Vulnerabilities Management in a Food Supply Chain through Innovation Strategies:

The case of Hurricane Maria

Authors

Maribel Ortiz Soto[1] Ana G. Méndez University

Karen L. Orengo Serra[2] Universityof Puerto Rico

Cynthia Sénquiz-Díaz[3] Ana G. Méndez University

Introduction

Natural disasters are disruptions that impact the supply chains of many companies causing interruptions and instability while augmenting the vulnerability of the organizations (Vargas, González & Cornejo, 2015). As a result, globalized supply chains face the inability to handle these emergencies (Lee, 2004), namely, vulnerabilities. Vulnerability refers to the state of being dependent on specific characteristics that may threaten the continuation of the supply chain in disruptive events. Meanwhile, disruption is an exceptional and anomalous situation compared to the everyday routine in business (Wagner & Bode, 2006).

Researchers ascertain companies handle supply chain disruptions better when they are resilient (Christopher, 2005; Ponomarov & Holcomb, 2009; Sheffi & Rice, 2005). In this sense, the

[1]**Corresponding author**: Dr. Maribel Ortiz Soto is an Associate Professor in the School of Business and Entrepreneurship at Ana G. Méndez University (Puerto Rico). She has a Ph.D. in business administration and has published widely at recognized peer-reviewed journals. Her research interests' lie in the areas of entrepreneurship and international business with an emphasis on export strategy for SME's among others. E-mail: mortiz126@suagm.edu

[2]Dr. Karen L. Orengo Serra is a Professor of International Business at the Graduate School of Business Administration, University of Puerto Rico. She holds a Ph.D. from the University of Sorbonne, Paris 3 (IHEAL). She served as a member of the International Editorial Board of the Journal of Small Business Management and has published widely at important peer-reviewed journals. Her research interests are rooted in the internationalization of SMEs and business networks. E-mail: karenl.orengo@upr.edu

[3]Cynthia Sénquiz-Díaz is a lecturer and is currently pursuing a doctoral degree in management at the School of Business and Entrepreneurship at Ana G. Méndez University (Puerto Rico). Sénquiz-Díaz has participated as a speaker at local and international conferences. Her research interest centers on innovation and strategic management, operations and supply chain management, and organizational behavior. E-mail: csenquiz@suagm.edu

provision of innovation strategies is one of the factors that will allow the company to recover with greater agility. As suggested by Golceci and Ponomarov (2013), those companies that are innovative will be able to handle disruptions in the supply chain achieving better outcomes. More specifically, innovation translates into the capacity of the chain to achieve small, but significant incremental changes in processes to improve efficiency and quality in risk management supporting a robust and resilient supply chain (Ahmed & Huma, 2018).

This study analyzes the catastrophic event of Hurricane Maria (category 5) which strongly hit Puerto Rico and other Caribbean territories in the morning of September 20, 2017, with winds of 125 to 150 MPH. The significant rainfall led to the devastation of the telecommunications infrastructure and the Island's energy system, limiting the essential access to internet and use of electronics by different companies. The recovery of the members representing the food and beverage supply chain became a real challenge.

The question then arises: How can innovation be a strategy in the effective and efficient management of vulnerabilities while supporting the continuous flow of the supply chain in a disruptive event? This study addresses this question through the focal groups' methodology employed in this research. Moreover, this investigation pretends to analyze if the participants of the supply chain in an island economy, possess and further apply the characteristics of agility, adaptability, and alignment in the management for the supply of food and beverages through innovative strategies seeking to reduce the vulnerabilities and obtain the continuous flow of the chain.

This research is original and expands the supply chain literature in several important ways. Initially, it is the first study in the food and beverage sector that analyzes the characteristics (agility, adaptability, and alignment) in retailers and distributors. The study also analyzes the

vulnerabilities influence regarding the supplier and customer's dependence. Besides, it is the first study, according to the authors' best knowledge, that analyzes the impact of innovation as a tool for the management of vulnerabilities in a catastrophic event in an insular environment where 85% of the food is imported.

This study centers on two major links (retailers and distributors) of the Food Supply Chain in Puerto Rico. These were assessed as a preliminary study to learn firsthand the strategies they adopted to respond and mitigate damage in the context of the disruptive event. To accomplish this purpose, the role (functionality) of innovation is studied as a strategy for companies to be more agile, adaptable, and able to align with the other members in the chain.

Literature review

From management and economic perspective, resilience encompasses individual and collective attitudes. It also calls for behaviors at different levels: individual, organizational, inter-organizational, and systemic. Regardless, the capabilities to absorb a shock, to bounce back and respond, and to learn from the experience to anticipate future disturbances are part of a continuously developing process (Brandon-Jones, Squire, Autry & Petersen, 2014).

Lee (2004) emphasizes the use of variables to mitigate the vulnerability of the supply chain under disruptive events. Accordingly, the author suggests that high-performance supply chains have three different, but interrelated qualities: (1) they are *agile* in reacting quickly to sudden changes in demand or supply; (2) they *adapt* over the time as market structures and strategies evolve, and (3) they *align* (common integration approach) with the interests of all companies within the supply network to optimize chain performance by maximizing their benefits. In contrast, Wagner et al. (2006) suggest the drivers of the vulnerability must be advanced from the perspective of supplier

dependence, consumer dependence, and the concentration of suppliers; a single provider and a global supplier (Wagner et al., 2006).

The research contends innovation is one of the fundamental elements for the firm's survival in the management of disruptive events and a key driver of a resilient supply chain. That is, innovation increases the opportunities to handle disruptions in the most effective way possible (Christopher & Peck, 2004). However, this implies an adequate combination of innovation capabilities combined with an effective strategy to successfully respond to the disruptive event (Golgeci & Ponomarov, 2013). Therefore, individual participants of the chain cannot handle these capabilities *efficiently* in isolation. It requires the consideration of two elements: (1) the implementation of constant changes within the firm and with its partners, and (2) the integration and collaborative interaction of the members towards the adoption of strategies and tactics under these disturbance situations (Adner & Eucher, 2014). In this sense, innovations will provide the participants of the supply chain with the required flexibility to attain the changes necessary for mitigating damages while responding to the new customers' expectations. Figure 1 presents the conceptual model for the analysis of the described scenario.

Methodology

The methodology employed in this qualitative study was the focus group, which also provided for the data collection. Two focus groups were carried out where the minimum number of participants was met. The retailers represented supermarkets, restaurants, and food convenience stores. Meanwhile, the distributors were representatives of significant international brands such as Kraft, Idaho, Parkay, among others, as well as small select products, gourmet and organic, food and beverages. Table 1summarizes relevant descriptive aspects (in an average) of the participants and their respective business.

Instrument design

The performed questions were elaborated based on the vulnerability literature and the characteristics (namely agility, adaptability, and alignment) each link must possess to effectively and efficiently manage a disruptive event (Lee, 2004; Wagner et al., 2006). A total of 24 questions were developed and grouped according to the characteristics and vulnerabilities based on the provider and customer perspective. At the beginning of each focal group session, participants were asked if they agree to be recorded with a video camera. The sole purpose of this methodology was to collect the data reliably and accurately avoiding omission mistakes.

Data collection, Analysis and triangulation of the data

The configuration of the focus groups was a thorough one. Exclusively, two focus groups were carried out: one for the distributors and another for the retailers. Dynamics lasted 2 hours during the morning in an appropriate room free of distractions. A video recorder, integrated recorder to the laptop and the writing of field notes, constituted the technological tools to collect and store the information that was obtained from the participants. The analysis process was conducted based on the recommendations of Powell and Single (1996) described in figure 2. Subsequently, this information was subjected to a process of triangulation with secondary data based on previous empirical research on the subject, published in scientific journals of the discipline.

Discussion of results

In general, the flexibility in the adopted strategies demonstrates the importance of innovation in the capacity for building resilience of these supply chain participants (Christopher et al., 2004; Golgeciet al., 2013; Ponis& Koronis, 2013). A review of the most important results is discussed as a support of the above statement.

Agility construct

Findings suggest that both retailers and distributors are considered agile in their vulnerability management. They were able to start the operations of the company relatively quickly and adjust to changes in supply and demand. The problem with the communication, access to diesel, issues of infrastructure in stores, and suitable land transportation were the most relevant situations that affected their ability to react quickly. However, to start operations rapidly, the participants emphasized the essential resource was to have their employees and carriers("carreros") that could distribute the products. Suppliers were not among the priorities. They comment: "*the first task was to review the physical plant, the communication with the employees, an inspection of the place, equipment, customers and finally the suppliers. There was a contingency plan for crisis management, but the total interruption of telecommunications was not contemplated, namely, cellular and fixed telephony, terrestrial communication "*.

Adaptability construct

In regard to adaptability, both groups of participants had to make creative decisions to solve the problem of lack of electricity and communication. Members, more specifically, retailers and distributors were able to identify new opportunities and exploited them. The environmental challenges encountered at the time urged them to be motivated in making innovative decisions. Findings state that both groups used architectural and incremental innovation since they used the established systems with the traditional components in a new way. For example, both groups were flexible in changing the Electronic Payment System (EPS) for manual cash payment. Retailers had to pick up the merchandise at distribution centers instead of waiting for distributors to arrive in their trucks. Business transactions were in person as there was lack of the usual communication

methods. The incremental and architectural innovation became evident when, as ascertained by the focal group members, "*we saw that the flow of the chain was reversed for the first time*."

Alignment construct

Retailers had a greater tendency to change suppliers more than the distributor group. The identification of alternative suppliers was necessary because there was no access on the roads. Therefore, many companies opted to start buying those geographically accessible with availability of products.

Vulnerabilities: Suppliers dependence

An interesting and important finding was that jointly developed strategies were not identified through the focus groups as part of networking collaboration. Most of the strategic decisions taken were isolated. In the case of distributors, for example, the most significant setback was the fact that products are mostly from foreign suppliers, who were limited by the control in the maritime ports, logistics, and ground transportation system of the Federal Emergency Management Agency (FEMA hereafter) whose naval ships had the priority of entry and unloading in ports.

Regarding the supplier dependency, distributors commented that they did depend on some with whom they had a long-term relationship. They had the option to look for others, but it was not necessary because they were proactive. A generalized and common complication was how to deliver the product to their customers.

Vulnerabilities: Customers dependence

Retailers have clients close to their establishments. Consequently, the consumer tends to buy food in areas close to their home or work, which fosters an absolute dependence on some of them. This promotes a certain degree of dependence on some of the customers' relationship. Companies had no choice than to be innovative to be agile in the process of providing goods to customers.

Conclusions

The lack of availability of products among the participants of the food supply chain was one of the most significant effects caused by the catastrophic event, Hurricane Maria. A relevant factor is that, unfortunately, Puerto Rico is limited in the local supply of food consumer products.

Through this research, we highlighted aspects for a successful recovery and efficient management of the crisis in disaster events (Hurricane Maria) recovery based on experiences within the context of an island economy where 85% of food is imported. Distributors and retailers were facing the same geographic and physical constraints. However, these restrictions served as an engine for the generation of innovative strategies demonstrating the resilience capabilities of the supply chain participants, since they succeeded to articulate operational and flexible lean processes to mitigate the damages and to respond with agility, adaptability and were capable of being aligned with the new stakeholders' needs (Wagner et al., 2006; Lee, 2004; Poni et al., 2013; Brandon-Jones et al., 2014).

Results suggest there is need to address the lack of integration in the food and beverage supply chain. Collaboration networks are indispensable in the development of a resilient supply chain, particularly, to mitigate damages that disruptive events cause in the perishable food supply chain (Ali, Nagalingam &Gurd, 2017).Accordingly, the use of innovative strategies proved to be an essential component to facilitate the continuous flow of the food supply chain. Even in a markedly unstable environment, new business opportunities emerged. Therefore, architectural and incremental innovations were the most present in the groups under study. However, it is emphasized that innovation does not arise as part of an integrated communication within the groups of members.

Although distributors and retailers present some successful crisis management strategies and efficient disaster recovery experiences, it is important to highlight that no proper alignment between the members is observed. There was no interest from any of the groups in developing networks and partners to coordinate and optimize the chain's performance. The urgency to have products available for customers boosted the need to seek viably alternatives that would give those results, but these were only from the perspective of the participant that had the demand at the moment. This hindered collaboration and integration with suppliers. The study suggests that distributors showed more dependence on suppliers because of their relationship and, therefore, face greater vulnerability. In contrast, the retailers felt that their suppliers were not fulfilling their expectations. Consequently, they decided to look for new collaborators.

Implications and implementation

Efficient companies require constant and direct communication with their suppliers and customers. In these endeavors, technology plays an essential role in the communication and innovation process. The need for alternative communication systems that do not depend on traditional networks and systems to enable business continuity is evident. The improvement in communication systems between the companies that make up the chain, including standardization of protocols, will create stronger supportive networks that help companies to be more agile, increasing opportunities for collaboration and synchronization between companies, making them more competitive.

The development of an innovation strategy demands the alignment of these strategies with the resources that are part of the chain to be able to innovate more quickly than the competition (Shakeel Sadiq, Brah, Zahoor Hassan, & Kannan, 2014). Those companies that react quickly (agility) to changes in demand or supply, can adapt to the changes that arise in the new market

structures, identify new strategies and modern opportunities (innovation), and can align their interests with the other chain participants forming an ecosystem. In this sense, companies that maximize their performance will be those developing a sustained competitive advantage(Lee, 2004).

From a theoretical perspective, the study suggests that more than a linear relationship between the characteristics or capabilities of the company and its effect on vulnerabilities, the relationship between the variables must be a bidirectional one where innovation is the critical component facilitating the continuous flow of the chain to handle vulnerabilities efficiently in the context of a disruptive event. To the extent that the event is of greater magnitude, the management vulnerabilities performed by the company may affect its ability to be more or less agile, adapt and align in a manner that innovation favors the continuity of the company and the chain as a whole. Figure 3 supports a better understanding of the relationship between the variables.

Limitations and future studies

The results of this study cannot be generalized since only two links (retailers and distributors) of the supply chain were analyzed through a qualitative approach. Future research may consider the topic from the perspective of all participants in the food supply chain, at a quantitative and qualitative analysis level to measure the variables found providing generalized information. Ideally, a replicate of the study in other industrial sectors is recommended to evaluate if the manifestation of the vulnerabilities is handled efficiently through the characteristics of agility, adaptability, and alignment. Research opportunities in the management of food supply chain vulnerabilities remain diverse as "no organization is an island, and even the most carefully controlled processes are still as good as the links and nodes that support them" (Christopher et al., 2004, p.1). (All references, tables and figures are included as appendixes on supplementary files)