could be increased for better generalizability. Because of the experimental design limitations, the same hypotheses in this study can be tested with different methods. Moreover, the data of this study were collected under the extra ordinary times during the Covid-19 pandemic; hence, the respondents' attitude can be also investigated under the normal conditions.

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Further reading

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(The Appendix follows overleaf)

Appendix

Construct	Items	Source
Organizational learning	Seven-point Likert a. Managers basically agree that our business unit's ability to learn is the key to our competitive advantage b. The basic values of this business unit include learning as key to improvement c. The sense around here is that employee learning is an investment, not an expense d. Learning in my organization is seen as a key commodity necessary to guarantee organizational survival e. Our culture is one that does not make employee learning a top priority f. The collective wisdom in this enterprise is that once we quit learning, we endanger our future	Baker and Sinkula (1999)
Organizational agility (operational and partnering)	Seven-point Likert a. We fulfill demands for rapid-response, special requests of our customers whenever such demands arise. Our customers have confidence in our ability b. We can quickly scale up or scale down our production/service levels to support fluctuations in demand from the market. c. Whenever there is a disruption in supply from our suppliers we can quickly make necessary alternative arrangements and internal adjustments d. We collect detailed information about our suppliers and service providers e. We are able to exploit the resources and capabilities of suppliers to enhance the quality and quantity of products and services f. We work with external suppliers to create high-value products and services g. We are able to manage relationships with outsourcing partners h. We can switch suppliers to avail ourselves of lower costs, better quality or improved delivery times	Felipe *et al.* (2017)
Organizational innovativeness	Seven-point Likert a. Our firm's management actively seeks innovative technologies, processes, techniques, and/or product ideas b. People are penalized for new ideas that do not work (R) c. Innovation in our firm is perceived as too risky and is resisted (R) d. Our firm is known as an innovator among firms in our area e. Our firm investigates and secures funds needed to implement new ideas f. Our firm constantly experiments with new ideas	Gölgeci and Ponomarov (2015)

Table A1.
Measurement of constructs

(*continued*)

Construct	Items	Source
Supply chain resilience	Seven-point Likert a. Material flow would be quickly restored b. It would not take long to recover normal operating performance c. The supply chain would easily recover to its original state d. Disruptions would be dealt with quickly e. We deploy alternative plans associated with identified risks f. We are able to maintain high situational awareness at all times	Brandon-Jones *et al.* (2014), Brusset and Teller (2017), Ambulkar *et al.* (2015)
Organizational resistance	Seven-point Likert a. Novel ideas are perceived as too risky and resisted b. Our culture prevents making learning a top priority c. The collective wisdom in our organization is to go against the status quo in order not to endanger our future	

Table A1.

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