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The Supply Chain Adaptation of the Companies at Manaus Industrial Pole as a Response to COVID-19 Impacts

A Adaptação da Cadeia de Suprimentos das Empresas do Polo Industrial de Manaus em Resposta aos Impactos da COVID-19

La Adaptación de la Cadena de Suministro de las Empresas del Polo Industrial de Manaos como Respuesta a los Impactos del COVID-19

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Abstract

The COVID-19 pandemic, which in early 2020 led the world into a devastation, brought with it a series of challenges and significant changes that humanity needed to adapt to. Among the impacted areas, the global Supply Chain had a solid remark. The aim of this paper is to analyze the international logistic scenario from the Amazon region's perspective with regards to the impacts inflicted either on the inbound and outbound shipments in the international logistic chain at the Manaus Industrial Pole, as well as to describe how it behave before the social distance protocols (lockdowns), since noticing the sudden change of habit caused by the pandemic crisis at several social spheres created obstacles that were very hard to overcome. Nonetheless, in the Supply chain scope, the literature proposes ways that the companies can take in order to make these obstacles less harmful in their processes. Thus, it was sought to examine what were the technological impacts and resilient measures to outwork the pandemic crisis. The method that made this evaluation possible was a multi-case study in a few companies located at the Manaus Industrial Pole, through a qualitative survey regarding the awareness of the logistic professionals during the lockdown, which provided a realistic scenario showing these companies' adapting potential. The great dependence on foreign suppliers, mainly from China, was evident. Resilience and flexibility were characteristics prioritized given the need to diversify supply sources, and the increase in technology allowing greater visibility and resilience with suppliers.

Keywords: Pandemic Crisis Response. Resilience Strategies. Logistics Disruption. Amazon Region Economy. Lockdown.

A Adaptação da Cadeia de Suprimentos das Empresas do Polo Industrial de Manaus em Resposta aos Impactos da COVID-19

Resumo

A pandemia da COVID-19, que no início de 2020 levou o mundo a uma devastação, trouxe consigo uma série de desafios e mudanças significativas aos quais a humanidade precisou se adaptar. Entre as áreas impactadas, a Cadeia de Suprimentos global teve uma observação sólida. O objetivo deste artigo é analisar o cenário logístico internacional sob a perspectiva da região Amazônica no que diz respeito aos impactos infligidos tanto nas remessas de entrada quanto na de saída da cadeia logística internacional no Polo Industrial de Manaus, bem como descrever como ela se comporta diante os protocolos de distanciamento social (lockdowns), pois perceber a mudança repentina de hábitos causada pela crise pandêmica em diversas esferas sociais criou obstáculos muito difíceis de serem superados. Porém, no âmbito da Cadeia de Suprimentos, a literatura propõe caminhos que as empresas podem tomar para tornar esses obstáculos menos prejudiciais em seus processos. Assim, procurou-se examinar quais foram os impactos tecnológicos e as medidas resilientes para superar a crise pandêmica. O método que possibilitou esta avaliação foi um estudo multicasos em algumas empresas localizadas no Polo Industrial de Manaus, por meio de uma pesquisa qualitativa sobre a conscientização dos profissionais de logística durante o bloqueio, que forneceu um cenário realista mostrando o potencial de adaptação dessas empresas. A grande dependência de fornecedores estrangeiros, principalmente da China, ficou evidenciada. Resiliência e flexibilidade foram características priorizadas ante a necessidade de diversificação das fontes de abastecimento, e o incremente de tecnologia permitindo maior visibilidade e resiliência junto aos fornecedores.

Palavras-chave: Resposta à crise pandémica. Estratégias de resiliência. Interrupção logística. Economia da Região Amazônica. Confinamento.

La Adaptación de la Cadena de Suministro de las Empresas del Polo Industrial de Manaos como Respuesta a los Impactos del COVID-19

Resume

La pandemia de COVID-19, que a principios de 2020 llevó al mundo a la devastación, trajo consigo una serie de desafíos y cambios significativos a los que la humanidad necesitaba adaptarse. Entre las áreas impactadas, la Cadena de Suministro global tuvo una nota sólida. El objetivo de este artículo es analizar el escenario logístico internacional desde la perspectiva de la región amazónica en cuanto a los impactos causados a los envíos entrantes y salientes en la cadena logística internacional en el Polo Industrial de Manaus, así como describir cómo se comporta ante los protocolos de distanciamiento social (lockdowns), ya que notar el cambio repentino de hábitos provocado por la crisis pandémica en varios ámbitos sociales generó obstáculos muy difíciles de superar. Sin embargo, en el ámbito de la cadena de suministro, la literatura propone formas que las empresas pueden tomar para que estos obstáculos sean menos dañinos en sus procesos. Así, se buscó examinar cuáles fueron los impactos tecnológicos y las medidas resilientes para superar la crisis pandémica. El método que hizo posible esta evaluación fue un estudio de casos múltiples en algunas empresas ubicadas en el Polo Industrial de Manaus, a través de una encuesta cualitativa sobre la sensibilización de los profesionales de la logística durante el confinamiento, que proporcionó un escenario realista que muestra el potencial de adaptación de estas empresas.

Palabras clave: COVID-19. Respuesta a la crisis pandémica. Estrategias de resiliencia. Interrupción logística. Economía de la Región Amazónica. Aislamiento.

1. INTRODUCTION

In March 2020, the population is surprised by the pandemic of an emerging virus, which at a very fast pace demonstrates to the world population its biohazard dimension, which were being monitored since December, 31st, 2019, when China reported to the World Health Organization (WHO) a series of severe pneumonia cases in Wuhan, Hubei province (Fiocruz, 2020). An alarming portion of humanity was susceptible to infection and then on the 11th of march, 2020, the WHO officially classified the outbreak as a pandemic (WHO, 2020).

As a result, health systems around the world were overloaded and the population was deprived of public circulation, soon several areas of the economy began to suffer harmful impacts as a consequence of the measures applied in order to contain the pace of contagion (Boone, 2020). In Brazil, on the other hand, the growth in the number of cases was exponential, since in May 2020 it already reached levels of greater number of cases and deaths compared to other countries, as shown by the graphs of the WHO Contagion Situation Report No. 103 (2020).

Over the course of the events the global economy collapses, and society faces a new reality: the *Lockdown.* Data from the Institute for Applied Economic Research – IPEA (2020) indicate that the need for remoteness as an attempt to reduce contagion, classified as high incidence, directly impacts the routine of a globalized world, which is governed by global value chains in most diverse industrial sectors, characterized by the strong link between the productive sectors of several countries around the globe and which depends on the transit of goods and people across international borders for its proper functioning. This impact forced an adaptation in the routine of humanity, which had to carry its activities remotely, which in a way boosted the growth of the use of digital and technological means, since these were the most practical ways of keeping the supply working.

In the context of supply chain, which is precisely an important economic bias for national development, one of the first impacts presented during this period was poor performance in the spheres of logistics activities, due to the drop in global demand for goods, as pointed out in the IPEA technical note (2020). In the commercial sphere, this drop generated a high freight price, due to the closure of Chinese ports and a shortage of containers and ships (Comex do Brasil, 2022). Also including problems to finance, lead time control, demand changes, and production performance (Moosavi, Fathollahi-Fard, & Dulebenets, 2022). The severe business disruption caused by the COVID-19 pandemic has challenged our understanding of building a resilient supply chain (Nikolopoulos et al., 2021).

In Brazil, it is noted that the greatest impacts were caused by the suspension of activities considered as non-essential, as recommended by the National Health Council (CNS) No. 036, of May 11th, 2020. Therefore, companies located in the Manaus Industrial Pole (PIM), ports and carriers also had highly relevant impacts, potentially demonstrating fluctuations and failed value chains with supply chain disruptions (Sanguinet et al., 2021).

Although the current situation is characterized as post-pandemic (Pan American Health Organization – PAHO, 2023), with current vaccines and increasingly less restricted protocols, it is estimated that international logistics in companies at PIM has been able to survive the strong impacts that the COVID-19 pandemic has inserted in the world economy, which was conditioned by the isolation protocols in which humanity was subjected.

In the logistical context of the Amazon, the Amazon rainforest region constitutes a major obstacle given its natural characteristics, with immense demographic voids, rainfall cycles, high temperatures, winding rivers, and tropical diseases, in addition to being geographically isolated from the other commercial poles of Brazil (Yotsuji, 2021), which makes logistics planning something of extreme complexity (Choudhury et al., 2023), and resilient supply chain network (Maharian, & Kato, 2022).

The lack of infrastructure in the region reflects in notorious precariousness and significant obstacles in practically all logistics modes, especially in the inbound flow, generating negative effects because of the privilege given to its foreign trade (Costa, 2011), without much progress in terms of intraregional integration and the respective subnational spaces (Virga, & Marques, 2020).

Considering the relevance of the aforementioned aspects, it is important to investigate what were the impacts that PIM companies had with the effects of this pandemic in addition to these existing logistical obstacles. To this end, the research question was established: how did PIM companies adapt their supply chain management through the impacts of COVID-19? To answer this question, this paper proposes research in some companies of the PIM during the Covid-19 pandemic, with the justification of identifying whether the supply chain of these companies has indeed resilience to meet the need for its supply, while surviving this crisis.

This work was organized into sections: starting with the introduction, in which the theme, research question, justification and objectives were presented and developed. In the section 2, there is the theoretical foundation that covers the literature related to the topic and its main authors, this topic was divided into five parts: (1) logistics: understanding historical developments, (2) resilience in the context of supply chain, (3) the supply chain in the context of the covid-19 pandemic and (4) the logistics scenario in the Amazon: challenges and limitations. Next, the methodology used in the work is presented, which characterizes the research and the context studied, as well as describing how the data were collected and analyzed. In the fourth section, the results are presented and analyzed. Afterwards, the conclusions of the study are presented. Finally, there are references used in research.

2. LITERATURE REVIEW

2.1 Logistics: understanding historical developments.

Per Ballou (2006), historically, logistics processes until shortly before 1950 were considered as inherent activities of the Armed Forces, which involved the acquisition, maintenance and transportation of military facilities, military materials and personnel.

Knowledge about logistics was gradually expanding from the military field to the field of management, Russi et al. (2021) points out that one of the first to examine logistics from an academic perspective was John Crowell (1857–1931), who in 1901 analyzed the costs and factors related to the distribution of agricultural materials. In this way, his study became a kickstart for a new vision on logistics, when in the 1960s companies began to adopt logistics

planning methods in their manufacturing processes, replacing the emphasis on efficiency with the emphasis on effectiveness and customer satisfaction.

From this new vision, a new concept emerges, with the aim of treating the topic in a more defined and embracing way: the supply chain. As Ballou (2006) explains, there is a deliberate distinction between logistics and Supply Chain Management (SCM), establishing logistics as one of the strands of the supply chain. In general, the concept of SCM is given by the set of the entire production process of organizations, which incorporates from the production of raw materials to the delivery of the product to the final consumer, involving several companies and people along the way (Moosavi, Fathollahi-Fard, & Dulebenets, 2022).

Cavalcante (2019), writes that the term is relatively recent and can be understood as an improvement in the logistics process, which was already inserted in the business sector. According to his research, the concept of SCM emerged around the 90s and ended up absorbing the logistics process, which at that time was not yet a completely solid and embracing process, but which had already been growing in business spheres (Choudhury et al., 2023). Moreover, in Brazil this fact was given by the stabilization and opening of the economy.

As per Grant (2017), SCM aims to address broader logistics activities in an economy that becomes more globalized over time, however since its emergence in the 80s many debates have arisen in the professional and academic environment regarding the scope of SCM and its relations with the already established concept of logistics.

The Council of Supply Chain Management Professionals (CSCMP), defines:

> Supply chain management encompasses the planning and management of all activities involved in the procurement and *sourcing* (provisioning), conversion and all logistics management activities. It also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and between companies [...]" whereas Logistics "is the part of the SCM that plans, implements, and controls the efficient forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption to meet customer needs [...].

Corroborating this, Stadtler, Kilger and Meyr (2015) state that the SCM was created upon identifying the necessity to better integrate and manage the internal and external logistics operations of the organizations, reflecting an interconnected system of these processes, thus giving etymological meaning to the supply chain term.

Amidst the points of view of the authors previously presented, it is possible to observe a common feature, all concepts converge to the same factor: the integration of logistics processes, plus, this factor seeks to fill the gaps that relate the scope and efficiency of production processes.

In the context of competitiveness within the organizational world, it is known that in order to survive the fluctuations in the economy, companies need to have an effective system to withstand the impacts on a given portion of their processes. Stalk (1989), states that it is paramount that organizations develop systems that have flexibility in their production

processes and automation of response mechanisms within companies, aiming to obtain faster results to deal with situational unpredictability and still remain competitive and innovative to meet the demand of society.

Confronting this, Christopher (2007), argues that companies need to start from the premise that to remain competitive in the market it is necessary to maintain the technique of optimizing the costs of their production processes and, at the same time, maintain the quality of service at high levels.

2.2 Resilience in the context of the supply chain.

According to Kamalahmadi and Parast (2016), resilience in the context of the supply chain is defined by the adaptive capacity of a given chain to reduce the probability of having to face sudden disturbances and, still, resist the spread of such disturbances, maintaining control, recovering, and responding through immediate and effective actions to overcome the disturbance and restore the supply chain to a robust state (Maharian, & Kato, 2022). Such a definition encompasses three phases: anticipation, through proactive plans and thoughts; resistance, given by control over structure and functions; and recovery and response, achieved through rapid and effective reactive actions (Choudhury et al., 2023).

Complementing, Gomes et al. (2023) cites that the resilience of an organization is also given by the function of two important variables that determine its recovery: the competitive position of the company and the responsiveness of the supply chain, so companies can increase their resilience, creating redundancy or flexibility, especially in times of crisis. According to Alvarenga et al. (2021), the resilience capacities most widely discussed in the literature are: collaboration, flexibility, visibility and, more recently, analytical guidance, emphasizing the importance of these capacities acting in synergy, since each isolated capacity is insufficient and may not fully optimize the resilience results of the supply chain (Maharian, & Kato, 2022; Nikolopoulos et al., 2021).

In Brazil, which is a country of great vastness and diversity, the resilience of supply chains has played a key role in maintaining business continuity and the supply of essential goods (Assunção et al., 2020). The resilience of Brazilian supply chains emerged strongly during the pandemic, many companies adopted innovative strategies to overcome the challenges, local production was prioritized, and new partnerships were established between suppliers and buyers to reduce dependence on imported inputs. In addition, the accelerated digitization of processes, automation, and the implementation of workplace safety measures have helped keep production on track (Costa, Fôro, & Vieira, 2020; Gomes et al., 2020).

2.3 The supply chain in the context of the covid-19 pandemic.

Health Crises of catastrophic nature impose serious impacts on society, impacting essential spheres such as: health, economy, and politics. The COVID-19 pandemic crisis has brought with it a range of challenges and significant changes in various aspects of society, whose impacts have spread for years. Therefore, the massive responsibility of governments prioritized containing the spread of the virus, for this, the main challenges were to outline restrictions on

society, among which include: (1) social distancing, (2) temporary closure of the market for goods and services, especially gastronomy, hospitality and leisure, (3) non-essential travel restrictions and (4) obligation to use masks and hand sanitizers (Ivanov, 2020; Loske, 2020, Silva, 2022).

The basic activities of social daily life have not been the only areas that the pandemic has swept away from humanity in recent years, it should be emphasized that this crisis, as well as other catastrophes, harm specific sectors that are key to the functioning and order of society, such as manufacturing operations, international trade, supply and economy, which test the resilience of the supply chain and value chain at a global level (Golan, Jernegan, & Linkov, 2020; Haren, & Simchi-Levi, 2020). According to Twinn et al. (2020), logistics operations companies responded to these uncertainties with the adoption of several changes and protocols aimed at protecting the health of their employees, which include safety distancing, disinfection of workspace and maintenance of time off for employees.

Among the impacted areas, the supply chain had a great prominence, since with the sudden outbreak in China, where it was the epicenter of the virus, there was an immediate impact on Chinese exports, which revealed the vulnerability of the global system of supply of products and services (Araz et al., 2020; Dente, & Hashimoto, 2020). For Choi (2020), the logistics system is a priority when it comes to managing interruptions and recovery of the supply chain, since in the scenario of a pandemic crisis items such as medicines, food and health equipment become extremely critical.

The United Nations International Children's Emergency Fund - UNICEF, points out that one of the major obstacles faced by supply chains is related to the limited access to air freight for logistics operations, since there was a reduction in commercial flights, which were also shared with small volume loads, including health items such as vaccines, this represents a considerable reduction in global air cargo capacity, causing indirect effects on the increase in freight prices (UNICEF, 2020). Also, the bottlenecks in logistics caused by the closure of borders, reduced movements of sea and air shipments and reduced capacity of land shipments, also represent strong impacts on the manufacture of finished products, including the personal protective equipment (PPE) recommended during the *lockdown* such as masks and gloves, since these depend on imported raw material and packaging, both of which cannot be supplied locally.

Paraphrasing Silva (2022), among the above-mentioned modes, maritime transport had a relatively minor impact in the 2020 period, presenting slightly constant rates, although with a low flow of vessel crossings due to the substantial demand decrease. Twinn et al. (2020) adds that this stability would not last for long, as a result of the interruptions and blockages that were already affecting logistics companies, predicting congestion, delays in deliveries and an increase in freight quotes.

Outlining a general scenario, there was an absence of raw materials and finished products in the ports of several locations around the world due to blockades in most ports, added to the decrease in demand, due to the focus on medicines and medical supplies. Thus, shipping companies operate with a low volume of cargo, causing an imbalance between revenue and operating costs (Kumar, 2020). For Hedwall (2020) it is very important that companies analyze

supply chains to mitigate disruptions in the future, taking into account that not only health crises, such as the COVID-19 pandemic, but also other factors such as trade wars, global and national policies, will have a direct influence on the structure of the supply chain. Therefore, discussing sustainability in the supply chain and high investment in technology are key (Sanguinet et al., 2021).

2.4 The logistics scenario in the amazon: challenges and limitations.

Logistics activities in the main capitals of the Amazon region face great obstacles due to their natural geographical characteristics, linked to the fact that the region is very large and surrounded by a dense forest mass, with huge demographic voids (Passos, 2013). About this aspect, Rodrigues (2021), also points out that here in the Amazonas, despite having an Industrial Pole, Logistics is still not as studied as it should be, his research highlights some characteristics identified in the state of Amazonas:

> - Precariousness in the road system: given the poor geographical conditions and isolation of the region;
> - Absence of Railways within the state;
> - Precariousness in the airport structure: low frequency of cargo flights and overloaded terminals;
> - Low efficiency in the waterway system: lack of multimodal warehouses, low offer, and high travel time due to the drought season.

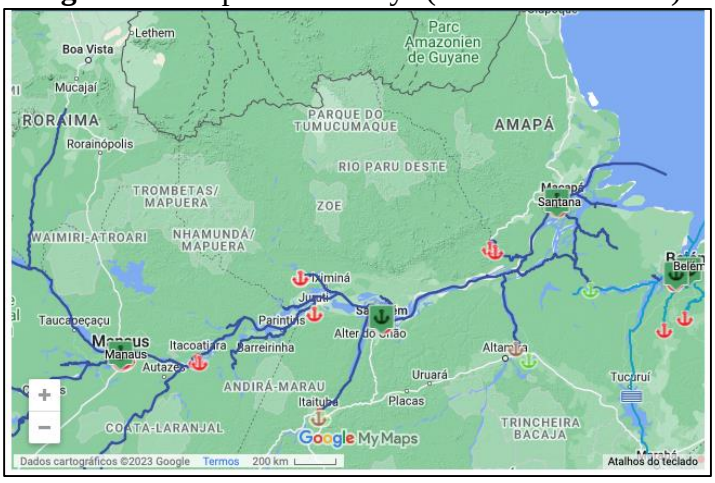
Complementing the points above, Virga, Nascimento and Marchi (2021), observe that the Amazon concentrates a large part of the problems that are associated with various intra-regional dependencies with regard to the development of transport. These are serious problems that accumulate in the Amazon region and are still little discussed, restricting the multimodality of transport, mainly to air and river, that is, extremely complex logistics (Choudhury et al. 2023).

On the railway network, Souza and Uchôa (2019), raise the discussion on how the absence of Railways in the Amazon significantly impacts the logistics chain of the region, highlighting through a case study the effectiveness that this mode would provide in the movement of large volumes of cargo, through the implementation of a railway connecting Manaus to Porto Velho. But, regarding transport in the Amazon region, for Yotsuji (2021), rivers, operationally, are considered the true roads of the Amazon region, with emphasis on the Juruá River, coming from Peru, to the Amazon River, which connects the region to the Atlantic Ocean. Galindo et al. (2021), when analyzing the Amazon hydrographic basin, stablishes the city of Santana in the state of Amapá as a gateway to the northern region, given its privileged location situated right at the transition of the Amazon River with the Atlantic, receiving great navigations from the main *hubs* of the world.

Within the scope of the waterway mode, the cabotage which according to Matos (2019) consists of a type of transport carried out between ports in a single country. In Brazil it usually occurs on the coast, but can also be made in lakes or rivers. Including the Amazon River, Brazil has 8.5 thousand kilometers of navigable Coast, which favors water transport, which becomes the most significant, given the extension of the hydrographic basins, when it comes to the Northern Region. Thus, the main ports on the cabotage route are Santos, Suape and Manaus.

At the PIM, the most used modes are water and air transport, while road transport is the least used due to its limited extent and poor conditions. Generally, in the input transport aimed at the national market, it is used the River Road Transport (Figura 1), which consists of using of the road mode to a certain point and resuming the rest of the route with the river mode (Picanço et al., 2023).

Figure 1 – Map of waterways (Santana – Manaus)



Source(s): ANTAQ-National Water Transport Agency

Still on the river transport, it is important to emphasize that there are some factors that for Violante et al. (2020) make maritime trafficability intermittent, which hinders logistical planning, as such: the inconstancy of the water level, periods of rain and the lack of adequate signaling. Taking this scenario into account, Santos (2016) states that the airway mode is paramount in the planning of the logistics chain in the Northern Region due to the great distances and the precariousness of surface connections.

For Souza (2022), the analysis of the flow of goods is essential to mitigate the time and costs of delivery, considering that this mode has high costs. Therefore, it is essential to evaluate the mode of transport that best meets the need of the merchandise being shipped, in order to achieve the best cost-benefit ratio (Liu, Zhang, & Wang, 2018). But Quintilhano (2014) states that the air mode can be advantageous, depending on the volume and urgency of cargo, since it is suitable for smaller volume loads and with certain restrictions on hazardous materials, considering that this is an agile means of transport of both cargo and passengers, being a key alternative in the strategy to obtain capital liquidity in the companies' logistics process.

> The air mode transport is regulated by IATA (*International Air Transport Association*), representing more than 300 airlines spread over 120 countries that operate national and international flights, also known as domestic and foreign trade flights, which means a percentage of 83% of all air traffic, in addition to being the party responsible for authorizing both scheduled and dangerous cargo (IATA, 2023; Souza, 2022). Currently the Manaus Eduardo Gomes International Airport is considered the focal point for the entry of goods into the Brazilian Amazon and one of the main *hubs* of cargo and passenger transport in the country, its infrastructure has a complex with three cargo terminals (TECAs) having an operational capacity of handling about 30,000 tons of cargo per month, thus playing an important role for the metropolitan region due to the strong presence of industries at the Manaus Industrial Pole (Vinci Airports, 2022).

It should be noted that another strong characteristic that makes up the gears of the logistics chain of the region is the Manaus Free Trade Zone (ZFM), whose role has an extreme influence on the volume of goods circulation in the region (Ferreira, & Botelho, 2014; Suframa, 2019). The Superintendence of the Manaus Free Trade Zone (Suframa) is one of the key parties within the SCM process, because on top of having regional development as its main objective, it also comprises is all regulations that boost imports and exports in the region, as a result, the generation of employment and income has been a reality since its creation in 1967 (Barbosa, 2013).

The fiscal incentives granted are related to the exemption of the following taxes: Tax on the Circulation of Goods and Services (ICMS), Tax on Industrialized Products (IPI), Import Tax and Any-nature services Tax (ISS) the legislations that grant these benefits include the states of western Amazonn and the Free Trade Areas (FTA) of the cities of Santana and Macapá, in Amapá (SUFRAMA, 2019).

Alanís (2022), cites that in order to fit the requirements of the ZFM model, companies need to have their product meet the basic production processes (PPBs). to do so, they have dense production chains, with a high added value in their portfolio. Most of the production processes at PIM use new technologies, which are currently linked to the concept of Industry 4.0, such as artificial intelligence (AI), robots, internet of things, etc.

Regarding the requirements to being eligible to use tax incentives of the ZFM, Sena and Magno (2022), highlight that in addition to the PPB, the classification of the Mercosul Common Nomenclature (NCM) is necessary, whose objective is to allocate the industrialized good in its respective tax rate according to the characteristics of the product. According to the Siscomex (2023), both PPB and NCM are arranged in the Technical-Economic Project (PTE), which acts as a basis for the administration to measure, at a given time, whether the company is complying with the commitment in exchange for granting tax incentives.

3. METHODOLOGICAL PROCEDURES

In this section, the methods used in this research will be presented. That being said, we can classify it as descriptive, following what Vergara (2005) proposes:

> Descriptive research exposes characteristics of a given population or phenomenon. It can also establish correlations between variables and define their nature. It has no commitment to explain the phenomena it describes, although it serves as the basis for such an explanation. Opinion polls are included in this classification.

Marconi and Lakatos (2002), on the other hand, emphasize that descriptive research outlines the phenomenon or fact, as well as characterizes the process in four aspects: description, registration, analysis and interpretation of current phenomena. Such aspects are aimed at understanding how they manifest themselves in the present.

With regard to the objectives, it's an exploratory research, since it is a recent phenomenon, there are few studies addressing this issue, regarding the specific context of the region, so it aims to understand how the supply of PIM was affected by the COVID-19 pandemic. As per Hair et al. (2005), exploratory research is particularly useful when the researcher has little

information, but when well conducted, it opens a window into perceptions, behaviors and needs of society.

The present work proposes nuances of a multicase study (Yin, 2015) represented by 6 different companies in PIM. According to Halldórsdóttir (2000) and Starks and Trinidad (2007) the sample size for phenomenological studies range from 1 to 20 participants. But this "depend" on several factors, in this case, available resource and time. The access was mediated both by self-professional experience and through additional networking. To preserve the identity of the respondents and the companies in which they work at, a generic identification was associated to each one of them, namely: R1; R2 and so on.

The period studied was the first semester of 2020, in which the scenario was more critical, as discussed at the beginning of this research. As for the collection instruments, a questionnaire with open and close questions was used to identify empirical facts through the perspective of professionals, who experience logistics operations on a daily basis. The theoretical lens was based

Therefore, when analyzing the characteristics that are closest to the above assumptions, the chosen instruments for data collection were: 1) Google Forms and instant messaging applications of the Meta platform (WhatsApp and/or Messenger) for distribution of the questionnaires and further clarification. The technological procedure chosen allows the protection of the researcher and his participants due to the critical moment.

About the analysis of the data obtained, this research is essentially characterized as qualitative, since its approach brings a dynamic interaction between the real world and the subject, that is, an interaction between the objective world and subjectivity of the researcher, which cannot be presented in numbers (Prodanov, & Freitas, 2013). Taking advantage of this opportunity, the technique addressed in this research will be Content Analysis which, according to the theory of Bardin (2004). Secondary data from ANTAQ (National Water Transport Agency) and ANAC (National Civil Aviation Agency) in order to discuss the data analysis performed as a triangulation procedure, one of the characteristics of the case study. To analyze the results, 3 categories were considered from the descriptive texts: resilience (Alvarenga et al. 2022; Ivanov, 2020), technologies (Costa, Fôro, & Vieira, 2020; Gomes et al., 2020), and modal (Choudhury et al., 2023; Kumar, 2020). It's a technique that gives importance to methodological accuracy where its execution is systematically, seeking to overcome uncertainties and enrich reading (Sousa, & Santos,2020).

4. RESULTS AND DISCUSSIONS

This research collected data provided by professionals in 6 different companies in the Manaus Industrial Pole, as well as secondary data from ANTAQ and ANAC regarding cargo handling during the studied period, in order to corroborate the data analysis performed.

4.1 Hierarchical level and experience of participants

As shown on Table 1, the questionnaire was applied with a greater focus on managers, considering that expertise and holistic view of the process are intrinsic factors to their role. However, the questionnaire was also applied to the other hierarchical levels, since these, being in the front line of the operation, have the potential to provide a more realistic view of the logistical scenario during the crisis.

Table 1 - Description of Research Participants

Interviewed	Age	Company Time	Experience Time	Education Background	Present Job (Position)
R1	41	13	17	Academic background	Foreign Trade Manager
R2	57	18	26	Academic background	Logistics Manager
R3	33	8	12	Academic background	Logistics Manager
R4	26	4	6	Enrolled in college	Foreign Trade Analyst
R5	45	7	20	Academic background	Academic background
R6	40	15	15	Undergraduate degree	Supply Chain Manager

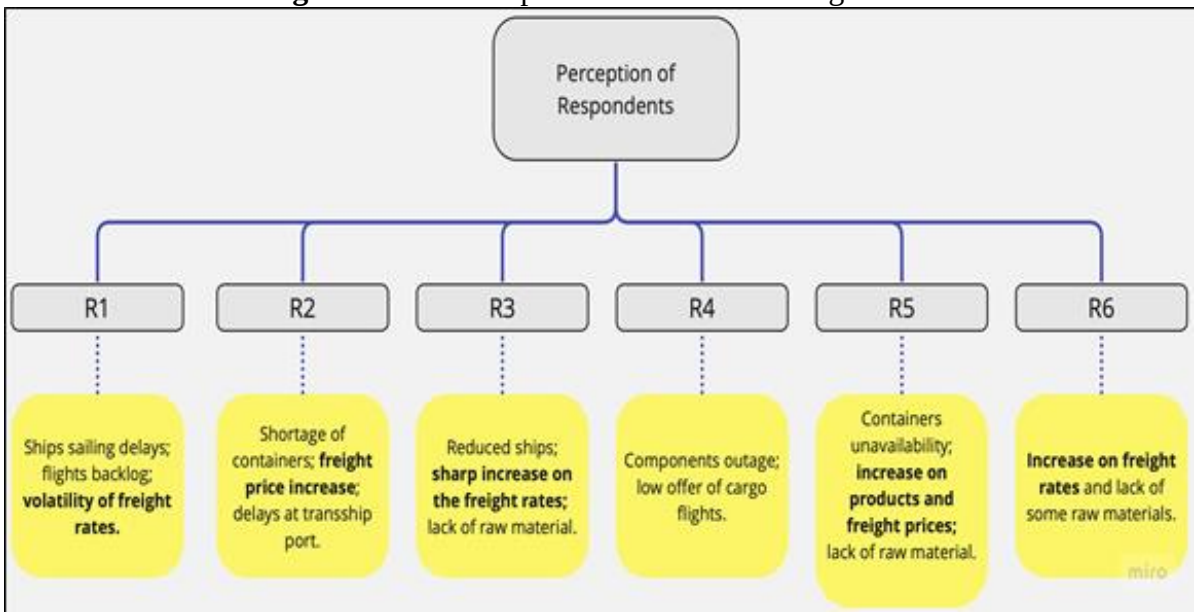
Source: Developed by the authors

In addition, the present research instrument evaluated the length of experience of these professionals, since to have a parameter on the standards of the logistics flow, it is necessary to have experience in the area of *supply-chain*, which includes a period prior to the pandemic. According to Table 1, it was found that most professionals have been working in the logistics/supply chain area for more than 6 years, that is, a time lapse of sufficient relevance to assess the perception of anomalies in the logistics flow before, during and after the pandemic.

4.2 Impacts caused in companies and its supply chain area.

After identifying the professionals and their respective experiences in the area, it was evaluated the initial perception of the impacts caused in the supply chain of the companies where each of the respondents work at. Among the responses obtained, as shown in Figure 2, the most predominant point was the increase of freight rates, followed by the shortage of containers, delay of ships, and as a result, lack of raw materials, which corresponds to the idea previously addressed regarding the emerging instability in the price of freights that was boosted by the congestions caused by blockages in ports around the world as well as the drop in demand for goods worldwide (Comex do Brasil, 2022; IPEA, 2020; Twinn et al., 2020).

Figure 2 – Main impacts on international logistics activities.

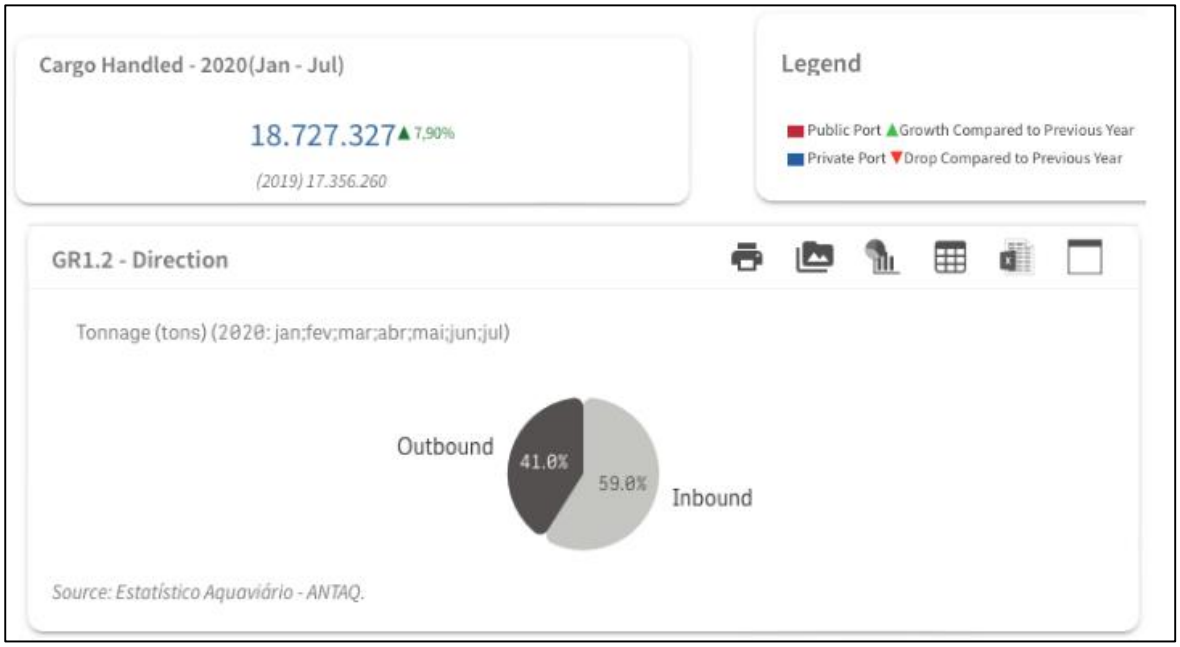


Source(s): Developed by the authors.

When analyzing the challenges that respondents noted, with regard to logistics activities, most stated that the harmonization between alternative routes, cost and transit time was one of the main points, which were aggravated by the focal crisis in Chinese ports and material shortages, however, there is also a secondary concern among respondents about the continuity of operations, to meet the demand of their customers and at the same time, to maintain the safety of their employees. Stalk (1989), proposed a base theory, as per mentioned on the references of this research, where he states that companies should seek flexible strategies to deal with unforeseen situations, in order to maintain competitiveness to meet demand.

Despite the high freight price and a shortage of empty containers, the logistics flow in the city of Manaus had a slight intensification at the beginning of the pandemic. According to data from ANTAQ (2023), in the first half of 2020, port cargo handling in the region was 18.7 million (Figure 3) tons, an increase of 7.9% compared to other months.

Figure 3 – Waterway Statistics.



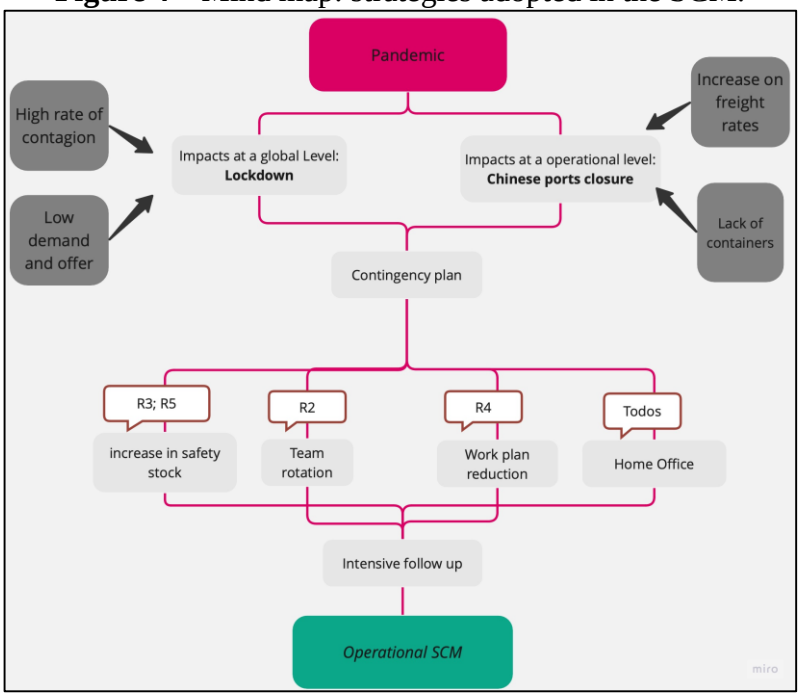
Source: National Water Transport Agency – ANTAQ (2023).

4.3 Resilience to keep SCM operational.

As for the strategies to overcome the main impacts of the pandemic crisis and keep the SCM operational, the ones that the research participants cited as most relevant were: *home office*, team alternation; reduction of work plan, intensive follow up, such points were raised by the authors as crucial for the resilience of the supply chain (Alvarenga et al., 2022; Ivanov, 2020; Loske, 2020; Silva, 2022). For a better view of these strategies, a mental map (Figure 4) was prepared, based on the main impacts that the pandemic caused and the respective related effects.

According to the majority of respondents, it was observed that the import flow suffered the greatest impacts, since most of these companies only export what is produced from the acquired inputs, whether of imported or national origin.

Figure 4 – Mind map: strategies adopted in the SCM.



Source(s): Developed by the authors.

4.4 Technologies to support operations.

The adaptations in the operation, of the 6 participating companies, 4 had to carry out some type of change in the methodology of performing the activities. Such changes are related to the adoption of technologies that would enable communication and, therefore, the shipment monitoring of their goods. It should be noted that this is precisely a characteristic of what is considered a resilient supply chain, due to the fact that its objective is linked to economic globalization, which in turn is driven by technological advancement and fast-feedback means of communication (Costa, Fôro, & Vieira, 2020; Gomes et al., 2020).

The technologies used in the adaptations of operations, apart from respondent R4, whose company implemented its own technology for monitoring the flow of cargoes and communication, all other companies used platforms such as Microsoft Teams and Google Meet, which, according to the interviewees, played a key role in the operation, due to their various functionalities such as information sharing and remote and simultaneous access, bringing positive impacts so that the execution was successful. Linking to what Hedwall (2020) proposes, with regard to carrying out activities, the matter of sustainability and technological investment cooperate so that the supply chain of organizations becomes resilient.

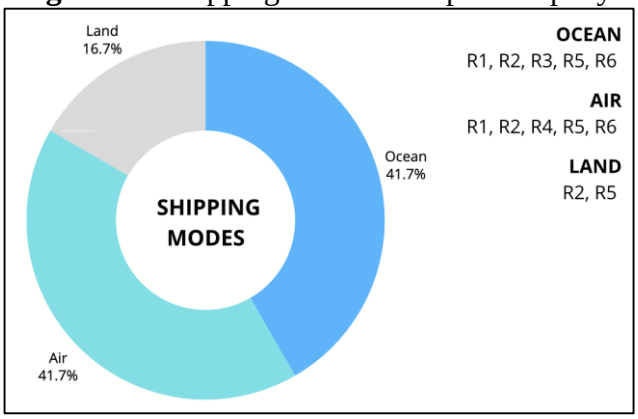
It is also important to note that these platforms had already been implemented in the corporate world shortly before the pandemic, and most organizations were already using their functionalities in their everyday activities, a recurring thought from Stadtler, Kilger and Meyr (2015). However, according to the respondents, it was precisely the pandemic that catalyzed

the implementation of these tools in organizations, since almost all SCM activities had to be coordinated remotely, which was only possible through the use of such technologies.

4.5 Modal supply chain.

The next stage of the research sought to verify which are the main shipping modes used by the companies, to get a glimpse of the range of the impacts on each of them and, from there, to verify whether the companies used strategies such as multimodality or alternative means to keep the supply chain running. According to Figure 5, the predominance of the maritime modal is observed, due to the fact that most companies carry out large volume movements for their raw materials.

Figure 5 – Shipping modes used per company.



Source(s): Developed by the authors.

Relating the analysis of the information in Figure 7, it was identified that at least 50% of the participants noticed that the general flow of shipments decreased. It can be noticed that this factor is related to both the reduction in demand and the absence of other modes in their supply chain, causing shipowners to operate with a low volume of containerized cargo, which subsequently influenced the volatility of sea freight quotes (Kumar, 2020; ANTAQ, 2023).

Outlining a general scenario, there was an absence of raw materials and finished products in the ports of several locations around the world due to blockades in most ports, added to the decrease in demand, due to the focus on medicines and medical supplies. Therefore, shipping companies operate with a low volume of cargo, causing an imbalance between revenue and operating costs (Kumar, 2020).

Listing these factors, it is important to highlight that the PIM is in a region of relevant geographical complexity, being surrounded by a dense forest mass, where its main access routes are rivers, highways in precarious conditions and by air, thus, logistics costs are usually high (Rodrigues, 2021; Virga, 2022).

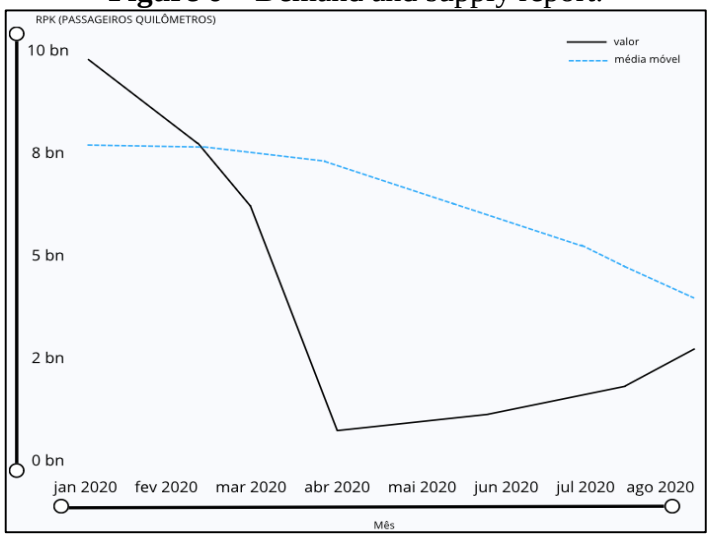
Upon shipping restrictions, the main strategies adopted by companies during the pandemic to move their cargo were very different from one another, due to the peculiarities in the flows of each company. For respondent 2, whose company has a high volume of cargo from China, the use of multimode shipment was crucial for the proper functioning of the supply chain, covering

strategic routes for loading in alternative ports of neighboring countries, so that this obstacle was overcome, despite the high expenditure on freight.

> We had to do a modal mix in China and shift the loading from China to South Korea port to minimize the impacts, but the cost of Shipping has increased substantially (Respondent 2)

For respondent 4, whose main mode used by the company is air, because of its low volume of cargo, the impact is related to the suspension of non-essential commercial flights, reflected in Figure 6 below, so the strategy adopted in response to this obstacle was the use of hotline shipments (sending the goods by hand with the passengers) for the most critical materials.

Figure 6 – Demand and supply report.

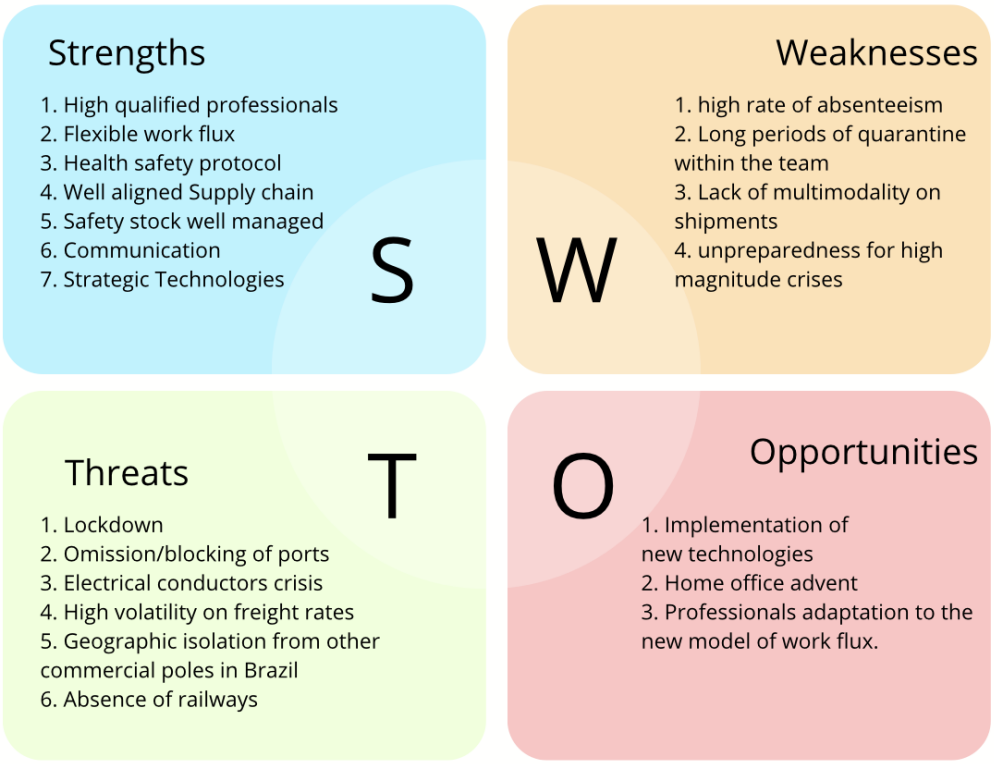


Source(s): National Civil Aviation Agency-ANAC (2023).

As for the other participants, it was observed that the absence of recurrent multimodality in the processes caused an operational impact, since the process takes into account the maritime mode as a standard, considering that this is the one that best meets the need according to the production plan and volume of raw material required, thus, a high investment in air freight was necessary. In this regard, the importance of mitigating delivery time and costs is emphasized, as the air modal can be advantageous for low-volume and extremely critical loads, since its cost is high (Souza, 2022; Quintilhano, 2014; Virga et al., 2021).

Getting to a conclusion, a SWOT analysis was elaborated to find out how the current scenario of the participating companies is in response to the impacts of the pandemic. According to Figure 7, by gathering the information obtained from the respondents, the scenario establishes that the participating companies have good flexibility in their processes and were able to withstand the impacts imposed by the pandemic.

Figure 7 – SWOT Matrix.



Source(s): Developed by the authors.

5. FINAL CONSIDERATIONS.

The threat of the pandemic has revealed several weaknesses in the global supply chain. First, the closure of borders and restrictions on the movement of people and goods affected the transport of products, creating logistical bottlenecks.

The focus of this paper was indeed to analyze the international logistics scenario from the perspective of the amazonian region facing uncertainties regarding the impacts caused on the flow of shipments at the Manaus Industrial Pole. From the discussions held, it is clear that the impact was severe, and that this pandemic exposed the excessive dependence of companies on foreign suppliers, especially from China.

The research contributes by demonstrating, in a specific Amazonian region context, overcoming the disruption of global supply chains, by forcing companies to reconsider their strategies, and diversify their supply sources, seeking greater resilience and flexibility. Technological innovation was important when translating routine work into the technological plan to maintain the functioning of the supply chain of PIM companies, which for Assunção et al. (2020), corresponds to one of the characteristics related to supply chain resilience.

On top of the existing difficulties related to local geography, such as seasonality, isolation from other commercial centers, and the absence of some modes, the COVID-19 pandemic also brought important lessons, one of them, as pointed out by Hedwall (2020), is the need to invest in innovation and technologies that allow greater visibility and better communication to obtain control over the supply chain.

Regarding the current scenario of the participating companies, based on a SWOT analysis, an innovative process can be observed in light of the delicate situation caused by the threats of the Pandemic. There is outstanding resilience in its supply chains, described by the high quality of its professionals, good management of safety stocks, technologies and communication, in general terms, maintaining the operation, even with a slight reduction.

After the most critical period, the current scenario of these companies is practically normalized, which for Stadtler, Kilger, and Meyr (2015), is what in fact characterizes the resilience of the SCM, based on the importance of solid partnerships along the supply chain, that is, companies that maintained open communication channels with their suppliers and partners, and entrusted their operations in the technological factor, had a greater ability to adapt to sudden changes in market conditions.

As a suggestion for future studies could explore the pandemic's impacts on supply chains in other isolated regions, comparing Amazon's unique challenges with those in other developing or remote areas. Research could investigate the long-term effects of the pandemic on supply chain structures, particularly whether the technological adaptations made during the crisis (such as remote work and digital platforms) have become permanent features. Or a quantitative analysis to measure the resilience of supply chains and assess the effectiveness of various strategies adopted during the pandemic.

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