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## The impact of supply chain disruptions on the opportunity cost of road transport companies in Poland. A case study

### Wpływ zakłóceń łańcucha dostaw na koszty alternatywne drogowych przedsiębiorstw transportowych w Polsce. Studium przypadku

**Teresa Gądek-Hawlana**

teresa\_gadek-hawlana@sggw.edu.pl; ORCID: 0000-0003-4350-1246  
Department of Logistics, Warsaw University of Life Sciences, Poland

**Patryk Heliosz**

Patryk.heliosz@ue.katowice.pl; ORCID: 0000-0002-1107-203X  
Department of Transport, University of Economics in Katowice, Poland

**Abstract.** The mission of many companies around the world is to strive for continuous development of their operations, thus increasing their own operability and profits generated. The ways to do this are at least several - from increasing the scope of the company's operations to looking for weak links inside the company, thus optimizing the costs incurred. It so happens, however, that it is not internal conditions that influence the way a business entity is shaped, but external influences over which one does not always have control. It then remains to adjust to the new reality and, as far as possible, reduce its negative impact. Emerging threats in the socioeconomic space, in recent years, caused by the COVID pandemic or the war in Ukraine, among others, have contributed to an area in which research should be undertaken. The purpose of the study was to analyze the disruptions created inside supply chains and their impact on the transport company. In the described research, the research questions were formulated as follows: How do disruptions in supply chains affect the opportunity costs of transportation companies and how can they be minimized? A research assumption was made that disruptions in supply chains affect the opportunity costs of transportation companies. These disruptions limit opportunities to expand economic activity. The problem discussed referred to the issue of opportunity cost - in particular, the cost of lost opportunities and benefits, in order to then propose changes and actions to reduce the adverse effects from external influences. Based on the research, it can be concluded that disruptions in supply chains affect the opportunity cost of companies (1). Identifying and analyzing disruptions Identifying disruptions and analyzing allows you to identify several options for minimizing opportunity costs (2). Considering the disruptions

in supply chains under the influence of the global crises among the most significant affecting the studied entity were: disruptions related to the timeliness of deliveries, the inability to hire new drivers and the possibility of acquiring another set of vehicles (3). These disruptions prevented the surveyed entity from expanding its operations and thus affected its opportunity costs.

**Keywords:** disruption, opportunity cost, supply chains, crisis, case study

**Abstrakt.** Misją wielu przedsiębiorstw na całym świecie jest dążenie do stałego rozwoju swojej działalności, a co za tym idzie zwiększania własnej operacyjności i generowanych zysków. Sposobów, aby tego dokonać jest co najmniej kilka – od zwiększenia zakresu działania przedsiębiorstwa po wyszukanie stałych ogniw wewnątrz firmy, optymalizując w ten sposób ponoszone koszty. Zdarza się jednak tak, że to nie wewnętrzne uwarunkowania wpływają na sposób kształtowania podmiotu gospodarczego, a zewnętrzne wpływy, nad którymi nie zawsze ma się kontrolę. Pozostaje wtedy dopasować się do nowej rzeczywistości i w miarę możliwości obniżyć jej negatywne oddziaływanie. Powstałe zagrożenia w przestrzeni społeczno-gospodarczej, w ostatnich latach, spowodowane między innymi pandemią COVID czy wojną na Ukrainie przyczyniły się do powstania obszaru w którym należy podjąć badania. Celem opracowania była analiza zakłóceń powstałych wewnątrz łańcuchów dostaw i ich wpływu na przedsiębiorstwo transportowe. W opisywanym badaniu pytania badawcze sformułowano następująco: w jaki sposób zakłócenia w łańcuchach dostaw wpływają na koszty alternatywne przedsiębiorstw transportowych i w jaki sposób można je minimalizować? Przyjęto hipotezę badawczą, iż zakłócenia w łańcuchach dostaw mają wpływ na koszty alternatywne przedsiębiorstw transportowych. Zakłócenia te ograniczają możliwości poszerzenia aktywności gospodarczej. Omawiany problem odnosił się do kwestii kosztu alternatywnego – w szczególności kosztu utraconych możliwości i korzyści, aby następnie zaproponować zmiany oraz działania, które pozwolą na obniżenie niekorzystnych skutków z zewnętrznych wpływów. Na podstawie przeprowadzonych badań można stwierdzić, że zakłócenia w łańcuchach dostaw wpływają na koszty alternatywne przedsiębiorstw (1). Identyfikacja i przeanalizowanie zakłóceń umożliwi wskazanie kilku opcji minimalizowania kosztów utraconych możliwości (2). Biorąc pod uwagę zakłócenia w łańcuchach dostaw pod wpływem światowych kryzysów, do najistotniejszych oddziałujących na badany podmiot zaliczamy: zakłócenia związane z terminowością dostaw, brakiem możliwości zatrudnienia nowych kierowców oraz możliwością nabycia kolejnego zestawu pojazdów (3). Zakłócenia te uniemożliwiły badanemu podmiotowi poszerzenie prowadzonej działalności, a tym samym wpłynęły na jego koszty utraconych możliwości.

**Słowa kluczowe:** zakłócenia, koszty alternatywne, łańcuchy dostaw, kryzys, studium przypadku

## Introduction

Analyzing the global and domestic economic situation in recent years, one can see progressive fluctuations in the operability of individual links in logistics chains. One of the most frequently encountered problems concerned the lack of fluidity in obtaining particular raw materials (e.g. steel), and thus the possibility of producing a particular semi-finished product within a given timeframe. The above situation created a domino effect, in which goods necessary for the production of the finished product are not delivered on time and most often contribute to causing an avalanche of delays in subsequent stages of flows. The shortage of electronic components needed to complete the equipment of various motor vehicles can be used as an example of the above situation. When placing an order for a new vehicle in 2020-2022, the approximate waiting time for its production was often 12 months and was in no way a guaranteed receipt date (Okurowski, 2021) (by comparison, in earlier years there was a wait of about 4 months for a personally configured vehicle). In addition, some dealerships offered the option of picking up a car with incomplete equipment,

which could be completed free of charge at a later date (Karczmarz, 2022). A similar state of affairs persisted for steel-intensive products, such as trailers (Pakulniewicz, 2021). The above situation caused a drastic increase in the price of used vehicles by up to 50%, and this in turn required operators to incur greater costs when deciding to replace their fleets or wanting to expand their own businesses.

Another phenomenon hitting business units operating in the logistics industry negatively concerned staff shortages for manual workers (for example, those operating warehouses) or people working as professional drivers (Money.pl, 2021). Companies that wanted to expand their operations had to reckon with the complicated nature of the labor market requiring them to provide above-standard wage levels while maintaining competitive employment conditions. This, of course, also involved the use of above-average company resources (Przybylski, 2021), thereby increasing the costs generated compared to previous years.

It is suggested that, to some extent, responsibility for the above state of affairs is attributed to significant events that occurred during the selected time period. These include, first and foremost, the outbreak of the coronavirus pandemic in the first half of 2020, when the production volumes of a huge number of players around the world dropped significantly, and due to the lack of an immediate solution to the problem, this situation persisted for the next 2 years.

In turn, in 2021, the drastic effects of Brexit, which took place in early 2020, were noticed. The UK's departure from the European Union was associated with significant shortages of professional drivers (businessinsider.pl, 2021), and thus increased the cost of imports and exports of goods to and from the country.

In contrast, 2022 brought a globally unexpected event - Russia attacked Ukraine on February 24. The conduct of military operations in the eastern part of Europe caused a renewed disruption of flows within logistics chains. Some companies ended their cooperation with the aggressor (Giz, 2022), while others were forced to accept delays in fulfilling orders placed with business entities located in Ukraine. Thus, the above phenomenon contributed to further increases in the prices of raw materials, semi-finished and finished products.

The purpose of the study was to identify the disruptions created inside the supply chains and analyze their impact on the transport company. The problem discussed referred to the issue of opportunity cost - in particular, the cost of lost opportunities and the identification of possible solutions that could allow to reduce the adverse effects of external influences.

## **Literature review**

The dependence of logistics operations on a variety of factors means that often the smallest disruptions to the operability of logistics chains involve drastic

consequences. A disruption in the general sense is a violation of the established order or course of affairs or processes. Disruption is sometimes equated with disorder, confusion, chaos, interruption, stoppage (Konecka, Stajniak, Szopik-Depczynska, 2016). According to Wieteska, a disruption is an event, whether expected or not, that causes unplanned, unfavorable deviations in the processes of delivering products and services conducted in accordance with the organization's objectives (Wieteska, 2011).

Dynamic phenomena occur in logistics chains. Due to the large number of random factors affecting the chain's processes, they are very rarely in a stable state. The destabilization effect of the logistics chain is the result of the overlap of many phenomena occurring in it (Konecka, 2015; Konecka, Stajniak, Szopik-Depczynska, 2016). The most important of these are shown in Table 1.

Table 1. Types of disruptions in supply chains

Type of effects	Characteristics
The Forrester effect (Bullwhip effect)	The phenomenon of amplifying the response of upstream production stages to changes in demand at the bottom of the supply chain (at final buyers) is called the Forrester effect. As a result, for example, a few percent decrease (increase) in retailers' demand translates into a several percent decrease (increase) in the production of intermediate goods. The main reason for the Forrester effect is the way inventories are managed. During an economic crisis, manufacturers not only reduce final production, but also adjust their inventories to the reduced order volume, so they order fewer intermediate goods than usual - the Forrester effect is stronger the longer the supply chain. As a result, the values of trade in intermediate goods during a crisis decrease more (correspondingly: they increase more during a recovery) than the values of trade in final products. The Forrester effect can be mitigated by: improving the flow of information in the supply chain, reducing supply delays, and better forecasting of changes in the volume of demand for final goods.
The Burbidge effect	It is sometimes also referred to as the Forridge effect or the clustering effect, and is associated with the use of the classic planning instrument of economic batching or periodicity of ordering. This instrument is designed to take advantage of economies of scale in production or transportation. It also results from the natural planning periods used in the economy. In the individual links of the logistics chain, decision centers group orders (or production orders) and batch (i.e., periodically) process them (e.g., ship or start the production process). Such activities are as rational as possible from the point of view of a single link. Their synchronization in time, however, results in a rapid periodic increase in order volumes in the logistics chain, followed by an equally rapid decrease. Both the periods of increases and decreases and their levels are difficult to predict - they carry a random character. They depend on a number of factors, such as the structure of the logistics system, the types of companies in each link of the chain, their size and the algorithms for calculating the economic batch, as well as their parameters. This effect, due to the indiscriminate use of the concept of economic lot and identical or very similar planning algorithms in management information systems, is sometimes very dangerous.

cd. tab. 1

The Houlihan effect	It is sometimes referred to as the shortage effect and it describes the behavior of decision-makers in the logistics chain links when they are affected by temporary supply shortages or delays regardless of their causes. The natural tendency, resulting from local rationality of actions and human psychology, is then to demand accelerated deliveries to replenish inventories and to increase orders beyond current needs (i.e., to increase the level of safety stock). This, in turn, triggers a build-up of the phenomena (delivery delays, supply shortages) that caused these behaviors. A typical positive feedback loop is created, leading to an increase in disorder. After a certain period of time, increased inventories are created in the various links of the chain. This leads to a reduction in orders, which exacerbates the destabilizing effect of the logistics chain by temporarily reducing or disappearing material flows. The best way to reduce the Houlihan effect is for cooperating parties to inform each other and to introduce penalties for returns or cancellation of contracts.
The effect of promotion	The promotional effect is one of the most commonly encountered types of disorganization in the operation of logistics chains. In this phenomenon, the flow of standard operations is disrupted by maneuvering product prices. Business entities use marketing activities to increase the value of demand for certain goods. Usually, the marketing activities undertaken are analyzed in advance by the enterprises concerned, and the effects of their operations are predictable. In connection with planned promotions, situations arise in which various entities generate significantly higher inventory levels. Unfortunately, at the moment when the planned sales volumes are not realized, enterprises are forced to continue promotional policies in order to sell off the remaining items. In such a case, the naturally forming values of demand and supply are shaken, and the enterprise begins to generate losses due to a reduction in the ability to make decisions - including responding to current demand and market trends.
The butterfly effect	The above term was first used by meteorologist E. Lorenz in 1961, when, while trying to reproduce some interesting weather charts with the help of a computer, he noticed that their picture was different from the analyses carried out previously. It was then that it was understood that seemingly small approximations of single mathematical values can cause significant changes on a larger scale (hence the theory that even the smallest actions are capable of affecting the effects of larger operations). The trajectories of the effects of one object on another outline a shape resembling the wings of a butterfly.  The effects of the butterfly effect can be observed in a variety of logistical operations. As an example, let's take a situation in which there is damage to goods in the warehouse. When the company is unable to replace a product in time, it becomes impossible to complete the order placed by the customer. Consequently, a situation arises in which delivery is delayed, and thus subsequent links in the chain are often deprived of the means to carry out further operations.

Source: (Grzybowska, Łopatowska ,2013; Folfas, 2016; Miłosz, Miłosz, 2014, Alizadeh, 2012; Houlihan, 1987; Shukla, Naim, Yaseen, 2009; Bodanko, 2013; Lent, 2016)

The disruptions in supply chains shown in Table 1 undoubtedly affect companies' costs, including opportunity costs. Opportunity cost is a measure of the value of the foregone benefits associated with not making the best use of one's resources. When the freedom of action is reduced due to the placement of capital (for example, in inventory), it is also called the cost of capital commitment (Mroczko, 2016). In logistics, the opportunity cost and benefits incurred by an organizational unit can be caused by a number of conditions. One of the most common situations are delays or disruptions in supply chain operability, which significantly limit the decision-making freedom of the involved entities. In the above situation, companies are not always in a position to respond at the moment they have chosen, and can only do so when all aspects have been met and operations have been carried out without any violations. It should also be borne in mind that the opportunity cost cannot always be expressed in financial units. However, business entities, when developing their economic efficiency, try to express the opportunity cost and benefits in monetary terms - assigning specific values to individual factors when this is acceptable.

### **Method of study**

One of the qualitative, scientific research methods - the case study - was chosen for the study. It is an empirical inference that deals with a phenomenon in its natural context, especially when the boundary between a case and its context cannot be clearly defined (Hakanen, Helander, Valkokari, 2016). As emphasized in the literature, the choice of qualitative approach is not based on the preference or convenience of the researcher. The use of this method should be based on the nature of the research questions posed (Matusek 2017). This method makes it possible to comprehensively capture the essential features of real events, such as management and organizational processes, changes in the business environment, international relations or the maturation of enterprises. It is recommended to use it in situations of the need to find answers to questions of an exploratory nature, that is, concerning "how" and "why" a phenomenon occurs (Yin, 2018). In the described research, the research questions were formulated as follows: How do disruptions in supply chains affect the opportunity costs of transportation companies and how can they be minimized?

### **Research subject**

A transport company operating on the market since 2014 was examined. At the beginning of its operation, the company's fleet consisted of only one set - a truck tractor and a curtain-type universal trailer. The company employed two people - the

driver and the owner, who dealt with shipping issues. Due to the lack of business contacts, most of the freight relations were drawn from various transport exchanges, including primarily the trans.eu platform.

In 2015, the surveyed entity managed to establish a business relationship with one of the grocery manufacturers in the Opole region. The lack of intermediaries contributed to an automatic increase in the rates for the courses taken, and also increased the variety of course choices. As a result, the next routes taken were mainly within the boundaries of the Silesian, Opole, Lower Silesian and Lesser Poland voivodeships. Due to the smaller distance of the set from the base, its possible breakdowns were less troublesome.

For the next 2 years, the company mainly focused on developing the cooperation it had undertaken with the food manufacturer, while there were occasional moments when it undertook activities for other companies. This also contributed to the unexpected, yet very desirable, result of taking up another direct cooperation with one of the producers of chemical products in the Silesian province.

The subsequent agreement guaranteed an increased number of courses. Therefore, the surveyed entity decided in mid-2017 to purchase another set of vehicles. Since then, the company has two sets of vehicles (a 2005 Scania R420 truck tractor and Kögel semi-trailers, and the same set from 2008).

Prior to the surveyed business entity's direct cooperation with the food and chemical manufacturer in 2017, the annual mileage of the set of vehicles ranged from 160,000 km to 240,000 km. Since 2017, the situation has changed, and thanks to a closer relationship between the carrier and the manufacturers, it was possible to reduce the average annual mileage per vehicle set by about 50%. For this reason, for the following years the average number of kilometers traveled by one truck oscillated between 80,000 km and 160,000 km.

Since the surveyed entity has been cooperating directly with food and chemical manufacturers, each transport relationship carried out is identical. Analyzing the period from the start of cooperation until 2022, one notices some regularly occurring dependencies in the studied entity. Firstly, during the analyzed period, there was a decline in demand for transportation services in December and January. One of the reasons for the above phenomenon was that these are months in which many people spend time with their families, and this significantly reduces the regularity of purchases. Another relationship noted was that throughout the entire period under study, Set 1 made fewer trips than Set 2.

Due to the fact that the audited company conducted almost unchangeable transport activities in 2018-2021, it is possible to present a theoretical opportunity cost generated by Set 1 in reference to Set 2. For the purpose of the comparison, it is assumed that the average price of a single transport order was 850 PLN. Data on the difference between Set 1 and Set 2 in terms of achieved revenues is presented in Table 2.

Table 2. Company's revenues in 2018-2021 and estimated opportunity cost

Year 2018		
Set number	Number of completed transport orders	Revenue in PLN
Set 1	318	270,300
Set 2	342	290,700
Estimated opportunity cost in 2018:		20,400
Year 2019		
Set number	Number of completed transport orders	Revenue in PLN
Set 1	324	275,400
Set 2	352	299,200
Estimated opportunity cost in 2019:		23,800
Year 2020		
Set number	Number of completed transport orders	Revenue in PLN
Set 1	303	257,550
Set 2	365	310,250
Estimated opportunity cost in 2020:		52,700
Year 2021		
Set number	Number of completed transport orders	Revenue in PLN
Set 1	392	333,200
Set 2	423	359,550
Estimated opportunity cost in 2021:		26,350

Source: List of transport orders. 2018 (unpublished materials). List of transport orders. 2020 (unpublished materials). List of transport orders. 2021 (unpublished materials).

The largest discrepancy occurred in 2020, when the difference in realized transport relations was equal to 62. In contrast, the smallest disparity was 24 in 2018. During the entire 2018-2021 period, Set 1 made 145 fewer trips (1337 realized transports by Set 1 and 1482 by Set 2). The main reason for the above was that the truck tractor included in Set 1 was 4 years older than the vehicle making up Set 2, and in addition, its mileage is about 400,000 km higher - these factors have a significant impact on the occurrence of possible breakdowns, of which there were significantly more in Set 1 than in Set 2 during the period under review.

According to the company's data, between 2018 and 2021, the highest estimated opportunity cost generated by the Set 1 was in 2020 – 52,700 PLN. On the other hand, the lowest estimated opportunity cost was generated in 2018 – 20,400 PLN. The total estimated opportunity cost generated in the studied period was 123,250 PLN.

## **Opportunity costs of the studied entity incurred due to disruptions in supply chains and methods of minimizing them**

In an attempt to reduce the impact of opportunity cost on the operation of the company under study, it was necessary to examine separately each of the problems that affect it. The isolated approach will accurately present possible solutions to the problem or disturbance encountered.

The first of the disruptions affecting the emergence of opportunity costs of the entity under study was the usually prolonged time of loading activities. It becomes impossible for the driver to realize his break during this time - due to the lack of clear definition of the time when the handling operations are completed. Thus, the driver was losing clearly defined working time, and this, in turn, was associated with the impossibility of completing the next transports. In the case of the entity studied, when there was a significant overrun of the contractual time developed for unloading or loading the vehicle, the owner of the enterprise received 25% of the freight value - this allowed to cover to some extent the cost of lost opportunities, but it should be borne in mind that if the time limit had not been exceeded, the driver could, in a certain situation, perform one more full carriage of 100% value. According to internally conducted analyses, on average, out of 100 transport relations performed, as many as 30% of them are disrupted in the smoothness of operations.

In the above situation, it is important to determine the degree of impact of the resulting delay on the entity's operations according to the time required to complete the operation included in the freight contract. Unfortunately, there were times when the difficulties encountered significantly affected the realization of sequentially scheduled transport relations. In order for the generated cost of lost opportunities and benefits to be as low as possible, it is advisable to enter into negotiations with the companies in direct contact. Increasing the compensation percentage would at least reduce the opportunity cost to the smallest extent possible. In the case of undertaking cooperation of a transport company with operators with whom interactions are less frequent or newly established, it is suggested to include in the transport contract information on the amount of compensation paid at the time of an above-normal violation of the provisions contained therein.

Another type of opportunity cost incurred by the surveyed company was that generated due to the significant impediment to the expansion of the company's operations. The above phenomenon consisted of two main reasons.

One of them was directly related to the difficult situation noted in the labor market, where for several years, internationally as well as domestically, a significant shortage of professional drivers has been noted - this often forces business units to take above-normal measures, the application of which allows them to successfully compete for market position but also requires the investment of additional money.

The second reason for the hindered expansion of transport companies was the increase in market prices for new and used vehicles - as in the case of passenger cars, the disruptions occurring in the supply chains of spare parts are primarily responsible for this state of affairs. The lack of availability of a particular raw material prevents the production of a needed component, and this causes increased demand. Thus, consumers and manufacturers who want to purchase a particular good are forced to pay more for the raw material, semi-finished or finished product they need.

Deciding to buy a third tractor-trailer and a curtain-type all-purpose trailer was much more difficult in the period under review than it was a few years ago. Among other things, this is because the return on this type of investment is currently estimated at about 8-10 years, when as recently as 2019 it was 5-6 years. In addition, the situation became more complicated when the surveyed company's purchase preferences for a particular make and model of truck were taken into account. The surveyed entity took into account the possibility of acquiring only a Scania R420 truck tractor with a manual transmission and a maximum mileage oscillating around 1,000,000 km. Unfortunately, for some time it has been impossible to acquire a new vehicle with the previously mentioned parameters, so wanting to expand the fleet, the only option left was to purchase a used truck. However, it should be borne in mind that over time the number of vehicles available on auction portals with the above-mentioned configuration was getting smaller and smaller.

In an attempt to reduce the impact of opportunity cost on the operation of the company under study, it was necessary to examine each of the previously mentioned problems separately. The isolated approach made it possible to accurately present possible solutions to the problem or impediment encountered.

For the second impediment, which concerned the acquisition of new employees - professional drivers, a twofold approach is suggested. First of all, the managing business entity should focus its actions towards employees so that they do not have to think about changing employers. In order to reduce the risk of losing any of the employees, the entity in question should offer drivers to take advantage of additional training or outline additional bonuses, the payment of which could depend on such factors as the average combustion of a set or punctuality of deliveries. Creating an additional opportunity for employees to increase their earnings would be a positive measure for both parties to the contract. Each driver would be free to earn bonuses. The company, in turn, would be able to record lower losses in the event of a reduction in the amount of fuel burned, and even increase its market position thanks to the good feedback generated by performing services at the highest possible level - in accordance with the agreed terms. However, if it turned out that the bonus system was not an attractive choice for the employees of the entity under study, a solution would have to be applied, which, for example, would allow leaving an anonymous or named suggestion about the company's activities (based on similar operating principles to the suggest box). The suggestion system is a tool included in the Kaizen

philosophy, its introduction often allows the company to acquire new ideas, which, after appropriate verification (Dziuba, Cierniak-Emerych, 2008), can be permanently implemented in the company's activities.

In the case of an expansive approach involving the expansion of the company, new professional drivers would have to be recruited. In this case, it is suggested to use primarily the network of contacts/relationships of existing employees.

Drivers are able to accurately present a preliminary picture of the company's operations to their industry friends – this, in turn, may encourage potential interested parties to take up a job at the investigated entity. However, if it turns out that the linkage networks are too weak or small to attract new staff, the marketing efforts available should be used. These could be:

- advertisements placed equally on the web (for example on the portals [pracuj.pl](http://pracuj.pl), [olx.pl](http://olx.pl) or [aplikuj.pl](http://aplikuj.pl)),
- information boards placed in the locations closest to the company's base or on semi-trailers and lorries owned by the company.

The ratio of the costs incurred at the time of using one of the aforementioned forms of advertising is marginal in relation to the benefits of recruiting new employees.

Where the investigated entity decided to replace the existing rolling stock or to purchase a new set of vehicles in connection with the development of its business, it could use one of two options.

If the current Scania R420 tractor units and Krone and Kögel semi-trailers were to remain in the company, it would have to be decided to carry out a thorough overhaul of the most important components of the vehicles. The positive aspect of choosing this option would be to continue the operation of the rolling stock, the construction and operation of which has been known to the company for several years. However, it should be remembered that the renovation works are associated with at least a few weeks of completion, and the cost of the entire operation may amount to tens of thousands of zlotys. Despite the investment of a lot of time and money, this does not mean that the refurbished rolling stock will be less emergency than before, as many original parts are no longer available and replacements offered by other manufacturers often have a much lower lifespan.

When the subject decides to replace the tractor units currently in use, he or she may either stick to the configuration of his or her choice or purchase a newer vehicle with different equipment. In both cases, due to years of experience, Scania vehicles should be taken into account.

The choice of the first of the above options is the prospect of searching a small number of available advertisements offering trucks with attachments selected by the operator of the investigated entity.

Staying with the second option, it would be necessary to learn about the latest generations of Scania truck tractors. In the official materials made available by

the truck manufacturer and statements of the members of the board, you can find information in favor of the new units. The assurances relate primarily to less fuel combustion and greater durability with the introduction of ever newer products on the market. However, it should be borne in mind that the above-mentioned sources may be highly subjective. Therefore, it is recommended to search online sources, conduct an interview with friendly carriers or get in touch with workshops dealing with the ongoing servicing of the latest generation of Scania vehicles.

## **Discussion**

The problem of contemporary disruptions in supply chains, analyzed in the article, is the subject of research by other authors. Thus, Łupicka and Konecka (2022), emphasize that the current situation in the global market indicates huge disruptions in global supply chains. These effects are seen, for example, in the lack of availability of many components for the production of medicines caused by supply chain disruptions as a result of pandemics. In addition, there are also hidden effects, characterized by costs that have not yet been counted. On the other hand, Fikus and Skórnóg (2023) believe that due to the increasing number of global crises that have a significant impact on the operation of supply chains, it is necessary to find ways to increase the level of security of continuity of material flows. The introduction of country-by-country restrictions related to attempts to prevent the spread of the SARS-CoV-2 coronavirus resulted in massive stockpiling to ensure business continuity and a high increase in storage costs. The beginning of another crisis occurred in February 2022 with the outbreak of armed conflict in Ukraine. As a result of the closure of airspace and a significant increase in fuel and raw material prices, there were difficulties in organizing global supply chains. A key role in ensuring the security of material flows is played in this aspect by the development of critical infrastructure. It guarantees the basic tools to ensure the security of supply chains. The current situation should teach society how to respond to situations that arise. Maternowska (2021) believes that creating the future of supply chains requires supply chain leaders to be primarily creative in determining how to co-create that future with all their collaborators (transparent supply chains). Doing so in the face of uncertainty will require having (and cultivating) the ability to quickly create hypotheses, experiment, and learn from those experiments and switch to new conditions. Milosz and Milosz (2014) on the other hand, point out that the variability of process parameters in logistics chains causes significant financial losses, increases the commitment of capital and other resources, and contributes to reduced reliability of supply. The destabilization of the chain is due to a whole range of effects, over which decision-makers very often have little influence. Some negative trends can

be minimized by adequate corrective actions (proper organization of information transmission channels, commensurate decision-making algorithms, maintaining emotional balance during supply problems, careful use of promotions). Corrective actions require adequate development and application of sound logistics decision-making procedures and policies. The results obtained are a kind of novelty due to the subject of the study and the factors that were taken into account in defining the impact of disruptions on opportunity costs and methods of reducing them. The approach presented in the article has not been presented so far, and in this regard, the approach should be considered new. In addition, the results obtained inspire further research and contribute to the science of logistics.

## **Conclusions**

The following conclusions emerge from the studies:

- Disruptions in supply chains resulting from global crises around the world affect the operating costs of transport companies, including alternative costs.
- In order to keep the costs of lost opportunities as low as possible, it is necessary to take measures to minimize them. Undertaking such actions involves identifying and analysing the risks in the supply chains, which makes it possible to identify several solutions limiting its alternative costs.
- The analysed entity focused on three disruptions in supply chains, i.e. late delivery, employment problems and the possibility of acquiring a new set. In case of application of any of the solutions indicated in the article, it is assumed that the alternative cost generated by the investigated economic entity will be reduced. The size of the profit is dependent on the implemented variant of changes. The decision on which of the solutions the entity will implement is conditioned by carrying out an analysis covering equally the operation of the audited transport undertaking as well as any external factors influencing it. The case study research conducted here represents one of the first stages of research into the impact of supply chain disruptions on companies' opportunity costs. Although disruptions in supply chains affecting a transportation company's opportunity costs have been identified and how they can be minimized, it is believed that such research should be expanded to include a larger number of companies with transportation operations. Investigating the relationship between disruptions in supply chains and the opportunity costs of companies with different scope and area of operations should be identified as a potential area for further analysis.

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