
Disruptions and Risk Management in Supply Chains Before and During the COVID-19 Pandemic

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Abstract:

Purpose: The article presents an analysis of the weaknesses of the current approach used in risk management during the COVID-19 pandemic. Referring to the previous (pre-pandemic) theoretical considerations, an assessment of the activities applied in companies is presented.

Design/Methodology/Approach: The first part of the article presents the theoretical aspects of risk management. The next part is discussing the survey results. The final part presents the effects of the COVID-19 pandemic and the details of changing attitudes towards the sphere of risk management.

Findings: Despite numerous literature studies, problems related to risk management have been marginalized for decades. This is confirmed by, for example, surveys. COVID-19 has forced a radical change in attitude to issues related to risk management.

Practical Implications: The directions of changes in the area of economic policy at the EU and US level as well as changes in the attitude of managers were indicated.

Originality/Value: The paper shows the scale, direction and intensity of changes under the influence of the COVID-19 pandemic.

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1. Introduction

The pre-pandemic literature on risk management in supply chains most often pointed to such sources of threats as terrorist attacks, legal and political instability in some countries, or the risk of disease in distant, even exotic parts of the world. This concerned diseases with little or no impact on societies in Europe or North America. The outbreak of the COVID-19 pandemic and Russian aggression against Ukraine have translated into a radical change in the rules of the game.

COVID-19 has become a global pandemic, the scale of which surprised most experts (with the exception of Bill Gates, who is already predicting further cataclysms). It also turned out that in the case of most companies, the previously used solutions turned out to be insufficient. COVID-19 has hit the automotive, electronics and transportation industries hard. No doubt it will have strategic implications for companies and governments of many countries in the future. The article presents an analysis of the weaknesses of the current approach.

2. Risk Management in Supply Chains – Theoretical Background and Practical Implication

Supply chain disruptions are considered as a combination of an unforeseen triggering event and the resulting consequences which jeopardize the flow of material and normal business activities significantly (Wagner and Bode, 2006). Supply chain risk has been defined as an unplanned and unexpected incident that disrupts the flow of goods or provision of services within the supply chain (Scholten *et al.*, 2019).

Disruptive triggers can be categorized into natural (earthquake, floods, fire, etc.) and man-made triggers (terrorist attacks, accidents in sea, road, rail and air transport or warehousing, supplier or other business partner bankruptcy, etc., and in the case of accidents their occurrence is usually a derivative of many factors, e.g., unfavorable weather conditions and human errors or negligence) (Fahimnia *et al.*, 2015).

Consequently, supply chain risks can be classified into operational and disruption risks (Craighead *et al.*, 2007). Operational risks are referred to the inherent uncertainties such as uncertain customer demand, supply and cost. These uncertainties are inherent in business operations. It is practically impossible to avoid them, but the scope of the impact is quite limited, and additionally careful planning allows to reduce the negative effects of these uncertainties.

Disruption risks are referred to the major disruptions caused by disasters such as earthquakes, floods, hurricanes, outbreak of a pandemic, terrorist attacks, sudden economic crises or strikes paralyzing e.g. transport in a given country. It may be also related to the outbreak of war. In most cases, the business impact associated disruption risks is much greater than that of the operational risks (Tang, 2006).

The reason is the limited scope of operational risk, against the background of disruption risks, which may adversely affect the functioning of the entire economy. Well documented disruption triggers have been for example the Hurricane Mitch, and the Taiwan earthquake in 1999.

In 2017, Hurricane Harvey, with an estimated damage of over 125 billion USD the costliest tropical cyclone on record, not only knocked out 11% of US oil refining capacity and 25% of oil production from the US Gulf of Mexico, but also shut down 90% of the country's capacity to produce and ship base plastics (Bugert and Lasch, 2018). According to the 2017 Supply Chain Resilience Report from the Business Continuity Institute, which surveyed over 400 companies from 65 countries, 65% of the participants had experienced at least one supply chain disruption that year (Alcantara *et al.*, 2017).

Research suggests that economic, political, and social developments are increasing the risk of supply chain disruption, particularly as supply chains get longer and more complex and involve more partners owing to the increase in global sourcing (Hendricks and Singhal, 2005). This was reflected in many theoretical models. The seemingly relentless pressure of globalization has produced a paradigm shift in supply chains, where companies seek to locate manufacturing based on low operating costs and also the outsourcing of their non-core activities to concentrate on areas with opportunities to build better competitive advantages (Vakharia and Yenipazarli, 2008).

Over the years many enterprises have relied to an increased degree on global supply networks in pursuit of delivering products and services to customers at lower costs. They have also adopted lean systems models to optimize their supply chains, which often means retaining lower inventories (Craighead *et al.*, 2007). The move toward a lean supply chain to obtain supply chain efficiencies has resulted in a loss of "slack" capacity and more interdependent links within the chain. Thus, it is likely that even a small "glitch" at one stage in the chain could result in a significantly larger effect (Vakharia and Yenipazarli, 2008).

Over the past 2-3 decades, supply chains have lengthened and expanded. One of the reasons was China's accession to the World Trade Organization in 2001. As a consequence of many intensive activities undertaken by both the authorities of this country and the management boards of global corporations, China has become the so-called "the factory of the world". Many products previously manufactured in developed countries began to be manufactured in China and then shipped to customers in Western Europe and North America.

The risk of supply chain disruptions has increased over the last decade due to the progress of globalization as well as outsourcing and an intensified focus on efficiency and lean management (Bugert and Lasch, 2018). Complex networks become more vulnerable to severe disruptions, which change the supply chain

structures. Because of that organizations have worked over the years to develop efficiencies to their global or international supply chains, which includes efforts to reduce costs, consolidate suppliers and distributors, better manage inventory, develop efficiencies in packaging, storage, and shipping of product, as well as utilizing digital solutions to manage logistics (Black and Glaser-Segura, 2020). The ability to manage and control risk become a key aspect of effective supply chain management.

3. Research Methodology and Empirical Results

Risk management has become an important issue over the last years as many organizations have experienced threats to their supply chains emerge, such as government tariffs (e.g., U.S.-China tariffs) or Brexit (Black and Glaser-Segura 2020). In this case, the most frequently used method (usually providing sufficient insight into the situation of the analyzed entities) was direct talks (interviews) with trade managers, company owners and their accountants.

However, when analyzing threats to flows in supply chains, the causes of which also apply to other areas of activity, a different approach was chosen. The survey conducted by the author of the article prior to the outbreak of the pandemic on a group of 426 enterprises being located in Poland showed that only 40 entities managed the risk, representing 9,4% of the total sample. These numbers contradict most of the theoretical considerations. The most common approach was to respond to a supply chain disruption only when it occurs. The data obtained in the group of 426 enterprises showing in detail the tools used to reduce risk, the results are presented in two tables.

Table 1. Risk management areas in the surveyed companies

Fields of activity in risk management area	Number of companies
Risk monitoring and control	17
Focusing on prevention and counteraction	8
Risk assessment	7
Creating risk reduction plans	5
Transfer of risk to external companies (outsourcing)	3

Source: Own study.

Table 1 shows the declared areas of activity in the field of risk management. These are classic, even textbook cases of approach to this area, based on risk monitoring and control, prevention, risk assessment and creating risk reduction plans.

Table 2. Sources of expected and observed risk in surveyed companies

	Low	Medium	High
Problems in communication (cultural differences, language)	21%	37%	42%

Changes in the political, economic, technological, social, legal environment	23%	46%	31%
Untimely, incomplete or inadequate quality of delivery	44%	36%	20%
Increase in costs of operating activity	64%	18%	18%
International purchasing disturbances	58%	32%	10%

Source: Own study.

Table 2 presents answers to questions about the scale of risk for individual threats. The surveyed companies were to indicate how important in their opinion the selected threats are. In retrospect, it can be seen that the main concerns concerned issues that were completely irrelevant in the time of the pandemic. Only 18% rated probability of cost increase as potentially dangerous, and 10% felt a high threat to the stability of deliveries from other countries.

Going further, during the pandemic Polish enterprises focused on a radical increase in the level of inventories, which would secure the continuity of activities. Detailed quarterly data on GDP growth in Poland in 2021 and the first quarter of 2022 indicated an excessively large increase in inventories in enterprises. These were even increases of several dozen percent compared to the last year and even the previous quarter.

In this way, companies protected themselves against disruptions in the supply of raw materials and components. In the first quarter of 2022, inventories in enterprises in Poland increased by PLN 65.7 billion (the highest quarterly increase in history) compared to an increase of PLN 46.9 billion in the fourth quarter of 2021 and PLN 99.3 billion in the entire 2021 (Credit Agricole). The contribution of the increase in inventories to economic growth (GDP) in Poland increased from 4.3 percentage points in the fourth quarter of 2021 to 7.7 points in the first quarter of 2022, being at the highest level in the history of data available to the bank presenting this data.

4. Theoretical Aspects of Supply Chain Management on Pandemic Days

Epidemic outbreaks are a special case of supply chain risks which is distinctively characterized by a long-term disruption existence, disruption propagations (i.e., the ripple effect), high uncertainty, and simultaneous disruptions in supply, demand, and logistics. Unlike other disruption risks, the epidemic outbreaks start small but scale fast and disperse over many geographic regions (Ivanov, 2020). The research on the impacts of pandemics on supply chains is nascent and still emerging (Ivanov and Dolgui, 2020).

There is limited risk assessment examining supply chain management under a pandemic situation such as COVID-19 for which effects are global and longer-lasting rather than regional and episodic ones (e.g., a tsunami, earthquake, or natural

disaster), with the core of the research remaining in logistics literature (Queiroz *et al.*, 2020). The reason is obvious. The last pandemic was over 100 years ago.

The 1918 influenza pandemic, also known as Spanish flu was an exceptionally deadly global influenza pandemic caused by the H1N1 influenza A virus. Nearly a third of the global population had been infected in four successive waves (Nickol and Kindrachuk, 2019). Spanish flu claimed between 50 and 100 million deaths. Their exact number is not known due to the avoidance of providing data on this subject. At that time, the First World War was taking place and, as part of the war censorship, the public was not provided with real information on this subject.

Estimates of deaths range from 17 million to 50 million, and possibly as high as 100 million, making it the second deadliest pandemic in human history after the Black Death bubonic plague of 1346–1353 (Tsoucalas *et al.*, 2016). Over the past decade, the world has been challenged by unprecedented emerging infections disease outbreaks, such as Ebola, influenza, MERS, SARS. However, their scope and impact on the economies of developed countries was imperceptible.

The disruption of COVID-19 extends over many countries, industries, and supply chains. The disruption is fluid in nature as it moves in waves from region to region and from one type of supply chain disruption to another. Moreover, the duration of the combined disruptions is undetermined and may endure for an extended period ranging from one year to several years (Black and Glaser-Segura, 2020).

5. Examples of Disturbances Caused by COVID-19 Pandemic

Recently, due to the COVID-19 pandemic, supply chains have experienced unprecedented significant disruptions. It has occurred on a global scale and created a rapid disruption in the supply chain both up-stream and down-stream and most organizations had not considered all the risks (Handfield *et al.*, 2020). A study by PwC, SpotData and the CBM research company showed that in the spring of 2020, i.e., during the first wave of COVID-19, disruptions in the supply chain were experienced by 31.7% of Polish enterprises (Achramowicz, 2021).

In the U.S. alone, an estimated 94% of Fortune 1000 companies have experienced supply chain disruptions due to COVID-19 (Black and Glaser-Segura, 2020). Research conducted in Poland on a group of over 1.1 thousand companies shows that during the pandemic more than half of them experienced disruptions in the supply chain. Delays in deliveries (45%), logistical problems (34%) and restrictions in international trade (24%) were among the main reasons (Achramowicz 2021). 51,000 companies worldwide, 163 of which are in the Fortune 1000, have one or more direct or tier 1 suppliers in the impacted Wuhan, China region (Smith, 2020). 73% of U.S. organizations experienced problems in their supplier base, and 75% had problems with their production and distribution (Black and Glaser-Segura, 2020).

Other industries experienced even more disruption. Overall, due to COVID-19 multiple sectors (e.g., manufacturing and logistics) across the globe have experienced severe disruptions, which have impacted global supply chains at unprecedented levels (Ivanov and Dolgui, 2020). Large losses were also recorded by air and coach carriers, retailers, travel agencies, hotels and gastronomy.

In the field of logistics, the first noticeable effect of COVID-19 was the extension of delivery times. The longer lead times for deliveries based on Chinese exporters were the result of measures taken by certain regions of the country to contain local COVID-19 outbreaks. Freight problems are illustrated by the global 40-foot container freight rate index. Prices rose to \$ 10,323 in August 2021 from \$ 1,946 in 2020. The automotive industry faced exceptional problems (blocked supplies of electronic parts imported to Europe from Asia).

An example is the stoppage of production at Skoda's factories in the Czech Republic. After a difficult pandemic year 2020 (when the Czech Republic was one of the worst-hit countries in the world for a while), it seemed that the car industry would regain momentum and car makers in the Czech Republic would be able to return to pre-crisis production levels. However, already in the summer 2021, production stopped again - this time due to the lack of microchips. On October 18, 2021 Skoda, which in the record year 2019 produced over 900 thousand. vehicles, had to stop working completely (Palata, 2022).

Admittedly, after delivering the chips from Malaysia, Skoda was able to resume work, but it turned out that the plants were still insufficiently supplied not only with chips but also with some raw materials, such as magnesium. The Korean concern Hyundai has announced that it will counteract any problems by producing its own chips. For several decades, manufacturers of various devices, located almost all over the globe, managed to jointly produce microprocessors and chips, often indicated as an example of successful globalization - peaceful integration of states at the technological level, on the basis of common economic interest.

At this point, it is also necessary to distinguish the types of economic strategies adopted by companies in this industry. The first group includes those that only order them, but do not produce them themselves (e.g., Apple or AMD). The second group produces chips for others (Taiwanese TSMC and Chinese SMIC), the third one both designs and manufactures them (Samsung and soon American Intel on a large scale) (Sajduk 2021). Few companies decide to build their own microprocessor factories.

Other prefer to outsource this activity to other entities, because the construction of such a plant is extremely demanding - it takes up to two years and costs from 8 to 12 billion dollars. Huge amounts of water are used in the production of microprocessors - one microprocessor factory needs million liters a day, and a large part of it also has to meet extremely high standards of cleanliness. All this means that the decision on the location of such a project is extremely risky and can be afforded by only a few

companies around the world. COVID-19 created a large imbalance between the production capacity of the currently existing factories and the demand for their products. The situation is also complicated by the fact that currently as much as 75 percent chips produced in the world come from Asian countries, with the production of 54 percent by one Taiwanese company (TSMC) (Sajduk, 2021).

The same problems have affected manufacturers of other devices, which also rely on the supply of electronic components from Asia. Many companies have tried to create a new supplier base, e.g., from Turkey, but it has turned out that they are not able to fill the supplier gap.

Countries around the world are preparing to introduce new options. New regulations and incentives in the US and EU are to ensure that semiconductors of key importance for the economy will be produced locally. By 2024, 72 new chip factories will be built worldwide.

In the microscale, as a result of the perturbation, 57% of enterprises in Poland plan to diversify their supply chain by acquiring new suppliers (Achramowicz, 2021). The companies also intend to mitigate the effects of the pandemic by increasing the level of digitization (36%) and modifying the supplier selection criteria (36%). As many as 77% of companies conduct risk identification and assessment, 42% of companies take measures to mitigate the risk, and 50% monitor the implemented measures (Achramowicz, 2021). This is a huge change from the pre-pandemic data.

6. Conclusions

The presented data prove that most supply chains were not prepared to this disturbance. Under pandemic conditions, other policies may need to be considered to mitigate the risk associated with supply chain disruption. Generally it seems to be necessary to focus more attention on disaster risk from BMC infectious “natural” hazards and provide new risk contingencies based on this threat. Economic shocks may sustained over longer periods of time and affect supply chains in the future. The example is situation in the branch of microprocessors producers. In this case, decisions were made at the macro level. At the same time, managers of various companies are clearly increasing their involvement in risk management at the micro level.

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