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Analysis of threats creating logistics barriers in the global supply chain

Analiza zagrożeń tworzących bariery logistyczne w globalnym łańcuchu dostaw

Abstract

The purpose of this study is to present current research and deliver a new description of a logistic barrier, helping to assess challenges and sustain a flow in the supply chain. The resilience of the global supply chains against logistics barriers is a key factor for strategic management in conditions of the global economy. Moreover, preserving the resilience of the organizations participating in the supply chain is a prerequisite of Industry 5.0. During a global pandemic, operations in the global supply chain have met an unusual risk. However, since that time, a multitude of other risk factors have arisen. Analysis of many research reports reveals a negative effect of present factors like wars, political crises and continuity of operations of a global supply chain. The outcome of this study concludes that spatial distribution of manufacturing and distributive operations revealed a particular vulnerability of supply chains. Many areas of global supply chains suffer repetitive disturbances in everyday operations. Such cases may cause the creation of logistic barriers, posing a further challenge for logistic operators.

Keywords:

supply chain management, threats, logistic barriers

Streszczenie

Celem tego opracowania jest prezentacja aktualnych badań i przedstawienie na nowo pojęcia bariery logistycznej, pomagającego ocenić wyzwania i utrzymać przepływ w łańcuchu dostaw. Odporność globalnych łańcuchów dostaw na bariery logistyczne jest kluczowym czynnikiem zarządzania strategicznego w warunkach gospodarki światowej. Ponadto zachowanie odporności organizacji uczestniczących w łańcuchu dostaw jest warunkiem wstępnym wdrażania Przemysłu 5.0. Podczas pandemii operacje w globalnym łańcuchu dostaw zostały narażone na niespotykane dotąd ryzyko. Od tego czasu pojawiło się także wiele innych czynników ryzyka. Analiza raportów badawczych ujawnia negatywny wpływ obecnych czynników, takich jak wojny czy kryzysy polityczne, na ciągłość operacji globalnego łańcucha dostaw. Przeprowadzona analiza prowadzi do wniosku, że przestrzenne rozmieszczenie operacji produkcyjnych i dystrybucyjnych ujawnia szczególną podatność łańcuchów dostaw na zakłócenia. Tworząc bariery logistyczne, stanowią one dodatkowe wyzwanie dla operatorów logistycznych.

Słowa kluczowe:

zarządzanie łańcuchem dostaw, zagrożenia, bariery logistyczne

JEL: M21, O32, L16

Introduction

The development of the international economy and, consequently, global supply chains, necessitates analysing potential threats to their

operation. The constant changing state of the global economy forces to identify risks that are likely to be active, impactful or contagious (Niu, 2018). The changing and complex international environment is a source of many threats and

challenges to the functioning of supply chains. On the one hand, there is a noticeable development of logistics management functions and instruments, increasing the level of control over activities in the supply chain, but on the other hand, the growing complexity of such networks increases their internal sensitivity to the impact of factors that threaten their functioning. The purpose of this study is to present current research and deliver a new description of a logistic barrier, helping to assess challenges and sustain a flow in the supply chain.

Previous studies dedicated to analysing supply chain vulnerabilities, such as the study by Jüttner and Nöring (2003) which pointed out areas of risk management applied to supply chain management, or the study by Christopher & Peck (2004), which was dedicated to preserve the resilience of the supply chain, did not prepare global supply chain managers for recent events significantly disturbing supply chains worldwide. This is visible in critical places for logistics flows and global trade, such as the Suez Canal. The crisis caused by the Yemeni Houthi attacks, which began with the seizure of the *Galaxy Leader* merchant ship in the Red Sea in November 2023 and the sinking of the *Rubymar* ship on 3 March 2024, has led to a decline in weekly container ship transit by 67% (Hoffmann, 2024). Similarly, the events of 2022 caused by the war in Ukraine triggered a wave of disruptions in European and global supply chains. Companies connected in international supply chains are forced to redesign them to ensure a constant flow of goods, information and money. Sudden military operations hindering or preventing logistic flows have forced the search for more local or regional strategies for obtaining goods and services. Such incidents induce a question: How the supply chain can sustain its operations despite existing logistics barriers?

Unfortunately, experiences of the years 2020–2021 proved that the catalogue of potential threats is growing, as is the complexity of these international structures and the demands placed on them. Previous works dedicated to researching the resilience of supply chains as works of Ambulkar et al., (2015), Pettit et al. (2019), or Gunasekaran et al. (2015) did not observe a cumulative effect of many factors disturbing supply chain. This study may add important observations as many enterprises encountered unexpected adversities. Present expectations are that international logistic flows would ensure uninterrupted continuity of supply in the global market is a result of the perceptions of end customers who perceive the waiting time for delivery as a time wasted. The impatient customers form the market, pressing on supply chain managers to accelerate transport and

logistics operations to improve their competitive position. On the other hand, the concept of cost-resilience trade-off helps to balance the expected risk factors (Baldwin, 2022). The COVID-19 pandemic has resulted in unprecedented disruption in global supply chains; therefore, it is worthy of analysis. National lockdowns, closed airspace and borders, the lack of international air connections, shortages of certain essential products, driver shortages and cross-border restrictions shrank road freight capacity. Ocean carriers removed shipping capacity from the market, and air freight capacity dropped because passenger traffic dried up. Simultaneously we observed fluctuating demand shifting towards e-commerce. Sudden changes, as in Italy, where e-commerce sales of consumer products rose by 81% in a single week, increase pressure on distributors and, finally, logistic operators. Caused by the anti-pandemic measures, long-term problems with manufacturing operations follow the known pattern of a bullwhip effect in the supply chain. Subsequent issues with supply effect in decreased availability of products and increased prices for the end consumer. Many pandemic threats and disturbances create logistic barriers to the supply flow, thus increasing logistics costs to maintain supply chain operations. The erection of these logistics barriers forces to innovate and modernize existing supply chains. The tools of Industry 5.0 may deliver solutions yet global supply chains face common challenges, as there are still unresolved issues, especially those related to the increasing supply chains complexity and inter-connectivity, where cyberattacks are spread across suppliers (Gokkaya, 2024). That is one of the reasons companies operating in a global environment re-evaluate locations manufacturing operations and signal a strategic shift towards nearshoring to decrease the risk involved in global operations.

Literature review and theoretical framework

To prepare a theoretical base for analysis, there is a need to look closer at definitions of various forms of threats in the supply chain, which may form a logistic barrier. Ideas of factors confronting the flow in supply chains are well-grounded in literature and various in form. To describe them in the order it is convenient to start from the broadest idea of uncertainty. Operating in conditions of uncertainty is an inherent feature of human activity. The multitude of factors influencing such activities as well as their potential effects, significantly increase the risk, which is particularly

important in the case of business activities. The operation of supply chains is therefore an example of cooperation between companies in conditions of uncertainty. The classic approach to the concept of uncertainty is presented in the definition of Goldstein, which compares uncertainty to an element of the environment characterized by a high level of variability. According to him, this variability is the reason for the necessity to adapt the organization (Goldstein, 1994). An operational recommendation resulting from the company's strategy is also such an influence towards the area of uncertainty that results in its reduction (Mason-Jones & Towill, 1998). If assumed, after Dixit and Pindyck, that the uncertainty may come from endogenous and exogenous sources for the enterprise, it should be indicated that while management activities may reduce those arising inside enterprises, those coming from outside the supply chain remain beyond the control of managers (Dixit & Pindyck, 1994). In the case of exogenous threats, only the emergence of the threat and its duration in a given period allows managers to work out ways to limit its impact on the supply chain. This fact means that gaining experience is a potential remedy for new, previously unknown threats. An idea following uncertainty – threat, is more precise yet not measurable. A supply chain threat is the primary form of a condition that can significantly affect the operation of the supply chain. Its rather general nature is related to the difficulty of predicting what kind of specific effects on the supply chain it may bring. The catalogue of threats changes, as does the global economy, along with the resources and opportunities available for given supply chains. Today's threats often focus on the security of data transmission, their quality, and the sensitivity of IT systems to intrusion attempts, as well as distorting the transmitted data (Chopra & Sodhi, 2004, p. 54). According to Kaczmarek, a threat is described as a certain danger compared to risk, which is only an estimated probability, usually lower than certainty (Kaczmarek, 2008, p. 52). Thus, a threat in the supply chain is a potential risk situation. On the other hand, the risk is a measurable value of the probability of the effects of a given threat (Kisieleski & Stanek, 2017).

The definition of risk linking the aspects of the supply chain competitiveness with the occurrence of factors described as a triggering event is the proposal of Heckmann et al. They describe the supply chain's risk as a potential loss for this chain caused in two areas characterizing the supply chain. The first is preventing the supply chain's value-added performance goals from being met. The second area is preventing the achievement of value-for-money goals in terms of efficiency. In any

case, the occurrence of trigger events is responsible for the loss formulated in this way (Heckmann et al., 2015). Narrowing even further the scope of research on the effects influencing the supply chain helps to understand another idea – the level of disturbances. Ivanov explains the disturbance as a result of the described risk in the supply chain (Ivanov & Sokolov, 2010). It follows that in order to identify a disorder, a causative act is required to implement the anticipated risk (Barroso et al., 2008). At the same time, there is a direct impact of the causative action on the normal functioning of the supply chain. This influence can be manifested in two ways. In the first case, the normal operation of the supply chain is disrupted. In the second, the stability of the organization or the entire supply chain is compromised. Regarding the concept of previously defined risk, Baroso et al. (2008) argue that the disorder can trigger a predicted or unforeseen event. Taking the perspective of the effects of the disturbance, Konecka believes that a disturbance is the inability to carry out planned activities or a certain critical number of activities enabling the further functioning of the supply chain (Konecka, 2015).

An idea closing this comparative analysis is disruption. Handfield and McCormack (2008) define disruption as major delays in production or distribution nodes that have consequences in the activities of other nodes in the supply chain. Disruptions are usually a bottleneck at one of the nodes, which in turn spreads through the entire supply chain. Every single event, such as fire, problems with the quality of manufactured products, machine failures, and delayed customer orders, may cause significant disruptions in the entire supply chain. Problems related to identified supply chain disruptions can have several consequences. They also include influencing investors through the media and looking for information that may affect the value of shares. It is widely assumed that vulnerable supply chains increase operating costs and decrease their efficiency. As a result, delays in the production and transportation processes in the global supply chain are expected (Hendricks & Singhal, 2003). This opinion further emphasizes the essence of the disruption – delay. According to Blackhurst et al., reducing the response time to a delay can significantly reduce the level of risk of disruption. Quick response is possible thanks to increased transparency of operations in the supply chain (visibility) (Blackhurst, et al., 2005).

The broadest concept of uncertainty creates an area in which a specific threat is revealed. Risk arises when a threat takes the probable form of a triggering event. This event, in turn, leads to a specific disturbance resulting in a disruption in

the supply chain. Thanks to this order, a more precise and realistic picture of the impact of many malicious factors on the supply chain is created. However, one should be sceptical about the effect of the description of the last, in a sense, final category, i.e. disturbance. It seems that reducing the effect of all dangers in the area of the supply chain operation only to the delay effect is insufficient. Therefore, trying to fill this research gap, this study describes a notion of a logistics barrier helping to research the effects of disturbing factors influencing global supply chains. After all, the consequences of the events threatening the supply chain, especially on a global scale, are much richer. For this reason, there is a need for a more general idea of an event influencing the flow in the supply chain – the logistic barrier. A logistics barrier is an obstacle that hinders or prevents the flow or logistic process in the supply chain in such a way that it directly or indirectly reduces the flow of goods, reducing the cross-section of the logistics channel or the speed of the products flowing in it (Bentyn, 2024). Such an approach allows allocating and analysing particular events affecting operations in a global supply chain with the most critical factor in focus: the flow of merchandise, money and information.

Global supply chain influenced by the pandemic conditions

The global pandemic caused by the SARS-CoV-2 pathogen revealed particular vulnerabilities of the global supply chain. Spreading a virus and new mutations may affect daily operations across the world, causing many disruptions in the global supply chain and forming logistics barriers to the flow. The feature that distinguishes logistic barriers and allows the classification of them is the place of their occurrence in the supply chain. An answer to a question: where geographically a logistic barrier occurs can be very beneficial for securing the supply chain. Recognition of the place of the appearance of a logistic barrier contributes to the determination of the entity responsible for its occurrence. It enables the allocation of geographical, organizational and competence-related activities that may neutralize its effects. In addition, the strength and nature of the impact it exerts on the supply chain depend on the location of the logistic barrier (Figure 1). An internal problem with storage will cause particular consequences, and in comparison, a different consequence will be caused by a political barrier arising in the area of the continent or a communication blockade of a city or region endangered by the

spread of the COVID-19 virus, for example. The simplified diagram of the supply chain and its relations illustrate three main areas of incidence for logistic barriers. The broadest area is the economic, political and social environment where all supply chain operations occur. Logistic external barriers are created there. In the area of relations between the links in the supply chain, inter-organisational barriers can be allocated, and within the links of the supply chain, internal logistics barriers arise.

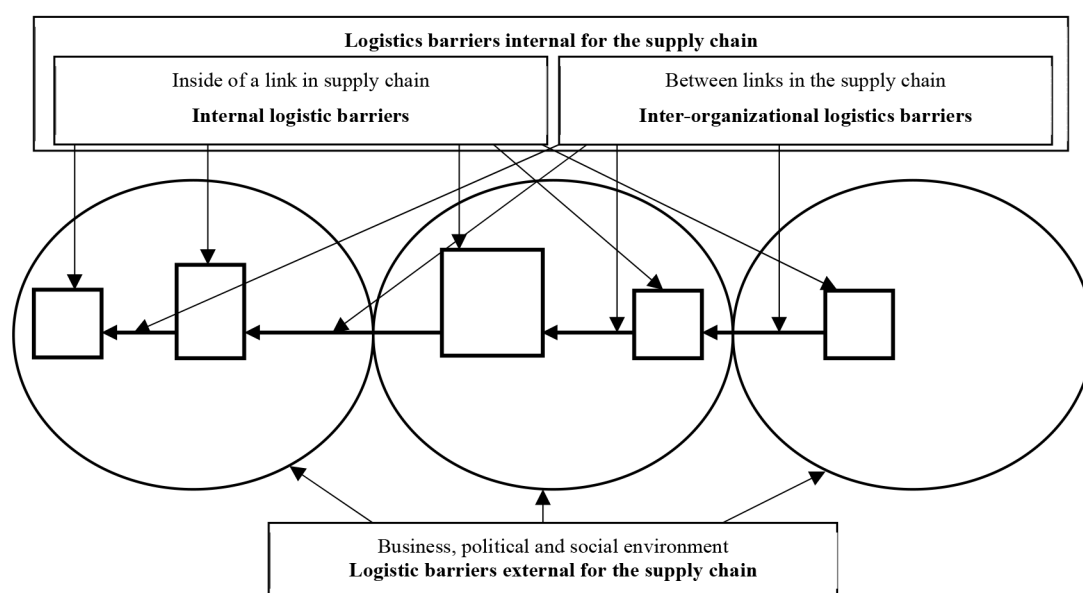
The quick spread of the virus from the most important manufacturing hub of the world China to three critical distributive hubs in Europe, the USA and Japan, impacted global structures of the supply. A trigger event in the form of COVID restriction in the Wuhan area started to disrupt the manufacturing schedule of this vital area. The epidemiologic blockade of logistic flows in the Hubei province, together with the essential city of Wuhan (11 million inhabitants), is an example of an external logistic barrier. The Chinese authorities, deciding to close the region on 23 January 2020, prevented the movement of goods and people in this important industrial centre and logistics hub. It is worth noticing that this is where the OBOR (One Belt One Road) project begins, aimed at accelerating logistics operations between Asia and Europe. On 8 April Wuhan Airport resumed flight operations after 76 days of closure. Thus, it is a symbolic end of the external barrier, bringing consequences in the form of delays in deliveries and the emergence of logistics costs and costs of restoring product manufacturing processes.

As the pandemic situation has developed, many internal logistics barriers have come to light. Problems with connecting partners in supply chain may be allocated to the inter-organizational logistics barriers. The disruptions in the operation of Chinese ports caused by the reduction in the number of crews resulted in congestion and the necessity to move to other free ports or the postponement of many transport operations. Cargo storage costs were rising, reducing the profitability of cooperation in the supply chain. Logistics operator Maersk announced an additional congestion charge of USD 1,000 per container for all refrigerated cargo towards Shanghai and Xingang. The Sea-Intelligence agency estimated at that time the costs of adapting transport routes, taking into account the resulting logistic barriers, at USD 350 million weekly.

Unfortunately, the nature of a virus affecting human labour caused disruption within manufacturing facilities. Such cases may qualify as an internal logistics barrier because they appear inside a link in a given supply chain. For example, the

Figure 1

Classification of logistics barriers depending on allocation in the supply chain



Source: Bentyn, 2024.

presence of the COVID-19 pathogen necessitates the protection of employees against the effects of a disease. Stopping all operations in factories in the automotive industry is also associated with the particular requirements that this type of activity places on partners in the supply chain. Just-in-time operations help to minimize storage costs, but at the same time increasing the risk of factory downtime if suppliers are unable to complete the scheduled delivery of parts. In such a case, the important question is: how long will the logistical barrier last?

An example is the activity of the automotive concern Fiat and Chrysler (FCA). Before the downtime, the factory in Tychy produced an average of 1,040 cars per day. In such conditions, a three-week downtime reduces the number of cars produced by over 21,000. This effect reduces plant efficiency and creates problems for car dealers and customers further down the supply chain.

All such events pose a significant test of the performance of global supply chains as seen from both a local and a global perspective. The awareness of the sensitivity of the structures of international chains to the occurrence of various types of logistic barriers should lead to a deeper understanding of them. Critical vulnerability of the global supply chain is due to the following factors:

1. Spatial distribution of operations. The impressive reach of a global supply chain poses a risk of delays of logistics operations, forming a phenomenon described in the literature as the

bullwhip effect. Operations before pandemic carried in the just-in-time mode were after impact involuntarily transformed into just-in-case scenarios. That fact increased the costs of logistics.

2. Manufacturing operation. Still, most of the operations require human labour. Such dependency is particularly dangerous in pandemic conditions. Preventing from spreading the virus and at the same time maintaining a manufacturing potential seem contradictory in factories relying on human labour. A reasonable solution in the form of automatization of operations may be difficult and time-consuming.
3. Logistics operations – transport and warehousing. Similarly, transport operations, as well as warehousing, require human work. Luckily in those areas, the advance in automatization processes is significant. Employing robots inside a warehouse may effectively increase operability during the pandemic. On the other hand, transportation still needs technical solutions and law regulations to employ automated transport modes.
4. Distribution. Supermarkets as a location potentially increasing virus spreading may be a target of restrictions. No wonder customers turned towards e-distribution solutions. Since a relatively rapid increase in customer interest in e-commerce, this area needs time to develop an efficient solution ready to serve a mass market.

5. Law restrictions. Lockdowns create prohibited areas for the movement of people and cargo. Such incidents may become a new normal because of arising new mutations. Transport costs may increase, and delays in the delivery time may influence scheduling and customer satisfaction level.
6. Capacity constraint. Shifting in demand among different channels of distribution may affect logistic operations. A limited number of containers already caused problems in the ability to ship requested merchandise. Forcing business owners to purchase and operate their own containers creates inefficient solutions, further decreasing the effectiveness of global operations.

Above delimitation of exposure areas in the global supply chain may serve as a checklist for global operators looking to resilience and maintaining a certain level of operations. Thanks to the independent organisations researching global supply chains, it is possible to confront their reports with the experiences of existing logistic operators.

Research reports delivering a diagnosis

With regard to the pandemic and its impact on supply chains, several reports (GEP, 2020; CISA, 2020; BCI, 2020; Interos, 2020; Gartner, 2020; PwC, 2020) have appeared confirming the occurrence of selected factors. GEP conducted a survey among 400 executives in European and American global companies. US Department of Homeland Security (DHS) in August 2020 conducted research on a sample of 50 companies in the area of information and communication technology, diverse in terms of size. At the request of the Business Continuity Institute (BCI, 2020), research was conducted in which over 350 companies from 19 industries and 77 countries participated. Serving global customers in the supply chain, finance, cybersecurity and compliance areas, in October 2020 Interos conducted a survey among 450 chief executives of risk and compliance, logistics, IT, and procurement and operations executives at companies with revenues in excess of \$ 1 billion. These companies came from the United States and operated in the following industries: aerospace, defence, finance, processing, manufacturing, technology and energy. From February to March 2020, Gartner also collected data from 260 global supply chain leaders responsible for chain management in many industries, including technology, industry and food. Both Americas and Europe were the study areas.

The next report was based on a series of surveys prepared and distributed by Price-waterhouseCoopers (PwC). Respondents were CFOs from the United States and Mexico. Four-fifths of them worked for Fortune 1000 companies.

All analysed reports indicate that the pandemic has more or less disrupted supply chains. According to GEP 45% of companies experienced significant disruptions in their supply chains. According to DHS 53% of respondents reported a moderate impact of the COVID-19 pandemic on their organisation's supply chains and 33% indicated minor difficulties. There have been no companies that have experienced catastrophic consequences that would paralyse their business. 60% of broadcasters, 56% of communication service providers, and 40% of IT service providers have experienced moderate disruptions in their supply chain. However, each broadcaster faced at least minimal disruptions from COVID-19.

According to BCI the epidemic affected 73% of enterprises, disrupting the chains on the supply side and 64% on the demand side. In the case of those polled who used cargo transport by air for deliveries, 54.1% said that the pandemic had a significant detrimental impact on their organizations. The International Air Cargo Association also reported that global cargo capacity decreased by 35%. Conversely, a quarter of those interviewed experienced "serious disruptions" in their shipments by sea. Ships were not allowed to enter ports and 120 of 126 countries imposed crew changes restrictions. Rail transport has had the least impact on its operation. Directors surveyed by Interos also found that they encountered delays in order fulfilment (52% of enterprises).

Gartner research showed that only 21% of enterprises had a non-disruptive supply chain. A resilient supply chain is understood as a chain monitored on many levels of suppliers, which in the event of disruptions does not lose efficiency and can quickly react to events such as Brexit, trade war or COVID-19. PwC research on the impact of the epidemic on the supply chain in March 2020 showed that 34% of executives thought that supply chain problems were the most significant, and 30% considered making changes to their existing supply chains.

Obviously, these disruptions resulted in financial losses, 64% of enterprises reported 6% to 20% loss in revenues in 2020 (GEP, 2020). The pandemic showed that 50.5% of companies did not have plans to take into account the disruptions in their supply chains caused by it. However, the losses caused by it led 53.2% to plan to create contingency plans in the future and 32.3% to adjust their current plans to avoid similar disruptions.

Responses to questions about supply chain transparency have shown that most supply chain

incidents arise from disruptions in the flow of information and goods at second and third-tier suppliers. During the pandemic, these disruptions were magnified which contributed to high financial losses of enterprises. According to the Interos research, the increase in costs also resulted in a significant increase in supplier prices (42%).

First of all, the root causes of the large-scale negative effects of the pandemic on supply chains were seen in their globalization and sourcing in countries with low labour costs. The collected data shows the evolution of the trend of relocating sourcing and manufacturing activities outside China. According to Gartner's research, 33% of enterprises have already done so or are planning to do so in the next three years. The COVID pandemic was just another reason for this, as global supply chains were disrupted long before COVID-19 emerged. The 2018–2019 trade war between China and the United States showed the weaknesses of global supply chains between these countries. These activities, exacerbated by the pandemic, resulted in the formation of the idea of regionalization of production, which allows for the strengthening of the company's network. The desire to strengthen the company's chain is the second reason, right after the increase in transport costs, caused by customs duties imposed by the US and Chinese governments in recent years, to move production from China to closer locations, such as Mexico. The problem of customs duties is so serious that the costs of chain service increased by up to 10% for over 40% of American companies.

Directors surveyed by Interos also indicated the need to look for new suppliers due to supplier downtime caused by health restrictions (40%) and to move to suppliers from other geographic locations due to import restrictions (38%). When asked about the vulnerable points of chains, 46% of respondents indicated dependence on unreliable partners or governments, and 44% blamed the lack of adequate short-term and long-term planning, 36% indicated geographic concentration and a lack of understanding of interconnections in global supply chains. Additionally, the majority (72%) of respondents believed that COVID-19 would be one of the reasons to move production to the United States in the near future. At the same time, 78% believed that the process of shifting production from the Far East to the United States would be continued in the longer term.

Likewise, DHS respondents pointed to communication problems with their suppliers at the start of the pandemic. Many Chinese suppliers have been locked in their homes for several weeks due to a lockdown. In the case of companies that had their production lines in China, many of them, as in previous years, replenished their stocks before

the Chinese New Year, when some factories can stop up to 3 working days. If not for advance orders, supply shortages would have been even more severe. However, the sources of components such as semiconductors are in Asia, which poses a risk of geographic concentration. Parts including processors, graphics cards and RAM memory are produced in the vast majority of five countries around the world (USA, Japan, Taiwan, South Korea, China), which results in low chain resistance to local perturbations. In this case, lockdowns introduced in the above countries resulted in plant downtime and significant global delays in production and shipping. Changing a semiconductor manufacturer is not easy for IT service providers. Since the level of customization of these components is very high, production requires appropriate technological processes, and these differ between producers. The disruption of the supply and demand curve resulted in a significant increase in prices.

BCI respondents also declared that they plan to limit supplies from Eastern Asia (30% of enterprises). More than two-thirds of manufacturers will try to use suppliers closer to their production plants as part of strengthening the supply chain. The report also outlines the importance of having geographically diversified suppliers and suggests that diversifying production may be a good way to minimize the risk of disruption. More than half of the producers did not conduct research on their suppliers of level 2 and above. The lower the supplier level, the less knowledge of supplier locations is. The events of 2020 meant that 60% of enterprises intend to conduct a more detailed analysis of their chains. In addition, 45.3% of organizations intend to locate all of their second-tier vendors, compared with 36% who do now. During the outbreak of the pandemic, many organizations faced delivery delays, first in Asia, then in Europe, and then in regions of South America. The report emphasizes the fact that as many as 57.2% of enterprises want to diversify their sources of supply, they will try to source goods locally. In March 2020, the institute's coronavirus preparedness report was released, which showed that 16.3% of organizations had started sourcing some or all of their goods more locally. Two months later, the figure had risen to 36.4%. At the same time, some respondents speculated that the industry might move away from the JIT concept to produce products with fewer product variants, which would allow for stocking and local production. 19.6% of the respondents replied that after the pandemic they would maintain more inventory.

Shippers and communication service providers (DHS, 2020) have listed inventory management as

having the greatest impact on supply chain disruptions. Many companies during the pandemic increased their inventory levels to protect themselves against potential future disruptions related to the coronavirus, and in some cases, e.g. in the sector of graphics cards that are used to mine cryptocurrencies, increased demand. The vast majority of companies declared that they would increase their orders and inventories. This is linked to the uncertainty surrounding the pandemic. Such an approach, however, exacerbates the current shortages in the supply chain and may extend the lead times.

IT service providers have identified reasons for supply chain disruptions such as impacts on transport and logistics or suppliers in different regions. Some companies order products based on a risk analysis. In the case of high value products or long lead times, they try to choose different sources of supply. However, their diversification is very difficult due to the aforementioned difficulties. In many cases, larger public firms had better insight into their subordinate suppliers than private firms. Many IT companies may have hundreds of downstream vendors for one product, and they often don't know who their tier 2, 3, or 4 vendor is.

In addition to these effects of the pandemic, approximately 38% of companies with revenues in excess of USD 1 billion have found "significant damage to their brand reputation" as a direct result of supply chain disruptions. It also found that in the face of the pandemic, despite spending millions on ERP solutions, most global companies are unable to effectively manage complex supply chains (GEP, 2020). During the pandemic, due to the lack of maintaining stocks, using the just-in-time practice, because it is cheaper and does not require having warehouse facilities, smaller companies were more susceptible to disruptions and interruptions in supply chains.

The above-mentioned studies also indicated the potential possibilities of coping with the events that supply chain managers had to deal with during the pandemic. Having a resilient supply chain comes at a higher cost. Companies wishing to combine the advantages of JIT management, which emphasizes the delivery of required materials in the required time and quantity, with just-in-case management, which emphasizes the planning and preparation of various scenarios, must commit to risk management, so as to be able to assess the willingness of the organization to take risks and compare this risk with other goals, e.g. cost effectiveness. The respondents indicated regionalization of production as one of the methods of dealing with disruptions in supply chains in the future. More than a quarter of respondents (Gartner, 2020) said they had already regionalized or re-localized production to

be closer to demand. As advantages of this practice, they emphasize that regional supply chains can mitigate delays and shortages during periods of disruption. Some companies are also planning hybrid methods, such as manufacturing in the Far East and moving only the final assembly closer to the customer.

The results of a survey conducted by PwC (2020) indicated that 56% of companies plan to develop additional, alternative sourcing options for their supply chains. Hence you can see an increase of 26% in one month. A quarter of 330 CFOs said supply chain strategies are critical to rebuilding or increasing corporate revenue streams after the coronavirus pandemic.

Prior to COVID-19, 58% of respondents had made or were in the process of making major changes to strengthen their supply chains, 20% planned such changes, and only 4% were not interested in making any improvements to the chain. The pandemic situation forced 40% of companies to make further big changes, 42% made small adjustments, 18% of companies planned further changes. Two companies that did not plan changes before the pandemic changed their position on this issue (Interos, 2020).

Selected studies on the impact of the COVID-19 pandemic on supply chains in Poland

Research on the impact of the pandemic on the operations of the company and supply chains was also carried out in Poland by Polish scientists, the conclusions drawn from them should be compared with those coming mainly from American sources. Marzantowicz, Nowicka & Jedliński (2020) undertook the description of supply chain disruptions at the beginning of the spread of the COVID-19 pandemic. The survey was conducted in March 2020 among Polish managers from the production, commercial and service sectors. The most significant, in the opinion of managers, was the introduction of restrictions and a drop in the number of orders. The reduced number of orders may be due to the closing of stores, which was one of the methods of fighting the pandemic. The managers' attention was also drawn to the issue of prolonged shipments and declining demand from European markets.

Enterprises encountered the following adversities through the pandemic:

- delivery delays (72%),
- failure to complete the shipment plan on time (63%),

- delays in the execution of orders due to the reduced number of available employees (54%),
- change of supplier required due to logistic problems at the supplier (45%),
- extended production time due to delays in the execution of orders with suppliers (45%),
- reduced access to transport outsourcing (45%),
- production stoppage for more than a week (27%).

The most popular methods of dealing with supply chain disruptions during a pandemic were increased cooperation with suppliers (82%). By exchanging information regularly, both sides were able to limit the negative impact of the existing risk of chain disruptions. In addition, 45% of respondents used macroeconomic analysis to predict the supply of a given product, so that they could order it in advance and create an appropriate time buffer.

Managers' ideas on what will be necessary to change to create more resilient supply chains were:

- to use technologies that reduce uncertainty and the number of unpredictable factors (72%),
- to change the structure of supply chains to more hermetic ones (45%),
- to renegotiate current contracts with suppliers in order to jointly be able to react better to similar events in the future (45%),
- to change the inventory management system, e.g. increase inventory levels instead of the JIT approach (45%),
- to increase the amount of technology use, digitization of supply chains (45%),
- to change the transport policy, e.g. to resign from logistics outsourcing for the benefit of own fleet (36%).

Taking into account all the adversities that occur during a pandemic, the most resistant to disruptions chains are those who can quickly adapt to the current situation, are reactive and can quickly introduce internal instruments to increase their resilience, using digital technology to manage risk and minimize the negative impact of disturbances on the chain. Research also confirms that the shorter the chains, the easier it is to manage and control the risk in them.

Subsequent studies concerned the transport, forwarding and logistics industry. They are worth considering due to the significant impact of traffic bans in certain periods of the pandemic and the serious impact of this industry on flows in the supply chain. Publications showing the impact of the pandemic on supply chains, logistics and transport are slowly appearing in the scientific world literature (Ivanov, 2020; Michail & Melas, 2020; Paché, 2020; Pinto, 2020; Trautrim, 2020; Rejeb, et al., 2020; Marzantowicz et al., 2020; Niewiadomski, 2020; Russell et al., 2020; Rojas-Rueda et al., 2021). In order to systematize and

broaden the knowledge in the presented research area, the results of own empirical research on Polish road carriers were presented. Similar analyses were carried out by Chinese researchers (Liu et al., 2020). In the context of the COVID-19 outbreak in China, they observed five impacts on China's logistics industry, which are: sharp drop in logistics demand, shortage of transportation capacity, disruption of logistics network, change of service mode, and increase in operating costs and number of loss-making enterprises.

The subjects of the research were road transport companies operating on the foreign and Polish market, which are registered in Poland and offer primarily transport services, then forwarding, storage and logistics services. The respondents pointed to the drastic decrease in transport, which was the result of the decline in orders. In total, over 80% of the respondents recorded a decrease in transport, including a significant decrease in over 50% of companies.

This effect is a result of the economic condition deterioration of enterprises operating in the basic spheres of the economy that are served by the transport sector. In April and May 2020, the decrease in orders on average was: in accommodation and catering 63.15%, in retail trade 31.55%, in construction 26.45%, in industrial processing 25.05% and in wholesale 25.15%. In the transport and warehousing industry alone, orders fell by 37.5%, which in fact were much greater in the transport industry. After decreases in the volume of transport recorded at the turn of March and April, their return to the volume in March did not take place until September 2020.

According to own research, in response to the question about which product groups were affected by the decrease in transport, 29.55% of respondents indicated a decrease in transport for products from the automotive industry. On the other hand, the increase in transport in the food industry was indicated by 15.9% of the respondents, while 70.45% of respondents reported that there was no increase in transport in any industry. It should be taken into account that the respondents' answers concern the situation at the turn of May and June 2020, when alternatives to changing the structure of the transported goods were still searched. At that time, first of all, declines in total transport were noted. The decrease in demand for deliveries in the HORECA, automotive, aviation, heavy industry, household appliances, clothing and footwear industries was supplemented by the growing demand for transport services in the electronics, packaging, pharmaceutical, e-commerce industries, including e-grocery.

The respondents were also asked to specify the most significant negative impact of the COVID-19

pandemic on transport activities. The respondents pointed to a general decline in revenues and profitability resulting from a decline in demand for orders, a decline in the volume of transported loads in contractual and occasional exchange relationships, and difficulties in obtaining return loads. In addition, the following have become a big problem: prolonged payments over 60/90 days and more, long debt collection procedures due to a weak judicial apparatus, unfair practices related to alleged bankruptcies, general stagnation caused by small amounts of cargo. Among the answers, a problematic issue was also the reduction of employees' wages in order to limit layoffs, the inability to use the existing rolling stock potential, reluctance to perform tasks by the older generation's staff, uncertainty, and even fear. The described factors reinforce each other. For example, as a result of too few loads, prices fall below the break-even point. Disturbances in the liquidity of enterprises prevent the repayment of current receivables and undertaking investments aimed at increasing the competitiveness of enterprises. Thanks to the research it is observed that SMEs in Poland accelerated their digital transformation. They adopted and used various digital transformation technologies to improve their business processes and performance (Kuczevska, 2023).

Conclusion and discussions

The presented theoretical analytical scheme is reflected in the quoted results of research on the impact of the COVID-19 pandemic on the supply chain and other barriers arising. Thanks to analytical approach it is possible to conclude gathered evidence in following statements. The epidemic itself has a social background and is a kind of external barrier. However, the pandemic affects both individual enterprises and industries, e.g. transport, forwarding and logistics, which can be treated as internal barriers to the supply chain. Disruptions in supply chains are reflected in a reduced level of demand for transport services. Strategies in supply chains regarding their globalization or regionalization, the use of JITs and the number of maintained stocks also have a direct impact on the structure of goods transported and the scope of orders carried out for individual industries. The broader aspect of the impact of the logistics barriers on the supply chain could include the following impacts: price increases due to shortages of goods and semi-finished products for production, increased volumes of orders for semi-

finished products and components to create a buffer stock, extended customs clearance time, lack of quarantined employees, drop in profits in many individual companies.

Due to the analysis, the need for progressive applications was discovered. The implementation of a solution that has a positive impact on logistics flows in the supply chain involves improving the operation of the supply chain by facilitating logistics flows or processes. Three areas of facilitation activities can be identified that influence the acceleration of logistics flows and the processes that enable them. Among the most critical are organizational, economic and technical facilitations.

An example of an organizational factor improving the operation of international supply chains is the use of blockchain technology in supply chain management as it was presented in drug supply chain (Tseng, 2018). It is a method of transmitting information that includes financial transactions passing through individual links in the supply chain. This creates an online transaction record that allows you to trace the entire journey of the goods. As an automated system, it is safe because it is based on cryptographic solutions and, therefore, resilient.

As proven in the reports from Poland in the area of technical facilitation, Industry 5.0 seems to be the answer. Future factories will be able to use information about demand and flexibly adjust production to current needs. A smart factory will be a basic element of the supply chain. Its advantage over existing manufacturing sites will be its ability to ensure communication between machines and products, automation of manufacturing processes, automatic transport systems, and continuous communication with the customer therefore delivering sustainable solutions. However, it is worth mentioning that use of such technologies has also considerably opened up various security threats and different security issues (Hammi, 2023).

The improvement of the operation of supply chains within economic factors is illustrated by the activities of companies based on the principles of the sharing economy. This phenomenon was revealed by the behaviour of Internet users sharing information resources in the form of music, films and applications. This phenomenon can be described as the willingness of a certain number of users to share resources. It is a human-centric system of obtaining and transferring goods and services or sharing access to them based on connections between individual users, coordinated by network services operating in the user community.

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ZAPOWIEDŹ

Autorka omawia uwarunkowania i mechanizmy kształtujące ścieżki kariery kadr kultury pracujących w publicznych instytucjach kultury w Polsce. Złożoność tego zjawiska organizacyjnego pokazuje dzięki zastosowanej strategii badawczej – instrumentalnemu studium przypadku. W procesie interpretacji danych empirycznych autorka sięga do teorii neoinstytucjonalnej i zjawiska konkurujących logik instytucjonalnych. Pokazuje, że w dziedzinie zarządzania ścieżkami kariery kadr kultury dochodzi do spotkania co najmniej trzech logik instytucjonalnych: logiki kultury, profesjonalizmu oraz menedżeryzmu,

które konkurują ze sobą w praktyce zarządzania karierą w publicznych instytucjach kultury. Każda z tych logik wnosi do codzienności pracy w publicznych instytucjach kultury nie tylko różne praktyki i metody działania, lecz także odmienne sposoby myślenia, wartościowania i postrzegania rzeczywistości, w istotny sposób wpływając na kształt ścieżek kariery kadr kultury.

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