

VULNERABILITIES MANAGEMENT OF A FOOD SUPPLY CHAIN THROUGH INNOVATION STRATEGIES TO COPE WITH NATURAL DISASTERS

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SUMMARY: This paper shows how distributors and retailers of the food and beverages supply chain (FBSC) coped with a natural catastrophe through innovative strategies and overcame underlying vulnerabilities and risks. External factors (power energy, telecommunications, road breakdown, FEMA) and the lack of collaboration between the links were obstacles for the chain to reach its optimal flow. Findings from the focus group methodology contend that the use of innovative strategies in a bidirectional form is an essential component of resilience to facilitate the smooth flow of the FBSC.

Keywords: innovation, vulnerabilities, food and beverages supply chain, natural disaster

Introduction

Natural disasters affect many companies' supply chains, causing interruptions and instability while augmenting the organizations' vulnerability (Vargas, González & Cornejo, 2015). Vulnerability refers to 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). As a result, globalized supply chains will face the inability to handle these emergencies (Lee, 2004), namely, vulnerabilities.

Researchers ascertain that businesses that handle supply chain disruptions are better when resilient (Christopher, 2005; Ponomarov & Holcomb, 2009; Sheffi & Rice, 2005). Therefore, the provision of innovation strategies is one of the factors that will allow the company to recover with greater agility. 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). In this sense, Golceci and Ponomarov (2013) suggested that those innovative companies will handle disruptions in the supply chain, achieving better outcomes. Notwithstanding, despite innovation's significance, it is seldom investigated towards risk mitigation and opportunities to build resilient supply chains.

This exploratory study seeks to contribute to this research gap. First, it expands the current literature on supply chain risk mitigation and vulnerability management. It also promotes the significance of the development of FBSC members' strategies.

This study takes as a framework the catastrophic event of Hurricane Maria (category 5), which hit Puerto Rico and other Caribbean territories in the morning of September 20, 2017, with winds of 125 to 150 MPH. The rainfall led to the devastation of the telecommunications infrastructure and the Island's energy system, limiting the essential access to the internet and the use of electronics by different companies. Thus, the food and beverage supply chain (FBSC) members' recovery became challenging. The question then arises: How can innovation be a strategy in effectively and efficiently managing vulnerabilities while supporting the continuous flow of the FBSC in a disruptive event?

The study focuses on two supply chain links (retailers and distributors) of the FBSC in Puerto Rico, where 85% of the food is imported. The research considers innovation's role (functionality) as a strategy for companies to be more agile, adaptable, and aligned with the other chain members. These groups were assessed to learn firsthand the strategies they adopted to respond and mitigate damage in the context of the disruptive event.

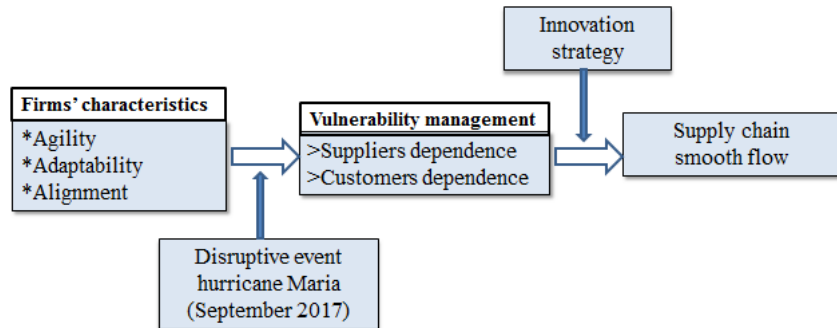
Literature Review

Resilience encompasses individual and collective attitudes. It also calls for behaviors at individual, organizational, inter-organizational, and systemic levels. Regardless of the ability to absorb a shock, bounce back and respond, learning from the experience to anticipate future disturbances is part of a continuously developing process (Brandon-Jones, Squire, Autry & Petersen, 2014).

For example, Lee (2004) emphasizes using variables to mitigate the supply chain's vulnerability under disruptive events. 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 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. Meanwhile, Wagner et al. (2006) suggest the drivers of the vulnerability must be advanced from the perspective of supplier and consumer dependence and the concentration of suppliers; a single provider and a global supplier (Wagner et al., 2006).

The research contends that innovation is one of the fundamental elements for the firm's survival in managing disruptive events and a key driver of a resilient supply chain. For instance, innovation increases the opportunities to handle disruptions in the most effective way (Christopher & Peck, 2004). However, this scenario demands a good combination of innovation capabilities and an effective strategy to successfully respond to the disruptive event (Golgeci & Ponomarov, 2013). Therefore, 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 under these disturbance situations (Adner & Eucher, 2014). In this way, innovations will provide the supply chain members 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.

Figure 1
Conceptual Model



Methodology

The Chamber of Marketing, Industry and Food Distribution (MIDA) of Puerto Rico encouraged this research, which employed the focus group methodology. We rely on this investigation approach as it embraces participants' attitudes and reactions to real experiences (Escobar & Bonilla-Jimenez, 2017; Hernández et al., 2010). Moreover, this approach was chosen to facilitate data compilation to explore further the impact of innovation as a tool for managing vulnerabilities in a catastrophic event and to address the current research gap. Group members consented to data collection, video cameras, and sessions recordings along with field notes. Integrating these technological resources enabled reliable handling of the data, including its filing for further corroboration. Thus, any errors of omission or misinterpretation of participants' expressions were avoided.

Two sessions were conducted where the minimum number of participants belonging to the food and beverages industry was met. The retailers (eight participants) represented supermarkets, restaurants, and food convenience stores. The distributors (twelve participants) were representatives of influential international brands such as Kraft, Idaho, Parkay, and small select products, gourmet and organic food and beverages. The sessions lasted two hours, where a total of twenty-four questions drove data gathering. One of the researchers prompted these open-ended questions and discussions while the others managed the data collection. The meetings were held at a MIDA facility free of distractions and interruptions. Table 1 presents descriptive data (averages) of the participants and respective businesses.

Table 1
Descriptive data

| Supply chain link | Job tenure | Years established | Number of employees | Number of branches |
|---------------------|------------|-------------------|---------------------|--------------------|
| <i>Retailers</i> | 28 | 41.8 | 773 | 27 |
| <i>Distributors</i> | 13 | 62.9 | 328 | 3 |

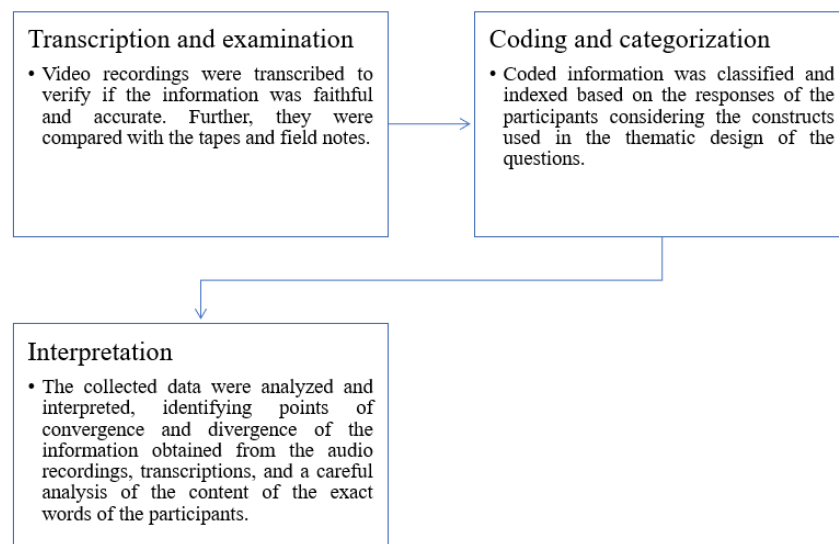
Instrument design

The questions were derived from 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). The questions were grouped according to the characteristics and vulnerabilities, focusing on the provider and customer perspectives.

Analysis and data validation

The analysis of the study was framed on evaluating if the members of the FBSC in an island economy possess and further apply the characteristics of agility, adaptability, and alignment in the chain management through innovative strategies and the examination of the vulnerabilities influencing the supplier and customer's dependence. Participants were classified according to their role or link in the FBSC. Data collected from the focus groups were classified and coded manually by researchers employing Microsoft Word and Excel programs. A matrix was developed to register and thoroughly organize the results obtained from the data analysis process. Figure 2 describes in detail the analysis process conducted following Powell & Single (1996).

Figure 2
Data analysis process



Results

Flexibility in the adopted strategies evidenced the importance of innovation in building the resilience of these supply chain participants (Christopher et al., 2004; Golgeci et al., 2013; Ponis & Koronis, 2013). The most relevant outcomes are discussed in support of the previous statement.

Agility

Findings suggest that both retailers and distributors were agile in their vulnerability management. They were able to start the company's operations 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 quickly, the participants emphasized that the essential resource was to have their employees and own carriers distribute the products. Suppliers were not among the priorities. They described: *"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

Regarding adaptability, both members had to make creative decisions to solve the lack of electricity and communication. Retailers and distributors were able to identify new opportunities and exploit 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 standard 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 a 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

Retailers denoted 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 the 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 by the Federal Emergency Management Agency (FEMA) whose naval ships had the priority of entry and unloading in ports. Regarding 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 facilities closer to their home or work, which fosters an absolute dependence while increasing customer relationships. As a result, companies had no choice but to be innovative and agile in providing goods to customers.

Conclusions

The lack of availability of products among the food supply chain participants was one of the most significant effects caused by Hurricane Maria. A relevant factor is that, unfortunately, Puerto Rico is limited in the local supply of food and consumer products. Distributors and retailers were facing similar geographic and physical constraints. These restrictions served as an engine for generating innovative strategies demonstrating the resilience capabilities of the supply chain participants. For example, they succeeded in articulating operational and flexible lean processes to mitigate the damages, respond with agility and 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 a need to address the lack of integration in the FBSC. Collaboration networks are essential in developing a resilient supply chain, particularly to mitigate damages that disruptive events cause in the perishable food supply chain (Ali, Nagalingam & Gurd, 2017). Moreover, 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. 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.

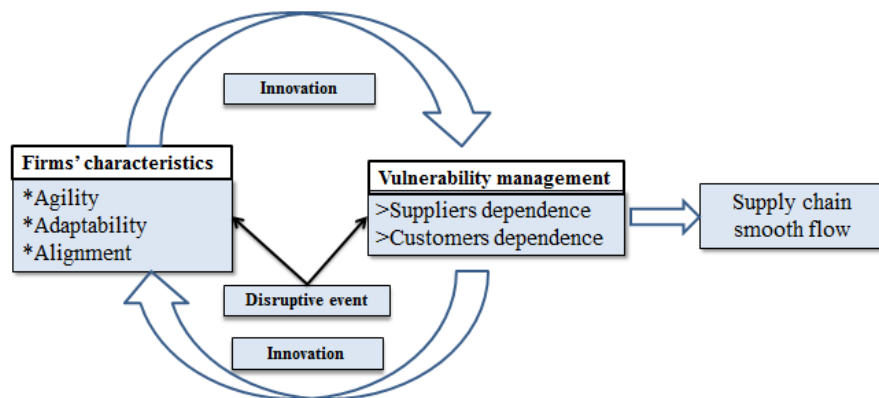
Although distributors and retailers present successful crisis management strategies and efficient disaster recovery experiences, it is important to highlight that no proper alignment between the members was observed. There was no interest from any of the groups in developing networks and partners to coordinate and optimize the chain's performance. The urgency to have products available for customers boosted the need to seek viable alternatives that would give those results, but these were only from the participant's perspective that had the demand at the moment. This situation hindered collaboration and integration with suppliers. The study suggests that distributors showed more dependence on suppliers because of their relationship and, therefore, faced greater vulnerability.

In contrast, the retailers felt that their suppliers were not fulfilling their expectations. Consequently, they decided to look for new collaborators. An efficient and smooth supply chain demands constant and direct communication within companies, respective 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 was 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 be more agile, increasing opportunities for collaboration and synchronization between businesses, thus 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 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 current opportunities (innovation), and align their interests with the other chain participants forming an ecosystem. In this sense, companies that maximize their performance will develop a sustained competitive advantage (Lee, 2004).

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).

Figure 3
Bidirectional relationship for the supply chain vulnerability management



The results of this study cannot be generalized since only two links (retailers and distributors) of the FBSC were analyzed through a qualitative approach. However, future research may consider the perspective of all FBSC participants at a quantitative analysis level to measure the significance of the variables found providing for risk mitigation and vulnerability strategies in supply chain management.

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