

The Impact of Covid-19 on International Supply Chains Looking Through the SCOR Model

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Abstract

The SARS-CoV-2 pandemic has brought challenges of unprecedented proportions to the world in many aspects. For supply chain the key problem has been to minimize losses in short and long terms. The purpose of this article is to demonstrate the impact of covid-19 in the supply chain and international logistics perspectives and evaluate the impacts comparing with the standard supply chain operation model. The research method applied consists in a bibliographic research with qualitative and inductive approaches applied in a single case study. The results demonstrated different impacts on the macroprocesses of the standard model, however it is important to understand the changes on the degree of impact over time due to the initial contagion increase and the in the following months. The conclusion was that an emergency plan built by the company mitigated the impacts and avoided the supply disruption of imported materials. This work stands out for being unique inside the perspective of a covid-19 in vitro diagnostic company.

Keywords

Supply Chains, COVID-19, SCOR model and International logistics impact

1. Introduction

On March 11, 2020, WHO Director-General (2020), Tedros A. Ghebreyesus announced to the world that COVID-19, a disease caused by the new coronavirus, was a PAHO pandemic (2020). In recent years, the world has felt the impacts of other pandemics, such as the H1N1 flu in 2009 and Ebola in 2014, Patel et al. (2017). In these events, the same effects of excess demand, reduction of production capacity, dependence on suppliers from China and risk of supply cut were also perceived. These consequences, according to Wang et al. (2020) were also identified in China during the SARS outbreak in 2003. For Akkermans and Van Wassenhove (2018) it is possible to make a comparison of these events with tsunamis in nature, as both occur with a certain time spacing, have low predictability and high impact, therefore, are confused with isolated events. COVID-19, can be considered the biggest tsunami that affected supply chains in the 21st century, which according to Ivanov (2020) reinforces that epidemic outbreaks especially impact supply chains by causing prolonged interruptions, propagating these interruptions by whip effect and generating high uncertainty in companies.

Resilience is presented as one of the advantages of the supply chain maturity model. Resilience is a term studied by many authors in recent years, such as Christopher and Peck (2004), Wied et al. (2020) and Chowdhury and Quaddus (2016). Christopher and Peck (2004) define resilience as the company's ability to return to its original state or move to a new desirable state after a disturbance. For Alicke and Azcue (2020), the low maturity of organizations' supply chains can be a risk and needs to be resolved. The term maturity in supply chains is addressed in the work of Oliveira (2009), Frederico (2012), Roque Júnior et al. (2019), Mendes et al. (2016), Miri et al. (2019), Yahiaoui et al. (2019). According to Oliveira (2009) and Frederico (2012), maturity models have been developed for evaluation in a specific domain of the organization based on a set of criteria. This process accelerated with the growth of globalization and the search for cost reduction. In recent years, supply chains have become globalized, trading products and services between different countries. This evolution increased the complexity of the environments since the competition was no longer for supply chains, but for supply chains. The complexity of these networks and the number of participating companies increase supply risks.

According to Shekarian et al. (2020) several studies have been carried out on risk management, which shows that supply chains are subject to a wide variety of interruptions that can have an immediate or long-term effect. The world is fighting daily against COVID-19 and, more than ever, supply chains are essential for maintaining the supply of inputs for food, health and other essential items for human life today. According to Sorbello et al. (2020) COVID-19, which was initially treated as an isolated event, did not have a significant impact on supply chains,

but in a matter of days, as mentioned by Wang et al. (2020), the outbreak spread to China and then to the world. For Wang et al. (2020) the first impact on supply chains occurred in the Chinese New Year period, when most factories and distributors were closed, leading to a shortage of medical supplies and personal protective equipment to combat the pandemic. This scarcity affected several countries, such as Italy, which, according to Sorbello et al. (2020) had the highest number of cases (41,035) and deaths (3405) due to COVID-19 in Europe and is the second globally until March 20, 2020. Even with a robust system and strong action by the authorities, in January 31, 2020, Italy no longer had the capacity to produce, purchase and distribute PPE's on all fronts to combat the disease. Wang et al. (2020) present some reasons that contributed to the lack of products, such as: the failure to finance inventories, lack of planning, lack of storage space and lack of a distribution strategy. According to Wang et al. (2020) few countries maintained strategic stocks to deal with health crisis situations, as was the case in the United States, which had certain products in government warehouses or private companies. Canada and Australia also adopted this strategy.

COVID-19 is not the first and will not be the last pandemic we will experience. According to Johnson et al. (2020) and Anzai et al. (2020) it is important to spread teleworking, to keep schools and borders closed in order to reduce transmission of the virus. Such measures were widely taken by countries, which also resulted in the limitation of air routes that are important for the supply of inputs destined to health. According to flightradar24 (2020) from January 12th to April 10th, 2020 there was a 58% reduction in the number of flights around the world.

The fact that the impacts on the supply chain have aggravated the crisis caused by the pandemic motivates us to carry out this research and to help companies be better prepared for the future. This research is important for the scientific aspect because it is the first to analyze the impact on a company at the forefront of the fight against COVID-19, responsible for the production of kits for diagnosing the disease. It is also the first article to link the SCOR model to the impacts of the pandemic. This work helps company managers presenting the main points affected in the SCOR model. Finally, it was concluded that the big problem is that we did not learn from previous pandemics as mentioned by Johnson et al. (2020) and Anzai et al. (2020), so we have not consolidated what the impacts are and how we can prevent them.

This article is divided as follows: the first section contains the theoretical framework for the importance of international logistics and the impact of Covid-19 and the concept of the reference model for supply chain operations (SCOR) is also presented. In the second section we discuss the methodology applied in the research. In the third section we demonstrate the results of the Covid-19 impacts on the macro processes of the SCOR model. In the fourth and last section we present the conclusions and direct themes and questions for future research.

1.1. Objectives

The objective of this article is to investigate the impacts of covid-19 on supply chains and international logistics, especially in the segment responsible for the production and testing of in vitro diagnostic kits, listing the impacts on processes through the lens of the operations reference model in SCOR logistics chain.

- Identify the impacts on the supply chain;
- Identify where in the SCOR model the supply chain was most affected;
- Identify what actions were taken to minimize the impact of COVID-19.

2. Literature Review

With the complexity of operations and the growth of international trade, the concept of international logistics is discussed by Davies (1983), citing that it is possible to consider the same concept of standard logistics, although there are three factors that differentiate international and national logistics, the first is related to documentation, according to the presence of a dispatcher and the form of order processing, these factors are still alive and strong in the year 2020, but are not widely considered in recent literature.

International supply chains can be severely interrupted by failures in international logistics processes. Therefore, an understanding of international logistical risks is essential according to Kwak et al. (2018). Since for Slater (1977) an international logistics system can be considered in two basic aspects: first, the planning and development phase, which optimizes long-term strategies; and second, the operational phase where day-to-day management problems occur. Failures in the planning stages lead to difficulties in operations, and this could be particularly crucial in a logistics system that is providing support for geographically distant production and marketing facilities.

According to Bowersox and Closs (2007), logistics has a central objective, which is to achieve an expected level of customer service at the lowest possible total cost, whereas for Ballou (2006), it is possible to measure the value of logistics in terms of time and place, based on this point of view, the importance of having the right material in the right place at the right time and in the desired quality is evident, leading to the satisfaction of customers who are willing to pay for products and services. For Bowersox and Closs (2007), a conservative estimate says that 90% of global demand is not fully satisfied by local suppliers, and the expansion of world trade is a major factor in changing the dynamics of competition between companies, starting to have as competitors in addition to those locally installed, international companies, which have the capacity to serve customers across the globe, become qualified competitors. Thus, with the expansion of companies around the world, their logistics and supply chain

management operations have become more complex, in this context a model that aims to be a standard for several segments, and for the health segment, being a one of the best to understand, evaluate performance and describe supply chain activities in the scope of research and practice is the reference model for supply chain operations SCOR Ayyildiz and Taskin Gumus, (2020).

Many studies observed in the literature use the SCOR model to assess supply chain performance, some of which we summarize here: Wang et al. (2004) adopt the performance metrics of level I of the SCOR model as a decision criterion when developing an integrated process of AHP analytical hierarchy and programming of PGP preventive goals, taking into account qualitative and quantitative factors for the selection of suppliers. Trkman et al. (2010) use the SCOR model to assess the impact of business analysis on the performance of different areas of the supply chain. Lockamy and McCormack (2004) investigate through the SCOR model the relationship between supply chain management planning practices and supply chain performance. Bai et al. (2012) use the SCOR model to develop metrics of economic and ecological performance in the supply chain and present a method that assists in the assessment, selection and monitoring of the performance of a sustainable supply chain. Ganga and Carpinetti (2011) in their article with a descriptive quantitative approach employ the performance metrics of level I and II of the SCOR model to develop a supply chain performance model based on fuzzy logic seeking to predict the performance of the chain. Sangari et al. (2015) rely on the SCOR model to examine the impact of knowledge management processes on the performance of supply chains. Lu et al. (2016) applied the structure of the SCOR model in the context of humanitarian supply chains in order to develop a set of indicators for measuring the performance of humanitarian logistics operations at the organizational level. Okongwu et al. (2016) combine the SCOR model and the CODP customer order decoupling point concept to investigate the positive, negative and conflicting relationships between determinants of tactical supply chain planning and supply chain performance for different manufacturing configurations. Lima and Carpinetti (2016) combine the performance metrics suggested by the SCOR model and the Fuzzy TOPSIS technique to propose a decision-making model and assist in the assessment and management of suppliers. Wu et al. (2020) use the SCOR model framework to demonstrate how to use emerging information technologies to mitigate vulnerabilities in the supply chain.

2.1. Supply Chain Operations Reference (SCOR)

2.1.1. Model SCOR

It is a management tool composed of a reference model in Supply Chain Management SCM, developed by the Supply-Chain Council SCC in 1996, the Supply Chain Operations Reference SCOR or in a free translation The reference model of supply chain operations it is a standard model for analysis, design and implementation of five supply chain processes: planning, supplying, making, delivering and returning Stefanovic, et al., (2009). SCOR is developed in a structure, with the objective of integrating processes, metrics, best practices and technology, seeking to improve collaboration between business partners (Zdravković et al., 2011). According to Vieira et al. (2007) the model covers the entire supply chain from the supplier to the end customer, with a broad methodology, whose objective is to improve the operations of the supply chains, as highlighted by Carraro et al. (2020). With this model according to Gomes (2020) companies can implement improvements in their processes quickly, meeting the needs of customers and their satisfaction. In general, SCOR is a strategic planning tool that allows managers to simplify the complexity of the supply chain Huan et al. (2004). Since its development, the model has undergone several revisions as stated by Gomes (2020), highlighting that this is due to the adaptation of the model to the changes that organizations have been undergoing within their supply chain, the author emphasizes that the model remains an important tool in the evaluation of activities and comparison of companies' performance in relation to the supply chain.

2.1.2. Model Business Processes

As previously mentioned, the model focuses on the five main supply chain management processes - Plan, Supply, Make, Deliver and Return - and will be discussed shortly.

The planning process encompasses processes that seek to balance supply, observing resource capacity and demand throughout the chain, in a way that meets business goals. These processes deal with demand and supply planning, which includes the activities of resource assessment, aggregation and prioritization of demand requirements, inventory management, production requirements, distribution and channels.

The supply process contains processes for the acquisition of goods and services that originate to meet planned demand. The acquisition of material includes the activities of purchasing, receiving, quality inspection and storage, in addition to supplier management.

The making process is related to manufacturing, so it includes functions that transform the inputs (raw material) into finished product to meet demand. This is the central process of the system in which the actual production execution takes place. Tasks include ordering and receiving material, manufacturing, product testing and packaging.

The delivery process consists of sub-processes that provide finished products and services to meet demand. In general, it includes the functions of order management, transport and distribution.

The return process is the latest addition to the SCOR model. It deals with the management of reverse material flow and information related to defective or non-conforming products. This includes authorization to return, schedule, receive, verify, discard, remanufacture and replace or credit to the customer.

A basic supply chain is a relationship between the supply, make, deliver and return execution processes. Each interaction of two execution processes is a 'link' in the supply chain and the planning goes above those links and manages them.

2.1.3. Application levels of the SCOR model

The model has 4 application levels:

Level 1 (Types of processes): defines the scope and content of the reference model of supply chain operations, it is also at this level that the basis of competition performance goals is defined.

Level 2 (Category of processes): the processes are configured, separating them into different categories, according to the supply chain strategy, this level allows to configure or reconfigure the supply chain.

Level 3 (Elements of processes): allows the detailed definition of identified processes, performance metrics and best practices for each activity. The inter and intra-organizational process elements are also defined, even at this level, the information of inputs and outputs of the process elements are captured.

Level 4 (Implementation): the processes are implemented and must be defined specifically for each supply chain, as it consists of the implementation of specific practices for the company, here the detailed tasks of the Level 3 activities are described. These tasks and their interactions are exclusive to each company, as it aims to achieve competitive advantages and adapt conditions in the business environment.

2.2. The impact of Covid-19 linking to the SCOR model

The impact of Covid-19 affected several supply chains around the world, several countries were completely lost, the topic is recent and it is not possible to measure all impacts, some authors have already managed to identify some impacts on food supply chains, pharmaceuticals, small companies, industries, from Asian, European, and American countries, the presence of the subject in several countries such as Colombia, India, Iran, Malaysia, Canada, United States of America, Kuwait, Brazil and types of segment such as commerce, pharmaceutical, transport, supermarkets, automotive, tourism, oil, construction, communications, shows that few companies were unaffected. Fonseca (2020), Che et al. (2020), Teresa et al. (2021), Rodrigues et al. (2020), Siche (2020), Ayati et al. (2020), Majumdar (2020), Richards and Rickard (2020), Hobbs (2020), Arellana et al. (2020), Konstantinos et al. (2020), Bhaskar et al. (2020), Yu et al. (2020), Singh et al. (2020), Al-Fadly, (2020), Lin and Zhang (2020), Qingbin et al. (2020), Ivanov (2020), GU and Wang (2020), Ray (2020), Hilmola et al. (2020).

Table 1 impacts of COVID-19 on macros SCOR processes

Processes	Impacts	Author
Plan	Low nationalization and local innovation, lack of physical structure to disseminate information about Covid-19 in inland regions such as riverside in the Amazon, change in the design of the supply network, new partnerships, cash flow problems, succession of positions for the top executives, lack of demand forecasting models.	Fonseca, (2020), Rodrigues et al.(2020), Che Omar et al.(2020), Ayati et al.(2020), Konstantinos et al.(2020)
Source	Selection and qualification of suppliers, blockages, lack of products, increase in prices, change in consumption of product categories, closure of suppliers, panic in the purchase of products, change of regulation, lack of labor, restriction of opening hours.	Fonseca (2020), Teresa et al. (2021),Che Omar et al.(2020), Ayati et al.(2020), Majumdar et al.(2020), Richards e Rickard (2020), Hobbs (2020), Bhaskar et al. (2020), Al-Fadly(2020), Qingbin et al. (2020),Gu e Wang, (2020), Zhu et al. (2020).
Make	Overcapacity, stopped machines, change of communication means, remote interactions through technology, change of technology and innovation process, development of local production, suspension of production.	Fonseca (2020),Siche (2020),Che Omar et al.(2020), Ayati et al. (2020), (Majumdar et al.(2020),Bhaskar et al(2020),(Al-Fadly (2020), Qingbin et al. (2020),Ray, (2020),Hilmola et al. (2020),Zhu et al.(2020)
Deliver	Decreased demand, lack of customers, health barriers, contamination of employees, restrictions on exports of products to combat COVID-19 (masks, medical coat, gloves, disinfectants, soap, detergents and alcohol), Change of distribution channel and markets , opening hours restriction, increase in freight price.	Fonseca (2020),Siche (2020),Che Omar et al. (2020), Ayati et al. (2020), Majumdar et al. (2020),Richards e Rickard (2020) , Arellana et al. (2020),Hobbs (2020), Singh et al.(2020),Al-Fadly, (2020),Lin e Zhang, (2020), Qingbin et al (2020), Hilmola et al (2020)

Return	Disposal of fresh products without consumption, fresh products from agroforestry sites, forests, markets. Disposal of contaminated PPE. Location for the installation of waste treatment centers.	Teresa et al. (2021), Rodrigues (2020), Ayati et al.(2020),Yu et al., (2020), Qingbin et al.(2020),Ray (2020)
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In view of the impacts mentioned in table 1, it is evident that pandemics affected companies of all sizes, with different impacts, with companies from more remote regions such as riverside in Amazonas being the most affected due to the lack of structure such as electricity, water, routes and the need to be supplied by distant suppliers and logistics, which is also the way to sell the production of fresh products, which was affected by restrictions leading to the disposal of products, a problem similar to the Canadian market according to Rodrigues et al. (2020), Richards and Rickard (2020), Hobbs (2020). Just as small businesses were impacted by closing suppliers, lack of cash flow, lack of labor and government aid due to difficulties in accessing credit, digitization of large companies like Amazon, will lead to the closure of many companies who do not have the same capabilities to establish an agile supply and distribution network and at the same time invest in online sales channels. Che Omar et al. (2020), Richards and Rickard (2020), Arellana et al. (2020), Al-Fadly (2020), different from these authors Hilmola et al. (2020) points out that logistics and manufacturing companies have less impact and nor should it be the sector with the worst performance during a pandemic, for example the Chinese companies that managed to operate without major interruptions and export and performance were not affected, the same authors also highlight my work the low impact caused by Covid-19 in Northern European logistics operations.

Pharmaceutical companies worldwide are dependent on the supply chain in China and India, even with local production the main inputs are provided by these large countries Ayati et al. (2020), Sharma et al. (2020). A second similar case that shows this dependency is the impact of COVID-19 on the clothing segment, which according to Majumdar et al. (2020) created an unprecedented disruption in the supply chain, where demand, supply and manufacturing have been completely disrupted and unlinked due to blockages in China, the closure of India's borders and the cancellation of purchases by European countries. For Majumdar et al. (2020) the impact of COVID-19 leaves the question of sustainability of companies open, taking into account not only the economic aspects, but the social aspects where millions of people lost their jobs and were left helpless by companies and the government. South Asian clothing chain suppliers are known for their low cost, which have as their background several illegal practices used to keep costs low, complementing this view of supply chains Zhu et al.(2020) states that there is a lack of transparency in supply chains and a lack of information sharing. Large companies are only working on top-tier suppliers, but the other tiers lack sustainable actions.

Most of the analyzed articles present a short, medium and long term view on the impacts of COVID-19, as is the work of Majumdar et al. (2020), Ayati et al. (2020), Richards and Rickard (2020), Sharma et al. (2020), Hobbs (2020), Bhaskar et al. (2020), Zhu et al. (2020) at the same time have something in common that are lean supply chain strategies, while companies increase profits in the short term, reducing inventories also contributed to the most fragile supply chain and vulnerable to events of great magnitude, some actions are proposed by the same authors to mitigate future impacts such as responsiveness and reconfigurability, diversity of suppliers, multiple sources of supply, risk management plans, merger of B2B (Business-to-Business) and B2C (Business-to-Consumer), digitization of supply chains, greater integration of operations, robust stocks as protection against interruptions in the supply chain.

To meet the objective of this work and look for a standard already known and used as a reference in supply chains, being able to measure the impact of COVID-19 in different supply chains in addition to different countries, we will use the SCOR model for this study.

The SCOR structure was analyzed from the perspective of the logistical performance of humanitarian organizations, contributing to the analysis of this study the work of Lu et al. (2016), the same authors reinforce that in the SCOR model there are five performance attributes: reliability, responsiveness, agility, cost and asset management, these are important attributes that for humanitarian organizations, but performance management is a challenge, performance management being a dimension of supply chain maturity management according to Roque Júnior et al. (2019), Lu et al. (2016) recommends the adoption of indicator and performance management as automation of indicators to facilitate the process of precision, documentation and reduce the workload for the logistics team by facilitating the implementation of new indicators, it is also possible to create panels in real time to improve supply chain visibility. According to Ivanov, (2020) it is essential to have a holistic model considering agility, resilience and sustainability perspectives so that it is possible to assess the impacts of changes and survive this challenging environment that COVID-19 has placed.

3. Methods

After the scientific review of the literature on supply chain management in the context of COVID-19, and considered the year 2020 until the month of January 2021. The main research base used for this work was web of Science. For the present study, the principles of qualitative applied research of a descriptive character, an inductive approach method and a single case study procedure method, according to Yin (2015), are applied.

For Marconi and Lakatos (2007), the induction method is a mental process through which, starting from particular data, sufficiently verified, a general or universal truth is inferred.

The analysis unit is a biotechnology company located in Paraná, focusing on the development of diagnostic kits for diseases neglected by large companies, the company has been operating since 1999 in research and since 2011 in the production of diagnostic kits for various diseases such as HIV and HCV and currently produces COVID-19 kits and performs testing of the kits at a central located in the same state. The analysis unit was chosen for the convenience of the researchers and for the relevance of the organization in the fight against COVID-19, being widely recognized by society and the local Government as a reference.

4. Data Collection

Data collection was performed using the questionnaire attached 1, formed by a 5-point Likert scale, with a focus on measuring the intensity of the impact of COVID-19 on the supply chain of the unit of analysis, being considered a scale of 1 to 5, item 1 very weak and 5 very strong, in addition to an open question. To create the criterion of very weak or very strong, the work carried out by Queiroz et al. (2020), Aday and Aday (2020) and Singh et al. (2020). So the five levels are in the table 2.

Table 2 Impact level

Level	Characteristics
Very weak	Suppliers, supplies, production, distribution and means of transport (airports, ports, highways, country borders) operating with restrictions.
Weak	Suppliers, supplies, production, distribution and means of transport (airports, ports, highways, country borders) operating with minimal restrictions.
Moderate	Suppliers, supplies, production, distribution and means of transport (airports, ports, highways, country borders) partially closed, operating with average restrictions.
Strong	Fornecedores, suprimentos, produção, distribuição e meio de transporte (aeroportos, portos, rodovias, fronteiras dos países) parcialmente fechados, operando com restrições severas.
Very strong	Suppliers, supplies, production, distribution and means of transport (airports, ports, highways, country borders) 100% closed.

In order to describe the moment in greater detail in view of the extraordinary scenario in which the research was carried out, the main manager of the company related to the area of Supply and Logistics was chosen to answer the questionnaire. The data collection process also used second sources, such as news available on the organization's website, enabling the triangulation of information according to Yin (2015).

5. Results and Discussion

The impact of COVID-19 on supply chains around the world was very similar, due to the restrictions imposed by governments, such measures impacted several sectors, with small companies being the most affected due to lack of capital, lack of access to credit lines. , lack of manpower, lack of raw materials, capacity to invest in new solutions and digital technologies, companies in regions with restricted energy, water and routes such as riverside in Amazonas, were also very affected, in general, the impact of COVID-19 in smaller companies was more severe than in large companies, such impact goes against the impact observed by the company under study, according to information disclosed by the company under study on its IBMP website (2021), the company increased its labor capacity, at the same time met a great demand for testing making the state of Paraná one of the states with the highest test volume, the representation of the company is 60% of the tests done across the state, passing more than 1 million tests.

In the scientific review, it was possible to perceive a great concern with the food supply chains, most of the works seek to examine these supply chains, such concern of the researchers is linked to the fact that there has never been an event like the COVID pandemic until now -19 that stopped the world and food is highly perishable in many cases cannot be stored and are considered essential, the supply chain and logistics of the studied company has products sensitive to temperature considered perishable, such risk of the operation shows a maturity of the company to be able to operate under pressure, showing maturity in their supply and logistics chains Mundo Logística (2020).

The main impacts on supply chains and international logistics cited in the literature were the lack of labor, lack of raw materials, lack of operating capital and difficulties in supply and distribution, including transportation difficulties due to generalized road closures and lockdown. , the company under study reports the impact of flights from Asia and Europe, which affected the supply operation, but did not stop the company's operation, the company showed maturity by having contracts with suppliers, without having the impact of the lack of product, this fact demonstrates how the Covid-19's impact on companies' logistics operations is diverse, difficult to predict.

5.1. Numerical Results

The data analysis process was carried out using secondary data and a questionnaire. The result of this analysis shows that the company under study showed a great increase in its operations “From the beginning of the year to the end of May, 190 trips have already been made, in the 32 tons of products and equipment and 757 volumes were transported, representing an increase of 221% in trips, 368% in transported weight and 215% more volumes, compared to the same period last year. ” IBMP (2020). Even with the increase above 100%, the company was stable, some factors such as a good relationship with suppliers contributed to the operation to continue operating, a relationship at the level of developing joint projects in search of improvements to processes. Table 3 presents the consolidated results of the questionnaire and secondary data according to each stage of the SCOR model, and shows how it was impacted on the company under study by looking at the macro processes of the SCOR model.

Table 3 Impacted SCOR processes

Process	Impactos
Plan	“There was a significant impact on input prices, especially those that competed with hospital demands, such as gloves, lab coats, hospital supplies, etc. However, as our Institute works with procurement planning and critical input contracts, the impacts were relatively small. ”
Source	“In the supply processes, the main obstacles were related to the number of flights available to receive inputs, mainly those from Europe and Asia.”
Make	“There was little impact on the supply chain for the production processes because the critical inputs are negotiated via contracts and the institute has purchase planning with the main suppliers.”
Deliver	“There was no significant impact on the Institute's distribution processes as we send products dedicated to a central.”
Return	“Não houve impacto significativo nos processos de devolução do Instituto.”

The results of the impact of COVID-19 are not the same over time as shown in figure 1, which will be addressed in the next topic.

5.2. Graphical Results

The impact on supply chains around the world was different for the company under study because it is a Brazilian research company which is dependent on imports, had a weak impact in most of the months analyzed in its supply chain as shown in figure 1, presents in the month March had a moderate impact on the operation and a weak one in the following months, even in the face of the increase in cases of Covid-19 over time, as the pandemic grew and the supply chain began to move closer to one month. routine before the pandemic.

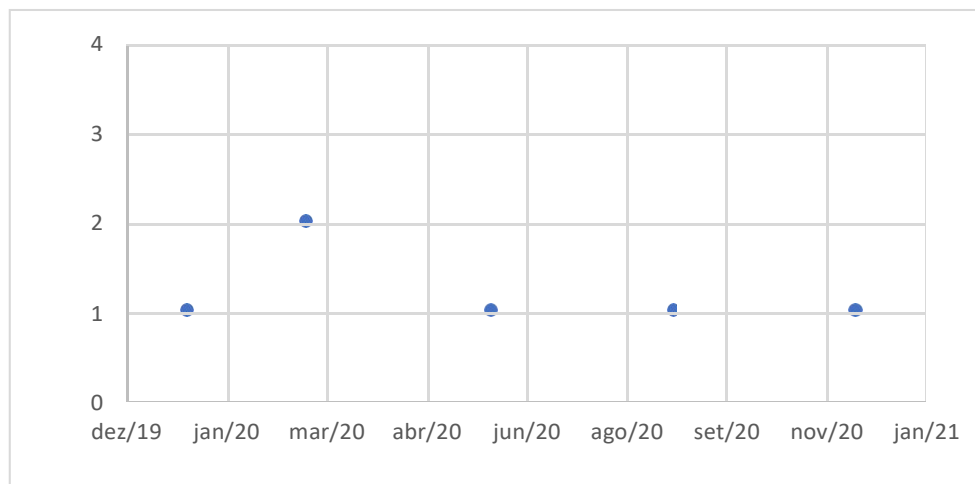


Figure 1- Impact of COVID-19 on the supply chain

5.3. Proposed Improvements

Based on the results found, we recommend actions for the short, medium and long term to be adopted by companies, being:

- For the short term: Alignment of strategic and tactical planning with the execution team, creation of a crisis committee, survey of critical items for the operation of companies, alignment with suppliers for alternative supply, identification of the impacts of the pandemic on the community where the company is inserted and how the company can contribute (food donation, transport resources, storage, PPE, knowledge, labor or health items), review of debts and expenses in the short, medium and long term, liquidity assessment main suppliers, adopting a strategy for new sales and distribution channels.

- For the medium term: Strengthen the transparency of the company's communication with mitigation actions for employees, managers, customers, suppliers and the community, strengthening of multichannel strategies, structured monitoring of the company's debts, development of new products, suppliers and customers. Digitization of supply and logistics operations, application of industry 4.0 concepts, training of employees to develop technological and resilience skills. The review of indicators and metrics to be able to monitor disruptions at their initial level are fundamental based on the organization's experience with the COVID-19 pandemic. The search for suppliers that take into account the principles of social, economic and environmental sustainability.

- For the long term: Review of the risk management plan, review of the cost reduction objective for supply chains, strengthening cash flow for long periods, such as the flexibility to move resources, develop operational, tactical and strategic flexibility for the acquisition, production and distribution of products throughout the supply chain, investment in the automation of the company to adapt to the movement of industry 4.0, create a sustainable supply chain in the economic, social and environmental aspects, carry out shared risk and benefit contracts, development of solid and reliable partnerships, a large investment must be made by companies seeking to nationalize the production of essential goods for the continuity of operations, even in moments like the pandemic of COVID-19.

All the recommendations placed here must be considered looking at the reality of each company, market and country, since the risks and impacts will be affected by the maturity of the supply chain of each company as well as the complexity of the internal and external environments where they are inserted.

5.4. Validation

The validation of the research is in the triangulation of data between literature, questionnaire, and secondary data of the company under study which provides the researchers with transparent information. Such validation process is in accordance with the recommendation of Yin's work (2015).

6. Conclusion

As with all research work, it has limitations, where the first one is related to the time for conducting the research, according to the availability of the company's response, the third was the lack of theoretical framework on the topic, since research on the subject. The vast majority of COVID-19 are focused on health areas and not on supply chain management or international logistics, the few articles available are analyzing a very short time on COVID-19. Despite these limitations, it is possible to recommend actions for company managers in three stages, for a short-term, medium-term and long-term vision. After investigating the impact of covid-19 on supply chains, international logistics and analyzing the company under study which operates with international logistics such as South America, Europe and Asia, we were able to achieve our goal by identifying the impact that was weak throughout the pandemic, to conclude, COVID-19 is an unprecedented event in the 21st century, in terms of supply chains, exposing several weaknesses, breakthroughs and riches not managed by companies and governments and only mature companies in management of supply chains that make investments in this regard can be more resilient in turbulent times.

Our study sought to identify the impact of COVID-19 in particular on one of the companies that acted on the front lines in combating COVID-19, developing, producing and distributing tests and results on contamination in an agile and efficient manner with little impact on its operations, the result of years invested in building a mature supply chain and which can now also be recognized as mature and resilient, so our contribution resolves part of the gap found in the work of Roque Júnior et al. (2019), and opens to doors for new searches. Using the SCOR model, which has been validated and used in the world since 1996, it was possible to identify which part of the supply chains was most affected as well as those that have been most identified in the literature so far as well. To conclude our last secondary objective of this research, actions were identified in the literature and in the company under study that contributed or may contribute to minimize the impact of COVID-19 or other similar pandemics. Our article was the first to analyze the impact of a frontline company in the production of kits and diagnostics for COVID-19, it is also the first article to link the SCOR model with the impacts of the pandemic. It was also the first to mention that the impact on supply chains and international logistics linking low impact to maturity in supply chains, showing that maturity models contribute to companies' resilience, making companies prepared for turbulence.

For researchers, we set up a research agenda for future studies. The research agenda cited here is a recommendation for themes for future study which were not addressed in this work, but were identified as relevant for future studies. The present work failed to answer all the impacts caused by COVID-19, something we are still

experiencing, and unfortunately thousands of people lost their lives to disease and the consequences of immature and unprepared supply chains, thus leaving some questions that remain unanswered. response and precision to be treated urgently by the academic community.

- How should companies be prepared for a new pandemic?
- What are the dimensions of maturity and resilience that companies need to invest to minimize impacts?
- Are the impacts of the companies under study similar or equal to those of other segments?
- Is digitalization a means to minimize the impacts of the pandemic on supply chains?
- How can the sustainability of supply chains minimize the impact of pandemics?
- What were the actions taken by the company to have a weak impact on its supply chain?

All of these questions remain in evidence, we hope they will be investigated soon so that companies' supply chain can be more robust to high impact events.

References

- Aday, S., and Aday, M. S., Impact of COVID-19 on the food supply chain. *Food Quality and Safety*, Vol. 4(4), pp. 167-180, 2020.
- Akkermans, H., Van Wassenhove, L. N., Supply Chain Tsunamis: Research on Low-Probability, High-Impact Disruptions, *Journal of Supply Chain Management*, Vol. 54(1), pp. 64-76, 2018.
- Al-Fadly, A., Impact of covid-19 on smes and employment. *Entrepreneurship and Sustainability Issues*, Vol. 8(2), pp. 629-648, 2020.
- Alicke, P. K., Azcue, X., and Barriball, E., Supply-chain recovery in coronavirus times-plan for now and the future. *McKinsey & Company*, pp. 1-8, 2020.
- Anzai, A., Kobayashi, T., Linton, N.M., Kinoshita, R., Hayashi, K., Suzuki, A., Yang, Y., Jung, S.-m., Miyama, T., Akhmetzhanov, A.R., and Nishiura, H., Assessing the Impact of Reduced Travel on Exportation Dynamics of Novel Coronavirus Infection (COVID-19). *Journal of Clinical Medicine*, Vol. 9(2), pp. 601, 2020.
- Aramuni, J. P. C., and Maia, L. C. G., Analise da adoção do lean manufacturing na gestão de projetos de tecnologia da informação: Estudo de Caso em uma Multinacional desse Segmento. *Gestão & Tecnologia de Projetos*, Vol. 13(1), 85, 2018.
- Arellana, J., Márquez, L., and Cantillo, V., COVID-19 Outbreak in Colombia: An Analysis of Its Impacts on Transport Systems. *Journal of Advanced Transportation*, 2020
- Ayati, N., Saiyarsarai, P., and Nikfar, S., Short and long term impacts of COVID-19 on the pharmaceutical sector. *DARU, Journal of Pharmaceutical Sciences*, Vol. 28(2), pp. 799-805, 2020.
- Ayyildiz, E., and Gumus, A. T., Interval-valued Pythagorean fuzzy AHP method-based supply chain performance evaluation by a new extension of SCOR model: SCOR 4.0. *Complex & Intelligent Systems*, 2020.
- Bai, C., Sarkis, J., Wei, X., and Koh, L., Evaluating ecological sustainable performance measures for supply chain management. *Supply Chain Management*, Vol. 17(1), pp. 78-92, 2012.
- Ballou, R. H., *Gerenciamento da Cadeia de Suprimentos: Logística Empresarial*. Porto Alegre, Bookman, 2006.
- Bhaskar, S., Tan, J., Bogers, M. L. A. M., Minssen, T., Badaruddin, H., Israeli-Korn, S., and Chesbrough, H., At the Epicenter of COVID-19—the Tragic Failure of the Global Supply Chain for Medical Supplies. *Frontiers in Public Health*, Vol. 8(November), pp. 1-9, 2020.
- Bowersox, D. J., and Closs, D. J., *Gestão da Cadeia de Suprimentos e Logística*. Rio de Janeiro, Elsevier, 2007.
- Carraro, E. R., Oliveira, U. R., and Thielmann, R., Estudo e análise para difusão do Modelo de Referência em Operações da Cadeia de Suprimentos (SCOR) nas universidades e organizações. *Revista Valore*, Vol. 5, 2021.
- Che Omar, A. R., Ishak, S., and Jusoh, M. A., The impact of Covid-19 Movement Control Order on SMEs' businesses and survival strategies. *Malaysian Journal of Society and Space*, Vol. 16(2), pp. 139-150, 2020.
- Chowdhury, M. M. H.; and Quaddus, M., Supply chain readiness, response and recovery for resilience. *Supply Chain Management*, Vol. 21, no. 6, pp. 709-731, 2016.
- Christopher, M., and Peck, H., Building the Resilient Supply Chain. *The International Journal of Logistics Management*, Vol. 15, no. 2, pp. 1-14, 2004.
- Davies, G.J., The International Logistics Concept, *International Journal of Physical Distribution & Materials Management*, Vol. 13 No. 1, pp. 47-55, 1983.
- Flightradar24. Live Flight Tracker - Real-Time Flight Tracker Map, Available: <https://www.flightradar24.com/-25.5,-49.29/8>, Mach 31, 2020
- Fonseca, L. M., COVID- 19: outcomes for Global Supply Chains. Management & Marketing. *Challenges for the Knowledge Society*, Vol. 15, pp. 424-438, 2020.

- Frederico, G. F., and Martins, R. A., Modelo para alinhamento entre a maturidade dos sistemas de medição de desempenho e a maturidade da gestão da cadeia de suprimentos. *Gestão & Produção*, Vol. 19(4), pp. 857-871, 2012.
- Ganga, G. M. D., and Carpinetti, L. C. R., A fuzzy logic approach to supply chain performance management. *International Journal of Production Economics*, Vol. 134(1), pp. 177-187, 2011.
- Gomes, L. L. A., Análise de Processos da Área de Planejamento e Controle da Produção em uma Empresa Farmacêutica: Aplicação do Modelo SCOR – Rio de Janeiro: UFRJ/Escola Politécnica, 2020.
- Gu, H. Y., and Wang, C. W., Impacts of the COVID-19 pandemic on vegetable production and countermeasures from an agricultural insurance perspective. *Journal of Integrative Agriculture*, 19(12), 2866-2876, 2020.
- Hilmola, O. P., Lähdeaho, O., Henttu, V., and Hilletoft, P., Covid-19 pandemic: Early implications for north european manufacturing and logistics. *Sustainability (Switzerland)*, Vol. 12(20), pp. 1-13, 2020.
- Hobbs, J. E., Food supply chains during the COVID-19 pandemic. *Canadian Journal of Agricultural Economics*, Vol. 68(2), pp. 171-176, 2020.
- Huan, S.H., Sheoran, S.K., and Wang, G., A review and analysis of supply chain operations reference (SCOR) model, *Supply Chain Management*, Vol. 9 No. 1, pp. 23-29, 2004.
- Impactos do COVID-19. KPMG, Available: <https://home.kpmg/br/pt/home/insights/2020/04/covid-visao-setorial.html>, September 30, 2020.
- Ivanov, D., Viable supply chain model: integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 pandemic. *Annals of Operations Research*, 2020.
- Johnson H.C., Gossner C.M., Colzani E., Kinsman J., Alexakis L., Beauté J., Würz A., Tsoleva S., Bundle N., and Ekdahl K., Potential scenarios for the progression of a COVID-19 epidemic in the European Union and the European Economic Area, *Euro Surveill*, Vol. 25, Issue 9, 2020.
- Júnior, L. C. R., Costa, M. L. N., and Frederico, G. F., Supply chain management maturity and complexity: findings from a case study at a health biotechnology company in Brazil. *International Journal of Logistics Systems and Management*, Vol. 33, no. 1, pp. 1, 2019.
- Kwak, D. W., Rodrigues, V. S., Mason, R., Pettit, S. and Beresford, A., Risk interaction identification in international supply chain logistics: Developing a holistic model, *International Journal of Operations & Production Management*, Vol. 38, no. 2, pp. 372-389, 2018.
- Lima-Junior, F. R., and Carpinetti, L. C. R., Combining SCOR® model and fuzzy TOPSIS for supplier evaluation and management. *International Journal of Production Economics*, 174, pp. 128-141, 2016.
- Lin, B. X., and Zhang, Y. Y., Impact of the COVID-19 pandemic on agricultural exports. *Journal of Integrative Agriculture*, Vol. 19(12), pp. 2937-2945, 2020.
- Lockamy, A., and McCormack, K., Linking SCOR planning practices to supply chain performance: An exploratory study. *International Journal of Operations and Production Management*, Vol. 24(12), pp. 1192-1218, 2004.
- Lu, Q., Goh, M., and De Souza, R., A SCOR framework to measure logistics performance of humanitarian organizations. *Journal of Humanitarian Logistics and Supply Chain Management*, Vol. 6(2), pp. 222-239, 2016.
- Majumdar, A., Shaw, M., and Sinha, S. K., COVID-19 debunks the myth of socially sustainable supply chain: A case of the clothing industry in South Asian countries. *Sustainable Production and Consumption*, Vol. 24, pp. 150-155, 2020.
- Marconi, M. A., and Lakatos, E., *Methodologic científica: ciência e conhecimento científico, métodos científicos, teoria, hipóteses e variáveis*. 5. ed. São Paulo, Atlas, 2007.
- Martins, J.T., Rodrigues, M. V. and Ferreira, T. A., Mapeamento do fluxo logístico fundamentado na metodologia SCOR (Supply Chain Operations Reference): Uma aplicação no setor calçadista. XXI SIMPEP Simpósio de engenharia de produção., 2014.
- Mendes, P., Leal J. E., and Thomé, A. M. T., A maturity model for demand-driven supply chains in the consumer product goods industry, *International Journal of Production Economics*, Vol. 179, pp. 153-165, 2016.
- Miri, F., Shahabi, N., and Asadipour, E., An appraisal of supply chain management maturity in the oil and gas sector of pakistan. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies International*, Vol. 10(10), pp. 1-6, 2019.
- Nikolopoulos, K., Punia, S., Schäfers, A., Tsinopoulos, C., and Vasilakis, C., Forecasting and planning during a pandemic: COVID-19 growth rates, supply chain disruptions, and governmental decisions. *European Journal of Operational Research*, Vol. 290(January), pp. 99-115, 2020
- Okongwu, U., Lauras, M., François, J., and Deschamps, J. C., Impact of the integration of tactical supply chain planning determinants on performance. *Journal of Manufacturing Systems*, 38, pp. 181-194, 2016.
- Oliveira, M. P. V., Modelo de Maturidade de Processos em Cadeias de Suprimentos: Precedências e os Pontos-Chave de Transição, Tese (Doutorado em Administração) - Universidade Federal de Minas Gerais, Belo Horizonte, 2009.

- OPAS. OMS afirma que COVID-19 é agora caracterizada como pandemia. Available: <https://www.paho.org/pt/brasil>, May 2020.
- Patel, A., D'Alessandro, M. M., Ireland, K. J., Burel, W. G., Wencil, E. B., and Rasmussen, S. A., Personal Protective Equipment Supply Chain: Lessons Learned from Recent Public Health Emergency Responses. *Health Security*. Vol. 15, no. 3, pp. 244-252, 2017.
- Qingbin, W. A. N. G., Liu, C. Q., Zhao, Y. F., Kitsos, A., Cannella, M., Wang, S. K., and Han, L., Impacts of the COVID-19 pandemic on the dairy industry: Lessons from China and the United States and policy implications. *Journal of Integrative Agriculture*, Vol. 19(12), pp. 2903-2915, 2020.
- Queiroz, M. M., Ivanov, D., Dolgui, A., and Fosso, W. S., Impacts of epidemic outbreaks on supply chains: mapping a research agenda amid the COVID-19 pandemic through a structured literature review. *In Annals of Operations Research*, 2020.
- Ray, A., Managing supply chain aspects of the COVID-19 pandemic in India. *Indian Chemical Engineer*, Vol. 0(0), pp. 1-6, 2020.
- Revista Mundo Logística, IBMP realizou sua maior operação logística durante a pandemia de covid-19, com planejamento estratégico e gestão de maturidade. Available: <https://revistamundologistica.com.br/noticias>, October, 2020.
- Richards, T. J., and Rickard, B., COVID-19 impact on fruit and vegetable markets. *Canadian Journal of Agricultural Economics*, Vol. 68(2), pp. 189-194, 2020.
- Sanae, Y., Faycal, F., and Ahmed, M., A Supply Chain Maturity Model for automotive SMEs: a case study, *IFAC-PapersOnLine*, Vol. 52, pp. 2044-2049, 2019.
- Sharma, A., Gupta, P., and Jha, R., COVID-19: Impact on Health Supply Chain and Lessons to Be Learnt. *Journal of Health Management*, Vol. 22(2), pp. 248-261, 2020.
- Shekarian, M., Nooraie, R. S. V., and Parast, M. M., An examination of the impact of flexibility and agility on mitigating supply chain disruptions. *International Journal of Production Economics*, Vol. 220, 2020.
- Siche, R., What is the impact of COVID-19 disease on agriculture? *Scientia Agropecuaria*, Vol. 11(1), pp. 3-9, 2020.
- Silva, J. R., Santos, J. P. G., Viana, F. M. F., Oler, J. R. L., and Steward, A. M., Impactos da Covid-19 nas cadeias produtivas e no cotidiano de comunidades tradicionais na Amazônia Central. *Mundo Amazônico*, Vol. 11(2), pp. 75-92, 2020.
- Singh, S., Kumar, R., Panchal, R., and Tiwari, M. K., Impact of COVID-19 on logistics systems and disruptions in food supply chain. *International Journal of Production Research*, Vol. 0(0), pp. 1-16, 2020.
- Slater, A. G., International Logistics Strategies. *Management Decision*, Vol. 15, no. 4, pp. 380-395, 1977.
- Sorbello, M., El-Boghdady, K., Di Giacinto, I., Cataldo, R., Esposito, C., Falcetta, S., Merli, G., Cortese, G., Corso, R. M., Bressan, F., Pintaudi, S., Greif, R., Donati, A., and Petrini, F., Società Italiana di Anestesia Analgesia Rianimazione e Terapia Intensiva (SIAARTI) Airway Research Group, and The European Airway Management Society. The Italian coronavirus disease 2019 outbreak: recommendations from clinical practice. *Anaesthesia*, Vol. 75(6), pp. 724-732, 2020.
- Stefanovic, D., Stefanovic, N., and Radenkovic, B., Supply network modelling and simulation methodology. *Simulation Modelling Practice and Theory*, 2009.
- Stephens, S., Supply chain council & supply chain operations reference model overview, *Supply Chain Council*, Inc, 2001.
- Trkman, P., McCormack, K., De Oliveira, M. P. V., and Ladeira, M. B., The impact of business analytics on supply chain performance. *Decision Support Systems*, Vol. 49(3), pp. 318-327, 2010.
- Vieira, H., Yamada, N., Marins, F., and Salomon, V., Melhoria no desempenho da Cadeia de Suprimentos com apoio do modelo SCOR. Available: https://www.aedb.br/seget/arquivos/artigos07/1076_Melhoria%20no%20desempenho%20da%20Cadeia%20de%20Suprimentos.pdf
- Yin, Robert k., *Estudo de Caso: planejamento e métodos*, Porto Alegre, Bookman, 2015.
- Sangari, M. S., Hosnavi, R., and Zahedi, M. R., The impact of knowledge management processes on supply chain performance: An empirical study. *International Journal of Logistics Management*, Vol. 26(3), pp. 603-626, 2015.
- Yu, H., Sun, X., Solvang, W. D., and Zhao, X., Reverse Logistics Network Design for Effective Management of Medical Waste in Epidemic Outbreak: Insights from the Coronavirus Disease 2019 (COVID-19) in Wuhan. *SSRN Electronic Journal*, 2020.
- Wang, G., Huang, S. H., and Dismukes, J. P., Product-driven supply chain selection using integrated multi-criteria decision-making methodology. *International Journal of Production Economics*, 91(1), 1-15, 2004.
- Wang, X., Zhang, X., and He, J., Challenges to the system of reserve medical supplies for public health emergencies: reflections on the outbreak of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) epidemic in China. *Biosci Trends*, Vol. 14(1), pp. 3-8, 2007.

- Wied, M., Oehmen, J., Welo, T., Conceptualizing resilience in engineering systems: An analysis of the literature. *Systems Engineering*, Vol. 23, no. 1, pp. 3-13, 2020.
- Wu, M., Yang, Z., Sun, J., and Gong, X., Addressing Supply Chain Vulnerability by Supporting Emerging IT: An Analysis Based on SCOR Framework, *2020 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, Singapore, pp. 576-580, 2020.
- Zdravković, M., Panetto, H., Trajanović, M., and Aubry, A., An approach for formalising the supply chain operations, *Enterprise Information Systems*, Vol. 5:4, pp. 401-421, 2011.
- Zhu, G., Chou, M. C., and Tsai, C. W., Lessons Learned from the COVID-19 pandemic exposing the shortcomings of current supply chain operations: A long-term prescriptive offering. *Sustainability* (Switzerland), Vol. 12(14), pp. 1-19, 2020.

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