

**CONTRIBUTION OF THE RESILIENCE OF THE HOSPITAL SUPPLY
CHAIN TO THE MITIGATION OF THE NEGATIVE CONSEQUENCES
OF THE COVID 19 PANDEMIC: THE CASE OF AGADIR REGIONAL
HOSPITAL**

**CONTRIBUTION DE LA RESILIENCE DE LA CHAINE LOGISTIQUE
HOSPITALIERE A L'ATTENUATION DES CONSEQUENCES
NEGATIVES DE LA PANDEMIE COVID 19 : CAS DU CENTRE
HOSPITALIER REGIONAL D'AGADIR**

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Abstract:

The purpose of this paper is to try to analyze and understand the supply chain resilience actions that are being implemented by the Regional Hospital Center of Agadir (RHC Agadir), to cope with the effects related to the Covid pandemic 19. Indeed, the pandemic crisis has revealed and reminded us of the strategic nature of logistics and supply chain management in the hospital sector, and has also shown the crucial nature of hospital logistics activities in the production cycle of patient care during this critical period. In particular, try to answer the question, "What are the key resiliency actions that should be taken to ensure the stability of a hospital supply chain in the face of pandemic Covid 19? To address our problem, we have referred to several theoretical and empirical works which show a diversity of approaches and resilience processes implemented by hospitals, in order to remedy the dysfunctions of their supply chain. The results of our survey confirmed the impact of the Covid crisis on the supply chain and that several resilience actions were taken to mitigate its effects. These actions clearly minimized the adverse disruptive effects caused by the pandemic and had a moderate impact on the hospital supply chain. In other words, this exploratory research that we conducted at the Agadir Regional Hospital Center allowed us to understand the risk mitigation mechanisms and to propose a hospital supply chain resilience approach that will help the Moroccan hospital sector overcome all challenges and avoid future risks.

Key words: Covid 19 crisis, Hospital supply chain, Resilience, Actions, Performance.

Résumé :

L'objectif du présent article est d'essayer d'analyser et de comprendre les actions de résilience de la chaîne logistique qui sont mises en œuvre par le centre hospitalier régional d'Agadir (CHR d'Agadir), pour faire face aux effets liés à la pandémie Covid 19. En effet, la crise pandémique a dévoilé et rappelé le caractère stratégique de la logistique et du Supply Chain Management dans le secteur hospitalier, elle a montré aussi le caractère crucial des activités logistiques hospitalières dans le cycle de production des soins prodigués aux patients pendant cette période critique. En particulier, essayer de répondre à la question suivante : "Quelles sont les principales actions de résilience à adopter pour garantir la stabilité d'une chaîne logistique hospitalière face à la pandémie Covid 19 ?". Pour traiter notre problématique, nous avons fait référence à plusieurs travaux théoriques et empiriques dont il ressort une diversité d'approches et de processus de résilience mise en œuvre par les établissements hospitaliers, afin de remédier les dysfonctionnements de leur chaîne logistique. Les résultats de notre enquête ont permis la confirmation de l'impact de la crise Covid sur la chaîne logistique et que plusieurs actions de résilience ont été prises pour atténuer ses effets. Ces mesures ont clairement permis de minimiser les effets néfastes de perturbation causés par la pandémie et d'avoir un impact modéré sur la chaîne logistique hospitalière. Autrement, cette recherche exploratoire que nous avons menée au CHR d'Agadir, nous a permis de comprendre les mécanismes d'atténuation des risques et de proposer une démarche de résilience de la chaîne logistique hospitalière qui aidera le secteur hospitalier marocain à surmonter tous les défis et à éviter les risques futurs.

Mots clés : Crise Covid 19, Chaîne logistique hospitalière, Résilience, Actions, Performance.

Introduction

The Covid 19 pandemic crisis has highlighted the crucial role of the supply chain as a lever for hospital performance. It affected the main upstream and downstream components of the hospital supply chain. According to the study by Alajmi et al (2021), the crisis affected delivery times for 58% of suppliers, drug purchasing in 33% of cases, inventory management in 25% of cases and transport costs in 17% of cases. For his part, Ivanov (2020) confirmed that epidemics are a source of vulnerability for supply chains in the short, medium and long term. In the short term, simultaneous disruptions to supply and demand were observed; in the medium term, the propagation of the disruption and the knock-on effect of the crisis throughout the hospital supply chain were observed; and in the long term, the installation of an unpredictable disruption affecting the entire supply chain was observed. However, the hospital Supply Chain is exposed to a panoply of risks, the best known of which are those identified by (Tang, 2006), Chopra and Sodhi, (2004), and Ivanov et al (2019) namely: disruptions, delays, forecast failures and stock-outs. In addition, supply chains are exposed to unpredictable risks such as: uncertainties regarding demand, supply, costs and lead times (Torabi et al, 2015). These dysfunctions have prompted hospital facilities to adopt resilience strategies, in order to mitigate and minimize the negative effects of the pandemic on the hospital supply chain (Hohenstein et al., 2015). Resilience offers the ability to react quickly against threats and absorb unexpected disruptions and surprises (Steen and Aven, 2011). Indeed, resilience is seen as a proactive approach that involves anticipating and foreseeing undesirable events in a highly turbulent and uncertain environment.

The most recent studies, have confirmed that a resilient supply chain can improve production capacity by 15% to 25% and increase customer satisfaction by 20% to 30% (Schatteman, 2020). In addition, resilience involves other dimensions such as flexibility, agility and robustness (Husdal, 2009) and Wieland and Wallenburg (2012). Our research problem is therefore as follows: "***What are the main resilience actions that have been adopted to guarantee the stability of a hospital supply chain in the face of the Covid 19 pandemic?***"

A number of theoretical and empirical studies were consulted to address this issue. What emerges is a diversity of resilience approaches and processes implemented by hospitals to remedy malfunctions in their supply chains, based mainly on agility, flexibility and disruptive innovation. Theoretical framework related to logistics resilience will be presented before addressing the main levers of a resilient supply chain. The second section will be devoted to presenting the methodology adopted. Finally, the third section will be devoted to presenting and discussing the results of the research in order to identify the main resilience actions that

contribute positively to mitigating the adverse effects of the pandemic on the performance of the hospital supply chain.

1. Theoretical framework

1.1 The key drivers of a resilient supply chain

The growing uncertainties in the hospital supply chain following the disruption caused by the Covid 19 pandemic have prompted hospitals to react quickly and effectively to threats that can affect the healthcare production circuit. The hospital supply chain generates physical, financial and information flows, and failure to control these can have a negative impact on logistics performance. In this sense, the literature provides a real source of Supply Chain resilience solutions and practices. A recent study by Mandal et al (2016) showed that a direct association exists between an organization's logistics capabilities and the characteristics of a resilient supply chain, which are based on collaboration, flexibility and speed. While Kumer et al (2020) demonstrated that supply chain resilience can only take place through the optimization and flexible reconfiguration of logistics infrastructure, staff motivation and the digitization of the logistics database.

According to a recent study by Thompson, D. D. and Anderson, R. (2021), supply chain resilience must be based on two fundamental principles: the ability of supply chain actors to resist by adopting measures to delay disruption, and the ability to recover by analyzing the situation and making decisions as quickly as possible. These principles can be applied in times of crisis (war, drought), and to cope with the disruptive consequences of supply disruptions.

1.2 Closer collaboration with suppliers and information sharing with all players in the hospital supply chain

The Covid 19 pandemic demonstrated the benefits of collaboration and coordination between the various stakeholders in the supply chain in the form of networks and strategic alliances (Nyaga et al, 2010). This collaboration can only take place if information is shared and supplier payment times are reduced (Donaldson and Preston, 1995). Indeed, the choice of suppliers is crucial for a resilient supply chain, and is the result of a combination of several variables: cost of ownership, quality, service, delivery time and risk factors (Chan et al, 2008). Other authors have added factors such as suppliers' production capacity, payment times, flexibility, reputation and environmental protection. Good relations must be established with suppliers to guarantee quality supplies, at a good price and within short lead times. Consequently, collaboration and cooperation between players generates gains and enables the creation of value, the ultimate source of competitive advantage (Crow, 2002).

1.3 Modelling and simulation methods for the hospital supply chain

As soon as the health crisis broke out, policy-makers and hospital managers turned to supply chain modeling and simulation methods to mitigate the adverse effects of the pandemic on hospital supply chain performance and reduce pressure on healthcare systems. It should be noted that the choice of a modeling method depends on management style, stakeholder interests, hospital strategy and the characteristics of the problem. In this sense, Currie et al (2020) have proposed a list of simulation models corresponding to a range of decisions. These simulation models are used to measure the impact of disruptions caused by the Covid 19 pandemic on supply chain performance, taking into account dimensions such as: disruption hazard, inventory management, supply management and delivery management (Ivanov and Dolgui, 2020). Simulation methods provide a means of developing supply chain resilience over time through the design of a Hospital Supply Chain based on planning, coordination, resource optimization and patient satisfaction particularly in an environment marked by uncertainty (Namdar et al, 2018). Risk propagation analysis has been one of the most frequently used mitigation strategies in the face of disruption, and the ripple effect as indicated in the work of Rajagopal et al. (2017). Modeling makes an excellent contribution to decision-making in times of crisis.

1.4 Implementing an innovative logistics strategy

Rapid recovery of hospital activities is one of the key objectives of a supply chain resilience strategy in times of crisis. Hospitals therefore need to react quickly, by implementing a strategy based on agility, flexibility and innovation. This strategy must anticipate and foresee crises, and adapt to environmental disruption and uncertainty. It is a supply chain risk mitigation strategy with well-defined objectives associated with reliable measurement indicators such as: cost/quality, delivery time, turnover rate and patient satisfaction. Other researchers have proposed resilient logistics strategies aimed at Zero Stock and Lean Management (Hosseini S. et al, 2019), thus promoting cost-cutting policies by reacting quickly to operational disruptions through a flexible contingency plan.

A resilient logistics strategy must ensure a balance between supply and demand through effective planning of needs and smooth production of care, in order to anticipate stock-outs, drug shortages and price fluctuations, and subsequently limit disruption to the hospital supply chain. According to Mecalux (2020), a resilient logistics strategy consists of continuous improvement of the logistics process, advance planning, design of a flexible and adaptable logistics plan, and investment in high-performance storage solutions.

1.5 Digitization of the logistics information system

According to a recent study by McKinsey (2020), 85% of logistics managers found supply chain management difficulties due to insufficient digital technologies in their supply chain. In this sense, the digitization of the supply chain through the introduction of information systems enabling the collection, processing and analysis of data through specialized platforms can be a facet of hospital supply chain resilience even outside crises. Digitization of the hospital supply chain thanks to information systems that effectively contribute to hospital logistics performance through information exchange between partners (Chougrani, Ouhadj, and Agag, 2013). Digitization creates a climate of trust and transparency between stakeholders. Indeed, hospitals with an efficient logistics information system stand a good chance of coping with the pandemic crisis by optimizing resource allocation, planning, reducing costs and delays, and ensuring patient satisfaction (Zerouali Quartiti, 2017). On the other hand, the absence of a supply chain digitalization strategy has a negative impact on hospital supply chain performance, particularly at the time of the Covid 19 crisis (Ivanov and Dolgui, 2020; Hosseini et al, 2019). Consequently, information systems will enable logistics performance to be steered with better decision-making, but also to carry out more accurate simulations in order to anticipate risks. Moreover, the experience of the Covid 19 health crisis showed that organizations that began a digital transformation before the pandemic were better able to adapt to disruptions.

2. Methodology

2.1 Research Area

This is an exploratory study of supply chain players at the Agadir regional hospital. This hospital was chosen because of the means and resources made available to it since the start of the Covid 19 crisis in March 2020. It has a bed capacity of 500 beds, with a total workforce of over 500, and is built on a 19.25-hectare site with a pavilion structure, serving some 700,000 patients. With the spread of the pandemic and the increasing number of cases of contamination, the hospital was reinforced by the construction of two tents with a bed capacity of over 100 beds each, equipped with modern materials and technologies. Funding was provided through a partnership between the Ministry of Health, the Souss Massa Regional Council and local authorities. The aim of this initiative is to relieve the pressure on healthcare facilities in the Souss Massa region.

2.2 Analysis techniques and Tools

The semi-directive interview technique was chosen as the main data collection method. The interview guide, comprising open-ended questions grouped by theme from the literature, was

administered face-to-face. The interview guide covers the organization of logistics within the facility, the impact of the Covid 19 pandemic on hospital logistics, and the resilience measures and actions taken to deal with the crisis.

The analysis method used for the semi-structured interviews is textual and thematic content analysis, carried out using Nvivo 12 software. This classic analysis technique enables the identification of thematic frequency repetitions, in order to count and classify significant items. The first step is a completely free, manual coding stage, which enables information to be stored, qualified and organized. The aim is to contextualize the semi-structured interview files in order to facilitate data processing in the form of nodes, codes and attributes. The second step in Nvivo is to recontextualize, to group the nodes together into an intelligible, meaningful whole, and to create matrices (cross-referencing the various nodes) or models.

3. Results and Discussion

The results obtained from this research work confirm a dual reality. The first is the negative impact of the Covid 19 pandemic on the operation of the hospital supply chain, particularly during the 1st and 2nd waves following the confinement and closure of borders. The second is the positive effect of the resilience actions implemented by the Agadir regional hospital center to mitigate and remedy the harmful consequences of the pandemic crisis on hospital logistics. Moreover, all those interviewed during the semi-structured interviews confirmed the importance of the concept of resilience as a new vision of hospital management, and can be considered the keystone of a high-performance logistics chain during times of crisis. The Figure 1 shows the main keywords raised by participants around the concept of hospital supply chain resilience during the Covid 19 pandemic.

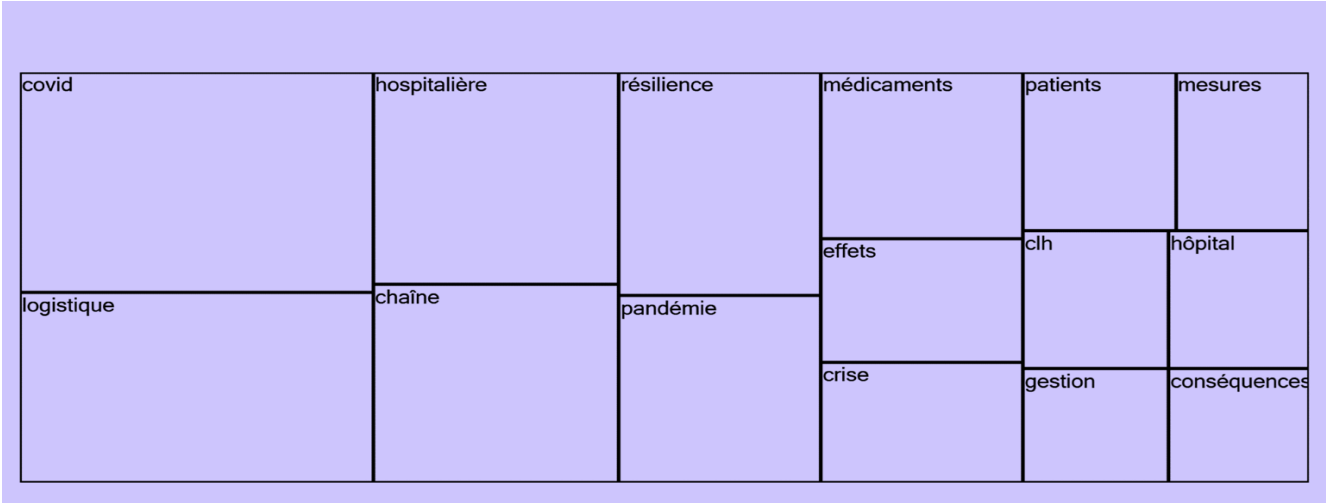
Figure 1: Perception of the concept of resilience at the Agadir Regional Hospital Centre



Source : output Nvivo12

The encoding work was continued at a more detailed level, by creating nodes according to the axes of our theme. Figure 2 shows all the concepts discussed by the interviewees:

Figure 3: Rectangular diagram of supply chain resilience

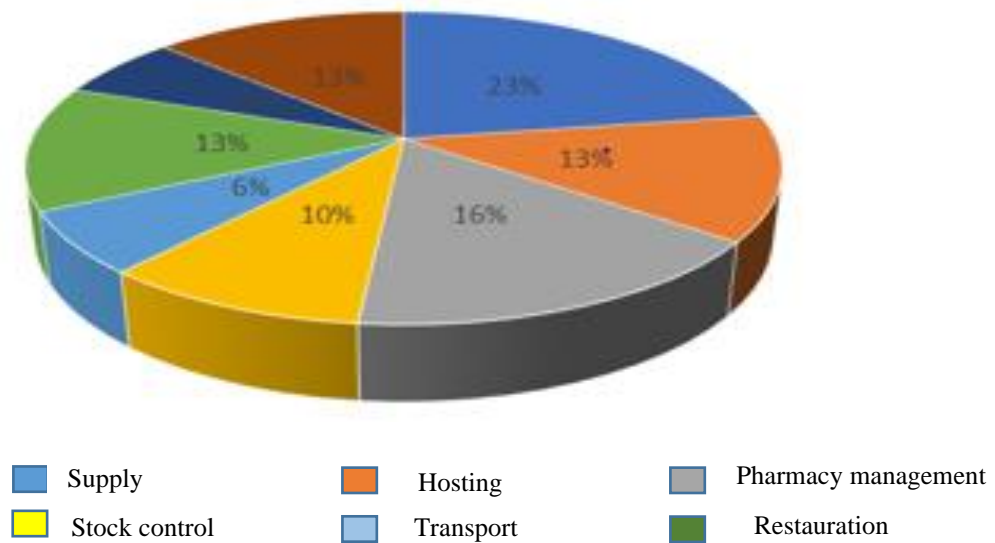


Source : output Nvivo12

3.1 Impact of the health crisis on the hospital supply chain

The first topic discussed during the interviews concerned the impact of the Covid 19 health crisis on the hospital supply chain (figure no. 2). Most respondents (53.4%) confirmed the impact of this unprecedented crisis on the supply chain, especially during the first and second waves due to the containment (March 20, 2020) and health restrictions put in place by the government. Several logistics activities were affected by the fallout from the pandemic, the main ones being: procurement (23%), pharmacy management (16%), materials management (13%), accommodation and catering (13%). Other activities, such as laundry (6%) and patient transport (6%), were able to withstand the adverse effects of the pandemic (**figure 3**). The disruption to logistical activities such as supplies led to stock-outs of certain drugs (antibiotics and corticoids), shortages of personal protective equipment (PPE): bibs, masks and gloves, and a growing demand for hygiene products such as soaps and detergents. In addition, this health crisis has led to disruptions in human resources management, with the redeployment of nursing staff from the Souss Massa region, the use of overtime to ensure the continuity of hospital services (24/7) and the cancellation of leave for logistics staff, particularly following the contamination of the department's staff by the Coronavirus.

Figure 3: Impact of the Covid 19 crisis on hospital supply chain activities (CHR D'AGADIR)

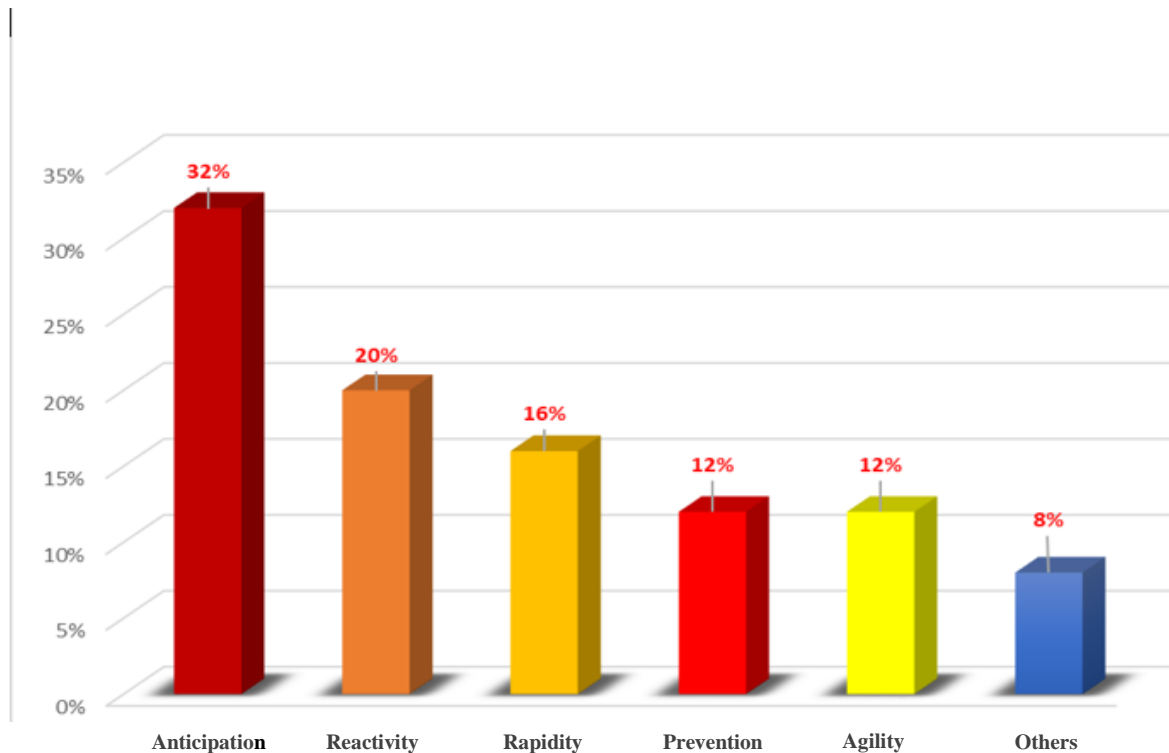


Source : output Nvivo12

3.2 Hospital supply chain resilience actions implemented at the Agadir Regional Hospital Center

Since the first cases of the Covid 19 pandemic appeared in Morocco, the government has set up a special fund dedicated to managing the Coronavirus pandemic (March 19, 2020). This 10-billion-dirham fund has been earmarked to cover hospital expenditure, in terms of medical devices, upgrading of appropriate infrastructures and additional resources to be acquired on an emergency basis. Against this backdrop of a state of health emergency, hospital management set up a crisis management committee bringing together all hospital stakeholders (administrators, pharmacists, logisticians, nursing staff) to implement a hospital emergency plan based on anticipation (32%), reactivity (20%), rapidity (16%), prevention and agility (12%). These initiatives can be associated with the concept of hospital supply chain resilience (figure 4).

**Figure 4: Hospital supply chain resistance to Covid 19
(CHR D'AGADIR)**



Source : output Nvivo12

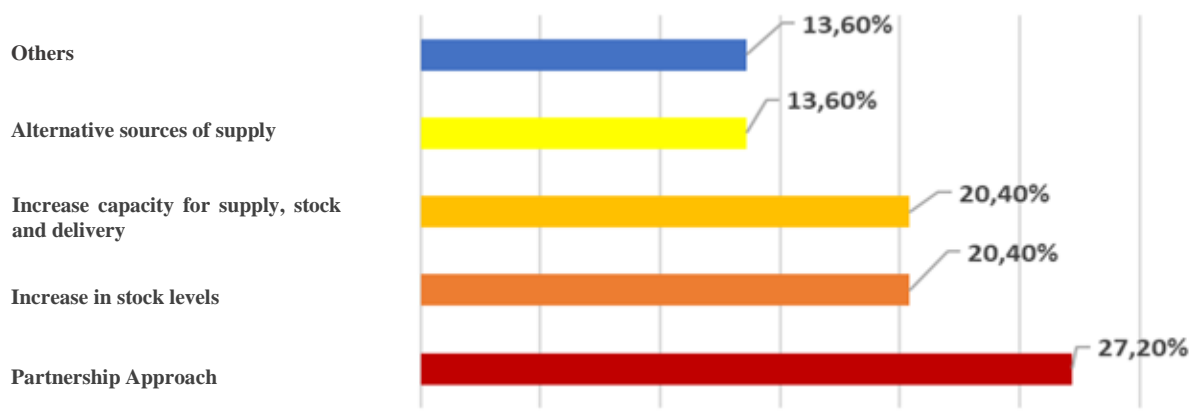
The resilience actions implemented by players in the hospital supply chain at the Agadir Regional Hospital Center can be broken down into four main options:

1. Increase stock levels (27.2%) through the use of contracts negotiated during the first wave of the pandemic for the purchase of medical equipment. Also, the use of purchase orders and collective purchasing (group purchasing) for vital drugs and oxygen. According to respondents, these purchasing procedures have enabled rapid restocking, shortened delivery times and reduced costs.
2. Reinforce replenishment, storage and delivery capacities (20.4%) by setting up a logistics team to ensure round-the-clock logistics activities (sometimes receiving and distribution took place at night).
3. Use alternative sources of supply (13.6%) by exchanging medicines and pharmaceutical products between hospital pharmacies in the Souss Massa region, to avoid overstocking and pre-emption of certain medicines.
4. Establishing partnerships (27.2%) with a number of players, including the Ministry of the Interior, the Souss Massa Regional Council, the FAR, the Royal Gendarmerie, hotels

and associations. This partnership approach, based on cooperation and collaboration, has ensured the satisfaction of patients and their families (95%) in terms of reception, accommodation and catering (additional meals, purchase of beds, blankets, medication) during their hospital stays.

The figure 5 illustrates the main resilience actions implemented by the crisis management committee at the Agadir Regional Hospital, to deal with the consequences of the Covid 19 pandemic on the hospital supply chain. These resilience measures have made it possible to achieve hospital logistics performance, reflected in the high number of hospitalizations of Covid19 patients, patient satisfaction, continuous product replenishment (no oxygen shortages) and the maintenance of a safety stock and an alert stock, especially during the first and second waves of the pandemic.

Figure 5: Hospital supply chain resilience to the Covid 19 pandemic (CHR D'AGADIR)



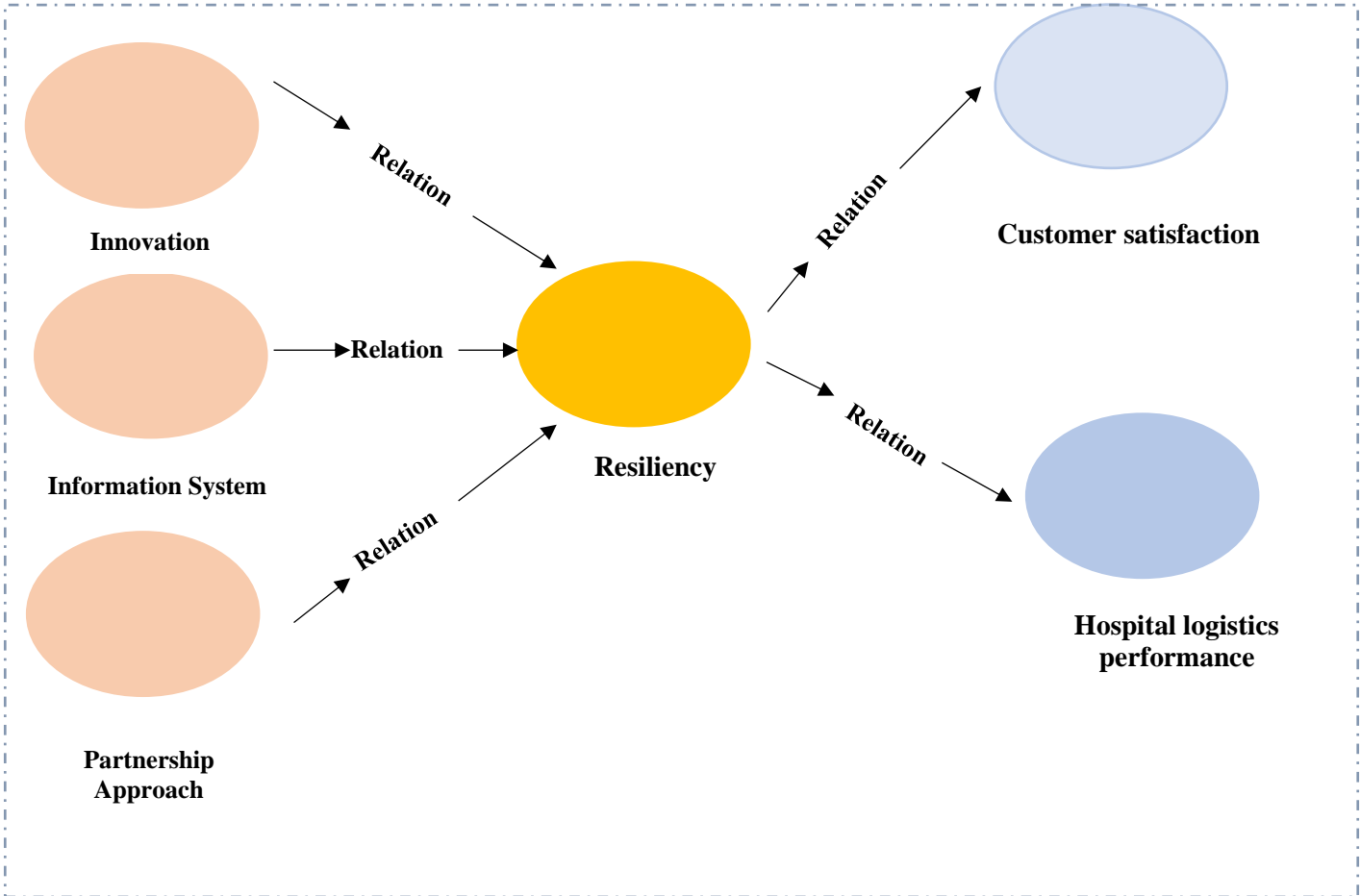
Source : output Nvivo12

The digitization of the supply chain is a concern for pharmacists and pharmacy assistants (9.6%), through the implementation of a dedicated supply chain information system enabling the collection, processing, sharing and communication of data to all hospital supply chain stakeholders. In addition, strengthening human capital by recruiting staff assigned to hospital logistics activities (24% of respondents), and guaranteeing them regular in-service training in crisis and disaster management, is an important element to include in the hospital emergency plan. However, public-private partnerships (PPP) can make an effective contribution to

remedying stock shortages (14.4% of respondents) through well-defined agreements and contracts.

However, the results of the qualitative analysis using Nvivo showed a strong correlation between the resilience actions implemented by the health crisis management committee and the satisfaction of Covid 19 patients during their hospital stay, as illustrated in figure 6:

Figure 6: Example of a relationship map with nodes



Source : output Nvivo12

Conclusion

Following the Covid 19 health crisis, the resilience of the hospital supply chain has been the subject of a growing body of theoretical and empirical research (Ivanov et al,2020; Remko, 2020, Alajmi et al, 2021; Beaulieu ,2021; Adam, 2022). Our research work is part of this dynamic and contributes to providing answers to the initial problem. Thus, the hospital supply chain resilience actions implemented at the Agadir CHR, based on reactivity, speed, anticipation, agility and prevention, have succeeded in mitigating the adverse effects of the

pandemic. The partnership approach based on the collaboration and coordination of all supply chain stakeholders has risen to the challenge, by dominating the negative consequences of the pandemic. However, human capital once again demonstrated its enthusiasm, determination and citizenship to protect citizens' health in the face of any crisis or threat, through the mobilization of healthcare professional's day and night, whose aim is to ensure quality care, at the right time, with greater safety. The pandemic crisis has revealed and reminded us of the strategic role of hospital logistics, a function that has been in the spotlight since the beginning of the crisis. For some, it has become an inescapable determinant in the development of any hospital logistics strategy. For others, it has become an essential determinant in the development of any strategy or action plan during periods of crisis. Furthermore, it is recommended that hospital decision-makers and managers increase the budget allocated to hospital logistics, and accelerate the digitization of healthcare services in the short term by implementing an information system dedicated to hospital supply chain management, which must be efficient and well adapted to the specific needs of the hospital establishment.

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