

Digital Transformation of Supply Chains during Crisis: Covid19

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Abstract

To optimize the process of decision making, supply chain management proposes a set of methods to coordinate the independent actors. However, the difficulty arises once supply chains are treated by different forms of risks, such as natural disasters, weather conditions, terrorist attacks or even global pandemics. This paper, based on an empirical study of supply chain actors, studies the digital transformation of supply chains during global crises. The results of our study show that it is necessary to adapt the digital transformation of supply chain as a solution to global crisis. In order to deal with this problem, a general analysis is necessary to study the effect of pandemics on the supply chain. Thereafter, the appropriate digital systems can be adapted. This paper tries to show new research directions to academics and practitioners in adaption of new digital systems.

Keywords

Digital Transformation, Digitalization, Crisis, Supply Chain

1. Introduction

Apart from being a sanitary crisis, at the economic level, a global pandemic can cause supply chain disruption around the world, causing huge uncertainties in both supply and demand parts of supply chains. On one side, the demand for some products and services can be reduced. On the other side, manufacturers around the world can be faced shortages of raw materials and parts, because of an interruption in the production, disruptions to transportation and labor shortage. In this context, organizations need to start to re-examine their production and service systems based on innovative solutions to not only mitigate the risk of a pandemic, but also to build a resilient supply chain, while continuing to reduce costs and maximizing profits with the objective to remain competitive. The Coronavirus is a reminder of the globalization of the outsourcing of activities, the development of collaborative models (Taghipour, 2009), customer and supplier integration (Mbiatem et al., 2018), the continuous search for competitiveness, and the development and research of new technologies. This made the Supply Chain at the same time the real engine for companies, a distinguishing factor face to face of their customers and one of their greatest risks in case of weakness. The COVID-19 pandemic is a health crisis, but its consequences are also economic.

Today's supply chains are highly sophisticated and innovative and are critical to the competitiveness of many organizations. But their global correlations and interactions make them increasingly fragile on a scale of risk, with more potential fading points and a smaller margin of error to reduce business disruptions and delays (Taghipour, 2014a). Efforts over the years to optimize the supply chain to reduce costs, decrease inventory and increase asset utilization have mainly squeezed out the room and flexibility needed to control delays and disruptions. The COVID-19 pandemic crisis demonstrated that many companies are unaware of how fragile they are to global shocks of abundance because of the relationships within their supply chain.

Advantageously, new technologies and techniques are making their approach, greatly improving visibility and clarity throughout the supply chain and promoting greater resilience and agility, without the collective costs associated with traditional risk management approaches (Ren et al., 2016). The traditional view of the linear supply chain and its improvement for organizations is giving way to digital supply networks, where functional silos are broken down within the enterprise and all parties are connected to the entire supply network, allowing for complete visibility,

responsiveness, participation, agility and improvement (Taghipour, 2014b). Increasingly, these digital supply networks are generated and created in order to anticipate disruptions and reorganize themselves appropriately to mitigate their impact.

In 2016, a study conducted by GT Nexus and Capgemini revealed that 70% of governments had approached projects related to digital change. The document states that by 2021, the general use of data between suppliers, companies and customers will have evolved considerably. Indeed, the field of supply chain has the characteristic of being strongly divided. Both from the actors' point of view (different providers) and from the IT point of view (each one works with its own application). Excellent communication will therefore allow for simplification and fluidity of the information sharing between the different parties as well as the logistic flows (Tliche et al., 2019). Particularly thanks to techniques that allow real-time monitoring of processes. Thus, what brings us to know the supply problems in connection with the covid-19 crisis, and why it is necessary to accelerate the digitalization of the supply chain?

In this paper, first, we will review the literature, then present and analyze the results of our questionnaire, the recommendations, and limitations of the study.

2. Literature review

Today's world has faced unprecedented pandemics (Larson and Nigmatulina, 2009), which have had serious negative outcomes on the company as a whole, but also on the efficiency of operations and supply chain (SC) management (OSCM) business models. Such impacts agitators frequently produce ripple effects (Ivanov 2020). While supply chains around the world have already been suffering from pandemics and epidemics, they have recently been severely impacted by an unprecedentedly disruptive pandemic, namely Covid-19 (Boccaletti et al. 2020), which is being investigated as a new type of coronavirus that is highly contagious with destructive consequences (Ivanov and Dolgui 2020).

2.1 Supply chains and crisis

The pandemic with the new coronavirus SARS-COV (coronaviral disease 2019; formerly 2019-nCoV), an outbreak originally focused in Hubei Province in the People's Republic of China, has spread worldwide. On January 30, 2020, the WHO Emergency Committee reported a global health emergency based on increased case notification rates in China and other countries. Contingency detection rates are increasing daily and can be monitored in real time on the official Johns Hopkins University website. As of mid-February 2020, China is bearing the heavy burden of mortality, while the impact in other Asian countries, North America, and Europe remains low so far.

Coronaviruses are single stranded, enveloped, positive RNA viruses that infect not only humans but also animals. Coronaviruses were first known in 1966 by Bynoe and Tyrell, who noticed the viruses in patients with common colds. Although the COVID-19 pandemic is primarily considered a health crisis, it is also an economic crisis. In the U.S., the industrial supply system has evolved over the years from a local base to a global network of relatively few multinational companies. The evolution of the COVID-19 health crisis proves the vulnerability of the entire industrial and food supply system, offering researchers little opportunity to explore this system and its underlying assets in real time.

COVID-19 has brought the industrial and food supply chain into the public arena as organizations and consumers in the supply chain respond to the health crisis. Consumers have stockpiled products in the face of real and anticipated deficiencies (Hall et al., 2020). Within the supply chain, sudden changes in production-related regulations and demand have led to business disruptions, such as changes in working conditions in processing plants and hampering productivity (Hall et al., 2020; Corkery and Yaffe-Bellany, 2020; Glaa et al., 2014). The negative impacts of COVID-19 on the supply chain have alarmed academics (Govindan et al. 2020) and industry experts (such as Deloitte; Forbes; Business Insider; Fortune; Harvard Business Review; Institute for Supply Chain Management). The COVID-19 epidemic is already having a large-scale impact on OSCM. Fortune (2020), in an article published on February 21, 2020, reported that 94% of Fortune 1000 companies were facing Supply Chain disruptions due to the pandemic (Covid-19). As for Deloitte (2020), the publication argued that the full impact of the epidemic on the supply chain remained unexplored. Past pandemics show valuable information regarding supply chains. The World Economic

Forum - WEF (2020) highlighted the need for organizations and companies to reorient and adapt their supply chains to meet future business challenges. For example, the short-term priority may be "movement of workers" and "transport and production", while in the long term, methods, strategies, and capabilities related to data sharing and digital readiness would be implemented and developed for oversight committees (World Economic Forum - WEF 2020).

In a situation where serious disruptions, such as the global or partial closure of craftsmen, airports operating with severe restrictions, and a lack of medical equipment and supplies, are consigned to the universal supply chains (Ivanov, 2020), many industries such as electronics, automotive, consumer goods, medical equipment, etc., have been affected. Indeed, as China is known as the factory of the world, the disruption of supply chains due to Covid-19 around the world started in China before spreading elsewhere. The significant impact of this challenge requires strong supply chain resilience actions and strategies (Pournader et al. 2020). On the other hand, OSCM responses to such pandemics should include making universal supply chains readier and more integrated for digitalization (World Economic Forum-WEF 2020). Digitization of scientific committees could strengthen and improve quality in the face of pandemic-related disruptions by increasing the flexibility of the model for managing ecological phenomena (Ivanov, 2020) under any circumstances.

Thus, according to (Aldrighetti et al. 2019) it is fair to say that recent improvements have been made in the literature regarding supply chain response. Thus, as well as pandemic operations (Paul and Venkateswaran 2020; El-Nemr et al., 2021), according to (Ivanov 2020), the consequences of epidemics on the supply chain need to be adequately studied and analyzed. To this end, operational management (OM) and operational research (OR) approaches such as complexity and network theories, e.g. Markov chains, Bayesian networks, ecological modeling, network theory (Li and Zobel 2020), also simulation (discrete event simulation, agent-based simulation, system dynamics) (Ivanov 2020), as well as optimization (strong optimization, random programming, mixed linear programming, heuristics, dynamic programming) (Amiri-Aref et al. 2019). All these approaches could bring interesting and relevant elements to address this complex epidemic situation. On the other hand, empirical theories such as dynamic capacities, contingency theory, resource-based visions (RBV), organizational information processing theory (OIPT) with applications to resilience, according to (Dubey et al. 2020) could be used in parallel with OM/OR approaches to examine the impacts of epidemics on the supply chain.

2.2 Digital transformation of supply chains

Within the company, the impacts of digitalization are not limited to the configuration of the supply chain. They also affect business lines and know-how. Within the company, the principle is the same: new forms of organization are being put in place, with the necessary existence of new players guaranteeing the availability of big data practices, data storage and IT architecture. This evolution is the result of changes within the enterprise's ecosystem. Companies are now facing increased globalized competition. To remain competitive and efficient, the digitalization of the supply chain has become mandatory. The benefits and advantages of digital technology for the supply chain are no longer in dispute. The digital supply chain goes far beyond the mere concept: conclusive results are multiplying. For example, Nexans (world leader in cable solutions) is promoting its range of TMS (Transportation Management System) adoption with several objectives: risk control, cost reduction and process automation.

The vast majority of organizations say they are experimenting, to varying degrees, a digital modification of their supply chain, but only a few of them believe they have arrived at a good destination. The wave is thick, of those that shake up the ancient models. According to the "Panorama of Digitalization 2019-2020", carried out by the Supply Chain and Logistics Association (Aslog), 90% of companies are exploring a "direct to Customer" model to cope with the arrival of new competitors, and among them, 40% have already opted for an omnichannel rather than multi-channel approach.

While more complex to implement, it is also the approach that best improves the customer experience and leads to the immediate corollary of this observation: 88% of the companies surveyed see their supply chain evolve, and more than 6 out of 10 say they are experiencing "strong impacts" in areas such as production, warehousing, transport, or customer service.

On the other hand, according to (Jim Kilpatrick & Lee Barter; 2020) "While COVID-19 may be the trigger for organizations to rethink their global supply chain management model and strategy and advance the adoption of digital

supply network models and capabilities, short-term measures will be required to address the immediate challenge. Ridha Derrouiche & Samir Lamouri (2020) believe that the gradual shift to Supply Chain 4.0 fulfills the promise of a more autonomous and flexible enterprise for organizations seeking productivity. These organizations are investing in new mechanisms for automation and empowerment of their means of production. Big data connected objects and artificial intelligence are welcomed at all levels of the production chain. Thus, Ridha Derrouiche & Samir Lamouri assume that the transition to digitalization offers organizations new potential in terms of reducing production costs, inventory management, time savings, among others. Thanks to an optimal tuning of Industry 4.0 solutions (connected objects, collection, and analysis of field data, etc.), companies can now place the customer at the heart of the supply chain by adjusting production to their needs.

(Shiyong et al., 2016) explains in his book that Industry 4.0 places a three-pronged focus on integration across the entire value chain:

- Horizontal integration: throughout the value chain, people and machines communicate in concrete time immediately to the operations center. Organizations are also connected to each other, fostering partnerships and industrial networks.
- Vertical integration: the piloting of systems and subsystems through the reconfiguration and flexibility of production networks.
- Time integration: Throughout the product lifecycle, connected objects record product usage, design data and manufacturing.

(Deniaud et al., 2020) focus on the Transition 4.0 strategy that each link in the supply chain must designate in order to fully maximize it. In this situation, they offer a decision support tool that agrees to prioritize and determine the growth strategy to adopt for a change to Supply Chain 4.0. (Fel et al. 2020) question the role of Industry 4.0 in the repatriation of production to France. They prove that the growth of Industry 4.0 is angry to encourage relocations and recognize both the suitable factors and the obstacles to this movement. They similarly analyze the effects of such an action on the supply chain.

3. Research methodology

We chose a quantitative analysis methodology in this study. The data is collected through a Google Forms survey and distributed on LinkedIn in order to target professionals in the logistics field of business. This analysis will help us get better insights on this field of business, and also allow us to identify the problems, and the behaviors of organizations facing the destabilization of their supplies after the lockdown. After data collection, we will proceed with the descriptive statistics analysis of the variables, this analysis will allow us to identify several relevant information and answer our problematic. And finally, we will analyze different solutions proposals. These proposals will be based on a scientific reflection and combine answers from our questionnaire and elements from articles published in this field, in particular the article “Impacts of epidemic outbreaks on supply chains: mapping a research agenda amid the COVID-19 pandemic through a structured literature review”. The objective of our questionnaire is to find out the negative effects of the pandemic on companies, and how they have tried to solve these problems. Finally, to know what the digitalization of the Supply Chain allows to bring in terms of solutions that ensure the stability of the stocks of the company during the crisis. In order to achieve our objective, we have elaborated a list of short and clear questions addressed to professionals in the logistics business, as well as to all the people in the company who have experienced the stock movements during the first lockdown and de-confinement, in order to define our problem and try to propose appropriate solutions.

4. Research analysis

In order to make the answers to our questionnaire more relevant and meaningful, we decided to target a socio-professional category that has experienced first-hand the movements of stocks during and after the crisis, but we ended up having answers from professionals who haven't had to deal with the stocks movements directly but had relevant information to provide about how the crisis was managed at their company. After distributing the questionnaire on the social network LinkedIn and sending it to our contacts to answer, we managed to collect 47 answers that seemed significant due to the nature of our target. Our participants comprise 14 Buyers, 8 in Supply chain, 6 Suppliers, 7

Sellers, 2 Forwarders, 2 Managers in operations and finally Export Business developer with a subtotal of 40 respondents and accounting for 85% of total responses.

In our analysis, we have made a small distinction between jobs that are directly related to logistics and flow management, and jobs that are not directly related to the supply chain. Based on this distribution, we notice that 85% of our answers come from respondents who have concrete experience in the supply chain field. This will make the obtained answers more relevant to our study. Everyone agrees that the Covid-19 pandemic crisis has disrupted the supply chain, especially at the supply level, this is well expressed by the majority of companies through publications on the web, as well as several articles published, especially the one published by the audit and consulting firm Deloitte on Risk Management and Disruption related to the supply chain. "by Jim Kilpatrick & Lee Barter.

On our part to confirm the existence of the problems and after surveying our target, we had the following results. The majority of responses with a percentage of 87.2% indicate the existence of problems due to the supply chain blockage during and after the first containment. only 12,8% did not have problems during this period.

The majority of respondents (16 answers) have had problems of Delay & Delivery Time, 15 respondents have had a supply & Out-of-stock problems, this means that most of the problems encountered are focused on these issues. but also, we found other problems in the supply chain such as Suppliers problems, production problems, order management, transports costs and customers problems. The majority of respondents (16 answers) have had problems of Delay & Delivery Time, 15 respondents have had a supply & Out-of-stock problems, this means that most of the problems encountered are focused on these issues. but also, we found other problems in the supply chain such as Suppliers problems, production problems, order management, transports costs and customers problems.

The problems of delivery and supply delays are the most frequent problems encountered during and after the lockdown, this is absolutely normal because customers cannot have a visibility on their suppliers that allows them to see production or delivery delays at real time in order to anticipate possible solutions. This brings us back to the connection between the different actors of the supply chain and their performance during crises in general. Through our questionnaire we find that 54.55% of the respondents said that the problems encountered during and after the containment have a great impact on their supply chain, so we have 29 % find that these problems are more or less impacting, and the rest see that these problems do not affect their activity very much. The problems cited by the professionals surveyed in our study, are common problems that always happen in the supply chain, but the Covid-19 pandemic has increased the rate of risk associated with supply chain problems. The traditional method of supply chain management has not been able to mitigate the magnitude of the problems, and the damage is considerable on companies at all levels (Financial, Brand Image, market share ...), hence the need for the generalization of digitalization in the supply chain. This will allow a connection between the different actors of the supply chain and improve visibility, in order to better forecast the possible alternatives (Tliche et al., 2020). Each year companies adopt strategies to reduce their stocking costs throughout the supply chain, they try to calculate their demand based on previous demand and refine the results to have a safety stock that removes the risk of normal fluctuation related to offer and demand (Lebosse et al., 2017).

With the magnitude of fluctuation of offer and demand related to Covid-19, the majority of the companies do not have the capacities to secure their stocks. the parameters of the security stock which were historically developed several times, have to be revised one more time, especially with the succession of crises and the decrease of the performance of the logistic chain to cope with the different problems which are accentuated with the disruption of the demand and the offer at world level.

We notice that the results of our study, show that the professionals of the Supply chain meet problems to minimize the risks supplies and secure their stocks in front of the demand, we have 47,83 % of the respondents stated that their security stocks were not sufficient to counter the fluctuation, against 39,13 % their security stocks were able to cope with the disruption in supply. So, professionals are looking for their part to face the different risks by trying to find some solutions that are workarounds only most of the time or have no use at all. the majority of the professionals (74,47%) questioned in our survey did not find solutions for problems encountered during and after Lockdown. 27.78% of our respondents consider the solutions to deal with the pandemic as definitive and useful to counter disruptions in the supply chain during the crisis, 27.78% consider that these solutions are not sustainable (Loivet et al., 2020) and are just workarounds, we also find that 22.22% consider that the solutions put in place are somewhat

useful and finally 11.11% see that these solutions are not in any way useful for the company. It is noticeable that some of the people surveyed have found solutions to deal with the destabilization of the supply chain, and although they have found these solutions, they judge them to be a little effective or even not useful to solve their problems. The professionals surveyed in our study affirm with a percentage of 87.23% the usefulness of the supply chain in solving the different problems encountered during the covid-19 crisis. This is quite normal because it offers several advantages, increases performance, and removes loopholes. some respondents to our questionnaire have given some answers that we will explain and try to analyze in Table 1.

Table 1. Impact of digitalization of SC during crisis

How digitalization of SC can Help in work during crisis?	Analysis
Blockchain system	Indeed, to talk about the digitalization of the supply chain, we have to discuss the security of information, the servers that will be storing and what someone can hack or take over the system because it can cause huge losses to the company. So, the blockchain That makes it difficult for one user to gain control of, or game, the network.
Digital SCM results in more data, higher planning abilities and shorter reaction times.	The digitization of the SC allows the sharing of data between the actors of the supply chain easily because everyone can access the data in real time, it also offers more capacity for planning and forecasting that helps to minimize the response time to various problems.
Digitalization is good for supply chain, but disruption is more or less in liaison with forecasts accuracy	In fact, forecasts are very important to face the fluctuation of demand and supply, but we must not forget that in order to forecast well it is necessary to consider all the possible variables, so it is necessary to have all the information relative to the market and the suppliers. The digitalization of the supply chain provides these elements in a short time and this makes the reaction of the company and the adaptation of the forecasts to the changing situation faster.
Digitalization is only one component of the supply chain ... It is still in its infancy, and needs to mature... To be followed of course	The digitalization of the Supply chain is in the beginning, this is clear because until now, there are not many research articles on this subject, but with the Covid-19 this subject has become a trend. Let's not forget that almost all companies rely now on information systems, which is the corner stone of future digitalization projects.
Digitalization of the supply chain facilitates access to information, minimizes delays	This is among the advantages of digitalization.
Digitalization would help in our cases of the suppliers were working but the pandemic made them stop, we had to inform our customer as it was direct impact on his production lines	Digitalization allows us to connect customers with their suppliers, which gives us visibility on their production chain to know the delays and to adapt according to changes.
Digitization will give you real time statute on your stock, delivery time and supplier's stock but it can't give you oversight of borders closing unfortunately	A very good point because the macroeconomic environment of companies is very complex. It is difficult to anticipate such measures from governments and their impact on our business.
Digitization will help all the departments of the company to stay in touch and to keep an eye on what they currently have in stock in real time and what is going to miss. So, it will be easier for everyone to anticipate. I think that anticipation is the key in the current context to avoid any disruption due to the virus.	The digitalization of the supply chain allows the anticipation of operational decisions, this is an essential element to avoid problems and reduce their impact.

Even if the digitalization of the logistic chain is in the beginning, it has so far shown an important efficiency	The supply chain has shown its efficiency, but it should be known that there are many areas for improvement such as data security.
I give as an example the Amazon company, which is part of the first generation that uses supply chain digitalization, which allows to reduce delivery times and reduce operating costs in order to reach record production levels.	Amazon is today an example of the efficiency of the supply chain.
It takes less time with digital tools to process orders	Time is money, and digitalization saves time at all levels.
It will give better visibility	
It will make time short, Real time Control	Time is money, and digitalization saves time at all levels, better control of traffic flows.
Makes information accessible	Today living in a world of information, who holds the information holds the power. The digitalization of the supply chain makes access to information easier and makes the company more able to react to challenges.
Timely follow-up of the supply chain and can be automatic follow-up notification to the buyer and supplier when inventory disturbances start to appear	For all logistics professionals, supplier monitoring is a priority because they are responsible for the availability of merchandise, products or raw materials. For this reason, the digitalization of the supply chain for them facilitates several tasks that allow them to negotiate more and have control over suppliers.

5. Conclusion

Accelerating the digitalization of the supply chain is needed to enable the supply chains during pandemics (Taghipour, 2018). In this case, it is essential to adapt more sophisticated simulation techniques (Currie et al. 2020; Cauhois et al., 2017). The impact of the covid-19 crisis on the supply chain, in particular on production systems, confirms that the 4.0 industry and digital manufacturing can play a critical role for SC resilience and ripple effect control (Ivanov and Dolgui 2019), because during the crisis, companies that adopt this digital industrial management mode, which is part of Industry 4.0, are best positioned during the pandemic crisis, and in the planning of future recovery processes (Dubey et al. 2019; Ivanov and Dolgui 2020; Ivanov and Das 2020). We need to strengthen the resilience of the supply chain including through increased SC viability (Ivanov and Dolgui 2020). Due to the problems encountered during pandemic crises throughout history, especially the Covid-19 crisis, and in today's computerized world, we must start to develop the supply chain towards 100% digital. Especially with the arrival of the 5G, digitization will become a necessity in the near future. Researchers need to conduct research on the security of digital tools, as well as the connection of company networks and information systems, because we are on a part of the company that contains sensitive information that can be used by a company's competitors to eliminate it. So, the question is: "is the digitalization of the supply chain secure?".

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