



Supply chain adaptability as a response to disruptions – theoretical and empirical aspects

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Abstract

This article concerns the increasing complexity and variability of the business environment and the challenges faced by enterprises that operate within supply chains to properly identify and anticipate disruptions and adequately respond to them (i.e., the ability to resist and rebuild). This article aims to identify and evaluate the importance of the main factors that determine supply chains' adaptability in the modern economy. A review of the literature on the subject, and the results of a survey conducted in the third quarter of 2022 among entities from the transport forwarding logistics (TFL) industry, diagnose the determinants of the adaptability of supply chains that operate when there are disruptions. They indicate the challenges faced by TFL companies that result from the COVID-19 pandemic and the war in Ukraine and the directions of changes that result from them, both from the short-term and strategic perspectives. The relationships between the development of adaptability of supply chains and the increase in the competitiveness of entities enable us to verify the research hypothesis that, in the face of increasing disruptions and uncertainty in the business environment, strengthens the adaptability of supply chains producing a great potential in terms of maintaining the competitiveness of enterprises in the TFL industry. To gain and maintain a long-term competitive advantage, companies should strive to create a resilient supply chain that can withstand challenges and disruptions.

Introduction

The dynamism and uncertainty of the business environment result in ever-increasing economic, social, and natural environmental requirements for organizations. An inseparable condition for maintaining a market position and development is a change that is permanently embedded in the culture of an organization (Sharma, Ghosh & Saha, 2020). For years, enterprises have been operating in a reality defined as VUCA (short for volatility, uncertainty, complexity, and ambiguity). The COVID-19 pandemic and the war in Ukraine have also created the reality of BANI (brittleness,

anxiety, non-linearity, and incomprehension). The Competitiveness Council confirms that managing a rapidly changing risk landscape is an emerging competitive challenge, which requires resilience (van Opstal, 2007, p. 5). Thus, modern enterprises must modify or design new supply chains in which they operate with greater care so that, if necessary, they can adapt to rapidly changing operating conditions. This article focuses on strengthening the adaptability of the supply chain to unexpected events, responding to disruptions, overcoming them by maintaining operational continuity at the desired level, and shaping strategies with adaptive features.

In an increasingly complex and volatile business environment, current and future increases in added value will be achieved by supply chains that are not only able to properly identify and predict disruptions but, above all, actively manage them. The analysis, assessment, and management of disruptions should not be focused only on the past but should also allow for an examination into the future, shaping resilience to disruptions. The search for a strategic development path and the possibility of building resistance to disruptions requires a detailed map of the supply chain. It is the basis for the dynamic configuration of a complex network structure that adapts its structures, processes, and technologies to changes and crises.

By presenting disruptions in supply chains and enterprises' possible reactions to them, this study aims to identify and assess the importance of the main factors that determine the adaptability of supply chains in the modern economy. Theoretical considerations are illustrated by using the results of an empirical study conducted in the third quarter of 2022 among people from the transport forwarding logistics (TFL) industry. Research into the relationships in supply chain disruptions and responses to existing and future disruptions determine the main research hypothesis: the increasing uncertainty of the environment has a significant impact on taking actions to maintain the competitiveness of TFL companies in the conditions of disruption and, consequently, strengthening the adaptability of supply chains.

The structure of this article is organized as follows. The Introduction is followed by a literature review of existing research. The Research Methodology section details the approach to disruptions in the supply chains and potential responses to them. We then present the results of an empirical study that enables us to determine the actions that can be taken to make modern supply chains resistant to potential crises and problems and, consequently, adapt to new conditions in the long term. The Discussion section presents the conclusions of the analyses and the study's contribution to the literature on the subject. It also includes suggestions for potential directions for further research. The Conclusions section contains recommendations and the most important limitations of the study.

Supply chain disruptions are a topical and important issue. Resilient supply chains, which are complex adaptive systems, can increase their added value when there are market threats. They can relatively gently traverse through a period of adverse socio-economic phenomena, quickly rebuild their potential, and provide market competition for customers.

Literature review – disruptions in supply chains

Research on disruptions in the supply chain continues to generate new areas of research in theoretical (Bukowska-Pietrzyńska et al., 2022) and practical terms. The research context varies depending on the situation, the complexity of the supply chain, the industry, the area, and the scope of the impact, alongside people's perceptions, while still deepening the understanding of disruptions. Based on the review of selected definitions by Konecka, Romanow, and Stajniak (Konecka, Romanow & Stajniak, 2019, pp. 13–16), it can be concluded that the concept of “supply chain disruption” is difficult to define; there is no one universal interpretation. This is largely due to the diversity of research directions in which the essence of this concept is analyzed. Some define a disruption in the supply chain by referring strictly to the assessment of the efficiency of physical flows, while others indicate the likelihood of a negative event destabilizing the supply chain.

Analysis of the literature on identifying the main features that characterize disruptions in the supply chain shows that the causes of disruptions, and the scope of their impact, are the pillars of the described approaches. Following Ivanov, Sokolov, and Kaeschel (Ivanov, Sokolov & Kaeschel, 2010, p. 441), sources of interference can be treated as the basis for dividing them into external and internal disturbances. In the last decade, it was the changes in the market environment, functioning in conditions of extreme natural events and legislative changes, that were the main sources of disruption in the supply chain for 77% of enterprises (3D Hubs, 2023, p. 11). Forty weather disasters in 2019 caused more than USD 1 billion in damage (Masters, 2020). Operating in the global economic space, supply chains are increasingly disrupted by trade disputes, higher tariffs, and growing geopolitical uncertainty. According to the World Bank, the share of global trade with countries with declining political stability increased from 16% in 2000 to 29% in 2018 (World Bank, 2019).

The 2020 McKinsey Global Institute report shows that significant supply chain disruptions lasting a month or more have occurred, on average, every 3.7 years (McKinsey Global Institute, 2020, p. 5). Shorter disruptions happen even more often. Estimates show that within a decade, entities can expect a loss of almost 45% of their annual profit. In the opinion of many logistics and transport companies, these losses may be much higher due to the

current geopolitical disturbances and the consequences of the COVID-19 pandemic. Over the past year, enterprises have struggled to respond quickly to increasingly serious threats and return their operations to a stable, reliable state (BCI, 2023, p. 34). Most faced challenges in all aspects of their business, including shortages of parts and critical materials (75%), delayed deliveries and longer lead times (74%), difficulties adjusting capacity to respond to fluctuations in demand (69%), and problems with planning for fluctuating customer demand (68%) (Capgemini Research Institute, 2020, p. 4). At the same time, 55% of enterprises needed three to six months to recover from supply chain disruptions, while 13% expected it to take six to twelve months.

In summary, maintaining continuity in the supply chain is a priority, and, at the same time, it is one of the most problematic issues in the functioning of enterprises. An ever-growing set of global challenges (from climate change and the emergence of a multipolar economic system to increased mobility and digitalization) has expanded the range and variety of supply chain risks (Ali et al., 2022, p. 17). Global disruptions have resulted in at least one in twenty companies experiencing USD 100 million worth of supply chain disruptions each year over the past few years. Removing disruptions throughout the supply chain is becoming impossible to achieve, and, as a consequence, building flexibility and resilience of operations has become one of the critical priorities for enterprises (Raj et al., 2022, p. 1126). In this context, organizations need a new approach to managing the risk of supply chain disruption and building resilience.

From resilience to the adaptability of supply chains – the theoretical aspect

Supply chain resilience, both in organizational and systemic terms, has been of interest to academia and business for over three decades. In general, the supply chain's ability to cope with changes is equated with resilience (Wieland & Wallenburg, 2013, p. 301; cited in Szymczak, 2015, p. 86). In the literature on the subject, resilience in the supply chain has various meanings. Most define it in the context of the dynamic nature of the supply chain using two aspects, i.e., maintaining the effectiveness of the actions taken and ensuring the implementation of a given function. The first of these aspects refers to resilience in terms of engineering (meaning ensuring balance and flexibility in adapting the supply chain to the new configuration). The second aspect refers

to ecological resilience (i.e., expressing the ability to maintain and develop the adaptability of a resilient supply chain that ensures its continuity in the face of turbulent, unpredictable changes).

The first extensive research into the origins of supply chain resilience was carried out in the UK. It was a response to the disruption of flows in transport processes caused by fuel protests in 2000 and the outbreak of the foot-and-mouth disease pandemic in early 2001. As a result of the analysis of British knowledge resources, researchers from Cranfield University formulated key conclusions for shaping the concept of supply chain resilience (Cranfield University, 2003). They concluded that the vulnerability of the supply chain to disruptions is an important business issue. However, there is little research in this area and little awareness of the importance of this issue, which indicates the need to develop a methodology for managing supply chain vulnerability.

As pointed out by Boin, Kelle, and Clay Whybark (Boin, Kelle & Clay Whybark, 2010), supply chain resilience focuses on adapting strategies and operations to avoid disruptions or mitigate their effects if they occur. In contrast, Brandon-Jones, Squire, Autry, and Petersen (Ali, Mahfouz & Arisha, 2017, pp. 16–39) argued that resilience comprises two critical but complementary elements of the system: resistance capacity and recovery capacity. Pettit, Fiksel, and Croxton (Pettit, Fiksel & Croxton, 2010, p. 17) defined it as the supply chain's ability to resist disruptions and recover from them. They argued that understanding the concept of resilience and where to invest in resilience will shape supply chains that respond quickly and recover from costly disruptions. After analyzing numerous case studies, Svensson (Svensson, 2004) indicated a direct relationship between the risk of disruption and enriching the management strategy with such features as flexibility, redundancy, security, and cooperation. He also demonstrated that disruption can also be an unexpected source of success.

According to Knemeyer, Corsi, and Murphy (Knemeyer, Corsi & Murphy, 2003, p. 89), preventing the strengthening of disruptions in the supply chain means modeling cooperation between entities, which may be an opportunity to gain the trust of customers and maintain their loyalty and, thus, increase the chances of that entity functioning long-term. According to Rice Jr. and Caniato (Rice Jr. & Caniato, 2003, p. 25), the ability to effectively return to the state before the disruption in the supply chain and adapt to new market conditions can strengthen the

competitive advantage. During discussions on shaping the concept of supply chain adaptability, a key consideration was the need to address current disruptions while also developing the ability to adapt to future challenges. This theme emerged as an important factor in the literature on the subject (Ali, Mahfouz & Arisha, 2017; Świerczek, 2020). These issues formed the basis of our research and were expressed in the research question: Did enterprises use the disruptions related to the COVID-19 pandemic/war in Ukraine to develop?

Adaptability has become a competitive challenge for modern enterprises. This understanding of adaptability allows it to be seen as an opportunity to run businesses efficiently and build a competitive advantage of the supply chain, not only when there are predictable disruptions but, above all, in an uncertain environment (Gurbuz et al., 2023, p. 2). The approach in Figure 1 enables us to take a broader look at how supply chains work in VUKA and BANI conditions. They require resilience and the ability to regenerate the operating strategy in a new market situation, i.e., adaptability (Singh, Soni & Badhotiya, 2019, pp. 110–114). It is shaped by two key processes, i.e., the ability to resist and regenerate the system along with the appropriate phases: anticipation, avoidance, containment, stabilization, and response.

Supply chain resilience is the ability to minimize the impact of a disruption by avoiding it completely (avoidance) or minimizing the time between the occurrence of a disruption and the start of recovery after the disruption (containment) (Melnik et al., 2014, p. 37). Identifying a potential disruption (anticipation), especially an unexpected one, is vital, while regeneration makes it possible to restore chain functionality after a disturbance occurs. Regeneration consists of a stabilization phase followed by a response phase and a return to a stable performance state. Therefore, an adaptive supply chain can adapt, react, and rebuild, ensuring that it continues to run in a complex and uncertain environment. A well-prepared supply chain can not only regain its position

from before the disruption but also achieve greater functionality, which can translate into strengthening the competitive advantage.

Research methodology

To achieve the aim of this research and verify the main hypothesis, both primary and secondary forms of data were used. The data was obtained using selected research methods and techniques. The elementary analysis was used to define the subject of the study and to identify the basic relationships within it. Desk research analysis helped systematize the current scientific achievements and the state of knowledge about the nature of disruptions in supply chains. The literature review was carried out in accordance with the classic approach, i.e., the selection of sources, search by keywords, review and selection of articles, and an in-depth analysis of selected publications related to the topic. It enabled us to identify a general gap in knowledge about an integrated approach to decision support in supply chains in VUKA and BANI conditions.

Using analysis and logical construction, a conceptual framework was developed for an adaptive supply chain model from a value chain perspective. An empirical study was conducted to help improve the development of adaptive supply chains and strengthen the competitiveness of enterprises. This study used a diagnostic survey, cause-and-effect analysis, and qualitative analysis. They enabled us to isolate thematic issues on how supply chains function during disruptions and uncertainty. Additionally, we identified mutual links in the supply chains by examining the operations of TFL companies in turbulent environments. Furthermore, we surveyed four experts to evaluate their perception of the significance of actions in enhancing chain adaptability.

The research consisted of three stages. In the first stage, we identified the key characteristics that describe how supply chains operate in constantly

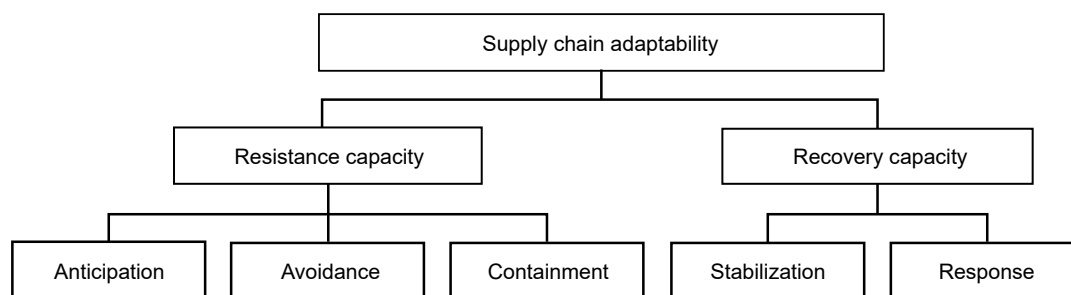


Figure 1. Components of the adaptive supply chain model (own study based on Singh, Soni & Badhotiya, 2019, pp. 110–114)

changing and disruptive conditions, which TFL companies often face. They were then assigned to three thematic groups:

- problems caused by the COVID-19 pandemic and the war in Ukraine,
- disruptions in supply chains from the perspective of their adaptability,
- challenges in logistics and supply chain management from the perspective of strengthening the competitiveness of TFL enterprises.

Then, the possible directions of development of TFL companies were listed, both current and long-term.

The second stage assessed the significance of the selected problems, activities, and directions of development of TFL companies. Experts were asked to answer three research questions:

1. What problems/challenges resulting from the pandemic and geopolitical crisis have TFL companies faced/are facing?
2. Has disruption in global supply chains created new growth opportunities for your businesses? If so, how have they been used?
3. What activities/strategies, in relation to logistics and supply chains, are crucial for maintaining the competitiveness of the surveyed TFL companies in a turbulent environment?

The questionnaire comprised 43 closed questions and required participants to provide responses online. The experts were asked to assign weights to individual characteristics on a scale of 1 (not very important) to 5 (a key issue). The omission of the neutral point in the answers allowed for more appropriate assessments, thanks to eliminating the central tendency error (Sroka, 2022, p. 177). At this stage of the study, the experts did not know the answers provided by other study participants. The results of the study enabled us to list the main determinants of the adaptability of supply chains, which became the foundation of the third stage.

The third stage of the study involved analyzing the survey results in-depth through individual interviews and, subsequently, discussing and comparing them with the study participants in a panel discussion. This made it possible to determine the thematic coherence of the characteristics that described the research questions.

The study was conducted in the third quarter of 2022. The selection of the research sample was purposeful, with experts from international TFL companies with many years of professional experience in managerial positions invited to participate. The panel of experts was attended by:

- the Global Commercial Manager at Gopet Trans;
- the Sales Director at Arvato Bertelsmann. Supply Chain Solutions;
- the Operations Director at Geis. Gold Logistics;
- the Managing Director of Supply Chain & Logistics Network Expert.

Gopet Trans and Geis are logistics operators that mainly deal with transport (but also storage) (GOPET Poland, 2022; GEIS, 2022). Arvato focuses on warehouse management and provides transport services thanks to its subcontractors (Arvato Supply Chain Solutions, 2022). The fourth expert in the TFL companies (Expert SC & LN) was the President of Dachster (Dachser Poland, 2022) for several years – an entity providing logistics services (using land, air, and sea transport) and, from this perspective, he referred to the questions asked.

Results

The first research question, which concerned the problems related to the COVID-19 pandemic and the war in Ukraine, was covered by 13 detailed questions. The main problems faced by TFL companies (Table 1) include the following:

- information chaos,
- increases in the prices of raw materials and materials,
- increases in transport costs,
- increases in warehouse service costs,
- development of the e-commerce market,
- problems with human and social capital,
- timely handling of orders,
- legislative instability.

The rapidly changing regulations were a challenge for all four experts, while the other problems were of concern for two of them. However, claims for late deliveries were not a problem for any of the respondents, which may indicate a high level of trust and transparency in forming their supply chains.

Table 2 presents the assessment of the importance of supply chain disruptions in the surveyed TFL companies, which created opportunities for their development.

From the group of 14 characteristics that refer to the second question, the respondents indicated that the increase in the speed of decision-making was the main pro-development factor. Two more factors may show that their companies have increased their adaptability: the flexibility of actions taken, as well as the increase in the effectiveness of actions through remote work. The least pro-development disturbances included development in packaging processes and

Table 1. Importance of the problems caused by the COVID-19 pandemic and the war in Ukraine in the functioning of entities TFL

What problems/challenges resulting from the pandemic and geopolitical crisis have TFL companies faced?	Gopet Trans	Arvato	Geis	Expert SC& LN
• information chaos (disruptions in the flow of information, inconsistency of information, lack of information, etc.)	5	3	5	3
• no products on the market	3	1	3	2
• extended delivery times for individual product groups	2	1	3	4
• increases in the prices of raw materials and materials	3	4	4	2
• increases in transport costs (increases in fuel and energy prices, alternative delivery routes, limited port capacity, increases in freight prices, mobility package, etc.)	5	1	5	3
• increases in storage costs (increases in fuel, energy, and tax prices)	2	5	5	3
• increases in packaging costs	2	3	2	2
• timely handling of orders	3	4	2	5
• inventory management problems and their consequences	2	3	2	4
• problems with human and social capital (outflow of employees, remote work, social relations, etc.)	3	5	4	3
• claims for late deliveries	2	1	1	1
• development of the e-commerce market	2	5	5	2
• rapidly changing regulations – legislative instability	4	4	4	4

The severity of the problem/challenge: from 1 (not very important) to 5 (essential).

Table 2. Importance of disruptions in supply chains in creating their adaptability

Did disruptions in global supply chains create new development opportunities for the surveyed companies? If so, what was their importance in enhancing the adaptability of strings?	Gopet Trans	Arvato	Geis	Expert SC& LN
• increased flexibility of activities	5	5	5	3
• increased decision-making speed	5	5	4	4
• diversification of supply sources	4	4	1	3
• selection of new regional and local suppliers	4	1	1	2
• entering new markets of activity/diversification of activity	4	3	3	2
• increasing the effectiveness of activities through remote work	4	4	4	2
• selection of substitutes for complex/unique solutions	3	3	1	2
• development of transport processes	3	1	3	2
• reorganization of transport routes/types/processes	4	1	2	1
• development of warehouse processes	1	4	4	2
• development of packaging processes	1	3	2	2
• innovative packaging	1	5	2	3
• development of order-handling processes	2	5	3	3
• new methods of managing inventory	1	4	1	4

The severity of the problem/challenge: from 1 (not very important) to 5 (essential).

the choice of substitutes when there are complex/unique solutions.

The list of 16 activities that may be key to maintaining the competitiveness of the surveyed enterprises is presented in Table 3.

As Table 3 shows, all the experts indicated that implementing new business models was a necessary direction of change for enterprises. It may indicate thinking in terms of “recovery capacity” and, thus, striving for adaptability in managing the

company and the supply chains within which it operates. Regarding logistics activities, implementing warehousing innovations was the key factor for three experts, while two mentioned new models in global logistics (which is also associated with strategic management), implementing transport innovations, order handling innovations, and focusing on last-mile logistics. They also mentioned considering the principles of sustainable development, which became a necessity for large enterprises from

Table 3. Importance of logistics and supply chain management activities in strengthening the competitive position of the surveyed enterprises

What logistics and supply chain activities are crucial for maintaining the competitiveness of the surveyed enterprises in a turbulent environment?	Gopet Trans	Arvato	Geis	Expert SC& LN
• implementing transport innovations	5	3	3	5
• implementing storage innovations	1	5	4	5
• implementing packaging and packaging innovations	1	5	2	3
• implementing handling innovations	3	5	3	4
• implementing new business models	5	4	5	4
• considering the principles of sustainable development	4	4	3	2
• considering the principles of the circular economy	3	4	3	3
• considering the principles of the economy/shared logistics	3	2	1	1
• improving the security of supply chains	3	3	3	3
• developing “risk maps”	3	4	3	2
• implementing risk management tools and procedures	3	4	3	1
• implementing new communication strategies with suppliers	4	3	1	2
• developing supply chain maps that show the structure of connections (geographical, financial, and logistics)	3	3	2	2
• increasing stocks	1	3	1	5
• new models in global logistics	4	3	3	4
• focus on last-mile logistics	3	1	5	4

The severity of the problem/challenge: from 1 (not very important) to 5 (essential).

01.01.2025 in light of the EU’s Sustainable Development Reporting Directive of 10/11/2022 (EU Directive, 2022 /2464).

Discussion

Our analysis indicates several important findings that enable us to positively verify the main hypothesis of this article. In the current context of preparing for unexpected events, responding to disruptions, and recovering from them, shaping the adaptability of supply chains has taken on a new level of importance. This involves maintaining operational continuity while also ensuring the desired level of links and control over the structure and function of the supply chain. It results primarily from the turbulent nature of the business environment and uncertainty as a permanent feature of the future. Previous research confirms the increased interest in developing adaptive supply chains and provides guidance in which direction this development should go. This article provides several findings that contribute to the development of research on strengthening the adaptability of chains.

The presented concept of the adaptive supply chain model indicates the need for an integrated approach from the perspective of the value chain and striving to strengthen the competitiveness of enterprises. This model identifies interactions between

disruptions and the main processes/pillars of shaping adaptability (i.e., the theoretical dimension). In addition to the need to build resilience, there are economic arguments for implementing recovery capacity strategies. The analyses and conclusions from previous studies show that this is a very complex process. It involves identifying the weak points that make the supply chain vulnerable to disruptions and defining the attributes that allow disruptions to be anticipated and overcome. This was confirmed by Pettit, Croxton, and Fiksel (Pettit, Croxton & Fiksel, 2013, p. 49). They showed that the adaptability of supply chains increases as capacity increases and susceptibility to disruption decreases. At the same time, in building the adaptability of supply chains, Melnyk et al. (Melnyk et al., 2014, 36) mentioned the need to use a multidimensional and balanced approach. This means that the supply chain may not be able to afford to invest in both improving resistance and rebuilding, which the TFL experts confirmed in their assessment with respect to the importance of actions taken and planned.

In the empirical part of this study, the experts confirmed that the multidimensional transformation is based on the belief that creating an adaptive supply chain model is a way to stay ahead of the competition. Simultaneously, the pressure to reduce costs is still high, as customers expect competitive prices and management boards expect certain

margins. The challenge for supply chain leaders and their organizations is to find new trade-offs between costs, which increases the ability to resist and recover in a turbulent environment with a key feature of increasingly higher customer expectations. Thus, it is possible to point to the need to strive for sustainable adaptability, which increases efficiency. This study shows that the COVID-19 pandemic and geopolitical disruptions have forced a change of approach to rebuilding the principles of the supply chain strategy, both in relation to current operational activities and future directions of development. The undertaken and planned activities are characterized by thematic cohesion resulting from the specificity of the TFL industry and the organizational structure of the surveyed enterprises. At the same time, the highly interconnected nature of value chains limits the economic justification for making large-scale changes in the near future. To maintain or strengthen the competitiveness of TFL companies, their supply chains require appropriate instruments to adapt to the constantly changing environment in which they operate.

One of the key challenges for future research directions is the context of measuring adaptability. Guided by the criterion of achieving sustainable adaptability, measuring and assessing the sustainable adaptability of supply chains can be considered an important subject of further research.

Conclusions

In a world that is constantly changing (VUCA) and becoming increasingly volatile (BANI), supply chains must be able to adapt and improve their current operations. Leaders must adopt an innovative approach to increase the productivity and resilience of all links in the chain, preparing them for the challenges ahead. Instead of a trade-off between resilience and efficiency, this rebalancing can benefit all actors in the chain.

The COVID-19 pandemic and the war in Ukraine forced enterprises to prioritize the adaptability (understood as the ability to resist and rebuild) of the supply chain. There is a growing awareness that supply chains need to be more flexible and agile in order to be able to react quickly and adapt to potential disruptions. Thus, a preventive approach to disruptions demonstrates the market maturity of its participants. The scale of the economic crisis related to the COVID-19 pandemic and the geopolitical crisis confirmed that developing such an approach is an extremely difficult challenge, but, at the same time, it

is necessary. According to data from the Institute for Supply Management, only 21% of the surveyed enterprises confirmed that they maintain the required level of business continuity in the supply chain (Ambroziak et al., 2020, p. 9). Simultaneously, for over 75% of the surveyed entities, increasing the resistance to disruptions of cargo flows within the supply chain and the reliability of these supplies was mentioned as a priority action over the next three years.

To summarize, the adaptability of the supply chain does not mean the ability to overcome difficulties that arise from unforeseen phenomena and single events. Rather, it should be treated in the context of constantly anticipating threats to business continuity or maintaining the current ability to operate (Azevedo et al., 2013, p. 135). Thus, it has been realized that there is a need to streamline the processes, procedures, and structures of the supply chain that determine its resilience and ability to rebuild.

This article does not assess the effectiveness of activities to strengthen the adaptability of supply chains in the entities covered by this study. A prerequisite for successfully performing such a task is the availability of a comprehensive and accurate dataset. The results of these analyses call for further extended research in this area, including the resistance matrix and the reconstruction of the supply chain.

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