Management capabilities in supply chain resilience

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Abstract

This paper aims to understand the capabilities that enables supply chain resilience. By systematic literature review in 22 select papers, between 2000-2013, we have identified the major capabilities: flexibility (supplier; product; process; transportation), collaboration (information sharing; joined decision making; working together); structure of chain (physical; information) and agility (visibility; velocity).

Keywords: Supply chain resilience; systematic literature review; management capabilities.

INTRODUCTION

Countries, communities, organizations and individuals are subject to a variety of environments and constantly changing. The threats that arise in these environments, often turbulent, can vary in intensity and frequency, and may have internal or external source to the analyzed system (Branha *et al.*, 2011).

Supply chains (SC) are also subject to these conditions. They are complex networks of companies that undergo continual turbulences (Pettit *et al* 2010), creating a potential for unpredictable disturbances which may create interruptions in the supply of products and services to final consumers and major disruptions for companies that constitute them.

The term "supply chain" is used here in its broadest sense, in other words, as a "network of organizations are involved, by linking upstream and downstream, in the different processes and activities that produce value in the form of products and services to be delivered to end consumers "(Christopher, 1998).

Therefore, any event that negatively affects the flow of materials and information between the original supplier and the end user must be considered as a risk of interruptions in the supply chain (Jüttner *et al.*, 2003). Interruptions can have a direct effect on the ability of an organization to get finished products in a market and provide critical services to customers (Jüttner, 2005).

According Ponomarov and Holcomb (2009 p. 125) disruptions in the supply chain can arise from external sources such as a natural disaster, and internal sources such as the inability to integrate all functions in a supply chain.

The strategic management of the companies requires a new focus on reducing risks "extends beyond the four walls of a single company" (Christopher and Peck, 2004). Therefore, managing the resilience of the supply chain is a proactive method that can complement and enhance the traditional risk management and provide business continuity (Pettit *et al*, 2010).

Previously, resilience was not a well-known concept in the business' world, and to some extent, its meaning is still limited to a minority of researchers and practitioners within the supply chain management field.

In this sense, Christopher and Peck (2004) state that Supply Chain Resilience (SCRes) is a scientific field research on the rise. To Ponomarov and Holcomb (2009), the SCRes is currently considered a critical component of Supply Chain Risk Management (SCRM), and a relatively new area of research and little explored. Pettit *et al.* (2010), consider the SCRes as an evolving concept.

While there are few conceptual differences in how supply chain resilience is defined in the current literature (see, for example, Christopher and Peck, 2004; Ponomarov and Holcomb, 2009; Wieland and Wallenburg, 2012), the formative elements needed to secure the adaptive capability of resilience are less consistent (Juttner and Maklan, 2011).

Thus, this paper aims to understand the capabilities that enables supply chain resilience, by systematic literature review in 22 select papers, between 2000-2013. This article is structured in five parts. After this introdution discusses the research method comprising the stages of systematic literature review. In the next section, the findings of this review are presented and the next one are discussed. Finally, the last part is dedicated to research conclusion, their managerial implications and directions for future research.

Research Method

This research adopted a systematic literature review approach based on the five-step outlined by Denyer and Tranfield (2009). The five steps, as illustrated in figure 1, include: question formulation, locating studies, study selection and evaluation, analysis and synthesis, and finally the reporting and using the results. Each step will now be discussed in turn.

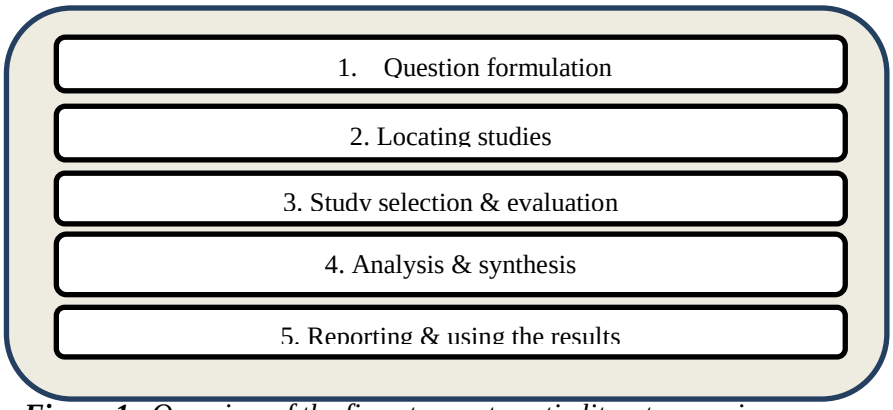

Figure 1– *Overview of the five-step systematic literature review process*
Source: *Adapted from Denyer and Tranfield (2009).*

Question formulation

A clear research question is critical to provide the focus and direction for any research. The primary question that this study seeks to address is:
1. Which are the management capabilities that enables supply chain resilience?
Supported by two supplementary questions:
1. How can they be defined?
2. How can they be operationalized to ensure the supply chain resilience management?

Locating studies

The next step is to locate the relevant studies. Three search engines were chosen: *Science Direct, Scopus,* and *Web of Science.* Given that the context for the study is the sypply chain, these were identified as the databases, available in Brazil, with the best coverage for this field.

Consistent with some systematic reviews in management (Colicchia and Strozzi, 2012; Hohenstein *et al*., 2014), our review used defined keywords as the search criteria. Following the authors' initial identification of a series of keywords, a team of two professors and three research assistants critiqued and validated the keywords to enhance quality. Finally, the set of keywords consisted of the phrase "supply chain" combined with at least one of the keywords "resilience", "resiliency", "resilient", was searched in the databases in the following fields: title, abstract and keywords. This search resulted in 185 articles.

Study selection and evaluation

In databases, a set of four filters was taken into account. In the first filter was the area of analysis, the second filter the document type was determined. In the third filter keywords were selected, and 42 paper resulted.

Finally, in the fourth filter, we carefully read the abstract of these 42 papers and selected those that could provide any insight to the research question: **What are the management capabilities that enables supply chain resilience?** After this final screening, only 22 papers remained.

In order to obtain and include relevant and importante documents to concentrate on, a series of inclusion and exclusion criteria should be defined. The following criteria, based on the ones proposed by Newbert (2007), have been considered to include/exclude papers:

- Search for papers published in peer-reviewed scientific journals in English.
- Search for papers published in the period: 2000 to 2013.
- Ensure substantive relevance by requiring that selected articles contain at least one keyword in their title or abstract.
- Eliminate substantively irrelevant articles by excluding papers related to very narrow aspects or contexts.
- Ensure substantive and empirical relevance by reading all remaining abstracts.
- Further ensure substantive and empirical relevance by reading all remaining articles in their entirety.

The rationale for considering articles published in the period of 2000 to 2013 is that the first article appearance in 2003 and the field of study has only relatively recently been addressed and the interest in this topic is growing increasingly in the last years.

The steps 4 (Analysis & synthesis) and 5 (Reporting & using the results) of systematic literature review are presented below as Findings and Conclusions.

Findings

Definition and scope of resilience in supply chains

"The first wide-spread study on supply chain resilience began in the United Kingdom, following transportation disruptions from fuel protests in 2000 and the outbreak of the Foot and Mouth Disease in early 2001"(Pettit *et al*., 2010 p. 4). These early studies found that: (1) supply chain vulnerability is an important business issue, (2) little research exists into supply chain vulnerability, (3) awareness of the subject is poor, and (4) a methodology is needed for managing supply chain vulnerability.

Based on empirical research these studies allowed Christopher and Peck (2004) develop an initial framework of supply chain resilience. For these authors the "supply chain resilience is a new and unexplored area of research, one of which is presented on the rise" (Christopher and Peck, 2004 p. 3).

In parallel to the studies of Cranfield, researchers at the Massachusetts Institute of Technology (MIT) analyzed several case studies of companies and supply chains that suffered disruptions, with focus on identifying vulnerabilities characteristics and management responses (Sheffi, 2005). They attempted to identify common threads between them and those who maintained good performance levels before disruptive events (Sheffi and Rice, 2005).

These two groups of researchers began their studies about supply chain resilience by the identification of vulnerabilities and risks to which the chains are submitted (Pettit *et al.*, 2010). The findings began to be published in international journals from 2003 and encouraged other research groups to contribute to the formation of this field of study.

However, there is no consensus on the definition of resilience in the SCM (Spiegler *et al.*, 2012). We can note the evolution conceptual of resilience in the scope of SCM. Initially the focus was on responsiveness after a disruption (Rice and Caniato, 2003). Thereafter, the reaction capability aligns with business continuity assurance (Christopher and Peck, 2004). There are, clearly, the need to develop risk mitigation strategies and adaptation to environmental conditions.

The conception of Ponomarov and Holcomb (2009) the definition of supply chain resilience must go beyond, that is, should include the supply chain's ability to anticipate the disruptive events capable of generating breaks and, should they occur, the supply chain should be able to recover quickly, restoring your operation without changes in its structure. These approach comprise the need for anticipation strategies, as well as recovery and adaptation.

In this conceptual breakthrough, Wieland and Wallenburg (2012) summarize the approaches to consider two dimensions form the concept of SCRes: *agility* - the ability to be reactive (Rice and Caniato, 2003; Christopher and Peck, 2004) and *robustness* – the ability to be proactive (Ponomarov and Holcomb, 2009).

Overall, the main idea of the concept of resilience in supply chain context is related to the ability of supply chain to ensure the maintaining their conditions over time (Christopher and Peck, 2004; Ponomarov and Holcomb, 2009), the ability to recover after a disruption (Rice and Caniato, 2003; Christopher and Peck, 2004; Ponomarov and Holcomb, 2009) and with the ability to anticipate possible disruptive events (Ponomarov and Holcomb, 2009; Wieland and Wallenburg, 2012).

Supply Chain Resilience – strategic capabilities

The term “capabilities” reflects the major role of strategic management in adapting, integrating, and reconfiguring resources, organizational skills and functional competencies to respond to the challenges of the external environment. Capabilities or distinctive competencies consist of those attributes, abilities, organizational processes, knowledge, and skills that allow a firm to achieve superior performance and sustained competitive advantage over competitors (Ponomarov and Holcomb, 2009 p. 134).

The formative elements describe how the supply chain event readiness, response and recovery can be secured and is therefore relevant from a supply chain management perspective. Juttner and Maklan (2011), argues that whereas some authors have defined the formative elements as “antecedents” of supply chain resilience (e.g. Ponomarov and Holcomb, 2009), others see them as constituting resilience elements (e.g. Christopher and Peck, 2004; Peck, 2005).

Christopher and Peck (2004), created a conceptualisation of a resilient supply chain from a system-level perspective. Their research identifies four primary capabilities for developing resilience: supply chain (re-)engineering; collaboration; agility and risk awareness.

For these authors, for building the resilient supply chain is necessary a) having a good understanding of the supply chain network and applying reengineering practices, b) applying a collaborative supplier base strategy based on information sharing, c) creating and maintaining agile supply chain networks capable of responding rapidly to changing conditions and e) introducing a supply chain risk management culture. Characteristics such as agility, availability, efficiency, flexibility, redundancy, velocity, and visibility, in this initial approach were treated as secondary factors (Petitt *et al*., 2010).

On the other hand,Ponomarov and Holcomb (2009), propose a framework of the relationship between logistic capabilities and supply chain resilience. Their conceptual model is based on the premise that logistic capabilities (e.g, delivery speed, reliability, responsiveness, and low cost distribution) are antecedents to supply chain resilience.

Some authors suggest that the SC should develop managerial abilities to prepare for the occurrence of unexpected events. Flexibility in logistics processes with use of multiple means of transport and route (Ishfaq, 2012), alliance network with strategic suppliers (Tang, 2006), reduction in lead time (Tang, 2006), collaborative planning (Ponomarov and Holcomb, 2009; Jüttner and Maklan, 2011), contingency plans (Spiegler *et al*., 2012), selection and certification suppliers (Vlajic *et al*., 2012) and implementation of a risk management culture (Zhang et *al*., 2011) are strategies aimed to improve supply chain resilience.

Considering the management elements found in the literature (Table I), several strategies can be incorporated by companies to increase their supply chain resilience. Many authors point to the diversification of suppliers and the collaboration as a strategy for dealing with interruptions (Christopher and Peck, 2004; Sheffi and Rice, 2005; Ponomarov and Holcomb, 2009; Pettit *et al*., 2010; Jüttner and Maklan, 2011; Zhang et *al*., 2011). Access to a wide supply base allows companies to invest in additional supply chain resilience and quickly change the volume of production in the event of an interruption (Sheffi, 2006; Tang, 2006).

Building a network of suppliers and creating a corporate culture of risk management (Christopher and Peck, 2004; Sheffi and Rice, 2005; Zhang et al., 2011) are strategies that could be combined with flexible contractual arrangements, inspections and suppliers qualified, and purchasing strategies (outsourcing) or to split the manufacture in different production plants (Sheffi, 2006).

Another strategic approach to ensure the uninterrupted supply is to plan and organize the inventory to ensure product availability (Sheffi and Rice, 2005) and ensure access to transport capacity using multiple routes (Ponomarov and Holcomb, 2009). Although redundant stocks

Elementos	Descrição	Autor (es)
Collaboration	Ability to work effectively with suppliers and customers for mutual benefits of supply chain (collaborative forecasting, customer management, communications, postponement, product life cycle management, risk sharing)	Christopher and Peck , 2004; Sheffi and Rice Jr, 2005; Ponomarov and Holcomb, 2009; Pettit *et al.*, 2010; Juttner and Maklan, 2011; Zhang *et al.*, 2011;
Risk management	Create an organizational culture for risk and vulnerability management: autonomy in making decisions and problem solving in the operational and strategic levels.	Christopher and Peck , 2004; Sheffi and Rice Jr, 2005; Zhang *et al.*, 2011.
Density	Connotes the geographical spacing of nodes within a supply chain, with supply chain density being inversely related to geographical spacing.	Craighead *et. al.*, 2007.
Flexibility	Flexibility ensures that the changes caused by risk event can be absorbed through the supply chain through effective reactions.	Christopher and Peck, 2004; Peck, 2005; Sheffi and Rice, 2005; Pettit *et al.*, 2010; Juttner and Maklan, 2011; Zhang *et al.*, 2011; Ishfaq, 2012.
Integration	Emphasizes the importance of the logistics interaction, downstream to upstream of supply chain. Interaction orders, inventory, transportation and distribution to facilitate the transparency of the supply chain.	Ponomarov and Holcomb, 2009.
Velocity (acceleration)	Means "movement speed, action or operation, speed and agility" and is defined as the supply chain's ability to respond to unexpected environmental changes (risks)	Christopher and Peck, 2004; Juttner and Maklan, 2011.
Visibility	Knowledge of operating assets (identity, structure, location) and the environment (identifying sources of vulnerabilities - risks) of the supply chain.	Peck (2005); Ponomarov and Holcomb, 2009; ; Pettit *et al*., 2010; Juttner and Maklan, 2011; Zhang *et al.*, 2011
Redundancy	Is the familiar concept to keep some reserve resources to be used in case of a disruption. The most common forms of redundancy are safety stock and the deliberate use of multiple suppliers.	Sheffi and Rice, 2005; Rice and Caniato, 2003; Christopher and Peck, 2004; Ponomarov and Holcomb, 2009; Pettit *et al*., 2010; ; Juttner and Maklan, 2011

Table I *– Capabilities of Supply chain resilience*

entail higher costs for businesses, they can ensure quick recovery in disruptions events (Sheffi, 2006; Tang, 2006). In addition, it is essential to use several means of transport, multiple carriers with multiple distribution channels (Tang, 2006).
In some cases, companies may even choose to maintain a transportation fleet dedicated to ensure greater control and reduced re-planning costs (Sheffi, 2006).

Finally, several authors (Peck, 2005; Pettit *et al.*,; Fiksel *et al.*, 2010; Ponomarov and Holcomb, 2009; Jüttner and Maklan, 2011; Zhang *et al.*, 2011) suggest that "visibility" in supply chain resilience is an important element resilience. In this sense, identify the most vulnerable companies in the supply chain structure and share knowledge and information are strategies that can help increase the resilience of the entire supply chain resilience.

Discussions – Management Capabilities

Supply chain resilience is considered a proactive risk management strategy, however, the concept also captures the reactive elements of being able to respond to a disruption and recover to the same or an improved state of functioning (Juttner and Maklan, 2011).

However, while there are few conceptual differences in how supply chain resilience is defined in the current literature (see, for example, Peck, 2005; Ponomarov and Holcomb, 2009; Sheffi and Rice, 2005), the formative elements needed to secure the adaptive capability of resilience are less consistent (Juttner and Maklan, 2011).

In this way, in order to have a clear view on all dimensions of resilience, this literature review helped us to target the management capabilities needed to build the resilient supply chain. We group these elements or dimensions in four management capabilities, which we call strategic capabilities, under which we identified in the literature the secondary elements, which we call operational capabilities, that is, the elements that should be worked through the supply chain to achieve its resilience.

Flexibility

Flexibility is defined as "being able to bend easily without breaking" and, as such, has been defined as an inherent part of resilience (Peck, 2005). Flexibility amounts to building organic capabilities that can sense threats and respond to them quickly. Not only does this bolster the resilience of an organization, but it also creates a competitive advantage in the marketplace (Sheffi and Rice Jr, 2005). The flexibility can be achieved by essential elements of any supply chain: Material flows from *supplier* (Christopher and Peck, 2004; Juttner and Maklan, 2011; Spiegler *et al*, 2012) through a *conversion process* (Christopher and Peck, 2004, Sheffi and Rice Jr, 2005; Bakshi and Kleindorfer, 2009; Pettit *et al.*, 2010; Juttner and Maklan, 2011, Spiegler *et al.*, 2012) then through distribution channels (Sheffi and Rice, 2005; Ponomarov and Holcomb, 2009; VanVactor, 2011, Ishfaq, 2012) and by introduction of new products (Spiegler *et al.*, 2012; Ivanov and Sokolov, 2013).

Initiatives to improve flexibility would include, for example, developing a multi-skilled work-force, designing production systems that can accommodate multiple products and real-time changes, and adopting sourcing strategies that permit transparent switching of suppliers (Rice and Caniato, 2003).

In summary, the flexibility of the production and distribution procedure is a key factor in coping with demand changes (Spiegler *et al.*, 2012). Nevertheless, some authors report that increased resilience through flexibility and agility would lead to increased operational costs

(Christopher and Peck 2004, Sheffi 2005, Sheffi and Rice 2005; Spiegler *et al.*, 2012). This is a trade off that managers have to deal with.

Collaboration

Approaches to coping with risk involve collaboration among supply chain participants. A high level of collaborative work across supply chains can significantly help mitigate risk (Christopher and Peck, 2004).

A key issue in developing a collaborative approach to managing supply chain risks is the extent to which a capability to cope with risk is developed and how the costs and benefits of that risk management are shared (Leat and Revoredo – Giha, 2013). This collaboration is, in part, the result of the weakest link property of supply chains and networks, and the recognition that a disruption along any link will cause a disruption in the entire supply chain (Bakshi and Kleindorfer, 2009). Hence, risk management strategies require participation of all supply chain partners, in order to be effective. In such a situation, it seems natural that ''cooperation'' (bargaining for redistribution of gains) among supply chain partners would be superior to a non-cooperative or uncoordinated approach (Bakshi and Kleindorfer, 2009).

The collaboration by *information sharing* (Christopher and Peck 2004; Sheffi and Rice, 2005; Ponomarov and Holcomb; Juttner and Maklan, 2011; Leat and Revoredo-Giha, 2013), *joined decision making* (Sheffi and Rice, 2005; Pettit *et al.*, 2010) and *working together* (Christopher and Peck 2004; Bakshi and Kleindorfer, 2009; Leat and Revoredo-Giha, 2013) can reduce uncertainty and improve the supply chain resilience.

Structure of chain

"A fundamental pre-requisite for improved supply chain resilience is an understanding of the network that connects the business to its suppliers and their suppliers and to its downstream customers" (Christopher and Peck, 2004 p. 7). Knowledge and understanding of supply chain structures, both physical and informational, and its ability to learn from changes, are important elements of supply chain resilience (Ponomarov and Holcomb, 2009).

According to Zhang *et al.*, (2011), a structure logistic to move material from one place to another, a flow of movable resources such as lorries, trains, and ships and the infrastructure such as roads, harbors and terminals are required.

Ponomarov and Holcomb (2009), argues that competitive advantage is created through logistics capabilities which are comprised of demand, supply and information management capabilities (see, Fawcett *et al*., 1997; Mentzer *et al*., 2004).

Agility

Supply chain agility means the ability to rapidly respond to unpredictable changes (Christopher and Peck, 2004). According then, two key elements of agility are "visibility" and "velocity". *Visibility* implies in knowledge of the status of operating assets and the environment (Pettit *et al*., 2010), and a clear view of intervening inventories upstream and downstream of the focal firm (Christopher and Peck, 2004). *Velocity* means "speed of motion, action, or operation, rapidity and swiftness" and is defined as distance over time (Christopher and Peck, 2004). We agree with Christopher and Peck (2004) to say that the visibility and velocity are secondary elements that determine the Supply Chain.

To summarize our findings, table II presents the management capabilites based this literature review.

MANAGEMENT CAPABILITES IN SUPLLY CHAIN RESILIENCE										
Flexibility				Collaboration			Structure chain		Agility	
Supplier	Product	Process	Transport	Information sharing	Joined Decision Making	Working Together	Physical	Information	Visibiliy	Velocity

***Table II**. Management capabilities in supply chain resilience*

Conclusions

This paper aimed to understand the capabilities that enables supply chain resilience. It was the lack of consensus for the authors of such capabilities. Some authors dealt as general principles underlying the supply chain (Christopher and Peck, 2004), others call formative elements of resilience (Ponomarov and Holcomb, 2009) or capability factors (Pettit et al., 2010).

We have identified the major capabilities: flexibility (supplier; product; process; transportation), collaboration (information sharing; joined decision making; working together); structure of chain (physical; information) and agility (visibility; velocity).

For future research, we believe that empirical studies which analyze the relationship between the management capabilities, to verify which are more relevant before, during and after a disruption in the supply chain is needed.

"These are challenging times but...there are ways in which companies can create more resiliente supply chains" (Christopher and Peck, 2004).

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