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Risk and uncertainty in supply chains as a consequence of COVID-19 pandemic

Abstract
The paper demonstrates enterprises gathered in supply chains and their condition in under the COVID-19 pandemic. The COVID-19 pandemic is treated here as a black swan phenomenon. The purpose of this paper is to identify the risks and uncertainty in the supply chains being a consequences of the COVID-19 pandemic. The research is based on a literature survey (LS) own research and business management practices. In addition, the authors provide some recommendations for increasing the resilience and robust of enterprises affected by the pandemic.

Keywords: risk, uncertainty, enterprise, supply chain, COVID-19 pandemic, black swan, robust, resilience

JEL classification: D21, D22

Paper type: Research paper

Introduction
Since the end of 2019 year, we have been observing permanent changes in the world and increasing risk and uncertainty in human life and in global supply chains. As we know, the highly-infectious COVID-19 Coronavirus was declared as a global pandemic by the World Health Organization.

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on 11 March 2020 (Armani et al. 2020). Although its exact origins are unknown, the COVID-19 pandemic is believed to have emerged in Wuhan, China in December 2019. A notable number of cases have resulted in hospitalization and even death (Zhou et al. 2020), globally, from the beginning pandemic to 21 January 2022 year, there have been 340 543 962 confirmed cases of COVID-19, including 5 570 163 deaths, reported to WHO (https://covid19.who.int).

The COVID-19 Coronavirus pandemic causes changes in many areas of supply chains execution. Because of pandemic COVID-19 there has been a shift from medium level of risk through high level of risk to very high level risk and uncertainty of many supply chains. This is called world pandemic.

The Coronavirus can be treated like a “Black Swan” event because this unexpected and hard-to-predict event was not within the range of normal expectations of managers. The concept of Black Swan events was developed by Nassim Taleb. As we can read in his 2007 book entitled The Black Swan, The Impact of the Highly Improbable a black swan event has three attributes: “First, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme impact (unlike the bird). Third, despite its outlier status, human nature makes us concoct explanations after the fact, making it explainable and predictable.” (Taleb 2007).

In a global business environment characterized by high complexity and uncertainty enterprises are forced to manage their supply chains effectively in order to increase efficiency and reactivity under the black swan event. The Covid-19 pandemic has highlighted weaknesses in the management of supply chains that have never suffered such disruptions before. Moreover, the supply chains were not even prepared for them. The outbreak of the pandemic stopped the import of many key components to countries all over Europe and beyond. This forced many entrepreneurs to take violent measures to maintain the continuity of production. As a result, it should be expected that some entrepreneurs will remodel their supply chains and approach risk management with greater care. They should undertake joint efforts to reduce potential threats in a globalized and post-pandemic world. It will entail substantial changes in the implementation of production processes and in the functioning of all supply chains.

Therefore, this chapter attempts to identify the risk and uncertainty of supply chains under COVID-19 pandemic in the context of already existing research in literature, as well as to identify key challenges that managers in the supply chains may face, in particular in the design and implementation of new redefined supply chains. In the summary, we will present the conclusions and propose directions for future research in this area.
1. Key elements of supply chains environment

Supply chains in recent years have acquired a comprehensive character, becoming the key elements of the competitiveness of many companies. Their interconnected, global nature also makes them increasingly vulnerable to a range of threats and failures. Decades of efforts to optimize supply chains to minimize costs, reduce inventory and increase resource utilization have resulted in reduced flexibility in mitigating delays and disruptions (Jüttner 2005). Although unpredictability and volatility have long been a consideration in logistics and supply chain management, the current situation shows that many organizations may overestimate their resilience to global shocks and changes in the supply chains. Disruption of any part of the value chain can affect the company’s ability to continue the process, deliver goods to the market and provide key services to customers.

Over the last 20 years, supply chain management has become a more sophisticated discipline. To cope with such turbulences and the changes inherent in today’s supply chains, great attention, both in practice and research, has been given to strategies that minimize supply chain risks (Bakshi and Kleindorfer, 2009; Hendricks et al., 2009; Kern et al., 2012; Sodhi et al., 2012; Wieland, Wallenburg 2012, 2013). The fundamental vision has been to create an integrated approach to a company’s end-to-end supply chain, from the furthest upstream suppliers to its end customers, with participants working in concert toward common goals. Through practices such as lean manufacturing, outsourcing, and supplier consolidation, companies have made tremendous progress in achieving that vision. For many companies and their customers these efforts have led to lower costs, higher quality, shorter time to market, and increased business agility (Marchese, Paramasivam 2013).

In mid-2012, Deloitte Consulting LLP surveyed 600 executives at manufacturing and retail companies to understand their perceptions of the impacts and causes of these risks, the actions they are taking to address them, and the continuing challenges they face. Respondents represented large and small companies in a variety of industries, and from countries around the globe, with the majority located in North America, Europe and China. The Deloitte report "The Ripple Effect - How manufacturing and retail executives view the growing challenge of supply chain risk" identified over 200 significant sources of risk in the supply chain, grouped into four main categories related to (Marchese, Paramasivam 2013):
1) internal operations - from production design to distribution and returns; 
2) the extended supply chain - cooperation with partners on the supply and distribution side as well as with logistics service providers; 
3) the macro-environment - covering the effects of a wide variety of economic, political, environmental, social and technological events - such as the current COVID-19 situation; 
4) functional support, e.g. in the areas of finance, human resources, legal or, in particular, IT, the limitations of which may lead to many problems, from the lack of required specialists to non-compliance with regulations and disruptions in the flow of key operational data.

The survey's key findings in the report include that supply chain risk is a strategic issue. There are now more risks to the supply chain and risk events are becoming more costly. As a result, 71 percent of executives said that supply chain risk is important in strategic decision making at their companies. Margin erosion and sudden demand changes cause the greatest impacts. The most common and the most costly outcomes of supply chain disruptions are erosion of margins and an inability to keep up with sudden changes in demand, which illustrates the extent to which the supply chain risk issue affects the "heart of the business." Most concern about extended value chain. Executives surveyed are more concerned about risks to their extended value chain - outside suppliers, distributors, and customers - than about risks to company-owned operations and supporting functions. Supply chain risk management is not always considered effective. Two thirds of companies have a supply chain risk management program in place, but only half the surveyed executives believed those programs are extremely or very effective. Companies face a wide variety of challenges. Executives cited a wide variety of challenges including problems with collaboration, end-to-end visibility, and justifying investment in supply chain risk programs, among others. However, no single challenge stood out, indicating the need for broad approaches. Many companies lack the latest tools. Current tools and limited adoption of advanced technologies are often constraining companies' ability to understand and mitigate today's evolving supply chain risks (Marchese, Paramasivam 2013).

2. The impact of COVID-19 – as a black swan event on the supply chains

The growing interest in the supply chains management, especially in the area of risk and uncertainty management under COVID-19 conditions results in a growing of articles and reports dedicated to it. As we know,
global supply chains are one of the key elements of the economy. Any disruptions in their functioning may have consequences for the global economic and financial situation - earlier it could be observed, among others, in 2002 SARS, 2003 “bird flu” H5NI virus, 2009 the “swine flu” H1N1, in 2011, after the earthquake and tsunami in Japan, or after the catastrophic floods in Thailand in 2011 and 2012, and in 2013 Ebola virus. The full impact of COVID-19 is of course still unknown, but one thing is certain - what we are now observing will certainly be felt by global supply chains, from raw materials to finished products. We can formulate a question: could the COVID-19 pandemic be an event that will force many companies and industries to rethink and transform their supply chain model?

As we know, on one hand outbreaks of SARS (2002-2003) the “bird flu” H5NI virus (2003-2007), the “swine flu” H1N1 virus (2009), MERS (2012+), and Ebola (2013-2016) resulted in numerous studies on management of risk and uncertainty. These studies identified the need for improved global risk management systems and procedures and additionally have recommended specific measures to rapidly detect, communicate, and control the threat of such pandemic. On the other hand modeling studies of global economic impact have also been done using virus pandemic scenarios with different degrees of virulence (disease severity) and infectiousness (ease of transmission) (Verikios et al. 2011). The prepared models show significant economic impacts, driven by factors such as reduction in global tourism, workers staying at home to avoid infection, and supply chain interruptions as different regions are affected at different timings (Murphy et al. 2020).

The Global Risks Report 2021 year warned of potential knock-on economic risks that are now clear and present dangers in many area of life and economics. Supply chain disruptions, inflation, debt, labor market gaps, protectionism and educational disparities are moving the world economy into choppy waters that both rapidly and slowly recovering countries alike will need to navigate to restore social cohesion, boost employment and thrive. These difficulties are impeding the visibility of emerging challenges, which include climate transition disorder, increased cyber vulnerabilities, greater barriers to international mobility, and crowding and competition in space. The Global Risk Report 2022 17th edition identifies tensions that will result from diverging trajectories and approaches within and between countries and then examines the risks that could arise from such tensions. This year’s report also highlights the implications of these risks for individuals, governments and businesses (GRIR 2022).
Risks of global chains arise from many internal and external factors. Some are related to macro trends - with the increasing globalization of supply chains and the increasing importance of the links between them, chains become more and more susceptible to disruptions. Other risks arise from the continued drive to improve efficiency and reduce operating costs. It is typical for supply chains be faced with the pressure of maintaining short lead times and low costs. Relying on a small number of suppliers can heighten risk of SC disruption in unexpected circumstances, as seen with the global COVID-19 pandemic.

In table 1 we present the most frequently risk and uncertainty in the supply chains as a consequences of COVID-19 pandemic cited in the literature and in the supply chain practice.

### Tab. 1. The risk and uncertainty in the supply chains during COVID-19 pandemic

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Potential Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>lack of staff</td>
<td>delays in procurement</td>
</tr>
<tr>
<td>cyberattacks</td>
<td>cancelled orders</td>
</tr>
<tr>
<td>increasing demand for goods</td>
<td>production outbreak</td>
</tr>
<tr>
<td>low quality of goods</td>
<td>delays in payment</td>
</tr>
<tr>
<td>increasing lead times</td>
<td>changing in routing</td>
</tr>
<tr>
<td>increasing transportation lead time</td>
<td>bankruptcy of the supplier</td>
</tr>
<tr>
<td>increasing transportation cost</td>
<td>increasing purchasing cost</td>
</tr>
<tr>
<td>reduced demand in the transportation sector</td>
<td>delays in cash flow</td>
</tr>
<tr>
<td>bankruptcy of the client</td>
<td>language barriers</td>
</tr>
</tbody>
</table>

Source: own elaboration
The operations of many organizations and enterprises gathered in the supply chains have been severely disrupted as the outbreak spread around the globe, impacting both supply and demand (Ivanov 2020). The unprecedented nature of the pandemic has meant that businesses had no prior planning and were exposed to significant risk. A survey conducted by Ernst & Young in 2019 found that of 500 senior board members globally, only 20% of the executives were confident that their companies were prepared to respond to a large adverse risk (Ernst and Young 2020). While most short- or medium-term impacts of COVID-19 can now be identified, the long-term impacts still remain uncertain. The pandemic has broken many global SCs (Araz et al. 2020), particularly for organizations with lean and globalized SC structures. In fact, it was reported that 94% of the Fortune 1000 companies have experienced COVID-19-driven SC disruptions (Sherman 2020; McMaster et al. 2020).

Another report shows that 95 percent of respondents of McKinsey & Company Report 20201 say they have formal supply chain risk management processes. A further 59 percent of respondents say they have adopted new supply chain risk management practices over the past 12 months. A small minority (4 percent) set up a new risk management function from scratch, but most respondents say they have strengthened existing capabilities. The actions taken by companies gathered in supply chains varied according to the pre-crisis maturity of their supply chain risk management capabilities. Companies with little or no risk management experience tended to invest in new software tools, while higher-maturity organizations mainly focused on the implementation of new practices (McKinsey 2021).

Additionally, we can read in the report that 92 percent of respondents claim that they improved resilience through physical changes to their supply chain footprints. As we can read in the report almost 90 percent of respondents expect to pursue some degree of regionalization during the next three years (McKinsey 2021). Could it lead to generalize new models such as lead to shorter value chains (i.e. increased local or regional sourcing)? Certainly, moving away from the “just in time” or “made-to-order” business models will have an impact on trading and transport patterns.

The proactive monitoring of supplier risks was the primary focus of these efforts. Over the past year, supply chain leaders have taken decisive action in response to the challenges of the pandemic: adapting effectively to new ways of working, boosting inventories, and ramping their digital and risk-management capabilities. Supply chains remain vulnerable to shocks and disruptions, with many sectors currently wrestling to overcome supply-side shortages and logistics-capacity constraints. In many sectors, there are signs that the rate of investment in digital supply-chain technologies is slowing down. Talent gaps are wider than ever, end-to-end transparency
remains elusive, and progress toward more localized, flexible supply-chain structures has been slower than anticipated (McKinsey 2021).

The pandemic has been a catalyst for further digitization of end-to-end supply chain processes. An overwhelming majority of survey respondents say they have invested in digital supply-chain technologies during the past year, with most investing more than they originally planned. While automotive and commodity players were reluctant to commit to additional investments amid the uncertainty of early 2020, for example, 100 percent of the respondents in those sectors eventually did so. Almost every company also plans for further digital investment in the future. Construction is the only sector in which respondents say they are less likely to invest in digital supply chain technologies in the coming years (McKinsey 2021).

In practice, companies were much more likely than expected to increase inventories, and much less likely either to diversify supply bases (with raw-material supply being a notable exception) or to implement nearshoring or regionalization strategies. Different industries have responded to the resilience challenge in markedly different ways. Healthcare players stand out as resilience leaders. They applied the broadest range of measures, with 60 percent of healthcare respondents saying they had regionalized their supply chains and 33 percent having moved production closer to end markets. By contrast, only 22 percent of automotive, aerospace, and defense players had regionalized production, even though more than three-quarters of them prioritized this approach in their answers to the 2020 survey. Chemicals and commodity players made the smallest overall changes to their supply chain footprints during the past year (McKinsey 2021).

Disruptions in the functioning of global supply chains have become an impulse to conduct research among entities located in Poland by the authors. The purpose of the research is to identify the key reasons for intensifying activities around risk management in the supply chains. In the research 137 enterprises have taken a part, including 118 with foreign capital. The research showed that the continuity of supply chains in Poland was not maintained, and companies were able to keep inventories only at a minimum level. As a result of the disruptions, many entities decided to reevaluate their activities, moving some of them to the network, in particular in terms of sales and customer service. The research also analyzed the impact of remote work on the effects of the functioning of enterprises and assessed the effects of support under anti-crisis shields. Among the most frequently mentioned by respondents were: (1) staff shortages related to the presence of some staff in quarantine and carers’ leave, (2) insolvency of contractors, (3) delays in payments, (4) reduction in demand for goods offered. The pandemic has an impact on the continuity of the supply chain. In this area, respondents mainly pointed to: (1) problems
with supplies from abroad, (2) the need to keep inventories at the lowest
level, (3) rupture of supply chains – lack of supply, (4) delays in deliveries,
(5) disruption of supply chains – failure of the supplier. In order to mitigate
the effects of the Covid-19 pandemic for many entrepreneurs,
the government has developed a project called anti-crisis shield. Among
the surveyed companies, slightly more than a half - 54% received aid under
the Government Anti-Crisis Shield, but it must be admitted that this aid
was much more often obtained by enterprises that conducted production
or trade activities. From the Crisis Shield Report. A lifeline for companies
and the economy? (Dębkowska et al. 2021) shows that 86% of the surveyed
enterprises were beneficiaries of the solutions available in the anti-crisis
shield. Most of them (92%) used more than one support instrument.

3. Conclusions

The unpredictability and instability of the supply chain environment
are becoming commonplace in logistics and supply chain management.
Therefore, supply chains need to be more dynamic, smarter and better
informed than ever in the past in order to be able to reduce and mitigate risk.
New technologies of Industry 4.0 such as the Internet of Things, Cloud,
5G, AI and robotics are key to enabling the necessary changes
that will secure the functioning of organizations around the world.
An unstable business environment makes this all the more necessary.
With the multifaceted nature of today’s risks, piecemeal solutions
and one-off initiatives are no longer sufficient. Instead, companies should
aim to take a more holistic approach to managing supply chain risk
and achieve greater visibility, flexibility, and control. In the long run,
the key will be to build a “resilient” supply chain that not only seeks
to reduce risks but also is prepared to quickly adjust and recover
from any unanticipated supply chain disruptions that occur. Such supply
chain resilience is quickly becoming a fundamental requirement. With today’s
complex, global supply chains, risk cannot be eliminated-and having
the ability to quickly bounce back from problems and continue business
operations as efficiently as possible will likely be integral to remaining
competitive.

We are now in the fifth wave of pandemic, the coming months could turn
out to be critical for supply-chain leaders. We can assume that some
companies will build upon the momentum they gained during the pandemic,
with decisive action to adapt their supply-chain footprint, modernize
their technologies, and build their capabilities. Others companies may slip
back, reverting to old ways of working that leave them struggling to compete
with their more agile competitors on cost or service, and still vulnerable
to shocks and disruptions.
Based on the literature, published report and own research we can state that: companies that are better prepared than others have developed and implemented a supply chain risk management process and have business continuity assurance strategies. The supply chains of these companies are geographically diversified to reduce supply-side risk from any country or region. The companies use key raw materials or products from multiple sources to reduce dependence on a single supplier. Additionally, they have inventory strategies in place to protect their operations from supply disruptions in their supply chains. built strong relationships with key suppliers and implemented systems that ensure high visibility of supply networks to better understand their risks and carry out specific actions based on their priorities. They maintain the agility of their processes and production and distribution networks so that they can quickly reconfigure and maintain supply in response to global demand. These companies are investing in supply chain planning and control tower solutions to better detect and respond and even anticipate supply chain problems.

**Literature**

5. Ernst and Young. 2020. Nearly 80% of Board Members Felt Unprepared for a Major Risk Even Like COVID-19: EY Survey