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BUILDING RESILIENT SUPPLY CHAINS WITH INFORMATION SYSTEMS: KEY LESSONS FROM MÉDECINS SANS FRONTIÈRES LOGISTIQUE DURING THE COVID-19 CRISIS.

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Abstract: This research aims to analyze the resilience of humanitarian supply chains, with a focus on the role of information systems, through a case study of Médecins Sans Frontières Logistique during the COVID-19 pandemic. The empirical research methodology is based on a qualitative study, which includes semi-structured interviews with key actors and operators from the Médecins Sans Frontières Logistique during the COVID-19 crisis in 2020 and 2021. The paper highlights the crucial and inherent role of information systems on each of the four dimensions of humanitarian supply chain resilience: reorganization capacity, collaboration, flexibility, and humanitarian culture. Drawing on recent theoretical works on supply chain resilience as well as empirical results, the paper underscores the importance of information systems and proposes a conceptual model of the relationship between humanitarian supply chain resilience and the role of information systems. The value of this research is linked to its empirical and qualitative study of a Non-Governmental Organization logistics operation during an international crisis, which contributes not only to the literature on resilience, but also provides guidance for managers to target their actions responsively and proactively to enhance resilience over time.

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1. INTRODUCTION

The COVID-19 pandemic has been a significant disruption to global supply chains, testing their resilience (Queiroz et al., 2020, 2022; Ivanov, 2020; Golan et al., 2020; Black & Glaser-Segura, 2020; Chowdhury et al., 2021; Pimenta et al., 2022). Epidemics and pandemics are unique disruptions that pose internal and external systemic threats to entire supply chains, distinguishing them from other types of disruptions such as natural disasters, industrial accidents, and terrorist attacks (Sheffi, 2007; Ivanov, 2020). In this context, the case of Médecins Sans Frontières Logistique (MSF Log), which faced the COVID-19 pandemic, is particularly relevant for examining the response of a logistics chain to a crisis and emergency situation.

The goal of our research is to answer questions regarding the extent to which MSF Log was able to rely on a resilient supply chain to navigate the first phase of the pandemic from March 2020 to spring 2021, and which strategies, factors, and dimensions were employed to achieve resilience. We also aim to analyze the role and characteristics of the Information Systems (IS) in supply chain management resilience in the specific context of a major crisis and emergency situation, and to propose a conceptual framework for analyzing this role.

Howden (2009) defines humanitarian supply chain management (HSCM) as a network created through the flow of supplies, services, finances, and information between donors, beneficiaries, suppliers, and different units of humanitarian organizations for the purpose of providing physical aid to beneficiaries. Kunz and Gold (2017) note that the field has evolved from a logistics perspective to a Supply Chain Management approach, involving not only physical flows, but also information and financial flows, as well as tasks such as procurement, coordination, and customs clearance. Although the logistics function in the humanitarian sector has been neglected until recently, it is now recognized as an important area of research (Charles et al., 2009, Michel and Bidan, 2018), and several recent literature reviews have been conducted to identify gaps, avenues, and directions for future research (Chandraprakaikul, 2010; Overstreet et al., 2011; Abidi et al., 2014; Baharmand et al., 2015; Chiappetta Jabbour et al., 2017).

In the second section, we will provide a literature review on resilience and its dimensions in the context of supply chain management. Next, in the third section, we will introduce our research site and methodology. In the fourth section, we will present

our findings. Finally, we will conclude in the fifth section."

2. RESILIENCE AND DIMENSIONS OF HUMANITARIAN SUPPLY CHAIN RESILIENCE

It should be noted that the literature on supply chain resilience is vast but lacks consolidation. Definitions of resilience and its dimensions are often imprecise (Pettit et al., 2013; Ali et al., 2017; Chen et al., 2017; Golan et al., 2020). However, the literature does offer two strong recommendations (Hohenstein et al., 2015; Kamalahmadi and Parast, 2016; Chowdhury and Quaddus, 2017; Ribeiro and Barbosa-Povoa, 2018; Hosseini et al., 2019; Golan et al., 2020): first, to conduct empirical studies, and second, to focus on specific supply chains, which is precisely what we do in this article.

2.1 What is resilience: definition

In recent years, several literature reviews on supply chain resilience have highlighted the diverse and unconsolidated definitions of the term (Wang et al., 2014; Hohenstein et al., 2015; Tukamuhabwa et al., 2015; Kamalahmadi and Parast, 2016; Ribeiro and Barbosa-Povoa, 2018; Hosseini et al., 2019). The literature uses a "fuzzy" vocabulary to approach the triggering event that requires resilience, including disturbances (Tukamuhabwa et al., 2015; Kamalahmadi and Parast, 2016; Ribeiro and Barbosa-Povoa, 2018; Hosseini et al., 2019), unexpected or disruptive events (Chowdhury and Quaddus, 2017), risks (Jüttner and Maklan, 2011; Hohenstein et al., 2015), terrorist attacks (Caniato and Rice, 2003), and natural disasters (Pettit et al., 2010), with recent emphasis on pandemics such as the COVID-19 crisis (Golan et al., 2020; Ivanov, 2020).

Moreover, authors differ in their objective of resilience, with some aiming to return to the pre-disturbance state (Ribeiro and Barbosa-Povoa, 2018; Hosseini et al., 2019) and others striving for a better state (Christopher and Peck, 2004b; Sheffi and Rice, 2005; Chowdhury and Quaddus, 2017). Time, speed, and chronology are also noted in some definitions, where rapid response or reconstruction is essential (Sheffi and Rice, 2005; Falasca et al., 2008; Kamalahmadi and Parast, 2016; Ribeiro and Barbosa-Povoa, 2018). Finally, the cost of resilience is considered by some authors, who emphasize its

minimization (Ribeiro and Barbosa-Povoa, 2018; Hosseini et al., 2019).

2.2 Main dimension of supply chain resilience

Hohenstein et al. (2015) conducted a systematic review of literature to identify the building blocks of a resilient supply chain. They referred to Christopher and Peck's (2004a, b) seminal work and identified four dimensions that characterize supply chain resilience: (1) supply chain reengineering, (2) collaboration, (3) agility, and (4) culture. These four dimensions have been reiterated in many studies, while others have added or removed dimensions or sub-dimensions. Some studies focus on the proactive aspects of resilience, such as flexibility, visibility, redundancy, and integration (Jüttner and Maklan, 2011), while others encompass both proactive and reactive capabilities (Christopher and Peck, 2004a, b; Sheffi and Rice, 2005; Falasca et al., 2008; Pettit et al., 2013). Recently, authors have employed specific theoretical frameworks to study resilience, such as Chowdhury and Quaddus (2017), who proposed a conceptualization of supply chain resilience based on Dynamic Capability Theory, by distinguishing three dimensions: proactive capability, reactive capability, and quality of supply chain management design.

Several important points can be highlighted. The multiple definitions, theoretical frameworks, dimensions, and sub-dimensions proposed have led to a loose conceptual framework. Additionally, a gap exists in resilience modeling and its application to specific supply chains, which the literature mainly focused on commercial supply chains and neglected the particularity of humanitarian supply chains (Kamalahmadi and Paras, 2016; Ribeiro and Barbosa-Povoa, 2018; Golan et al., 2020). Finally, Chowdhury et al. (2021) identified research opportunities created by the COVID-19 crisis in the field of supply chain resilience, which include the impact of the pandemic on supply chain resilience, resilience strategies implemented, the role of technology in implementing these strategies, and supply chain sustainability. Therefore, in line with our research question, we aim to empirically propose a conceptual framework to understand the role of IS in humanitarian supply chain resilience through a case study method.

3. CASE SELECTION

3.1 Presentation of MSF Log

MSF Log is an international non-profit organization focused on providing humanitarian and medical aid, established in Paris in 1971 by doctors and journalists. It operates in around 70 countries worldwide, offering medical assistance to populations whose lives or health are threatened, particularly in cases of armed conflicts, epidemics, pandemics, or natural disasters. In 1979, MSF undertook its first major missions in regions where there was a massive influx of refugees, and it was then that the organization acquired professional resources in logistics, a priority sector for their work. In 1986, MSF created a dedicated logistics department called MSF Log, which is located in Mérignac, France.

MSF Log plays a crucial role in ensuring that MSF's programs receive the necessary materials, equipment, consumables, ready-to-use kits, and vehicles. For regular programs, orders are prepared periodically and delivered within 4 weeks, while for emergency interventions such as those involving displaced populations, epidemics, natural disasters, or conflicts, orders are ready in less than 24 hours. To ensure efficient supply chain management, MSF Log integrates all the professions involved in the supply chain, including purchasing, storage and warehousing, order preparation, palletizing, securing, customs and police formalities, and product transport (land, air, sea).

Currently, MSF Log has more than 170 employees and manages a diverse inventory of over 14,000 product-references, with 18,000 m² of storage capacity. The organization ships about 5,000 tons of equipment per year, thereby ensuring the successful completion of MSF's humanitarian missions.

3.2 Single case study methodology

MSF Log presents a unique opportunity for in-depth research on our question. While this case study is not generalizable, it is the most appropriate way to achieve a sufficient understanding of the phenomenon, paying particular attention to the context of its implementation. To conduct this case study, we drew on proposals from the literature review and contrasted them with our data, following Yin's (2017) approach.

Case studies have already been conducted in the field of supply chain management (Spieske et al., 2022; Abdellatif and Graham, 2019). Unique cases are particularly interesting for research because they provide opportunities for unusual research access, and can confirm, challenge or develop theory. This case study allows us to investigate in-depth how and why supply chain resilience was mobilized at MSF Log.

We collected various materials, including semi-structured remote interviews lasting approximately one hour, conducted in late 2020 and early 2021. The interviews focused on the specificities of the supply chain and the actions implemented before and during the pandemic. The interview guide contained four themes: (1) the presentation of the interviewee (position, background, seniority, motivations for working at MSF Log); (2) the specificities of the humanitarian supply chain and its necessary qualities, such as resilience; (3) humanitarian supply chain resilience in times of health crisis; and (4) a deeper exploration of the notion of resilience, its dimensions, and the interviewee's perspectives. Semi-structured interviews were conducted with the six primary managers of MSF Logistics' supply chain during the early stages of the COVID-19 pandemic, from March 2020 to April 2021. This period marked a significant increase in contamination, with no vaccine or easy testing available, and procurement challenges. The interviews, conducted remotely, lasted approximately one hour each. These interviews questioned the specificities of the supply chain and the actions implemented before and during the pandemic. After transcription, the interviews underwent thematic content analysis, and data and verbatim were triangulated to enhance the reliability and validity of the findings.

4. RESULTS

The COVID-19 crisis was perceived as a significant shock by the managers of the organization. However, our findings indicate that MSF Log was able to leverage its supply chain resilience to respond to the crisis. Specifically, MSF Log implemented a range of reactive and anticipatory measures to manage the crisis effectively.

4.1 Case analysis

4.1.1 An emergency supply chain with IS Robustness for reorganization

During the COVID-19 crisis, MSF Log was able to rely on its humanitarian logistics chain, which could reorganize itself in a reactive and anticipatory manner. Quantitatively, the organization was able to respond to an increase in activity by modifying working hours and implementing a new organization of work, including a 3x8 schedule, seven days a week. To support this reorganization, the IS was robust and secure, allowing for remote work and increasing bandwidth. About 70 out of a total of 180 employees were able to switch to teleworking. For

warehouse staff, the objective was to continue to provide emergency shipments without being contaminated by the virus.

MSF Log had anticipated certain measures, and business continuity and recovery plans had been designed and tested, with existing formalized processes that proved efficient. Furthermore, the organization had undergone a major transformation of its IS to reinforce its robustness before the pandemic. The IS organization department (DOSI) decided to change all equipment, moving from fixed computers to laptops (about 200) in anticipation of future flexibility needs. All meeting rooms were equipped with cameras and video to facilitate strong interaction between those working face-to-face and remotely during the pandemic. Before the crisis, Microsoft Teams was an installed but little-used application that proved crucial during the crisis. In terms of security, MSF Log decided to have all servers local.

4.1.2 A Collaborative Humanitarian Supply Chain Supported by a Cross-Functional IS

MSF Log's supply chain resilience was based on the collaboration of both internal and external actors, facilitated by their IS. As soon as the health crisis was recognized, crisis management units were set up. For instance, a computer hotline comprising of two teams (applications and networks, both belonging to DOSI) was established. The hotline was heavily tested during the pandemic due to the increase in telecommuting, which required enhanced user support. However, the workload was successfully managed by sharing schedules and on-call days.

Proactive measures, in terms of external collaboration, contributed to MSF Log's supply chain resilience. For example, their choice of a local service provider in Bordeaux allowed them to ask for an increase in bandwidth when the pandemic lockdown was announced, and the provider complied that same afternoon. As a result, information sharing was made possible both internally and externally, thanks to their cross-functional Information System.

4.1.3 A flexible humanitarian supply chain supported by IS agility

The COVID-19 crisis brought about new requirements for the sudden implementation of telework. Fortunately, MSF Log had already incorporated communication tools such as meeting and remote work software, an internal helpdesk for technical support, secure connections via a Virtual

Private Network (VPN) channel, and international communication tools for use with international project managers into its IS before the crisis. However, this equipment only catered to around ten people.

Within ten days of the onset of the pandemic, the teams successfully set up the IS equipment for secure teleworking for about 100 people. This involved providing business laptops, increasing the bandwidth, opening up the required VPN channel, and implementing device management software with anti-attack protection, among other measures. This level of flexibility was only possible due to the agility of MSF Log's Information System, which was able to adapt quickly to new requirements and allow the organization to continue functioning effectively during the crisis.

4.1.4 Humanitarian culture reinforced by the IS as a social network

The IS played a crucial role in strengthening the humanitarian culture of MSF Log, which has been a major asset to the supply chain resilience. The organization's culture of emergency response, as well as its international reach with interventions in 70 countries, are deeply ingrained in the daily lives of its employees, who are motivated by the desire to make a meaningful impact in their work. This commitment to serving others has helped to establish a strong and resilient supply chain.

Many of the employees at MSF Log come from different backgrounds and have worked in various fields before joining the organization. For instance, the network/infrastructure director had previously worked in a large digital services company, and a project manager had worked in the insurance industry. Despite their diverse backgrounds, the employees at MSF Log share a moral imperative to help others, which is a key factor in the organization's resilience.

During the crisis, the warehouse and infrastructure teams had to work extended hours, and the IS played a critical role in enabling communication, collaboration, and mutual support. The discussion tools, hotline, and extended working hours made it possible to strengthen social connections and promote a sense of community within the organization.

Overall, the IS helped to reinforce the organization's culture and values, which were critical to its ability to adapt and respond to the crisis.

4.2 Conceptual Model Proposal: Dimensions of Emergency Supply

Chain Resilience through the Role of Transversal IS

We propose a conceptual model of humanitarian supply chain resilience, composed of four dimensions: reorganization capacity, collaboration, flexibility, and humanitarian culture, with the transversal IS playing a crucial role.

4.2.1 Proposition 1: The reorganization dimension of HSCM resilience is facilitated by the robustness of its IS.

The ability of a humanitarian supply chain to reorganize during a disaster or emergency depends on the robustness of its IS. The organization of the IS, its ability to resist, and the provided equipment are essential in responding to an emergency.

4.2.2 Proposition 2: The collaboration dimension of HSCM resilience is facilitated by a transversal IS.

The second dimension that allows a humanitarian supply chain to be resilient concerns collaborations, both internal and external. The implementation of a transversal IS allowed for internal collaboration even with remote work. External collaboration with suppliers and partners is also a key element of resilience and is mediated by the IS.

4.2.3 Proposition 3: The flexibility dimension of HSCM resilience is facilitated by IS agility.

The third dimension of humanitarian supply chain resilience is its flexibility. This flexibility is based on two sub-dimensions: velocity and IS agility. Speed of adaptation is one of the keys to flexibility. The actors of the humanitarian supply chain must be able to quickly reorganize all the tasks. This velocity is based on an agile IS. The agility of the IS is a central asset that enables resilience by providing flexibility to the supply chain.

4.2.4 Proposition 4: The culture dimension of HSCM resilience is enhanced by the IS as a social network.

Finally, the fourth dimension specific to the humanitarian logistics chain is a strong humanitarian culture, which includes a culture of emergency and a culture of duty. The culture of emergency is ingrained in all humanitarian logistics workers. They are used to emergency and international situations. The sense of duty is a special dedication that gives

meaning to what they do: saving lives. To achieve this, they are willing to sacrifice time, make themselves very available, and aim for success at all costs. This culture of duty is one of the pillars that allow the humanitarian supply chain to be resilient. This culture of duty is facilitated by the IS acting as a social network.

Therefore, we propose a conceptual framework for emergency supply chain resilience. Our results allow us to characterize MSF Log's humanitarian supply chain resilience through the IS: the capacity to reorganize, which relies on a robust IS architecture; collaboration enabled by a transversal IS; flexibility, which is mobilized mainly through IS agility, and the humanitarian culture oriented towards the notion of duty and facilitated by the IS acting as a social network.

5. Conclusions

The results of our empirical research have significant implications for both theory and practice, as well as directions for future research.

A. Theoretical Contributions:

Building Resilience on Four Dimensions Our theoretical contribution consolidates the field of supply chain resilience research and confirms two key points in the literature. Firstly, we highlight the four dimensions of resilience (reorganization, collaboration, agility, and humanitarian culture) which helps to consolidate the conceptual framework of supply chain resilience. Secondly, our research highlights the crucial role of IS in building resilience, as it acts through its robustness, agility, transversality, and sociability. Our study confirms the IS role as an instrument to "implement" resilience strategies even for humanitarian culture. This finding is consistent with previous research in the literature and suggests that investment in IT is a viable path to foster resilience.

Humanitarian Supply Chain Resilience built on IS Our study emphasizes the importance of IS in the four dimensions of resilience, and its role is increasingly questioned as central to resilience, especially in times of crisis such as the COVID-19 pandemic. Our findings are consistent with Pimenta et al. (2022) who showed that technology was one of the pillars of resilience during the COVID-19 crisis to reorganize the labor force. Our research confirms the IS role as an instrument to "implement" resilience strategies even for humanitarian culture. In the case of MSF Logistics, the IS helps to improve the "care" culture as a social network and sometimes as a professional network on difficult fields. Although our analysis was based on a single case, our findings

are consistent with previous research and contribute to the existing literature on supply chain resilience.

B. Practical Implications: Our research provides a guide for managers to identify the four dimensions and sub-dimensions of supply chain resilience, enabling them to target their decisions and actions on the dimensions that will enable them to act on resilience. Our study highlights the need to plan resilience proactively while accepting uncertainty and not denying organizational improvisation.

Furthermore, our research emphasizes the characteristics of IS for all dimensions. To facilitate the reorganization dimension, managers must proactively identify and formalize all IS needs. Similarly, MSF prefers to answer "how can we be better prepared, better anticipated" rather than "what can we do next time," and the modification of crisis plans is a major avenue. The capitalization of this experience is already being studied. Organizational transversality must also be considered, with the creation of the Information Systems Organization Department (DOSI).

In terms of external collaboration, we suggest that managers integrate their organization's IS with that of their suppliers and partners. In the same way, internal collaboration must also be enabled by a cross-functional IS, designed to be accessible by various departments, even in times of crisis.

In terms of agility, our research highlights the importance and difficulty of proactive anticipation, and the IS must be able to adapt quickly to high demands. This should be kept in mind when making choices about capacity, suppliers, security, etc.

As far as the cultural dimension is concerned, our research emphasizes the importance of capitalizing on the strength of humanitarian action, the culture of emergency, and the sense of duty. Thus, the HR department should integrate IS as a social network into its actions.

In conclusion, our research highlights the importance of IS for building resilience in the humanitarian supply chain. Further research is needed to confirm this model in other cases of HSCM and other contexts to enrich the model with other dimensions and to test the validity of this conceptual framework of resilience.

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