Journal of Operations Management 33–34 (2015) 111–122

Contents lists available at ScienceDirect

Journal of Operations Management

journal homepage: www.elsevier.com/locate/jom

Firm's resilience to supply chain disruptions: Scale development and empirical examination

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ARTICLE INFO

Article history:
Received 13 August 2013
Received in revised form
30 September 2014
Accepted 7 November 2014
Available online 18 November 2014

Keywords:
Supply chain
Resilience
Scale development
Risk management

ABSTRACT

This paper expands our understanding of factors that contribute to development of firm resilience to supply chain disruptions. In doing so, we operationalize firm resilience to understand how supply chain disruption orientated firms can develop resilience to supply chain disruptions. We find that supply chain disruption orientation alone is not enough for a firm to develop resilience. Supply chain disruption oriented firms require the ability to reconfigure resources or have a risk management resource infrastructure to develop resilience. The way in which supply chain disruption oriented firms develop resilience through resource reconfiguration or risk management infrastructure depends on the context of the disruption as high impact or low impact. In a high impact disruption context, resource reconfiguration fully mediates the relationship between supply chain disruption orientation and firm resilience. In a low impact disruption context, supply chain disruption orientation and risk management infrastructure have a synergistic effect on developing firm resilience.

1. Introduction

In today's turbulent and uncertain environment, every firm in the supply chain is susceptible to disruption events (Knemeyer et al., 2009). As such, an understanding of how firms can manage supply chain disruptions has become an important topic for both academics and practitioners (Craighead et al., 2007; Blackhurst et al., 2011). A supply chain disruption is an event that disrupts the flow of goods or services in a supply chain (Craighead et al., 2007). It can have severe negative consequences on the financial, market and operational performance of the firm (Hendricks and Singhal, 2003; Hendricks and Singhal, 2005; Wagner and Bode, 2008; Narasimhan and Talluri, 2009). In a recent study by the World Economic Forum and Accenture, 80% of firms reported that resilience to supply chain disruptions has become a top priority (World Economic Forum Report, 2013; Wright, 2013). Firms, realizing that disruptions in the supply chain can have negative consequences, are now focusing on building resilience in order to mitigate the impact of disruptions (Juttner and Maklan, 2011; Melnyk et al., 2010; Wieland and Wallenburg, 2013).

The importance of resilience in the face of supply chain disruptions should not be understated. Resilient firms are less vulnerable to supply chain disruptions and are more capable of handling supply chain disruptions when they do occur (Sheffi and Rice, 2005; Ponomarov and Holcomb, 2009; Zsidisin and Wagner, 2010; Blackhurst et al., 2011; Pettit et al., 2013). Resilience allows firms to manage the supply chain disruption and continue to deliver their products and services to the customer. Sheffi and Rice (2005) note that it is important for firms to build resilience in order to deal with unforeseen and unquantifiable risks. Therefore, we identify factors which are antecedents impacting firm resilience to supply chain disruptions.

Extant research suggests that resiliency is an effective way to manage risk and recover from a supply chain disruption (Chopra and Sodhi, 2014; Hora and Klassen, 2013; Blackhurst et al., 2011; Juttner and Maklan, 2011; Zsidisin and Wagner, 2010). Hendricks and Singhal (2005) note that is it critical to develop resilience as firms face disruptions and call for more research in this area. While resiliency may be the key to a firm's ability to manage supply chain disruptions, there is limited research on how firms develop resilience to supply chain disruptions (Blackhurst et al., 2011; Juttner and Maklan, 2011). This study seeks to fill this gap by examining factors that help firms develop resilience to supply chain disruptions. Prior to examining factors that contribute to development of resilience to supply chain disruptions in a firm, it is important to provide a unified definition of firm resilience. However there is a lack of agreement regarding the definition of resilience in the literature (Bhamra et al., 2011; Ponomarov and Holcomb, 2009). Definitions of resilience at the firm level are shown in Table 1.

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http://dx.doi.org/10.1016/j.jom.2014.11.002
0272-6963/Published by Elsevier B.V.

Table 1
Definitions of resilience at the firm level.

Definition	Reference
The capability to anticipate and overcome supply chain disruptions.	Pettit et al. (2010, 2013)
A firm's ability to recover from supply chain disruptions quickly.	Blackhurst et al. (2011)
The capacity of organizations to cope with unanticipated dangers after they have become manifest.	Weick et al. (1999) and Wildavsky (1991)
The ability to respond to disruptions and restore normal operations.	Rice and Caniato (2003)

The lack of a unified definition of resilience has contributed to ambiguity of the concept of resilience related to supply chain disruptions noted by Bhamra et al. (2011), Ponomarov and Holcomb (2009) and Wieland and Wallenburg (2013). In this study, we contribute to the resilience and supply chain disruption literature by defining, operationalizing and validating firm resilience to supply chain disruptions as well as examining the factors that contribute to the development of resilience to supply chain disruptions in firms.

Following Gilliam and Voss's (2013) procedure for developing a construct definition based on prior literature, we compare the extant definitions of firm resilience and develop a preliminary definition. This preliminary definition is then used to develop measurement items that conceptualize firm resilience. The measurement items are subjected to an expert judging process via a substantive validity test. This is followed by an exploratory factor analysis to identify reflective measures that reduce the confusion surrounding the conceptualization of firm resilience to supply chain disruptions. These measurement items are then used to develop a refined inclusive definition of firm resilience. Firm's resilience to supply chain disruptions is defined as the capability of the firm to be alert to, adapt to, and quickly respond to changes brought by a supply chain disruption. This definition is in accordance with Gilliam and Voss's (2013) criteria of reducing ambiguity and vagueness surrounding the construct and addressing the imbalance between conceptualization and empirical validation of the construct. The details on the development of measurement items, substantive validity test and exploratory factor analysis are provided in the methodology section.

We investigate three antecedents to developing firm resilience to supply chain disruptions. First, we examine supply chain disruption orientation, which is characterized as the firm's recognition and awareness of pending disruptions and how firms analyze and learn from prior disruptions (Bode et al., 2011). Bode et al. (2011) note that firms can improve disruption response by cultivating a strong supply chain disruption orientation. In this study, we expand our understanding of supply chain disruption orientation, noting that though it is a necessary precursor it may not be sufficient by itself for developing firm resilience. Therefore, we propose a more nuanced set of antecedents to developing firm resilience to supply chain disruptions by considering two additional factors: a firm's resource reconfiguration capabilities and a firm's risk management infrastructure. We define resource reconfiguration as the ability of a firm to reconfigure, realign and reorganize their resources in response to changes in the firm's external environment (Wei and Wang, 2010; Helfat et al., 2007; Marsh and Stock, 2006; Zahra et al., 2006). Risk management infrastructure describes a firm's structure of resources designed to manage risk in the supply chain (Blackhurst et al., 2011). In addition to the antecedents to developing firm resilience to supply chain disruptions, we also examine the importance of resilience when firms face high impact disruptions and low impact disruptions. We measured extent of the negative impact using firm's overall operational efficiency, procurement costs and delivery reliability to the customer.

In the following sections, we present the development of our hypotheses. We propose a new model with an expansive view of firm resilience to supply chain disruptions. This is followed by a discussion of our research methodology, including a summary of the process used for developing the scale for resilience. We then offer a discussion of the results of our results and implications for researchers and managers. We conclude with a summary of the research.

2. Hypothesis development

In this study, we postulate that supply chain disruption oriented firms are better able to reconfigure resources. This, in turn, enhances firm resilience to supply chain disruptions. We note that this postulation is contingent on the level of disruption impact faced by the firm.

2.1. Resource reconfiguration and supply chain disruption orientation

The ability to manage resources and reconfigure them according to the environmental setting is critical to firm survival and superior firm performance (Sapienza et al., 2006; Sirmon et al., 2007; Davis et al., 2009). Supply chain disruptions are events that are characterized by high uncertainty (Bode et al., 2011) and disrupt the normal flow of goods and services within the supply chain (Craighead et al., 2007). The high uncertainty shrouding supply chain disruptions creates ambiguity about the value and utility of existing resources to generate capabilities that aid in recovering from a disruption. Facing disruptions, firms may sense new threats or opportunities and may need to renew, reconfigure or realign its risk management infrastructure to mitigate threats and exploit opportunities. In situations of high uncertainty such as new product development or new market entry, the ability of the firm to restructure and reconfigure its resource base has been shown to be crucial in developing capabilities that contribute to firm survival and growth (Tushman and Anderson, 1986; Sirmon et al., 2007). Marsh and Stock (2006) and Helfat et al. (2007) note that to respond to changes in the market, firms have to reconfigure and realign existing innovation resources and processes in order to enhance their innovation capacity. Similarly, Sirmon et al. (2007) note that when firms face environmental shock due to discontinuities in the industry, firms need to restructure their resource base. In other words, firms need to acquire, shed and reorganize their existing resource base to develop capabilities that allow them to adapt to the changing environment. A firm that is able to reconfigure and reorganize its resource base (Sirmon et al., 2007; Eddleston et al., 2008) in a dynamic environment may have a greater chance to develop capabilities that mitigate the impact of disruption (Blackhurst et al., 2011).

Having argued above that firm's ability to reconfigure resources is significant for firm to be resilient to supply chain disruptions, we expect to find that supply chain disruption oriented firms are more likely to engage in resource reconfiguration. Firms with a supply chain disruption orientation are aware that disruptions can occur based on past experience and are motivated to learn from disruptions. They proactively configure and manage resources to respond to a supply chain disruption (Bode et al., 2011). Ramaswami et al. (2009) note that firms that spend time scanning and learning from the environment are better able to develop capabilities that improve responsiveness (market oriented firms possess market-based capabilities that increase their responsiveness to changing customer demands). Helfat and Peteraf (2003) also note that firms that learn from the external environment are able to reconfigure and realign their resources and processes to develop capabilities that provide a sustainable advantage. Bode et al. (2011)

conceptualize a supply chain disruption orientation as being similar to market orientation and entrepreneurial orientation. They point out that supply chain disruption oriented firms strive to learn from their past supply chain disruption experiences and proactively build capabilities that allow firms to effectively respond to supply chain disruptions.

We note that the mediating role of resource reconfiguration between supply chain disruption orientation and firm resilience is contingent on the level of disruption impact faced by the firm (Bode et al., 2011). Firms participating in our study gave examples of disruptions they had faced and described the severity of the impact of those disruptions. Severity of impact was measured using overall operational efficiency, procurement costs, and delivery reliability to the customer. Disruptions were grouped into high impact and low impact categories based on level of negative impact on operational efficiency, procurement costs, and delivery reliability to the customer. We believe that the level of the disruption impact plays an important role in the way in which firm resilience to supply chain disruptions is developed. Bode et al. (2011) note that the motivation to act is influenced by the size of the impact of the disruption. In the case of high impact disruptions, the ability to quickly acquire new resources or restructure existing resources (Sirmon et al., 2007; Eddleston et al., 2008) is important to quickly adapt and respond to changes resulting from the disruption (Blackhurst et al., 2011). Therefore, in high disruption impact situations, the firm's ability to reconfigure resources becomes important as an intermediary mechanism that enables a supply chain disruption oriented firm to develop resilience to supply chain disruptions. Olcott and Oliver (2014) highlight an example in which firms in Japan were dealing with the aftermath of a massive earthquake in 2011. The ability to leverage and reconfigure resources was a key aspect of recovery from the disruption.

If the severity of the disruption is low, the reconfiguration of resources may not be necessary to establish resilience. Consider low impact supply disruptions in which suppliers may delay a shipment or send the wrong part. In such cases, firms that are supply chain disruption oriented may use their prior disruption experience to be better prepared to deal with them. As such, firms may not need to invest in reconfiguring and mobilizing resources but rather they may be able to absorb the impact of low impact disruptions (Melnyk et al., 2014).

H1. Resource reconfiguration fully mediates the relationship between supply chain disruption orientation and firm resilience for high disruption impact situations.

H2. Resource reconfiguration does not mediate the relationship between supply chain disruption orientation and firm resilience for low disruption impact situations.

2.2. Risk management infrastructure and supply chain disruption orientation

Risk management infrastructure describes a resource structure that a firm has in place to manage supply chain risks and disruptions. These resources include the presence of a department to manage supply chain risks/disruptions, the existence of information systems to manage supply chain risks/disruptions, and the use of key performance indicators (KPI) and metrics to monitor the supply chain risk management/disruption management process. Risk management infrastructure also includes the organization of assets to enhance a firm's resilience to supply chain disruptions (Blackhurst et al., 2011).

Having a proper resource structure enables firms to have a systematic approach to manage supply chain risks (Cooper, 1998; Koen et al., 2001). A risk management infrastructure provides many benefits to the firm: reduction of work ambiguity, increased task specialization, the ability to replicate learning, and enhanced information exchange (Perrow, 1986; Bonner et al., 2002). When facing a disruption, increased task specialization helps individuals and firms take quick action, which is critical when a firm is hit with a supply chain disruption. A quick response can lead to a quick recovery (Blackhurst et al., 2011; Bode et al., 2011). Firms with the proper resource structure can also use prior disruption experiences to efficiently manage similar disruptions in the future.

A risk management infrastructure, however, can also have a few disadvantages especially when firms face high impact disruptions. When faced with high impact disruptions, firms may respond to disruptions using risk mitigation approaches that have worked for them in the past and in doing so, overlook certain contextual factors related to disruptions. These factors may call for a more creative and restructured approach to respond to the disruption (Sirmon et al., 2007). However, risk management infrastructure may act as an impediment to the development of these alternative approaches to managing disruptions. Having people, information systems and metrics in place to assess and manage supply chain risks can lead to process formalization (Wouters and Wilderom, 2008), which may result in a linear, more rigid and less flexible risk management processes (Gilbert, 2005) thereby limiting the ability of the firm to reconfigure resources and be resilient to supply chain disruptions.

In low impact disruptions, we believe that risk management infrastructure and supply chain disruption orientation can provide synergistic benefits for firm resilience. The synergistic effect implies that the interaction of a firm's supply chain disruption orientation and risk management infrastructure provides benefits to firm resilience beyond the additive effect of the factors. In other words, the impact of the combination is greater than the impact created by adding each of the factors. When faced with a low impact disruption, supply chain disruption oriented firms can use the existing resource structure to manage minor disruptions. Risk management infrastructure can allow the firm to address disruptions without the need for reconfiguration. Information systems and professionals assigned to identify and manage disruptions can often employ operational exceptions or initiate processes within existing firm activities to minimize downside effects to such disruptions. As such, supply chain disruption oriented firms can use the existing resource structure to manage low impact disruptions.

Therefore, we predict the following:

H3. Risk management infrastructure diminishes the mediation impact of resource reconfiguration for high disruption impact situations.

H4. There is a synergistic impact of supply chain disruption orientation and risk management infrastructure on firm resilience for low disruption impact situations.

Our proposed model is shown in Fig. 1.

3. Methodology

The current research aims to develop firm resilience for further empirical study. In doing so, we developed a survey using new and existing multi-item scales (Churchill, 1979). New scales were developed for firm resilience and risk management infrastructure due to the lack of existing survey items. Pre-established scales were used to measure supply chain disruption orientation and resource reconfiguration. An overview of the steps take in our research is shown in Fig. 2.

3.1. Pretest procedure for firm resilience scale development

To develop the scale for firm resilience, we followed Churchill's method for building and testing reflective scales (Churchill, 1979;

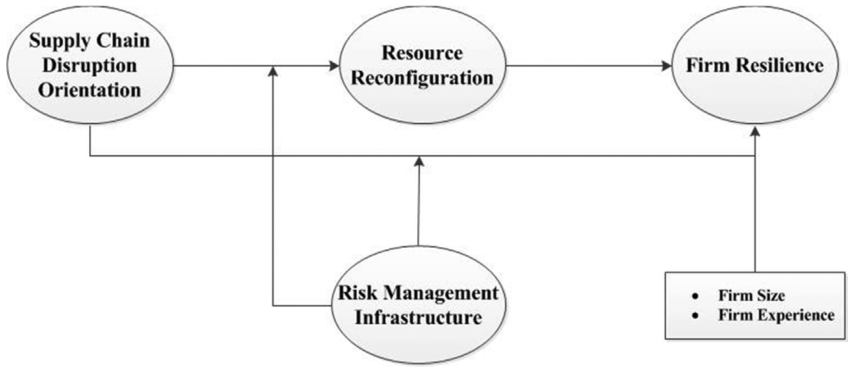

Fig. 1. Proposed model under high and low impact supply chain disruption situations.

Anderson and Gerbing, 1988; Bollen and Lennox, 1991). This method consists of four major steps: (1) developing the construct and checking content and face validity; (2) testing the dimensionality; (3) checking the internal consistency and (4) ensuring convergent, discriminant, and nomological validity of the measures (Anderson and Gerbing, 1988; Churchill, 1979). In the first step, 13 items were generated from a thorough investigation of the literature. These items captured capabilities such as adaptability, responsiveness, awareness, redundancy, visibility and coordination (Sheffi and Rice, 2005; Zsidisin and Wagner, 2010; Juttner and Maklan, 2011; Pettit et al., 2013). After the initial pool generation, a substantive validity test was used for scale purification (Lawshe, 1975; Anderson and Gerbing, 1991). The substantive validity of a measure is defined as how well the measurement item is reflective of, or theoretically linked to, the construct of interest (Anderson and Gerbing, 1991). This procedure is recommended when the construct is relatively new in the field and has seen limited to no operationalization (Lawshe, 1975). The 13-item scale, along with the definitions of firm resilience from the extant literature, was first presented to ten research faculty members for face validity and then presented to 71 industry experts. Research faculty were asked to consider each item's relevance to the concept of firm resilience. The opinions of the industry experts were collected to assess the substantive validity of the scale. In addition, industry experts were also asked to consider a disruption that their firm had faced in the last year. Each industry expert was then asked to:

(a) rate if the knowledge/ability measured by the item was either essential or not essential to the understanding of firm resilience, and
(b) use a Likert scale (1–7) to indicate how satisfied they were with their firm's implementation of the knowledge/ability captured by that that item.

The substantive validity coefficient is measured as $C_{sv} = (n_c - n_0)/N$ (Lawshe, 1975; Anderson and Gerbing, 1991), where n_c is the number of respondents assigning an item as essential for firm resilience, n_0 is the number of respondents assigning the item as non-essential to firm resilience, and N is the total number of respondents. The values of C_{sv} range from −1 to +1, where larger values indicate greater substantive validity. Large positive values indicate substantive validity for an item for its theorized construct, whereas large negative values indicate substantive validity for an item other than the theorized construct. Items with a C_{sv} value equal to or greater than 0.5 were retained (Anderson and Gerbing, 1991). In this way, the scale was reduced to four items. A similar procedure was used to develop the scale for risk management infrastructure.

Table 2
Scale development – pretest results.

Construct	Cronbach alpha (α)	Range of factor loadings
Firm resilience	0.86	0.67–0.83
Risk management infrastructure	0.90	0.76–0.91

The next step in the scale development process is the reliability and validity analysis. Exploratory factor analysis was conducted on the retained items in SPSS using principal component analysis, varimax rotation, and extraction criterion of eigenvalue greater than 1.00. Analysis for the firm resilience construct provided a single factor solution that explained 70.40% of the variance. The resulting Keyser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.81 and the χ^2 was 125.46 (d.f. = 6, p = 0.000). A single factor solution suggests unidimensionality of the firm resilience construct. The KMO measure of 0.81 (greater than recommended value of 0.6) suggests that the sample is adequate for factor analysis and that factor analysis is likely to provide reliable factors (Black and Porter, 1996). The significance of the χ^2 value also suggests that the single-factor solution is significant. The analysis for risk management infrastructure provided a single-factor solution that explained 85.60% of the variance (KMO measure of sampling adequacy = 0.735, χ^2 = 345.13, d.f. = 3, p = 0.000). Convergent validity and reliability were assessed using factor loadings and Cronbach's alpha values, respectively. Each scale demonstrated acceptable levels of convergent validity and reliability. These values are provided in Table 2.

The final step was to assess discriminant validity of the constructs. We used a chi-square difference test to measure discriminant validity (Ahire et al., 1996; Stratman and Roth, 2002). In the first confirmatory factor analysis (CFA) between constructs, the two latent constructs are allowed to freely correlate; in the second CFA between constructs, the correlation between two latent constructs is constrained to one. The difference in chi-square values between the unconstrained model and constrained model is noted and checked for significance. A significant chi-square difference value indicates two unique constructs thereby establishing discriminant validity. As shown in Table 3, the results of the analysis support discriminant validity among the constructs.

The predictive and nomological validity of the firm resilience construct were established using the scale as a part of a questionnaire administered to 199 respondents. The predictive validity is a measure of how well the construct is predicted by its antecedent variables (Narasimhan et al., 2001; Stratman and Roth, 2002). The results of the pretest procedure in scale development were shared with five academic experts and 20 industry experts (from the respondents in the pretest sample) for their feedback. Both the

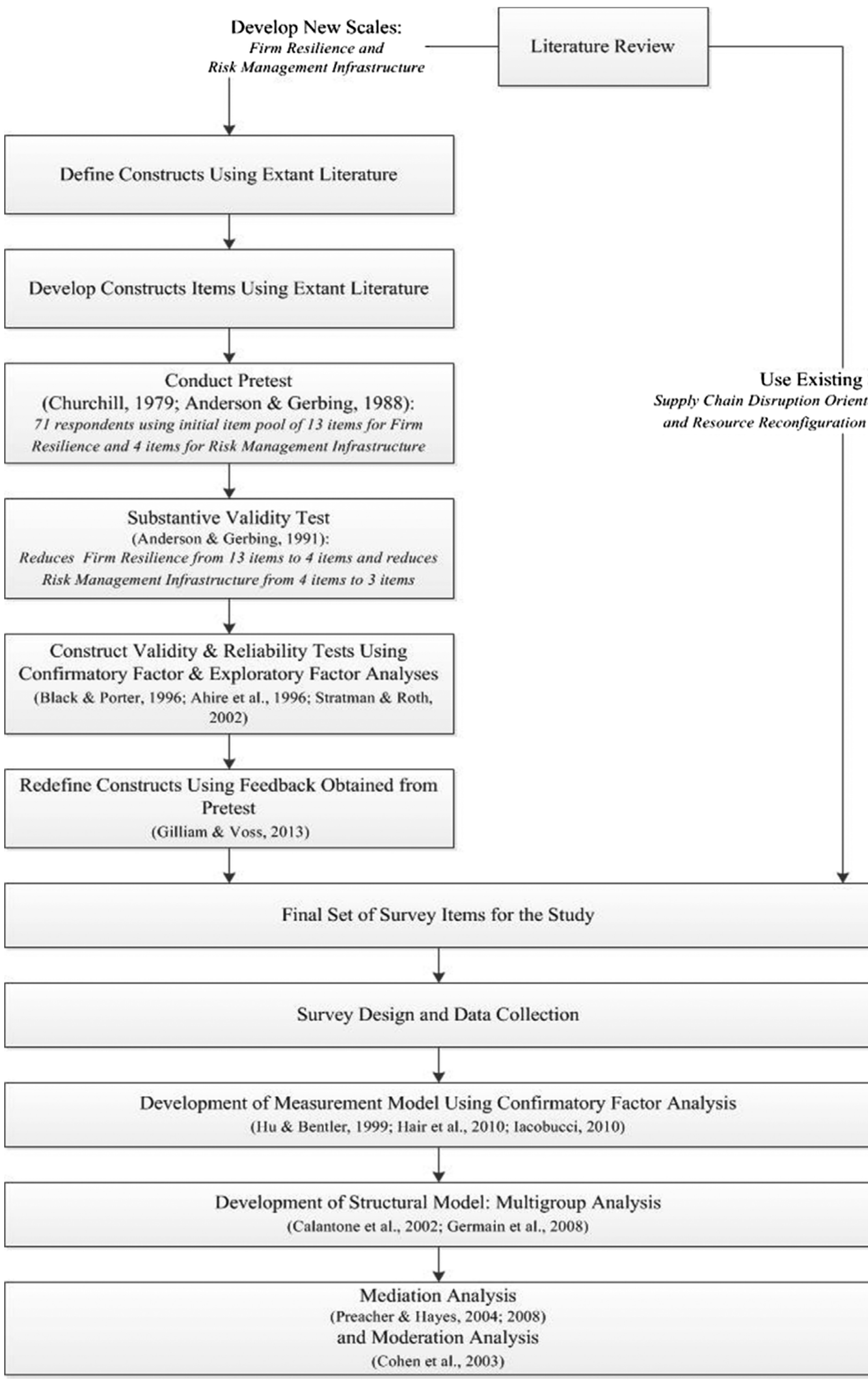

Fig. 2. Research methods flow chart.

Table 3
Test for measurement of discriminant validity.

Construct pairs		Unconstrained model	Constrained model	χ^2 difference
Firm resilience	Risk management infrastructure	$\chi^2 = 30.47$, d.f. = 13	$\chi^2 = 36.24$, d.f. = 14	5.77**

* $p < .1$.
*** $p < .001$.
** $p < .05$.

Table 4
Demographic characteristics of the sample.

Job title	Number of respondents
CEO/CFO/CIO/president	6
Vice president/director/partner/principal/general manager	23
Managers	60
Planner/scheduler/analyst/buyer	44
Engineers	66
Type of firm	**Number of respondents**
Manufacturing	154
Power management	7
Trucking/logistics/transportation/shipping	17
Process control/chemicals	6
Retail	12
Direct sales	3
Firm sales	**Number of respondents**
$10 million or less	7
More than $10 million, up to $50 million	11
More than $50 million, up to $100 million	18
More than $100 million, up to $200 million	13
More than $200 million up to $500 million	16
More than $500 million, up to $1 billion	73
More than $1 billion	61

academic experts and industry experts agreed with the conceptualization of each construct.

3.2. Sample and data collection

Prior to launching the survey, the survey was pretested with six faculty members and fifteen industry experts. Feedback from the pretest sample was then used to improve the survey and prepare it for distribution to a larger sample. The survey was then distributed to supply chain professionals using an online survey hosted by Survey Monkey (www.surveymonkey.com). The supply chain professionals are all alumni from a large university with a supply chain program. As with any survey, potential respondents were pre-qualified as they needed to have in-depth knowledge of their firm's supply chain operations. Each respondent received an email containing the link to the survey questionnaire. All participants were first pre-alerted and notified about the survey (Dillman, 2000). After the first notification, the respondents were sent regular reminders to complete the survey (Dillman, 2000). The survey was distributed to 1898 potential respondents, of which 91 were unreachable. Out of the remaining 1807 potential respondents, 199 completed and returned usable surveys, resulting in a response rate of 11.01%. Table 4 provides the demographic characteristics of the sample. The majority of respondents were engineers (33.17%), managers (30.15%) and senior-level officers (14.57%). The average experience held by respondents was between five and ten years. 79% of respondents had a role in production/supply chain in their current organization (30% worked in supply chain/logistics, 18% worked in manufacturing, 16% worked in purchasing and 15% worked in quality engineering). 30.65% of the firms had a sales revenue of $1 billion or greater. Respondents were asked to list a disruption that they faced in the past year and were then asked to answer the questionnaire considering this disruption. Out of the 199 disruptions reported, 62 were supply glitches, 42 were logistics/delivery glitches, 44 were in-house plant/factory glitches and 51 were reported as natural hazards, regulatory issues, or political issues. Table 5 provides examples of the four types of disruptions provided by the respondents.

We tested for non-response bias by comparing early (first 30 responses) and late respondents (last 30 responses) in terms of

Table 5
Disruption types and examples.

Disruption type	Example
Supply disruption	Late shipment of inbound materials from the supplier.
Logistics/delivery disruptions	Truckload transportation provider did not pick up a load of product as they said they would.
In house/plant disruptions	Plant shutdown due to major machine breakdown.
Natural hazards/regulatory and political issues	Disruption stemming from a country whose government cracked down on illegal re-sterilization of products only intended for single use, after which those products saw high levels of unanticipated demand.

firm revenue and number of employees (Armstrong and Overton, 1977). We found no significant differences. Multiple methods were used to check for common-method bias (Harman, 1976; Lindell and Whitney, 2001; Podsakoff et al., 2003). First, we checked for common method bias using the Harman's single factor test (Harman, 1976). In our study, the largest variance explained by any single factor was 34.54%. To further support the absence of common method bias, we conducted the latent factor test (Podsakoff et al., 2003). In this test, a latent factor is introduced to the original measurement model. We found no loss in significance of the factor loadings, further indicating that common method bias is minimized in our study.

3.3. Measures

Firm resilience was operationalized using four items measured on a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree). The items measure the ability of the firm to cope with changes due to a supply chain disruption, the ability to adapt to a supply chain disruption and provide a quick response, and the ability to maintain high situational awareness.

Supply chain disruption orientation was adapted from Bode et al. (2011). The scale consists of five items measured on a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree). The items capture the firm's recognition that supply chain disruptions are always looming, the need to be alert to supply chain disruptions, how supply chain disruptions can be avoided, analysis of an occurred supply chain disruption, and learning present in supply chain disruptions.

Risk management infrastructure was operationalized as a three-item scale based on the conceptualization of organizational resources as assets that enhance a firm's resilience to supply chain disruptions (Blackhurst et al., 2011). It was also measured using a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree). The items for the risk management infrastructure construct consider the presence of a person/department in the firm to manage supply chain risks/disruptions, use of KPIs and metrics to monitor supply chain risks and disruptions, and use of information systems to manage supply risks and disruptions.

The resource reconfiguration scale was adapted from Wei and Wang (2010) and is based on literature by Helfat et al. (2007), Marsh and Stock (2006) and Zahra et al. (2006). The construct is represented by four items that are measured on a seven-point Likert scale (1 = strongly disagree, 7 = strongly agree). The items in the scale captured the ability of the firm to realign their resource base in response to environmental changes, to reconfigure their resource base in response to the dynamic environment, the ability to restructure their resource base to react to the changing business environment, and the ability to renew the resource base in response to the changing business environment.

Table 6
Summary statistics (convergent validity).

Construct	Average variance extracted	Composite reliability	Range of factor loadings
Supply chain disruption orientation	0.52	0.84	0.67–0.80
Risk management infrastructure	0.8	0.92	0.78–0.96
Resource reconfiguration	0.56	0.83	0.63–0.92
Firm resilience	0.62	0.86	0.60–0.89
Disruption impact	0.52	0.76	0.54–0.80

Table 7
Average variance extracted and correlations.

Construct	1	2	3	4	5
1. Supply chain disruption orientation	*0.52*	**0.02**	**0.36**	**0.36**	**0.00**
2. Risk management infrastructure	0.14	*0.80*	**0.00**	**0.04**	**0.00**
3. Resource reconfiguration	0.60***	0.07***	*0.56*	**0.35**	**0.02**
4. Firm resilience	0.60***	0.21**	0.59***	*0.62*	**0.06**
5. Disruption Impact	0.07	0.07***	−0.13	−0.24**	*0.52*

Entries in italic, on the diagonal represent the average variances extracted; items in bold and above the diagonal are square of correlations (shared variances); items below the diagonal are the inter-construct correlations.
** $p < .05$.
*** $p < .001$.

Disruption impact was also adapted from Bode et al. (2011). The scale measures how supply chain disruptions reported by the respondents impacted their firm's overall efficiency of operations, delivery reliability to customer, and procurement costs of supplies. The measurement items were measured using a five-point scale (1 = not at all, 5 = a great deal).

In our study we controlled for two variables. First, we controlled for size of the firm which was measured using number of employees in the firm. Large firms tend to have access to a greater number of resources. Smaller firms, while not as rich in resources, may have the ability to be nimble in the face of adversity, due to the shorter chain of command (D'Amboise and Muldowney, 1988; Ramaswami et al., 2009). Second, we control for the firm's market experience. A firm having greater market experience is more likely to have greater exposure to disruptions and more experience managing disruptions, thereby making them more likely to be able to recover from disruptions quickly and improve firm performance (Thornhill and Amit, 2003; Ramaswami et al., 2009).

3.4. The measurement model

Reliability, validity and dimensionality of constructs were assessed using CFA. In CFA, comparative fit index (CFI), Tucker–Lewis index (TLI) and root mean square error of approximation index (RMSEA) (Anderson and Gerbing, 1988) were used to evaluate the measurement model and to ensure acceptable psychometric properties for all constructs in the model. The CFA showed a good fit, with measures being $\chi^2 = 280.54$ (d.f. = 143, χ^2/d.f. = 1.96, $p < 0.001$), CFI = 0.93, TLI = 0.91, and RMSEA = 0.07 (Hu and Bentler, 1999; Iacobucci, 2010). Table 6 shows the CFA results. All measurement items with their descriptive statistics are provided in the Appendix.

Factor loadings, composite reliabilities (CR) and average variance extracted (AVE) estimates were examined to ensure convergent validity of constructs. All factor loadings were greater than 0.50 and significant at $p < 0.001$ suggesting high convergence (Hair et al., 2010). Convergent validity and internal consistency were also supported in an examination of the composite reliabilities. All CR values were greater than 0.7 (Hair et al., 2010). The AVE for each construct was greater than 0.5, indicating support for convergent validity. AVEs for each construct also exceeded the squared correlations of the remaining constructs, indicating support for discriminant validity. Variance extracted estimates and correlations are shown in Table 7.

4. Analysis and results

4.1. The structural model

We used structural equation modeling to test the hypothesized relationships shown in Model 1 under high disruption impact and low disruption impact situations. Fig. 3a and b shows the results of the testing in each situation. To test the hypotheses under high and low disruption impact situations, multigroup analysis was performed using the disruption impact scale to separate the groups. The mean of the three items in the disruption impact scale was calculated to create a composite index. The median of this index was then calculated and the sample was split as close as possible to the median (Calantone et al., 2002; Germain et al., 2008). This lead to creation of two groups: those reporting a high impact disruption ($n = 81$) and those reporting a low impact disruption ($n = 118$).

In the multigroup analysis, we noted the strength (path estimates) of the hypothesized relationships. The equivalence of path estimates is examined using a chi-square difference test. Values are noted for both constrained and unconstrained two-group baseline model,[1] and the difference is checked for significance. Significance of chi-square difference suggests that across the two groups, path estimates are different (unconstrained model: $\chi^2 = 186.53$, d.f. = 122; constrained model: $\chi^2 = 1973.45$, df = 136; χ^2 difference = 1786.92; $p < 0.001$). The results of the structural analysis yielded acceptable fit statistics: $\chi^2 = 186.53$ (d.f. = 122, χ^2/d.f. = 1.53, $p < 0.001$), CFI = 0.94, TLI = 0.92, and RMSEA = 0.052 (0.036, 0.066).

A mediation analysis was used to test hypotheses H1 and H2. To test for mediation, we use the bootstrapping method recommended by Preacher and Hayes (2004, 2008). Bootstrapping is a nonparametric statistical procedure in which the dataset is repeatedly sampled and indirect effects are calculated. These indirect effects are then tested for significance using confidence intervals. If the indirect effects are significant, mediation is inferred in the model. In this study, we measured the significance of indirect effects by setting the number of sampling iterations (n) equal to 5000. The direct and indirect effects between supply chain disruption orientation and firm resilience were found to be significant at $p < 0.001$, inferring partial mediation. The indirect effect between supply chain disruption orientation and firm resilience under high

[1] To calculate the difference, the path estimates are first constrained and set equal across the two groups and then allowed to be free.

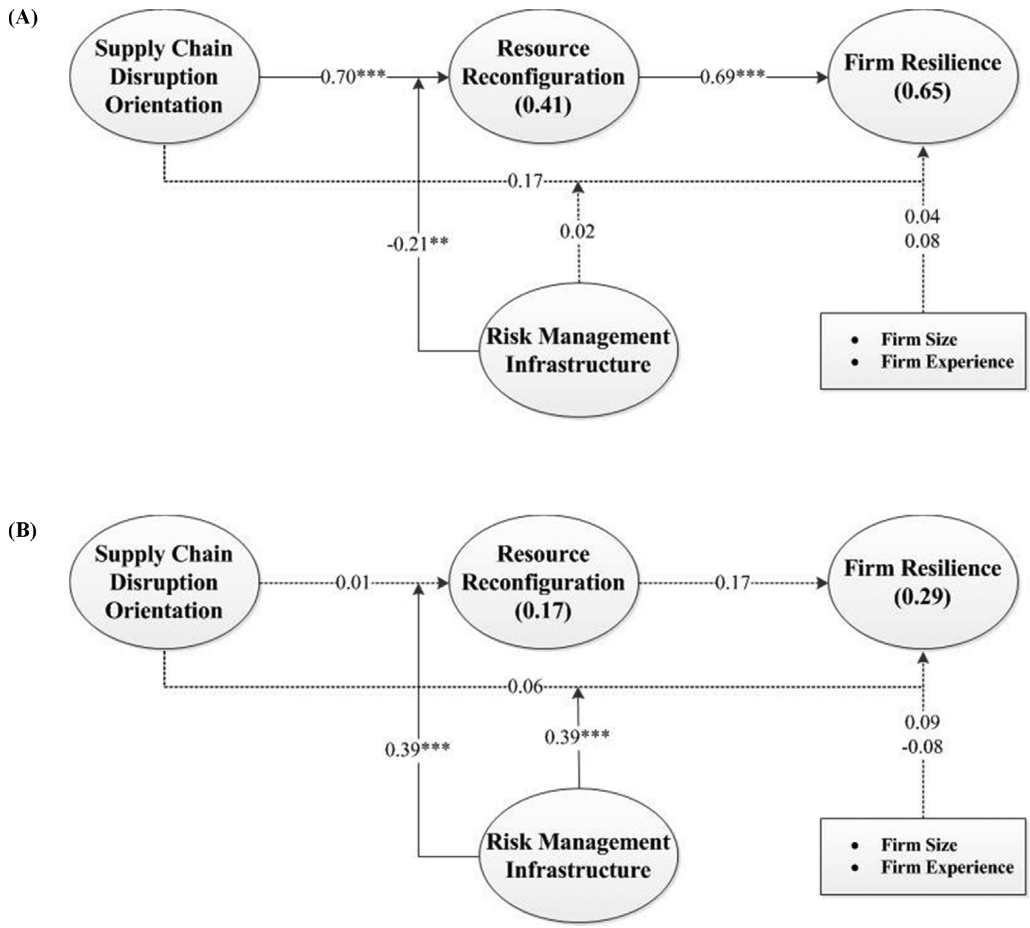

Fig. 3. (A) Structural model 1 (high disruption impact situation). (B) Structural model 2 (low disruption impact situation).

impact disruptions was found to be significant and the direct effect was found to be insignificant, inferring full mediation (supporting hypothesis H1). The direct effect of resource reconfiguration on firm resilience was found to be insignificant under low impact disruptions, suggesting that mediation does not exist (supporting hypothesis H2). Table 8 presents the bootstrapping results.

To test the moderation effect of risk management infrastructure (hypotheses H3 and H4), we used the interaction method (Cohen et al., 2003). A cross-product term was created to measure the moderation impact of risk management infrastructure on the mediation impact of resource reconfiguration, and the relationship between supply chain disruption orientation and firm resilience. The predictor variables were mean centered to reduce multicollinearity with the interaction term (Aiken and West, 1991; Cohen et al., 2003). The results (in Fig. 3a and b) show that hypotheses H3 and H4 were supported. H3 predicted that the mediation impact of resource reconfiguration would be diminished by risk management infrastructure under high impact disruptions. H4 predicted that the supply chain disruption orientation and risk management infrastructure would have a synergistic impact (Cohen et al., 2003) on firm resilience under low impact disruptions. The interaction effects are shown in Fig. 4a and b. In Fig. 4a, we find the slope estimate for the high risk management infrastructure line is 0.34 and for low risk management infrastructure is 0.62. Both slope estimates are significant at the 0.05 level. In Fig. 4b, we find the slope estimate for high risk management infrastructure line is 0.05

Table 8
Test for mediation – bootstrapping results.[a]

Constructs	High impact disruption situation		Low impact disruption situation	
	RR	FR	RR	FR
SCDO				
Total effect	0.59***	0.57***	0.2	0.27**
Direct effect	0.59***	0.17	0.2	0.21**
Indirect effect		0.40*** (0.15, 0.68)	–	0.06
RR				
Total effect		0.68***		0.32
Direct effect		0.68***		0.32
Indirect effect		–		–

** $p < .05$.
*** $p < .001$.
[a] The number in parentheses indicate the 95% confidence interval for n = 5000 bootstrap.
[b] (SCDO = supply chain disruption orientation, RR = resource reconfiguration, FR = firm resilience).

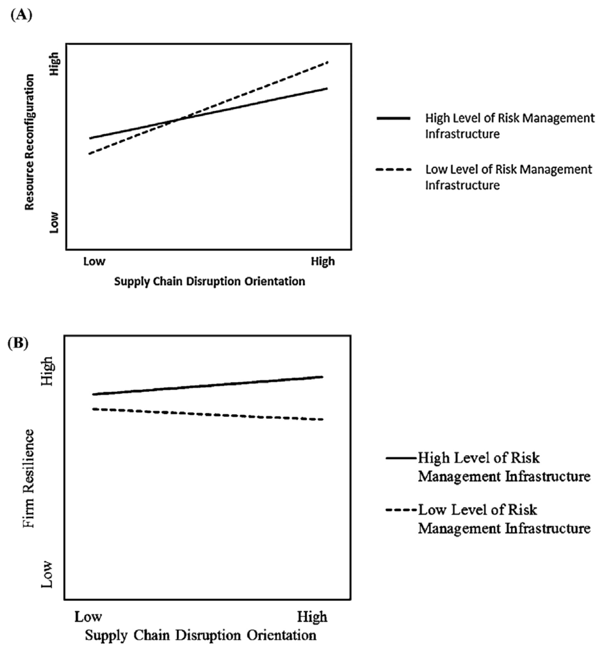

Fig. 4. (A) Interaction plots (high disruption impact situation). (B) Interaction plots (low disruption impact situation).

and for low risk management infrastructure is −0.03. All the slope estimates were significant at the 0.05 level.

5. Discussion and implications

In our study, we present a clear definition and operationalization of firm resilience. We utilize our newly developed scale to examine the impact of key variables on firm resilience. We begin by showing that while a supply chain disruption orientation is important in developing resilience, it is not always sufficient for doing so. The context can play a critical role in determining the ability for such an orientation to lead to firm resilience. Our findings extend the supply chain disruption literature to include a better understanding of firm resilience in two different contexts: high impact disruptions and low impact disruptions.

As we have noted, supply chain disruption oriented firms learn from prior disruptions and maintain an awareness of the environment to allow them to manage future disruptions. Our research model proposes that to achieve this resilience, firms must be able to reconfigure their resources in the face of disruptions. In the context of high impact disruptions, this path to resilience is supported. Simply having a supply chain disruption orientation and resources in place is not sufficient. Resource reconfiguration fully mediates the relationship between supply chain disruption orientation and firm resilience. While it is important for a firm to have resources to be resilient, resources by themselves cannot guarantee resilience. The ability to leverage those resources and reconfigure them is also critical to firm resilience. When facing a disruption, a firm must be able to evaluate their current resource base (i.e., identify current resource inventory and nature of resources available) and add new resources, shed existing resources or recombine/reorganize existing resource bundles. Not all resources are equally effective or hold equal value under different environmental conditions (Sirmon and Hitt, 2003). As such, acquiring valuable resources and shedding less important ones becomes crucial for a firm's resilience to disruptions. To ensure quick identification of and response to the supply chain disruptions, supply chain disruption oriented firms are engaged in developing and updating resources that ensure effective response to a supply chain disruption (Bode et al., 2011). They understand the need to acquire new resources or release unnecessary ones in order to be more adaptive to the changes brought by a high impact supply chain disruption. This is in line with Galunic and Rodan (1998), who note the importance of engaging in creating new resources through experimentally trying different resource combinations.

Our findings show a slightly different path to firm resilience under low impact disruptions. When faced with low impact disruptions, resource reconfiguration is not directly related to firm resilience, indicating that it does not mediate the relationship between supply chain disruption orientation and firm resilience in such cases. Risk management infrastructure, however, plays a critical role in low impact disruptions. Supply chain disruption orientation and risk management infrastructure have a synergistic effect on firm resilience. As supply chain disruption oriented firms develop greater risk management infrastructure, they become more resilient. Risk management infrastructure provides role formalization and task specialization that reduces operational ambiguity during supply chain disruptions and allows the firm to take quick action against disruptions. For firms that recognize that disruptions are always looming and are motivated to work towards recovering from disruptions, having a risk management infrastructure can provide protection against low impact disruptions. Issues such as late shipments can often easily be managed by having people and systems in place to monitor and take actions to correct such problems.

High impact disruptions and low impact disruptions affect firms differently. Accordingly, each has a unique path to firm resilience. The effective development and management of resources provides the bridge between understanding the disruption environment and being prepared to succeed in the face of disruptions. We show that many supply chain disruption oriented firms will be capable of absorbing low impact disruptions by having the right infrastructure in place. However, in more severe or high impact conditions, the ability to actively manage and reconfigure those resources is necessary to develop firm resilience.

5.1. Managerial implications

The findings from this study should aid managers in the planning and preparation for supply chain disruptions. In particular, senior-level managers should take note of the importance of maintaining a supply chain disruption orientation. This is the starting point for establishing firm resilience as it guides management decisions regarding the establishment and reconfiguration of critical resources. The orientation can be reinforced through regular communication and measurement. In doing so, employees at all levels of the firm are likely to maintain an awareness of disruptions and take steps to learn from even small disruptions within the supply chain. Managers should also seek to establish a formal risk management infrastructure by dedicating human and information resources to specialize in managing and responding to real and perceived risks to the firm's operations. As our research shows, such an infrastructure can allow firms to easily absorb low impact disruptions. Our findings demonstrate that although the mere presence of such resources does not make the firm more resilient in the event of high impact disruptions, they can keep operations running smoothly when faced with low impact disruptions. Resources of this type should include processes and procedures for monitoring the flow of goods upstream and downstream and for expediting and re-prioritizing workflow to meet firm and customer expectations.

Managers should also play an active role in making sure that the resources of the firm are aligned with the changing needs of the firm and the marketplace. Managers must be willing and able to make changes to their resource portfolio which may involve making major adjustments. Such changes may impact product offerings, service offerings, labor, facility operations, and relationships with other entities. One example might include using alternative suppliers and service providers to provide the firm with an array of options in the event of larger disruptions to the flow of products and services.

6. Conclusions

Our goal with this study was to understand what enables a firm to be resilient when facing supply chain disruptions. We extend the literature develop and operationalize a new firm resilience construct and examine its relationship with key resources and capabilities of the firm in the context of supply chain disruptions. Specifically, we show by employing our new scale you can show that supply chain disruption orientation is not the sole determinant of firm resilience to supply chain disruptions. Instead, there are important mediating and synergistic relationships that need to be taken into account. Our study contributes in a number of meaningful ways. First, this study develops, operationalizes and validates a firm resilience measurement scale. Next, the study demonstrates that a supply chain disruption orientation does not directly impact firm resilience in high-impact disruptions. Finally, the study highlights the importance of establishing a risk management infrastructure for managing low impact supply chain disruptions.

As with all research, there are some limitations that should be noted. First, the data used in the analysis is cross-sectional. Cross-sectional data collection limits the ability to draw conclusions related to causality. Therefore, future research should include alternative types of data, such as longitudinal data or event studies. Another limitation of the research is the use of a single respondent from each firm. Future studies of firm resilience should attempt to acquire additional data sources for the measurement of dependent variables. Future studies should also consider other approaches to capturing resilience. Scholars should explore firm resilience through the use of different types of event studies. For example, one study could examine the effect of supply disruptions on firm resilience and another could examine the effect of a natural disaster. Our research did not identify and test specific elements of risk management infrastructure, but future research could be directed at such exploration. Finally, we encourage scholars to extend the concept of resilience beyond the boundaries of a single firm to encompass broader supply chain resilience. Is it possible to develop relational or supply chain resilience between two or more firms in a supply chain? We believe that our research could be extended to explore such questions.

Appendix.

Construct items (descriptive statistics, factor loadings and reliability).[a]

Construct	Mean	Standard deviation	λ	α
Supply chain disruption orientation				0.82
SCDO1	We feel the need to be alert for possible supply chain disruptions at all times.	5.65	1.10	0.67
SCDO2	Supply chain disruptions show us where we can improve.	5.70	0.99	0.72
SCDO3	We recognize that supply chain disruptions are always looming.	5.83	0.93	0.80
SCDO4	We think a lot about how a supply chain disruption could have been avoided.	5.10	1.27	0.74
SCDO5	After a supply chain disruption has occurred, it is analyzed thoroughly.	4.84	1.39	0.66
Risk management infrastructure				0.91
RMR1	We have a department to manage supply chain risks and disruptions	4.92	1.43	0.78
RMR2	We have KPI and metrics to monitor supply chain risk	4.97	1.35	0.94
RMR3	We have information systems in place to manage supply chain risks and disruptions.	4.91	1.36	0.96
Resource reconfiguration	0.81			
RR1	We realign our firm resources and processes in response to environmental changes.	4.54	1.43	0.62
RR2	We reconfigure our resources and processes in response to the dynamic environment.	5.30	1.41	0.92
RR3	We restructure our resource base to react to the changing business environment.	5.20	1.38	0.74
RR4	We renew our resource base in response to the changing business environment	4.52	1.49	0.67
Firm resilience				0.85
FR1	We are able to cope with changes brought by the supply chain disruption.	4.75	1.15	0.89
FR2	We are able to adapt to the supply chain disruption easily.	4.40	1.29	0.87
FR3	We are able to provide a quick response to the supply chain disruption.	4.79	1.19	0.75
FR4	We are able to maintain high situational awareness at all times.	4.86	1.15	0.60
Disruption impact: how did disruption negatively affect				0.75
DI1	Overall efficiency of operations	3.58	1.06	0.54
DI2	Lead time for delivery (delivery reliability)	3.43	1.27	0.80
DI3	Purchasing costs for supplies	3.50	1.29	0.79

[a] "λ" refers to standardized factor loading; "α" refers to Cronbach's alpha value (represents construct reliability).

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jom.2014.11.002.

References

Ahire, S.L., Golhar, D.Y., Waller, M.A., 1996. Development and validation of TQM implementation constructs. Decis. Sci. 27 (1), 23–56.

Aiken, L.S., West, S.G., 1991. Multiple Regression: Testing and Interpreting Interactions. Sage Publications, Thousand Oaks.

Anderson, J.C., Gerbing, D.W., 1988. An updated paradigm for scale development incorporating unidimensioality and its assessment. J. Mark. Res. 25, 186–192.

Anderson, J.C., Gerbing, D.W., 1991. Predicting the performance of measures in a confirmatory factor analysis with a pretest assessment of their substantive validities. J. Appl. Psychol. 76 (October), 732–740.

Armstrong, J.S., Overton, T.S., 1977. Estimating nonresponse bias in mail surveys. J. Market. Res. 14 (3), 396–402.

Bhamra, R., Dani, S., Burnard, K., 2011. Resilience: the concept, a literature review and future directions. Int. J. Prod. Res. 49 (18), 5375–5393.

Black, S.A., Porter, L.J., 1996. Identification of the critical factors of TQM. Decis. Sci. 27, 1–21.

Blackhurst, J., Dunn, K., Craighead, C.W., 2011. An empirically derived framework of global supply resiliency. J. Bus. Logist. 32 (4), 374–391.

Bode, C., Wagner, S.M., Petersen, K.J., Ellram, L.M., 2011. Understanding responses to supply chain disruptions: insights from information processing and resource dependence perspectives. Acad. Manage. J. 54 (4), 833–856.

Bollen, K.A., Lennox, R., 1991. Conventional wisdom on measurement: a structural equation perspective. Psychol. Bull. 110, 305–314.

Bonner, J.M., Ruekert, R.W., Walker Jr., O.C., 2002. Upper management control of new product development projects and project performance. J. Prod. Innov. Manage. 19, 233–245.

Calantone, R., Droge, C., Vickery, S., 2002. Investigating the manufacturing–marketing interface in new product development: does context affect the strength of relationships? J. Oper. Manage. 20 (3), 273–287.

Chopra, S., Sodhi, M., 2014. Reducing the risk of supply chain disruptions. MIT Sloan Manage. Rev. 55, 73–80.

Churchill Jr., G.A., 1979. A paradigm for developing better measures of marketing constructs. J. Mark. Res. 16, 64–73.

Cohen, J., Cohen, P., West, S.G., Aiken, L.S., 2003. Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences. Lawrence Erlbaum Associates, London.

Cooper, R.G., 1998. Winning at New Products: Accelerating the Process From Idea to Launch, 2nd ed. Addison Wesley Publishing Company, Reading, MA.

Craighead, C.W., Blackhurst, J., Rungtusanatham, M.J., Handfield, R.B., 2007. The severity of supply chain disruptions: design characteristics and mitigation capabilities. Decis. Sci. J. 38, 131–156.

D'Amboise, G., Muldowney, M., 1988. Managemenet theory for small business: attempts and requirements. Acad. Manage. Rev. 13 (2), 228–240.

Davis, J.P., Eisenhardt, K.M., Bingham, C.B., 2009. Optimal structure, market dynamism, and the strategy of simple rules. Adm. Sci. Q. 54, 413–452.

Dillman, D.A., 2000. Mail and Internet Surveys – The Tailored Design Method, 2nd ed. Wiley, New York.

Eddleston, K.A., Kellermans, F.W., Sarathy, R., 2008. Resource configuration in family firms: linking resources, strategic planning and technological opportunities to performance. J. Manage. Stud. 45 (1), 26–50.

Galunic, D.C., Rodan, S., 1998. Resource recombinations in the firm: knowledge structures and the potential for Schumpeterian innovation. Strat. Manage. J. 19 (12), 1193–1201.

Germain, R., Claycomb, C., Dröge, C., 2008. Supply chain variability, organizational structure, and performance: the moderating effect of demand unpredictability. J. Oper. Manage. 26, 557–570.

Gilbert, C.G., 2005. Unbundling the structure of inertia: resource versus routine rigidity. Acad. Manage. J. 48 (5), 741–763.

Gilliam, D.A., Voss, K., 2013. A proposed procedure for construct definition in marketing. Eur. J. Mark. 47 (1/2), 5–26.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E., 2010. Multivariate Data Analysis, 7th ed. Prentice-Hall, Upper Saddle River, NJ.

Harman, H.H., 1976. Modern Factor Analysis. The University of Chicago Press, Chicago.

Helfat, C.E., Peteraf, M.A., 2003. The dynamic resource based view: capabilities life cycles. Strat. Manage. J. 24, 997–1010.

Helfat, C.E., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D.J., Winter, S.J., 2007. Dynamic Capabilities: Understanding Strategic Chance in Organizations. Blackwell, Oxford.

Hendricks, K., Singhal, V., 2003. The effect of supply chain glitches on shareholder wealth. J. Oper. Manage. 21 (5), 501–522.

Hendricks, K., Singhal, V., 2005. Association between supply chain glitches and operating performance. Manage. Sci. 51 (5), 695–711.

Hora, M., Klassen, R.D., 2013. Learning from others' misfortune: factors influencing knowledge acquisition to reduce operational risk. J. Oper. Manage. 31, 52–61.

Hu, L., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct. Equat. Model. 6 (1), 1–55.

Iacobucci, D., 2010. Structural equations modeling: fit indices, sample size, and advanced topics. J. Consum. Psychol. 20, 90–98.

Juttner, U., Maklan, S., 2011. Supply chain resilience in the global financial crisis: and empirical study. Supply Chain Manage.: Int. J. 16 (4), 246–259.

Knemeyer, A.M., Zinn, W., Eroglu, C., 2009. Proactive planning for catastrophic events in supply chains. J. Oper. Manage. 27, 141–153.

Koen, P., Ajamian, G., Burkart, R., Clamen, A., Fisher, E., Fountoulakis, S., et al., 2001. Providing clarity and a common Language to the "Fuzzy Front End". Res. Technol. Manage. 44 (2), 46–55.

Lawshe, C.H., 1975. A quantitative approach to content validity. Pers. Psychol. 28, 563–575.

Lindell, M.K., Whitney, D.J., 2001. Accounting for common method variance in cross-sectional research designs. J. Appl. Psychol. 86 (1), 114–121.

Marsh, S.J., Stock, G.N., 2006. Creating dynamic capability: the role of intertemporal integration, knowledge retention, and interpretation. J. Prod. Innov. Manage. 23 (5), 422–436.

Melnyk, S.A., Closs, D.J., Griffis, S.E., Zobel, S.W., Macdonald, J.R., 2014. Understanding supply chain resilience. Supply Chain Manage. Rev. January/February, 34–41.

Melnyk, S.A., Davis, E.W., Spekman, R.E., Sandor, J., 2010. Outcome-driven supply chains. MIT Sloan Manage. Rev. 51 (2), 33–38.

Narasimhan, R., Jayaram, J., Carter, J.R., 2001. An empirical examination of the underlying dimensions of purchasing competence. Prod. Oper. Manage. J. 10 (1), 1–15.

Narasimhan, R., Talluri, S., 2009. Perspectives on risk management in supply chains. J. Oper. Manage. 27 (2), 114–118.

Olcott, G., Oliver, N., 2014. Social capital, sense-making and recovery from disaster: Japanese companies and the march 2011 earthquake. Calif. Manage. Rev. 56 (2), 5–22.

Perrow, C., 1986. Complex Organizations, 3rd ed. Random House, New York.

Pettit, T., Croxton, K., Fiksel, J., 2013. Ensuring supply chain resilience: development and implementation of an assessment tool. J. Bus. Logist. 34 (1), 46–76.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y., Podsakoff, N.P., 2003. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J. Appl. Psychol. 88, 879.

Ponomarov, S., Holcomb, M., 2009. Understanding the concept of supply chain resilience. Int. J. Logist. Manage. 20 (1), 124–143.

Preacher, K.J., Hayes, A.F., 2004. SPSS and SAS procedures for estimating indirect effects in simple mediation models. Behav. Res. Methods 36 (4), 717–731.

Preacher, K.J., Hayes, A.F., 2008. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behav. Res. Methods 40 (3), 879–891.

Ramaswami, S.N., Srivastava, R.K., Bhargava, M., 2009. Market-based capabilities and financial performance of firms: Insights into marketing's contribution to firm value. J. Acad. Mark. Sci. 37 (2), 97–116.

Rice, J., Caniato, F., 2003. Building a secure and resilient supply chain. Supply Chain Manage. Rev. 7 (5), 22–30.

Sapienza, H.J., Autio, E., George, G., Zahra, S.A., 2006. A capabilities perspective on the effects of early internationalization on firm survival and growth. Acad. Manage. Rev. 31 (4), 914–933.

Sheffi, Y., Rice Jr., J.B., 2005. A supply chain view of the resilient enterprise. Sloan Manage. Rev. 47 (1), 41–48.

Sirmon, D.G., Hitt, M.A., 2003. Managing resources: linking unique resources, management and wealth creation in family firms. Entrep.: Theory Pract. 27 (4), 339–358.

Sirmon, D.G., Hitt, M.A., Ireland, R.D., 2007. Managing firm resources in dynamic environments to create value: looking inside the black box. Acad. Manage. Rev. 32 (1), 273–292.

Stratman, J.K., Roth, A.V., 2002. Enterprise resource planning (ERP) competence constructs: two-stage multi-item scale development and validation. Decis. Sci. 33 (4), 601–628.

Thornhill, S., Amit, R., 2003. Learning about failure: bankruptcy, firm age, and the resource-based view. Organ. Sci. 14 (5), 497–509.

Tushman, M.L., Anderson, P., 1986. Technological discontinuities and organizational environments. Adm. Sci. Q. 31, 439–465.

Wagner, S.M., Bode, C., 2008. An empirical examination of supply chain performance along several dimensions of risk. J. Bus. Logist. 29, 307–325.

Wei, H.-L., Wang, E., 2010. The strategic value of supply chain visibility: increasing the ability to reconfigure. Eur. J. Inform. Syst. 19, 238–249.

Weick, K., Sutcliffe, K., Obstfeld, D., 1999. Organizing for high reliability: processes of collective mindfulness. In: Staw, B., Sutton, R. (Eds.), Research in Organizational Behavior. JAI Press Inc., Stamford, CT, pp. 81–117.

Wildavsky, A., 1991. Searching for Safety. Transaction, New Brunswick.

Wieland, A., Wallenburg, C.M., 2013. The influence of relational competencies on supply chain resilience: a relational view. Int. J. Phys. Disitrub. Logisit. Manage. 43 (4), 300–320.

World Economic Forum, 2013. Global Risks 2013. World Economic Forum, Davos, Switzerland.

Wouters, M., Wilderom, C., 2008. Developing performance-measurement systems as enabling formalization: a longitudinal field study of a logistics department. Account. Organ. Soc. 33 (4), 488–516.

Wright, J., 2013. Taking a broader view of supply chain resilience. Supply Chain Manage. Rev. March/April, 26–31.

Zahra, S., Sapienza, H.J., Davidsson, P., 2006. Entrepreneurship and dynamic capabilities: a review, model and research agenda. J. Manage. Stud. 43, 917–955.

Zsidisin, G.A., Wagner, S.M., 2010. Do perceptions become reality? The moderating role of supply chain resiliency on disruption occurrence. J. Bus. Logist. 31 (2), 1–20.