

Marcin HALICKI
Rzeszów University

THE CONCEPT OF THE SUPPLY CHAIN IN THE LIGHT OF DISASTERS AND CONFLICT IN UKRAINE

Abstract:

The aim of the article is to discuss the concept of the supply chain using a model approach, while taking into account the armed conflict in Ukraine. It has been shown that the standard model allows for the analysis of supply chains in terms of the application of disaster recovery strategies. It breaks them down into 2 types based on probabilities established in the past. The paper briefly presents the conflict in Ukraine and its possible negative impact on the world's economies. In the case of the presented model approach, appropriate modifications must be taken into account in order to apply the selected strategy that allows to increase the level of operational efficiency of enterprises. Such an assumption will allow links in the supply chain to function more effectively. Thanks to the proposed modifications, these cells will be able to hedge against an increase in the level of costs, as well as against price and wage volatility. The considerations carried out in the work may constitute the basis for separate empirical research, if military operations in Ukraine would last, for example, a year. Such a period is necessary for the construction of appropriate assumptions used in specific simulation analyzes.

Key words: companies, strategy, supply chain, disasters, Ukraine.

Introduction

The supply chain concept has been studied for many years. More and more often, one can encounter works in the field of economic sciences that analyze them taking into account formulas that are designed to capture other aspects of them that have not been presented so far. One such aspect is catastrophes that disrupt the operation of the chains. This concept, although it may be considered innovative, did not include the possibility of an armed conflict in Ukraine, for example. For this reason, it is worth confronting this concept with the economic realities that may appear soon and which will have a very strong impact

on the functioning of supply chains, as well as on the economies of the European Union countries or the entire world. The first thing to consider is why supply chains are so important to the functioning of national economies, and why are they complex entities? Well, you can often observe a very high pace and intensity of changes in the socio-economic sphere in the economy of states and in the entire world economy, where phenomena often occur that disrupt the functioning of supply chains, which include, for example, terrorism, droughts, floods, as well as disturbances in the circulation and collection of information using IT systems.

All this means is that they may not cope with all the challenges posed by the economic environment. In addition, new phenomena are also appearing, although known in the past, but now taking the rank of world problems. One is here talking about the armed conflict in Ukraine.

If we add to this that in all conditions, economic activity is associated with the processes of moving various goods from the sources of their acquisition to the final recipient, and this movement is accompanied by quantitative and qualitative transformational processes, then we will understand that supply chains, because they are entities involved in such a movement must be complicated and sensitive. This sensitivity is partly due to the fact that this shift occurs not only within but also between individual enterprises. Apart from the method of defining supply chains, it can be added in the introduction that it always includes the full process of delivering goods and services to final recipients, including supply, production and distribution, while the entities that are its links can achieve their own goals through the proper functioning of this chain as a mega-chain organization. Thus, any disruptions within the supply chains will translate into economic activity not only at the local or regional level, but also national, international, and in the event of a conflict in Ukraine – worldwide levels.

The aim of the article is to discuss the topic of supply chains in the light of the occurrence of disasters and the armed conflict in Ukraine, using a critical analysis of Polish and foreign literature as well as a model approach and scientific reflection. The considerations carried out in the work may constitute the basis for separate empirical research, if military operations in Ukraine would last, for example, a year. Such a period is necessary for the construction of appropriate assumptions used in specific simulation analyzes.

Supply chain as a multi-element entity

There are many definitions of supply chains that present them differently, taking into account their aspects from different perspectives, or simplify their characteristics to highlight the most important features. Therefore, it is very difficult to find one definition that best presents the essence of supply chains. Based on the conducted literature research, it was found that the most common research subjects in Polish and foreign literature are classic supply chains - in the case of cooperating enterprises, between which there is a "supplier-recipient" relationship, if the term "classic" can be used. This is because, since the 1990s, other entities of a similar nature, albeit much more complicated, have been examined. They are called project supply chains or construction supply chains (Halicki, Kwater, 2020).

However, their characteristics go beyond the scope of this article, and therefore they were not explored in this paper. However, it is worth remembering that such entities which are very large and complex, also function in economic realities, although their number is small compared to their classic versions. However, it should be remembered that it is defined differently, and the definitions that can be found in Polish and foreign journals (Tab. 1) are characterized by similarities and differences. Due to the multitude of works devoted to this issue, it can therefore be called classic to emphasize its distinctiveness from the project supply chain or the construction supply chain. It should not be forgotten that the literature on the subject also includes the concept of supply chain project, which can be defined as "(...) dyadic activities between existing alliance partners that have already established a relationship. These dyadic activities include joint-improvement of existing processes and / or building new ones (e.g., designing new information exchange or electronic procurement systems)" (Brinkhoff, Özer, Sargut, 2014).

Table 1: Examples of classic supply chain definitions

Author (Auhors)	Year	Definition
Chopra, Meindl	2007	„A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves. Within each organization, such as a manufacturer, the supply chain includes all functions involved in receiving and filling a customer request. These functions include, but are not limited to, new product development, marketing,

Halicki, M., 2022. *The concept of the supply chain in the light of disasters and conflict in Ukraine, Przegląd Geopolityczny, 41, s. 50-69.*

		operations, distribution, finance, and customer service”.
Witkowski	2010	"Mining, production, commercial and service companies operating in various functional areas and their customers, between which streams of products, information and financial resources flow".
Blaik	2010	"A specific chain, viewed from a pervasive and transverse perspective, that includes a network of companies involved, through links with suppliers and customers, in a variety of processes and activities that create value in the form of products and services delivered to customers. The supply chain represents the flow of goods, information and financial resources through the value-creation network that is an expression of business-to-business integration, extending from raw material suppliers to end users ”.
Gołemska	2010	The necessary condition for creating a supply chain is the warehouse and transport chain, also known as the logistics chain. Well, the logistics chain as a logistics base is a warehouse and transport chain that is a technological connection of warehouse and transshipment points by means of goods transport, as well as organizational and financial coordination of operations, procurement processes and inventory policy of all links in this chain.
Mentzeri in.	2001	„A supply chain is defined as a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer”.
Ayers	2001	"Life cycle processes comprising physical, information, financial, and knowledge flows whose purpose is to satisfy end-user requirements with products and services from multiple linked suppliers". According to this definition, the supply chain encompasses processes that cover a broad range of activities including sourcing, manufacturing, transporting, and selling physical products and services. Life cycle refers to both the market life cycle and the usage life cycle and these are not the same for durable goods and services. Therefore, product support after the sale becomes an important supply chain component”
CSCMP Supply Chain Management Definitions and Glossary	2022	“Supply Chain: 1) starting with unprocessed raw materials and ending with the final customer using the finished goods, the supply chain links many companies together. 2) the material and informational interchanges in the logistical process stretching from acquisition of raw materials to delivery of finished products to the end user. All vendors, service providers and customers are links in the supply chain”.

Investopedia	2021	"A supply chain is a network between a company and its suppliers to produce and distribute a specific product to the final buyer. This network includes different activities, people, entities, information, and resources. The supply chain also represents the steps it takes to get the product or service from its original state to the customer. Companies develop supply chains so they can reduce their costs and remain competitive in the business landscape".
Logistics Bureau	2015	"The total sequence of business processes, within a single or multiple enterprise environments, that enable customer demand for a product or service to be satisfied".

Source: own study based on literature research

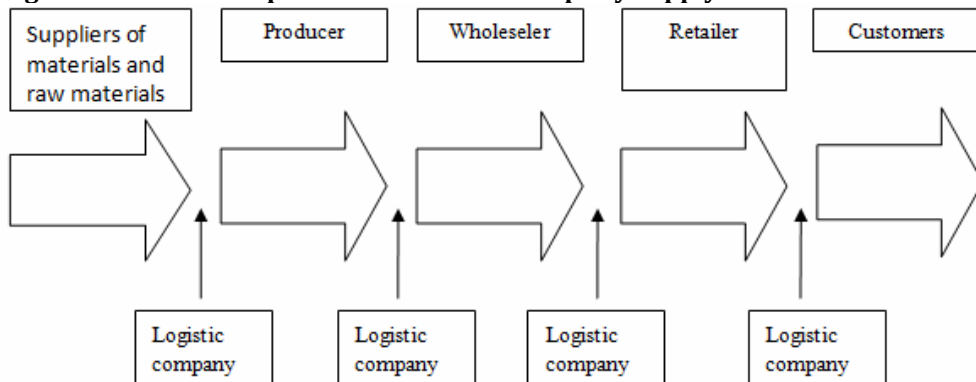
The presented definitions suggest that the supply chain is associated with the activities of various entities, but most often enterprises, which focus on the flow of products and information. This flow begins with the source of origin and ends with the last entity, the final customer. The latter is also a user of these products. Nevertheless, there is a noticeable trend that "along with the changing conditions of competition, the development of globalization and technological progress, there was a conceptual evolution of the supply chain, consisting in different interpretations of its essence, goals and participants.

The differences in the subjective interpretation of the chain are translated into the differences of views on the objective and functional scope and goals of cooperation. As a result of this evolution, the concept of the supply chain has become very ambiguous and imprecise (Witkowski, 2010). While characterizing supply chains, its most important features cannot be ignored. The literature on the subject suggests that the features of the classic supply chain are as follows (Witkowski, 2003):

- entity structure,
- object of flow,
- goals, functional scope and areas of cooperation of the participating entities.

When looking at the subjective structure of the supply chain, it is often said that its links may be "various types of mining, processing and trading companies" (Witkowski, 2003). Although the supply chain can be presented graphically in various ways, its subjective scope, including the most important links, allows it to be presented in the form of a clear drawing (Figure 1).

Figure 1. The most important links in an exemplary supply chain



Source: Halicki, 2020.

The characteristics of supply chains can pose problems in determining the minimum number of elements that are included in them to be able to form such a chain, not just a team of organizations. These elements, i.e. enterprises, for example, are links in the entire chain, and therefore they build it in such a way that it functions in an effective way. Literature studies indicate that the classic supply chain should be formed by at least 3 links (Mentzer 2001), therefore, if it is built only by 2 enterprises, then it cannot be assumed that they form such a chain. However, it must not be forgotten that the functioning of the chain does not only concern the flow of products or information, but also the connection of processes and activities of these links. And this is related to human activity, the presence of technology and specific systems. Only all of this within a specific supply chain is a combination, the main goal of which is to deliver goods and services to the end customer (Halicki, 2020).

So we note that complexity is one of the most important characteristics of supply chains. However, if we add to their nature the variability of operating conditions, because enterprises operate in a rapidly changing business environment, then we will conclude that it is very difficult to analyze supply chains in practice, especially since the turbulent environment always influences their operation in a certain way. Moreover, the business environment in the time of the conflict in Ukraine is unpredictable in many countries of the world, not only in the European Union.

It is therefore as surprising as it is turbulent, it is volatile and it places increasing demands on the competitiveness of enterprises. In

addition, it can also be assumed that the position of customers in many markets is and will be increasingly stronger, and the changes will not only concern the business sphere, but also political, social or even environmental ones. One cannot forget about technological changes, because in the economies, enterprises of the "FinTech" type (short for Financial Technology) are starting to play an increasingly important role. These relatively new organizations use the latest available technology and IT solutions to improve financial services. Therefore, they can be considered innovative in the area of technology and finance. Therefore, they form not only a group of entities, but in the 21st century their development and expansion resulted in the creation of a new sector of the economy, more and more important and dynamically developing.

Returning to supply chains and not delving into unnecessary details, the emergence of new sectors of the economy, new methods of obtaining financing, the opportunities associated with it and the risks arising from the armed conflict in Ukraine, forces organizations to adapt to such a turbulent environment and to implement appropriate processes adjustments. All of the above are needed to calculate the changes that are taking place and to increase the flexibility of operation and improve the speed of reaction to signals announcing any changes. Such an approach will allow for more efficient functioning of supply chains in various conditions, in which there are both such threats that cannot be predicted and those whose probability of occurrence can be estimated. In other words, they operate under conditions of uncertainty and risk, increasing the complexity of their management. It cannot be ignored that the greater number of elements in supply chains make them complex entities, which does not mean that they may be even more sensitive. It also means that in a turbulent environment they have to withstand various disturbances that result from risk and uncertainty, as well as numerous external threats, which, if easy to predict, could not always be maneuvered or even adapted to each other.

The essence of disasters disrupting the functioning of supply chains and the states of their links

Supply chains, which consist of many elements, do not have to have the same share in creating added value for end customers, which also complicates their analysis, especially since they can create entities that form a large organization dedicated to the implementation of one and unique project (Korpysa, Halicki, Lopatka, 2020, p. 215). Since the environment is turbulent, then companies can assume different states,

which are often different from each other. The worst thing, however, is that they can change, unexpectedly, without the possibility of forecasting these states, which in turn may lead to a complete break in the supply chain, because it cannot function properly if one of the links does not create added value. We should also remember that it is not always possible to replace a given link with another, when they offer unique products. An example is the current Canadian rail strike (Global News, 2022), in which the number of participants fluctuates around 3,000, and which automatically breaks the supply chain, because there is no other link that could act as an enterprise providing transport services for goods and passengers by rail.

These situations that are often beyond the control of a supply chain management perspective are called disasters. Enterprises building the supply chain are therefore exposed to the effects of various disasters, which may cause their states to change. It can be assumed that the state of a given link determines its ability to perform a function in the event of various disasters occurring during the year, regardless of the possibility of their prediction. In order to be able to reflect the state of such an enterprise, which is a link in a given supply chain, it can be assumed that it can assume three states, allowing for the analysis of the impact of such disasters on these links. It can also be assumed that the highest possible state of the enterprise is 2, therefore the "lower" states must have lower values. Such assumptions mean that the company "i" can have three states on a given day in a given year (assuming that the year has 365 days). If we consider that such states reflect the operational ability of an enterprise in terms of its ability to function as a link in supply chains (Martinez et al., 2018), then enterprises in the supply chain on a given day can be divided into 3 categories:

- Enterprises with the highest status, i.e. the first which are considered good and marked as $s_i(t) = 2$. Such enterprises are fully operational, so level "2" is the highest, which has already been mentioned.
- Enterprises with a normal state, i.e. the second state, marked as $s_i(t) = 1$. This state of affairs is acceptable from the perspective of supply chain management, as the enterprise in such a state is not fully operational, however, it does not prevent it from fulfilling the function of a link in the supply chain. Thus, it is assumed that the value "1" signifies the average state.
- The enterprise with the lowest state, i.e. the third state, considered to be in a bad state, which can be analogically marked

as $s_i(t) = 0$. Since this condition is considered to be the lowest, then it should be expected that a company in this condition is only slightly operational, and therefore it may even expect production to stop. Such a division is most advisable because it allows the construction of various models that can constitute the basis for the analysis of many situational variants in which supply chains are located.

Knowing the states of enterprises, it is already possible to take up the subject of disasters that have the greatest impact on the operational capacity of enterprises in supply chains, i.e. their condition. Well, the conducted literature studies (Halicki, Kwater, 2021) indicate that they include all threats that reduce such operational capacity. For example, an epidemic threat such as the COVID pandemic can also be counted as a catastrophe. They, in turn, are characterized by the fact that they not only cause the loss of the ability to function of individual links, but also the entire supply chain. However, in order to be able to carry out various simulation analysis, it is also worth determining how such disasters affect individual companies and thus the entire chain. The literature on the subject assumes that they are divided into small and large (Chen L.-M., Liu Y. E., Yang S.-J. S, 2015). Such an approach is needed in order to be able to apply a strategy of recovery from such disasters, taking into account not only the states of enterprises, but also the sequence and number of days on which they may occur. This assumption is useful for a number of reasons. It is helpful not only because it helps to indicate the number of days negatively affecting enterprises in the supply chain, but is also useful for examining the value of enterprise resource levels, which can be treated as specific assets, allowing for development for defense against disasters (Halicki, Quarters, 2021).

If it is assumed that disasters understood in this way negatively affect the property resources of enterprises in the supply chain, then they can be easily divided into small and large, because they threaten links and entire chains to different degrees. It is assumed in the literature (Chen L.-M., Liu Y. E., Yang S.-J. S, 2015) that:

- small disasters affect the company in such a way that they reduce the cell's condition by the value of "1",
- major disasters are more negative for enterprises because, once they occur, the link will always be "0".

All these assumptions that have been made are necessary from the perspective of considering crises, catastrophes or disruptions that links in the supply chains encounter or may encounter. Thanks to this

approach, it becomes possible to build strategies that allow for overcoming crises. In order to be able to develop any strategy, certain rules should be established, which are presented in the form of a table (Table 2.)

Table 2: Principles of operation of enterprises in conditions of disasters

Description	Rule
The state of the enterprise before the disaster	$s_i(t) \in \{0,1,2\}$
The state of the company after a small disaster	$s_i(t) \in \{0,1\}$
The state of the company after a major disaster	$s_i(t) = 0$
Quantity of companies	$i = 1,2, \dots N$
The number of days on which disasters can occur	$t = 1,2, \dots T$, where $T = 365 \text{ days}$
The desired state of the company after the disaster	$s_i(t) \in \{1,2\}$
The maximum possible state of the company after the disaster	$s_i(t) = 2$
The probability of a small disaster	$pg=134/365$
The probability of a big disaster	$pf=17/365$
A model that allows you to predict a disaster	not available
Initial resources of a company that wishes to participate in the supply chain	$R = 3$

Source: own study based on (Halicki, Kwater, 2021)

The enterprise operating conditions presented in Table 1 contain the most important information that is needed to quantify the impact of disasters on enterprises cooperating within supply chains. We note that the probabilities of various disasters, no matter what they are, have been calculated in the past (Chen L.-M., Liu Y. E., Yang S.-J. S, 2015). We also note that each company desires to have the state $s_i(t) \in \{1,2\}$ in order to be able to fulfill its functions in the supply chain. The considerations are therefore valuable because the link, after the occurrence of a disaster, wants to attempt to regain the highest possible operational level $s_i(t) = 2$, and if this is not possible, then at least the state $s_i(t) = 1$. All of this is referred to as a decision rule (Chen L.-M., Liu Y. E., Yang S.-J. S, 2015). In other words, having specific conditions for the functioning of the enterprise in the manner presented above, it is possible to define various strategies of overcoming crises, even the most severe ones.

Another characteristic feature of the proposed approach is that no attempt was made to build a model to predict disasters, but the probability of their occurrence was determined. Secondly, companies unable to forecast must expect a crisis to occur at any time, that is, on each of the 365 days, although it does not have to happen every day. Nevertheless, it can hit different companies in the supply chain for several days in a row, each of them being affected by the crisis at the same time.

This approach, although model and theoretical, has many practical advantages, as it allows the development of the strategy that has already been mentioned. It also allows for the division of crises that may strike with different force and frequency.

It should be remembered that the enterprise, wishing to raise the state level to the value of $s_i(t) \in \{1,2\}$, must have resources that it uses in the fight against crises. It must not be forgotten that the best situation for the entire supply chain is not the case when a single company has the status at level 2, but such a combination in which all cells during the year will be most often (even 365 times) characterized by the highest level of operability. All this will allow us to achieve the required efficiency at the level of the entire supply chain, which allows us to meet customer expectations. The assumptions made, although theoretical, cannot guarantee in economic practice that "full operability" will ensure the proper functioning of the entire supply chain in all conditions. However, when wanting to test such an ability or wanting to investigate the ways of achieving it, the probabilities of various unfavorable events can be captured, so that the considerations may be of an application nature. It cannot be ignored that disasters disrupting the operation of supply chains exist in practice (Chen L.-M., Liu Y. E., Yang S.-J. S, 2015).

For model development, it is possible to create strategy elements to be ensured that there is room for improvement. These assumptions, placed on the training table (Table 3).

For the proposed model, an appropriate RC strategy was selected, because both the "crisis - COVID-19" as well as any armed conflict that currently occurs in Ukraine may force enterprises to use resources of the highest value, and the state $s_i(t) = 1$ may not be sufficient in practical conditions to act as a link in the supply chain. Referring to all undesirable phenomena related to the functioning of supply chains, the literature also mentions disruptions that must be taken into account during the cooperation of cells. They are an unexpected phenomenon that leads to an interruption as well as a delay in the execution of tasks or projects. In

other words, disruptions are delays in manufacturing, distribution, or procurement companies in the supply chain, which simultaneously affect the functioning of other parts of the supply chain. Disruptions can also be characterized as expected or unexpected events that cause unplanned, negative deviations in the processes of delivering products and services conducted in accordance with the organization's goals (Wieteska, 2011).

Table 3: Elements of a corporate strategy used in disaster conditions

Description	Rule
The value of the company's resources in the period $t = 0$	$R = 3$
Increase in resources over the period $t + 1$	$\Delta R = 1$
Value of resources consumed when the cell wishes to increase a state from $s_i(t) = 0$ to the state $s_i(t) = 1$	$RC = 1$
Value of resources used when the cell wishes to increase the state from $s_i(t) = 1$ to the state $s_i(t) = 2$	$RC = 2$
Value of resources consumed when the cell wishes to increase z state from $s_i(t) = 0$ to the state $s_i(t) = 2$	$RC = 10$
In case $R < RC$	$RC = 0$ (no application of the strategy, so $\Delta s_i(t) = 0$)
In case $R > RC$	$s_i(t) \in \{1,2\}$ and $RC \in \{1,2,10\}$
Determine the number and number of days when disasters occur to apply the strategy	„A pseudorandom number generator (PRNG)” using parameters of normal distribution, where the number of attempts made was equal to 365

Source: own study based on (Halicki, Kwater, 2021)

Disruptions can also turn into a bottleneck in one of the links, which may have a negative effect on the entire supply chain, and not only on the neighboring links. Consequently, there are many different negative events that affect the entire chain inappropriately. These include, for example, fires, breakdowns, and quality problems (Handfield, Blackhurst, Elkins, & Craighead, 2008). The literature review confirms that there are many different approaches to negative events affecting supply chains, although specific definitions will not be given due to the formal limitations of the article. However, on the geopolitical

ground, the armed conflict in Ukraine, combined with the COVID-19 pandemic, represent a mix of events that disrupt the functioning of, or even the building of, supply chains. Such an environment beyond the control of the links significantly threatens the existence of chains by disrupting the implementation of all business processes, especially the most important ones that contribute to the creation of added value.

The armed conflict in Ukraine as a catastrophe threatening the functioning of supply chains

When analyzing the literature on the subject, it is impossible to find an exact definition of a catastrophe. It is noted, however, that "empirical studies indicate that most supply chains tend to collapse during disruptions caused by major unanticipated disasters and many of them never recover afterwards" (Chen L.-M., Liu YE, Yang S.-J. S, 2015). The armed conflict in Ukraine is undoubtedly a catastrophe that could break many supply chains in numerous industries around the world. It negatively affects many sectors of different economies, causing unexpected perturbations in the financial systems, so introducing all possible measures to restore stability can be assessed as desirable. Regarding the conflict in Ukraine, it was decided to focus on the most important events in the period 2014-2022, because the work concerns the economic aspects of the functioning of supply chains, and not the broadly understood policy or macroeconomic situation. It is worth mentioning, however, that the history of Ukraine in this period is undoubtedly turbulent, not only politically but also economically. This country is in a rather atypical position, because on the one hand it borders with NATO countries and the European Union and on the other hand with Russia, which has been influencing its economy and politics for many years. It is not without significance that Ukrainians started protests in the streets as early as 2004, refusing to agree to the results of the presidential election, which was the beginning of the so-called "Maidan", meaning many months of protests.

After many years of the turbulent history of Ukraine, problems with unemployment and inflation, the next geopolitical flash point has become Crimea, which after 1992 remained within the borders of Ukraine, being the so-called Republic. It is mostly inhabited by Russians who were reluctant to join Ukraine. As a consequence, the soldiers of unknown troops, the so-called "Green Men" stormed selected objects of Crimea, after which Russian flags were hoisted. Russia, in turn, treated this event as an act of the Russian-speaking citizens of Crimea. These

soldiers occupied airports and other parts of the infrastructure. Consequently, this event marked the beginning of the military conflict between Ukraine and Russia, which reached its peak in 2022.

In the meantime, however, the war has practically started, but in the form of a "hybrid war", because Ukraine often had to deal with IT attacks, known as hackers, and a flood of false information. There was also a referendum in the Crimea, the results of which unanimously indicated that the indigenous people chose to join Russia. Additionally, another spark of the current conflict was the announcement of the creation of new republics in Donetsk and Lugansk, in which Russia is already directly involved and seems to control these two areas until today. When the next president, who showed pro-Western tendencies, was elected in 2019, Russia hardened its attitude towards Ukraine even more, as already in 2021, significant forces of the Russian army had been concentrated along the Ukrainian border and in Crimea. Then, a Russian-Belarusian military exercise was conducted, in which hundreds of thousands of soldiers participated, after which, from November, Russian soldiers began concentrating along the borders with Ukraine. Ultimately, on February 24, 2022, Russia attacked Ukraine with the aim of demilitarizing it. Many countries around the world condemned the military invasion of Ukraine. Its effects include the bombing of both military and residential facilities, as well as schools, hospitals and kindergartens, which continue to this day. As for the conditions in which supply chains will function, the global consequences of the conflict in Ukraine should be expected in the first place. This conflict and the sanctions imposed on Russia will translate into the prices of energy, as well as raw materials and food products. What is worse, supply chains were not prepared for such a development, which is visible, for example, in the automotive industry, which manifests itself in a long wait for a new car after placing an order.

This conflict may affect the phases of the economic cycles of the European Union countries changing their course and duration. You can also expect very high inflation, which may have an impact on the state budget revenues, but it will be spent on helping refugees from Ukraine. Expenditure on energy infrastructure and on armaments can also increase. This will be accompanied by an increase in fuel prices, which will again have an impact on the prices of other goods, increasing the costs of transport. Such a situation will be accompanied by an increase in interest rates in many countries of the world, which may become a stimulus reducing economic development and increasing the level of

unemployment, which in many world economies, including Poland, was relatively low, despite the COVID 19 pandemic.

With regard to supply chains, it was mentioned that they are complex entities, inside which various logistic processes are carried out, the number of which can be extremely high. Therefore, the conflict in Ukraine will cause more and more problems in various areas of business activity. If it is a link in a specific supply chain, then these problems will create further problems in other links of this chain. It should be remembered that in the 21st century there is a kind of fashion for reducing the stocks in cells in order to reduce logistic costs, therefore the chains become very sensitive to any disturbances, and the conflict will be a disturbance of very high strength. This disruption can therefore have the greatest possible negative impact on the functioning of supply chains. Therefore, in order to change the strategy proposed for overcoming crises and maximizing the value of the resources of cells and the entire chain, certain assumptions should be changed so that such a strategy is effective and allows for various simulations. These changes are presented in the form of a table (Table 4).

Summarizing the data contained in the table, it should first be mentioned that the proposed strategy that allows simulations can be used in calculations and any case studies of supply chains in the conditions of armed conflicts, also such as in Ukraine. Nevertheless, there are two important things to note. Firstly, in a conflict situation, the companies forming the supply chain should increase the level of their resources, the value of which cannot be determined from the upper limit, but should be selected according to the industry and the general situation, on an individual basis. This will avoid bankruptcy. After all, enterprises have to protect themselves against the increase in operating costs as well as against price and wage volatility. Second, the probabilities used in the calculations should also be changed. The probability of a small catastrophe should be correspondingly lower, because in a conflict situation a small catastrophe should be treated as a normal incident for which R resources should be prepared, but not as negative as it was before the conflict in Ukraine. In the case of the likelihood of a large catastrophe occurring, it should be set at a higher level, because the strategy must take into account the fact that in the present conditions a large catastrophe is a very negative event that cannot be predicted, however it can have a sharp and strong impact on reducing resources in the chain enterprises who have to constantly cope with the frequent reduction of these resources.

Table 4: The principles of operation of enterprises in the conditions of disasters and armed conflict in Ukraine

Description	Rule
The state of the enterprise before the disaster	$s_i(t) \in \{0,1,2\}$
The state of the company after a small disaster	$s_i(t) \in \{0,1\}$
The state of the company after a major disaster	$s_i(t) = 0$
Quantity of companies	$i = 1,2, \dots, N$
The number of days on which disasters can occur	$t = 1,2, \dots, T$, where $T = 365 \text{ days}$
The desired state of the company after the disaster	$s_i(t) \in \{1,2\}$
The maximum possible state of the company after the disaster	$s_i(t) = 2$
The probability of a small disaster	pg - correspondingly lower, because in the present conditions a small catastrophe should be treated as a normal event for which resources should be prepared R
The probability of a big disaster	pf - correspondingly higher, because in the present conditions a major catastrophe should be treated more seriously, i.e. as an unpredictable event, which has a very high impact on the reduction of resources R , therefore it is required from the entire chain to increase the necessary resources
A model that allows you to predict a disaster	not available
Initial resources of a company that wishes to participate in the supply chain	R – high, without specifying the upper limit, because the cell must protect itself against an increase in operating costs and volatility of prices and wages

Source: own study.

Conclusions

The paper mentions that the negative disruptions encountered in supply chains also affect economic activity in local, regional, national and global areas. The conflict in Ukraine creates and will create very unpredictable threats to the supply chains, which for analytical purposes can be called catastrophes. The paper presents the essence of disasters and the probabilities of their occurrence calculated in the past. It also shows what supply chains are and what elements they consist of. These

elements are called links. It also mentions that in the event of disasters, the operating conditions of enterprises can be defined, along with the various information that is required to quantify their impact on the enterprises that perform their functions within the supply chains. The purpose of this is to apply an appropriate strategy that allows the company to increase the level of operability. It was shown that the probabilities of disasters, which were divided into two types, were calculated in the past.

Nevertheless, in the event of an armed conflict in Ukraine, the presented model approach must be modified. The resources that the links in the supply chain must contain should be adjusted, as a strong disruption can happen relatively more often than a small one. Therefore, it may relatively more often reduce the level of operability of enterprises building the supply chain. Thus, the change of the probability values is also necessary in order to be able to study the influence of the strategy on the states of enterprises in the future.

Literature

- Ayers, J.B., 2001. *Handbook of Supply Chain Management*, Boca Raton: The St. Lucie Press/APICS Series.
- Blaik, P., 2010. *Logistyka. Koncepcja zintegrowanego zarządzania*, Wyd. 3. popr., Polskie Wydawnictwo Ekonomiczne, Warszawa.
- Brinkhoff, A., Özer, Ö., Sargut, G., 2014. *All You Need Is Trust? An Examination of Inter-organizational Supply Chain Projects*, *Production and Operations Management*, 24 (2), p. 181–200.
- Chen, L.-M., Liu, Y. E., Yang, S.-J. S., 2015. *Robust supply chain strategies for recovering from unanticipated disasters*, *Transportation Research, Part E*, 77, pp. 198-214.
- Chopra, S., Meindl, P., 2007. *Supply chain management: strategy, planning, and Operation*, 3rd edition, Upper Saddle River: Pearson Prentice Hall.
- CSCMP Supply Chain Management Definitions and Glossary, (https://cscmp.org/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx), accessed on 15.03.2022.
- Domian, M., 2019. *Geopolityczne ryzyko zachowania ciągłości importu ropy naftowej do Unii Europejskiej*, *Przegląd Geopolityczny*, 29, s. 25-52.

Halicki, M., 2022. *The concept of the supply chain in the light of disasters and conflict in Ukraine*, Przegląd Geopolityczny, 41, s. 50-69.

- Falkowski, M., Pytel, M., 2013. *Typology of basic academic notions related to the transport system*, European Journal of Geopolitics, 1, pp. 37-60.
- Global News, (<https://globalnews.ca/news/8694459/cp-rail-strike-begins/>), 21.03.2022.
- Gołomska, E., (red.), 2010. *Kompendium wiedzy o logistyce*, PWN, Nowe Wydanie, Warszawa.
- Halicki, M., Kwater, T., 2021. *Simulation experiments of supply chain in a period of small and big disasters*, Journal of Economics & Management, 43, pp. 339-356.
- Halicki, M., Kwater, T., 2020. *Supply chain risk management and the modern strategy for analysis of disasters – a proposal for Polish companies*, Wybrane problem rozwoju sektora przedsiębiorstw w Polsce, Archae Graph, Łódź.
- Halicki, M., 2020. *Projektowy łańcuch dostaw w innowacyjnym zarządzaniu*, [w:]G. Gajdek, Cz. Puchalski (red.), *Ekonomiczno-technologiczne aspekty rolnictwa i energetyki*, UR, Rzeszów, pp. 61-70.
- Handfield, R.B., Blackhurst, J., Elkins, D., Craighead, C.W., 2008. *A framework for reducing the impact of disruptions to the supply Chain: Observations from multiple executives*, [w:] R.B. Handfield, K. McCormack (eds.), *Supply Chain Risk Management. Minimizing Disruptions in Global Sourcing*, Taylor & Francis Group, London – New York, pp. 29-49.
- Investopedia, 2021. <https://www.investopedia.com/terms/s/supplychain.asp>, accessed on 15.03.2022.
- Jarubas, A.S., 2021. *Zmiany w prawie dotyczącym przemysłu zbrojeniowego w Polsce. Perspektywa postpandemiczna*, Przegląd Geopolityczny, 38, s. 57-94.
- Korpysa, J., Halicki, M., Lopatka, A., 2020. *Entrepreneurial management of project supply chain – a model approach*, Problems and Perspectives in Management, 18 (3).
- Logistics Bureau, *Supply Chain Glossary of Terms*, 2015. <https://www.logisticsbureau.com/supply-chain-glossary/>, accessed on 15.03.2022.
- Martínez, R., Lizarraga, G., Cavazos, L., Salais, T., Saucedo, J., 2018. *A new objective function to simulate supply chain performance under disruptions with cellular automata*. In: F. Torres-Guerrero, J. Lozoya-Santos, E. Gonzalez Mendivil, L. Neira-Tovar, P. Ramirez-

Halicki, M., 2022. *The concept of the supply chain in the light of disasters and conflict in Ukraine*, Przegląd Geopolityczny, 41, s. 50-69.

- Flores, J. Martin-Gutierrez (eds.), *Smart Technology*. First International Conference, MTYMEX 2017, May 24-26, 2017, Monterrey, Mexico (pp. 21-30). Berlin: Springer International Publishing.
- Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D., Zacharia, Z.G., 2001. *Defining Supply Chain Management*, Journal of Business Logistics, 22 (2).
- Ogrodniczuk, M., 2015. *The International Trade Policy in the American Political System*, Przegląd Geopolityczny, 12, s. 159-172.
- Paszkiwicz, E., 2018. *Bezpieczeństwo energetyczne Unii Europejskiej w sektorze gazu ziemnego*, Przegląd Geopolityczny, 23, s. 123-143.
- Rogała-Lewicki, A., 2021. *Infrastruktura pozostająca w dyspozycji przedsiębiorcy o szczególnym znaczeniu dla bezpieczeństwa państwa*, Przegląd Geopolityczny, 35, s. 126-142.
- Vitale, A., 2020. *The rebirth of economic nationalism – from neo-protectionism to the new world geo-economy*, Przegląd Geopolityczny, 34, s. 36-51.
- Wieteska G., 2011. *Zarządzanie ryzykiem w łańcuchu dostaw na rynku B2B*, Difin, Warszawa.
- Wilczyński, P.L., 2017. *Problematyka bezpieczeństwa we współczesnym dyskursie eksperckim w Polsce*, Przegląd Geopolityczny, 21, s. 48-66.
- Wilczyński, P.L. 2021. *Arms trade and resources exploitation – survey of neo-colonialism and neo-imperialism in Africa*, European Journal of Geopolitics, 9, pp. 61-92.
- Wilczyński, P.L., 2022. *New sources of alloying metals for the steel industry in a changing global market*, Przegląd Geopolityczny, 40, s. 44-83.
- Witkowski, J., 2003. *Zarządzanie łańcuchem dostaw. Koncepcje. Procedury. Doświadczenia*, Polskie Wydawnictwo Ekonomiczne, Warszawa.
- Witkowski, J., 2010. *Zarządzanie łańcuchem dostaw. Koncepcje. Procedury. Doświadczenia*, wyd. II, Polskie Wydawnictwo Ekonomiczne, Warszawa.

Koncepcja łańcucha dostaw w świetle katastrof i konfliktu na Ukrainie

Celem artykułu jest prezentacja koncepcji łańcucha dostaw, z wykorzystaniem podejścia modelowego i uwzględnieniem konfliktu zbrojnego na Ukrainie. Pokazano, iż standardowy model pozwala na analizy łańcuchów dostaw pod kątem zastosowania strategii wychodzenia z katastrof. Dzieli on je na 2 typy, bazując na ustalonych w przeszłości prawdopodobieństwach. W pracy przedstawiono w dużym skrócie konflikt na Ukrainie oraz jego możliwy negatywny wpływ na gospodarkę świata. W przypadku prezentowanego podejścia modelowego, odpowiednie modyfikacje muszą być uwzględniane celem stosowania wybranej strategii pozwalającej na podnoszenie poziomu operacyjności przedsiębiorstw. Takie założenie pozwoli ogniwom w łańcuchu dostaw funkcjonować bardziej efektywnie. Dzięki proponowanym modyfikacjom, ogniwa te będą w stanie zabezpieczyć się przed wzrostem poziomu kosztów, jak również przed zmiennością cen i płac. Studium może stanowić podstawę do odrębnych badań empirycznych, jeśli operacje wojskowe na Ukrainie trwałyby np. rok. Taką okres jest niezbędny do skonstruowania odpowiednich założeń wykorzystywanych w konkretnych analizach symulacyjnych.

Key words: przedsiębiorstwa, strategia, łańcuch dostaw, katastrofy, Ukraina.