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Assessment of Logistics Performance Indicators in Network SMES during the COVID-19 Pandemic: The Case of Tomaszów County, Poland

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ABSTRACT

The issue of small and medium-sized (SME) enterprises has been widely covered in both domestic and international literature. In Poland, sector accounts for 99.8% of the activities of all enterprises. Theoretical analysis and he research discussed in the article was carried out on a sample of network companies from the SME sector and enterprises located in smaller towns and villages in the Łódź Voivodeship (outside the Łódź agglomeration) in Poland, which not often feature in the literature on the subject, Studies also focused on the analysis of the economic performance of the Łódź Voivodeship, especially of the Tomaszów County during the COVID-19 crisis. The article has been based, among others, on: literature on the subject, reports of the Polish Agency for Enterprise Development (PARP), BVL reports, practical knowledge about logistics shared by logistics companies on their websites and own research, which was carried out in the form of surveys among enterprises in the SME sector in the Łódź Voivodeship, and selected statistics. The explored indicators concerning the quality of transport and logistics were at a good level. Although they slightly deteriorated during the COVID-19 pandemic, the decline remained within the range of 0-3%.

Keywords: Network Enterprises, Supply Chain Management, Logistics and Transport Indicators, Regional Development of Tomaszów County During and Post-Pandemic
JEL Classifications: D20, L20, R11

1. INTRODUCTION

The COVID-19 pandemic, which broke out in the early 2020 negatively affected all aspects of social and economic life. The world was faced with a totally unexpected cascade crisis. Under such circumstances, businesses were unable to prepare to the crisis and the same can be said about international organisations, such as the UN or WHO (Cieślarczyk, 2022 r., p.8). Due to the slowdown in economic sectors and company development, changes have occurred in business processes in the global economy, including in supply chain management (Attinasi et al., 2021, https://www.ecb.europa.eu/press/). Recent literature increasingly emphasises that resilience should be understood not only as the ability to recover after disruptions but also as preparedness, adaptability and continuity of supply chain operations under conditions of uncertainty (Ivanov, 2024). Therefore the aim of this paper is to discuss changes that have occurred in logistics based on selected indicators for transport and logistics in Poland using the SME sector in the Tomaszów Mazowiecki County as an example. In 2024, the SME sector represented as many as 99.8% of all enterprises in Poland and included: micro-enterprises (97.1%, 2.2 million.), small enterprises (2.1%, 48.7%), and medium enterprises (0.6%, 14.4%), (PARP, 2025, p.11). The paper attempts to answer the following research questions:

RQ.1: Do development perspectives for the logistics sector presented in global reports (taking the BVL report as an example) consider unpredictable factors in supply chain management?

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RQ.2: Has the COVID-19 pandemic adversely affected indicators for transport and logistics in the SME sector in Poland in the Łódź Voivodeship, as illustrated by the example of the Tomaszów County?

These research questions are reflected in the paper in two research hypotheses formulated as follows:

- H_1: Global logistics reports identify major uncertainty factors affecting supply-chain performance.
- H_2: COVID-19 pandemic has had a significant negative impact on the development of logistics and transport indicators in SMEs in the Łódź Voivodeship as exemplified by the Tomaszów County.

Acknowledgements should be presented using Times New Roman 10 pt (use style Acknowledgements, or Alt + Ctrl + W). You must ensure that anyone named in the acknowledgments agrees to being named.

2. SUPPLY CHAIN MANAGEMENT UNDER UNCERTAINTY-LITERATURE REVIEW

COVID-19 pandemic had significantly distorted the flow of goods in supply chains within global economy and the logistics industry was among economic sectors that were hit the most; many businesses from the TSL sector went bankrupt. To a large extent the situation was far from neutral when it comes to supply chain management hence the difficulties involved in the identification of principal areas of uncertainty in the supply chains considered in different reports on investment climate and development perspectives for logistics services in the global economy.

However, a neutral state in supply networks does not mean that these networks are completely immune to internal and external factors affecting the environment in which the company operates. A neutral state should rather be understood as a situation in which the company is able to restore the supply chain to its original state as quickly as possible in the event of incidental occurrences that have a negative impact and are most often related to operational risk (Świerczek and Szozda, 2019). On the other hand, as observed by Marzantowicz, conditions of uncertainty emerge as a result of unpredictable and predictable events and uncertainty clearly impacts the effectiveness of supply networks (Marzantowicz, 2017, pp. 62-70).

Many reports dedicated to the development perspectives of logistics in the global economy which consider both internal and external conditions in the flows of goods address uncertainty of supply networks resulting from disturbances in flows across supply networks. One of BVL reports discusses megatrends in logistics development and takes account of unpredictable distortions in flows across the supply chains. Its content is presented in Table 1.

From pieces of information included in Table 1 we can conclude that the sooner external (No. 1-6 Table 1) and internal (No. 7-9 Table 1) conditions are identified that inform about investment climate and are crucial for potential risks and uncertainty in global and regional economy, the faster we can specify trends in logistics development and consider how they can be perceived in the context of strategic decisions, e.g., in supply chain management and how we can prepare to face cascade consequences that may emerge in the global economy. In turn, components of logistics development trends linked with the development of servitization and enhanced importance of sustainable growth can bring us to discussions on aspects such as:

- How changing lifestyle and consumption patterns will affect the development of servitization services and their dependence on external factors, and how they will be managed in the context of emerging problems related to the shortage of skilled workers and drivers;
- And how the automotive market will operate from the point of view of the development of new drive systems (e-vehicles) in the context of supply dependencies, which in the case of the German automotive industry, for example, are characterised by multi-networking and the dispersion of supply networks around the world (Schwemmer et al., 2020, pp.3-10).

Development perspectives for the logistics industry are important for businesses active in the global economy but, according to Taleb, in the economy there will always be so-called black swans, i.e., unpredictable events of enormous scale and unexpected for the observer, despite the belief that they are impossible. Taleb also believes that there are no models or theories that will be able to predict unpredictable events in the world.

However, it is important to prepare companies for strategic actions aimed at preparing businesses for black swan shocks in the economy, such as COVID-19, and not just to introduce methods of protection against risk, e.g., by insuring against extreme and random events, i.e., by shifting responsibility to other entities (Taleb, 2023, Mączyńska, 2020, https://gazeta.sgh.waw.pl/). On the other hand, after the COVID-19 pandemic suppliers cope much better with diverse threats looming on the horizon or potentially threatening the global economy, primarily with regard to agile supply chain management.

The above analysis of subject-matter literature draws our attention to the fact that logistics and transport are crucial if we think of changes in business processes in the global economy. During the COVID-19 pandemic, the logistics and transport industry was not in as bad a situation as companies in industries such as catering, tourism, or those related to fitness, etc., due to the increased demand for online delivery of larger quantities of goods and changes in consumer behaviour. On the other hand, the industry had to face a lockdown. Therefore, it is worth looking at the issue of logistics indicators, which are important for logistics-related operational activities in a company and have an impact on strategic management in logistics, and their performance influences changes such as:

- Identification of logistics areas in a company that necessitate change and will dictate the scope of such changes;
- Putting in place alternative solutions that will improve the performance of logistics processes within a company by collecting data that help in identifying issues and deviations (opportunities and risk) in supply networks;

Table 1: Megatrends in logistics in the global economy and the description of uncertainty factors related to them in the context of supply chain management

No.	Megatrends in logistics in the global economy	Uncertainty in supply chain management
1.	Changing volume of the market and trade flows in global economy:	• Global trade conflicts (USA, China) • Slowdown and distortions in the global trade due to Covid-19 causing cascade effects and increased uncertainty of business operations
2.	Demographic changes-aging societies, migrations and urbanisation	• Changing consumer habits -new challenges in the field of e-commerce (resulting from innovative technologies and ICT structures), rapid growth of e-commerce during the pandemic • Urban and rural areas call for different approaches to meeting the needs of individual consumers. Rural areas can grow by offering individual, consumer-oriented logistics services
3.	Growing servitization	• Potential growth of servitization can be used to take over the portfolio of auxiliary services or services in newly emerging market segments (e.g., logistics know-how or health logistics) • In logistics benefits to consumer grow when transport is tailored to customer needs (transparent shipment tracking, detailed information about shipment status)
4.	Sustainable growth-a path to greater environmental awareness	• Increased relevance of new technologies for the mobility of goods and passengers (growing importance of e-mobility in the EU) • Expanded requirements for sustainable growth (CSR)
5.	New types of risk and uncertainty-shocks and variability caused by economic instability, climate change (e.g., terrorism, pandemic, cybercrime)	• Partial slowdown in globally shifting value chains (e.g., due to isolation measures applied during the pandemic: ban on human contact, requirements with regard to distance, closure of businesses)
6.	Technological innovation, digital transformation, automation, analytics	• Faster and stronger growth of technological innovations following COVID-19 in accordance with the low-hanging fruit concept to create resilient and agile supply networks
7.	New actors-new market forces	• Mergers in the logistics market, dynamic growth of logistics start-ups, new business models in e-commerce (omnichannel, multichannel)
8.	Professionalisation-industrialisation-effectiveness-oriented thinking	• Proliferation of online work-from-home, video communication • Professionalisation of logistics systems in the field of managing risk and uncertainty in the external environment (resulting from, e.g., fears of pandemic)
9.	Core concept-based thinking- effectiveness and the logic of value success for shareholders	• Big listed companies are nowadays trying to focus on core competencies in their respective industries leaving the remaining links of the supply chain to other businesses (e.g., through outsourcing contracts, development of 4PL and LLP business models); there are obstacles in outsourcing development because big companies often have requirements that cannot be fulfilled by SMEs offering outsourcing services.

Source: Author's own compilation based on: Schwemmer et al., 2020, pp. 3-10

- Tracking the effects of changes in logistics processes in supply networks with a view to accomplish goals of the business strategy (Twaróg, pp.27,107).

Based on the above data, one needs to note that logistics indicators and how they are assessed is connected primarily with the notion of risk, i.e., circumstances (e.g., delays in transport, complaints caused by shipping mistakes, etc.) and changes thereof that companies have to face. Yet risk concerns only countable circumstances and changes, contrary to unpredictable risks, such as the COVID-19 pandemic. Such circumstances are very important for future investment and employment in the SME sector since, as noted by Dixit and Pindyck in their publication, when companies are faced with uncertain future, they tend to refrain from investing and recruiting new workers. Their behaviour can be explained by the fact that for business it may be more beneficial to wait and see what will happen in the market and then decide about future investment or recruiting new people (https://www.maastrichtuniversity.nl/, Avinash et al., 1994, pp.1-469). Therefore, in the second part of the paper we will explore changes that have taken place in logistics indicators during the COVID-19 pandemic in Poland, especially in the SME sector in the Tomaszów County where changes referred to:

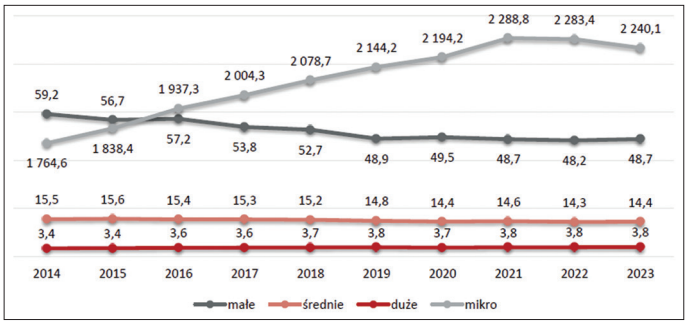
- A downturn in the growth trend of the SME sector in terms of the number of enterprises, which recorded a 2% decline in 2023 compared to 2020 (from 2,262,000 in 2020 to 2,307,000 enterprises), although the downward trend was only recorded for small enterprises, which fell by 2% (from 49,500 to 48,700 enterprises). On the other hand, in the case of micro-enterprises, a slight increase of 2% was recorded (from 2,194,200 to 2,240,100 enterprises) and no change in the number of medium-sized enterprises, i.e. 14,400 (Figure 1).
- Number of people employed in the SME sector, which in 2023 exceeded 6.9 million people (36,500 fewer than in 2022 and 5,000 fewer than in 2022-2021). The highest number of employees was recorded in micro-enterprises (over 4.3 million people) (PARP, 2025. pp.11-12, 18-19; PARP, 2024. pp.15, 23-24; PARP, 2023. pp.13, 21-22).

According to the report by the Santander Bank Polska S.A., during the pandemic companies responded with, inter alia, reduced recruitment of new employees, drops in remuneration, and staff dismissals. Employment reductions were observed mainly in industries, such as: Hotel and catering services, culture, education, and also transport. The trend was observed in the SME sector in Poland but also globally (https://www.oecd.org/). In industries

such as manufacturing and construction only between February and June 2020 output strongly correlated with reduction in employment.

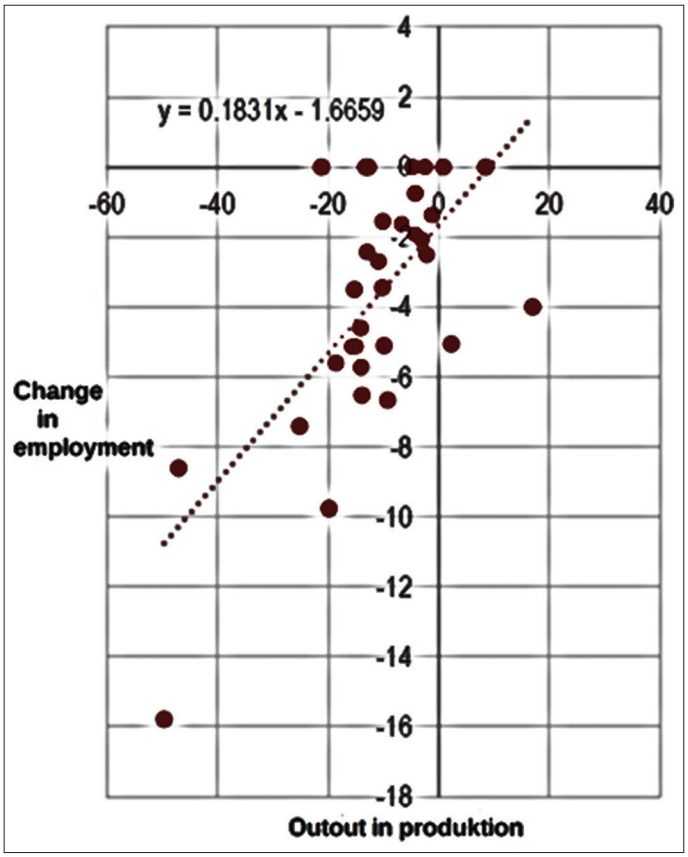
Figure 2 shows that the correlation coefficient for employment between February and June and the difference in average growth in the output for the period between March and June compared to January-February amounted to 0.68. It means that sectors which reported drops in the output were also affected by the reduction in employment, i.e., an additional drop in the output by 10% resulted in the drop in employment by 1.83% (https://odpowiedzialnybiznes.pl).

Figure 1: Companies actively operating in Poland grouped by size over the period 2014-2023



Source: (PARP, 2025. p.12)

Figure 2: Changes in output and employment in manufacturing and construction



Source: https://odpowiedzialnybiznes.pl

3. RESEARCH METHODS

The aim of the empirical study was to assess the impact of the COVID-19 pandemic on selected logistics performance indicators of network SMEs operating in the Łódź Voivodeship, with particular emphasis on Tomaszów County. The paper uses survey research aimed at examining the effectiveness of logistics indicators in the SME sector, conducted online between 2019 and 2023, with most of the analysed research carried out during the COVID-19 pandemic. The research technique was an original survey questionnaire, which was sent to 59 companies, 58 of which were qualified for the study. As there are numerous studies on the effectiveness of selected logistics indicators carried out for Łódź companies, most of the surveyed companies were based not in the Łódź agglomeration, but had their headquarters in other smaller towns in the Łódź Voivodeship. The selection of the sample for the survey research was carried out using a non-random technique convenience sampling technique and was determined in accordance with the definition of SME sector companies applicable in the EU. To show the significance of differences in transport and logistics indicators between TSL companies and manufacturing-service companies outside the TSL industry, we used Student's t-test for independent samples in the paper and two-proportion test for quality.

4. ANALYSIS OF AUTHOR'S RESEARCH BASED ON THE QUESTIONNAIRE SURVEY ON THE EFFECTS OF COVID-19 PANDEMIC ON THE EFFECTIVENESS OF LOGISTICS INDICATORS IN SMES IN POLAND, IN THE ŁÓDŹ VOIVODESHIP, WITH SPECIAL FOCUS ON THE TOMASZÓW COUNTY

The survey research used in the article to examine the effectiveness of logistics indicators in the SME sector was conducted between 2019 and 2023, although most of the analysed surveys were conducted online during the COVID-19 pandemic. Over 80% of the surveyed companies are network companies, i.e., they cooperate with at least one first-tier supplier and one first-tier customer. Most of the companies participating in the research were located in the Łódź Voivodeship (84% of companies), including 4 companies based in Łódź, while the remaining companies were mainly based in Tomaszów Mazowiecki and in towns, villages and rural areas in the vicinity of Tomaszów Mazowiecki. The rest of companies were based in the following voivodeships: Mazowieckie, Śląskie, Opolskie, and Dolnośląskie. The choice of the Łódź Voivodeship as the research area was dictated by the rapid development of logistics in the Łódź Voivodeship in recent years, which has been facilitated by, among other things, the construction of new freight transport infrastructure investment projects and the fact that the Łódź Voivodeship belongs to one of the largest logistics areas in Poland (expansion of multi-tenant and built-to-suit warehouse facilities and expansion of intermodal terminals) (https://strategia.lodzkie.pl/).

In the study, the selection of transport and logistics quality indicators for assessing the effectiveness of SMEs in the survey was based on the literature on the subject and interviews conducted with students of Management, full-time and part-time studies in the years 2019-2023, specialising in Logistics. Table 2 presents selected transport and logistics quality indicators for companies in the TSL sector and manufacturing and service companies (outside the TSL industry).

Based on the studies on the assessment of logistics and transport indicators and their changes in the SME sector during the COVID-19 pandemic in the Łódź Voivodeship in the Tomaszów County we can draw the following conclusions:

- First, the analysed logistics and transport quality indicators are at a good level. This result is influenced by:
  - Opinions of selected authors of publications, who claim that the cost of logistics should represent between 10% and 40% of company's turnover, (Kowalska et al., 2020, p.23, Englon et al., 2022, pp. 29-35)
  - Noteworthy, selected values of quality indicators for enterprises from the SME sector for TSL companies are higher than for enterprises from the manufacturing and service (outside of the TSL industry) industries and this is caused by the specificity of TSL companies, e.g., by high operating costs including, inter alia, the cost of transport, maintaining vehicle roadworthiness, road tolls (https://www.logistyka.net.pl/bank-wiedzy). A similar situation also applied to the following indicators: the share of transport and handling costs to total turnover (transport costs related to deliveries, distribution and the flow of goods), the share of storage costs (the amount of costs related to infrastructure, equipment and personnel), the cost of inventory, and amounted to 37% and 26%, 21% and 11%, and 6% and 15% for TSL companies and manufacturing and service companies (outside the TSL industry), respectively (Andrzejczak, 2025, pp.9-22).

The hypothesis that there are differences in the analysed transport averages indicators between TSL companies and manufacturing and service companies (outside the TSL industry) is also confirmed by the calculations of the t-test statistical value for independent sample (with the assumed deviation, operationally $s = 5$ p.p.). and two-proportion test for quality. Based on data from Table 2 we can note that in general trend statistically significant differences have been found for the costs of transport administration and storage, meaning the TSL sector pays relatively more for the above types of costs compared to companies from other industries. While the share of the cost of inventories in TSL companies is lower compared to manufacturing and service companies (outside of TSL industry). The quality of logistics service measured with the percentage of error-free transport documents turned out to be similar for both groups of analysed companies.

Table 2: Effectiveness assessment for logistics and transport indicators (including the use of the Student's t-test, the two-proportion test for quality), and their changes for network companies of the SME sector in the period 2020-2023

Definition of an indicator of transport and logistics quality and its formula (in %)	Effectiveness assessment for selected measures of transport and logistics quality for					Assessment of changes in the effectiveness of logistics and transport indicators triggered by the COVID-19 pandemic	
	TSL companies (%)	Manufacturing and service companies outside of TSL sector (%)	SE	t/z***	Conclusion	TSL companies**** (%)	Manufacturing and service companies outside of TSL sector***** (%)
1.Share of logistics costs in the turnover Total costs of logistics×100% Turnover	33*	25	1.31	t=6.1	Significant	−2.5	−0.2
2. Share of transport and handling costs to total turnover Transport and handling costs×100% Turnover	37	26*	1.30	t=8.5	Significant	−1.5	+1.6
3. Share of storage cost (cost of own storage or warehouse services) to company turnover Cost of storage×100% Turnover	21	12**	1.32	t=6.8	Significant	−1.5	0
4. Share of inventory cost to company turnover Cost of inventory×100% Turnover	7*	16*	1.32	t=−6.8	Significant	−1,5	0
5. Share of administrative costs of Logistics to company turnover Administrative costs×100% Turnover	18	13**	1.30	t=3.8	Significant	−3	−0.8
6. Share of error-free transport documents No. of error-free transport documents×100% No. of issued transport documents	85	80	9.90	z=0.5	Insignificant	−1.5	0

Source: Author's own research. *One company failed to provide data, **Two companies failed to provide data, ***(P-values for significant differences <0.001; two-tailed test, α=0.05). ****10 companies provided answers, *****25 companies provided answers

- Second- studies on the development of transport and logistics indicators also took into account changes in the values of these indicators during the COVID-19 pandemic. Unfortunately, not all of the companies surveyed responded to the question in the survey: Which of the logistics and transport quality indicators have changed significantly for your company (and to what extent) in connection with the COVID-19 pandemic. Ten TSL companies answered this question together with 25 companies dealing with manufacturing and services (outside of TSL industry).

Based on answers provided by SME sector companies we can observe that:

- Changes in these indicators were not significant and ranged from 0% to −3%, with the exception of the share of the cost of transport and handling in total turnover, which increased by +1.6% for manufacturing and service companies (outside the TSL industry). The downward trend in transport and logistics indicators was caused, among other things, by employees falling ill with COVID-19 and drivers failing to deliver shipments on time due to pandemic-related restrictions.
- The indicators for transport and logistics in the case of manufacturing and service companies (outside the TSL industry) recorded slightly lower declines than in the case of TSL companies. This situation is most likely due to the specific nature of the surveyed SME network companies, as the surveyed companies were not responsible for managing all links in the supply chains (i.e., by the leader), and some of the orders were carried out by external operators, e.g., as part of outsourcing. Logistics was not core business in these companies. Considering minor changes that have been observed in the analysed indicators during the COVID-19 pandemic (the dominant response for companies was 0%, i.e., no change in the effectiveness of companies' operations caused by the crisis), SMEs in the Łódź Voivodeship reacted flexibly and quickly to changing external conditions. This situation occurred despite the fact that:
- Companies from the SME sector are in general more prone and vulnerable to all unpredictable changes in the investment climate in the economy; and
- Most SMEs covered by the study operate internationally (over 60% of the surveyed companies), which is connected with extended supply chains that can be broken more quickly as a result of crisis (Andrzejczak, 2025, pp.35-46).

5. CONCLUSION

COVID-19 pandemic revealed strengths and weaknesses of enterprises active in the global economy, including the resilience of supply networks to external uncertainty factors, which emerged in both global and regional economy. On the other hand, logistics played a crucial role in crisis management in the global economy across all industries. As a result, we witnessed deep reorganisation and transformation of supply chains, because the demand side of the market did not collapse (as it was the case during previous global crises), and changes in the global economy affected the supply side. In supply network management these changes were connected with: ordering and delivery processes, production/design and service delivery, and strategic management (https://www.parp.gov.pl, 2022). Despite unfavourable economic situation in business during the pandemic, Polish economy was relatively little hit compared to other EU Member States if we look at macroeconomic metrics, such as: employment and unemployment rate, exports, and GDP. This conclusion is evidenced by:

- Data from the Polish Agency for Enterprise Development (Polish abbr. PARP) and Statistics Poland (Polish abbr. GUS). Here attention should be paid to, e.g., small reduction by 2% of the population of active SMEs between 2020 and 2023;
- And questionnaire surveys assessing the effectiveness of indicators for transport and logistics, which in the Łódź Voivodeship were at a satisfactory level. During the COVID-19 pandemic no major changes were reported in these indicators and they remained at the level between 0% and (−3%). The findings do not support H_2, as the observed changes in the analysed logistics and transport indicators during the COVID-19 pandemic were limited and generally ranged from 0% to −3%.

The lessons learned by the global economy from the COVID-19 pandemic include a genuine need for businesses to be ready to face further threats and crises. They should make such preparations based on business models, appropriate safety culture, and good research methodology, Reports produced by global and regional organisations, such as, e.g., BVL, will be useful tools that might significantly help in predicting the upcoming threats in changing external conditions of the global economy. Therefore, based on the analysed BVL reports, we can positively validate the first hypothesis proposed in the paper, which asserts that perspectives for logistics development described in global reports (using the BVL report as an example) consider unpredictable factors in supply network management, however, the reports need to better explore risk factors that may emerge in the near future, e.g., in logistics.

Nevertheless, the primary focus of companies should be on the development of strategies that will help them cope with crisis situations rather than operate following the "I think so" principle (Cieślarczyk, 2022 p. 123, Naimat and Davies, 2025, pp.192-221). Hence the analysis of sensitivity, flexibility, and resilience of supply networks to potential uncertainty factors in the global economy is nowadays vital. Research indicates that supply chain flexibility significantly enhances resilience, coordination, and overall operational performance in the post-pandemic environment (Agrawal et al., 2024). Its outcomes should provide companies with the ability to maintain the operational liquidity of supply networks (e.g., by achieving high effectiveness of transport and logistics indicators) to preserve their competitive advantage.

Global supply chain management will contribute to the integration of business processes and strategic partnership development with a view to mitigate the effects of market uncertainty in the times of crisis (Remyha, 2021. pp.40-47). These transformations can be interpreted in light of classical economic development theory by Schumpeter, which emphasizes structural change driven by entrepreneurial activity (Mikosik, 1993, pp.1-189).

The research that was carried out in the counties of the Łódź Voivodeship may provide valuable information for city offices and county offices in terms of supporting the SME sector in these areas. This support for the development of these enterprises may include, among others: in reports on urban regeneration (e.g. in the Municipal Revitalization Program of the city of Tomaszów Mazowiecki). Successful implementation of these projects will certainly contribute to improving greater interest in research on the issue of networking in the SME sector (e.g. from the point of view of logistics development), because at the moment the research carried out in the article cannot be reduced to research on this topic, both regarding the networking of enterprises in the SME sector in Łódź and in other voivodeships, due to limitations in the literature on the subject. In addition to its practical implications, the present study also contributes to the existing body of research on supply chain resilience. The findings indicate that network SMEs operating within regional logistics systems were capable of maintaining relatively stable logistics performance during the COVID-19 pandemic. These findings contribute to a better understanding of the functioning of regional network SMEs under conditions of prolonged uncertainty and provide a basis for future research on the determinants of organisational resilience.

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