

ANALYSIS AND EVALUATION OF THE SUPPLY CHAIN IN THE LOGISTICS TRANSPORT NETWORK

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Abstract – Competition in the integrated transport market in the European Union is extremely fierce. Therefore, it is important that transport processes are not viewed solely through the prism of service efficiency but also through the prism of efficiency of deliveries throughout the entire supply chain. The dynamic development of the economy has had a huge impact on transport, which has become an indispensable element of a company's functioning in the goods and services market. In view of the above, the aim of this article is to highlight the importance of road transport in the national and international economy. In addition, the authors analyzed freight transport routes in the context of the logistics transport network, which contributes not only to integrated enterprise management but also to the efficient functioning of the supply chain.

Key words – supply chain, transport process, road transport, transport network

JEL Classification – R00, R4, R41, O1

INTRODUCTION

Transport plays a key role in the supply chain, which is why transport companies are the entities that determine the proper flow of goods from suppliers to recipients [11, 19]. In view of this fact, it is important to manage the supply chain properly in order to ensure coordinated and efficient delivery of goods [1, 10, 16]. In recent years, the supply chain has been changing under the influence of globalization and the simultaneous need to satisfy the demand for shared access to resources, as well as pressure on freight delivery times [4], [8]. Due to the ever-increasing distance of freight transport, the supply chain is under time pressure, which is why companies are focusing heavily on proper transport network planning [6, 28]. H.Ch. Pfohl believes that logistics services are becoming increasingly important in a competitive economy. For this reason, it is not so much the product itself that will count in gaining a competitive advantage, but rather an effective supply chain [2-3, 14, 20-21].

The modern economy is characterized by volatility, which means that transport companies must constantly improve their management skills so that their focus on transport services has a significant impact not only on the functioning and development of the company but also on building a sustainable competitive advantage [7, 12]. Therefore, if a company wants to be competitive, it must gradually rationalize the organization of its logistics chain [9, 18]. The transport services market is constantly introducing new regulations and standards. Therefore, freight forwarders should be prepared for the unpredictability of forecasts and react quickly to changing market conditions [17]. In view of the above, proper planning of the transport process in the transport network is a difficult task that requires taking into account a number of factors, including the

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physical characteristics of the cargo, the characteristics of the means of transport, and the working time conditions of drivers [23, 27]. If a company can meet these requirements, it will gain a competitive advantage [22]. Therefore, the aim of this article is to demonstrate the importance of road transport in the domestic and international economy. To achieve this goal, the article analyzes and evaluates the supply chain in terms of transport processes.

1. TRANSPORT PROCESSES AS A SOURCE OF VALUE IN THE SUPPLY CHAIN

A number of factors, such as versatility, accessibility, and flexibility, which directly affect the efficiency of the processes involved, have made transport a leading sector not only in the domestic economy but also internationally. What is more, transport plays a decisive role in the supply chain. In view of the above, the European Union constantly draws attention to the importance of transport companies.

Poland's huge share in the transport of goods within Europe, the constantly growing dynamics of these transports, as well as the high share of road transport in total transport in Poland have made road transport the leading branch of transport at present. The volume of transport in Poland in 2004–2011 is shown in Figure 1.

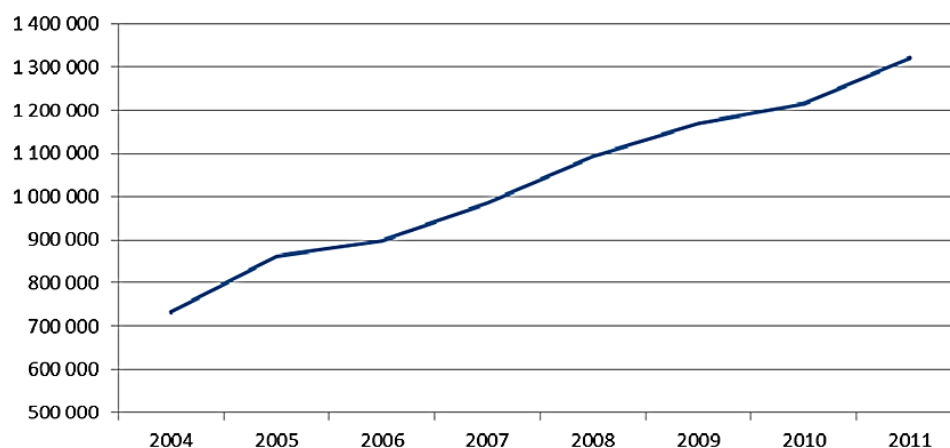


Fig. 1. Annual volume of road transport in tonnes in Poland in 2004–2011 [13]

Based on the above data and data available from Eurostat, it follows that in 2011, Polish road transport companies transported 80.6% more cargo than in 2004, approaching the level of Italy (1,339,949 t), Spain (1,466,146 t), and the United Kingdom (1,521,135 t) in terms of the number of tonnes transported (1,322,237 t). No other EU country recorded similar dynamics, as Estonia, which ranked second, achieved a growth of 26.1% in the same period, with a much smaller transport volume. In addition, the number of road transport companies in Poland has also been growing since 2004, reaching a total of over 85,000 in 2010, comprising 24,895 international road transport companies and approximately 61,200 domestic transport companies (Fig. 1) [13].

It should be emphasized that from 2012 to 2016, domestic transport remained at almost the same level. In 2012, the volume of transport was 1,082,475 tonnes, while in 2013 there was a slight increase of 3.19%; only in 2015 was there a noticeable decrease of 2.05%. However, in 2017, there was a significant increase in domestic transport compared to 2016, by as much as 13.64% (Fig. 2).

In summary, it is worth noting that Poland continues to maintain a high level of road freight transport (1,216,818 tonnes), exceeding Italy (864,194 tonnes) and approaching Spain (1,334,438 tonnes) and the United Kingdom (1,402,948 tonnes).

Poland, providing freight transport services in international road transport, was already among the leading European Union countries, such as the Netherlands and Germany, in 2008–2011. What is more, between 2012 and 2017, Poland significantly exceeded other European Union countries in terms of the volume of transport (284.993 million tonnes) compared to the Netherlands (132.740 million tonnes) and Germany (125.039 million tonnes). An analysis of the available Eurostat data shows that Poland has become a leader in international transport, achieving enormous progress of 75.30% between 2012 and 2017 (Fig. 3).

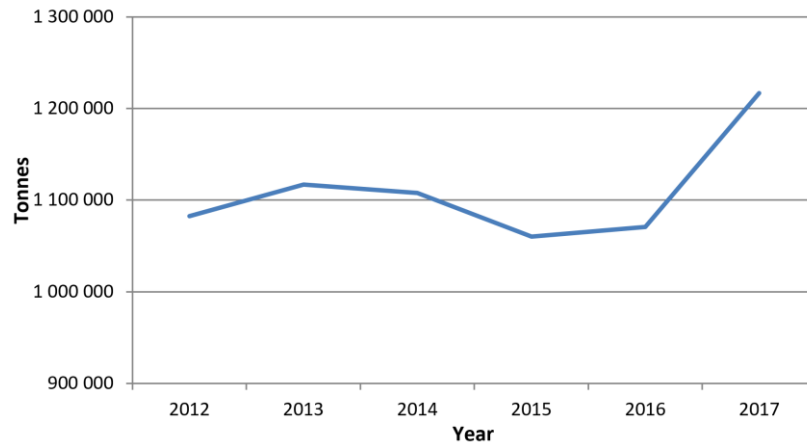


Fig. 2. Annual volume of goods transported by road in Poland (in tonnes) in 2012–2017 (based on [5])

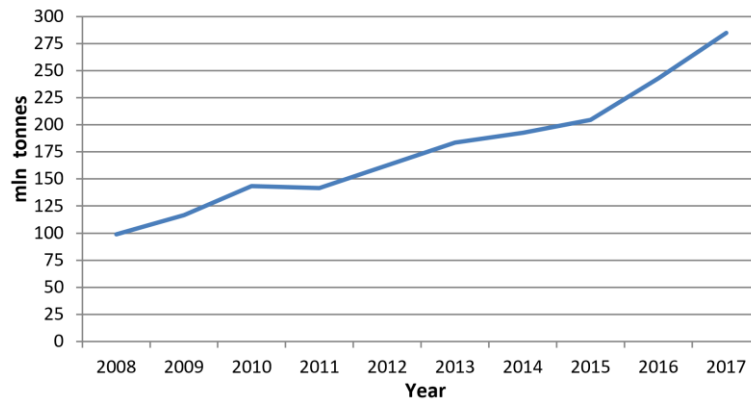


Fig. 3. Annual volume of cargo transported by international road transport through Poland (in tonnes) in 2008–2017 (based on [5])

An analysis of freight transport on the domestic market in 2019–2020 was also carried out, taking into account the situation on the transport services market. As a result, a breakdown of freight transport by different modes of transport was presented.

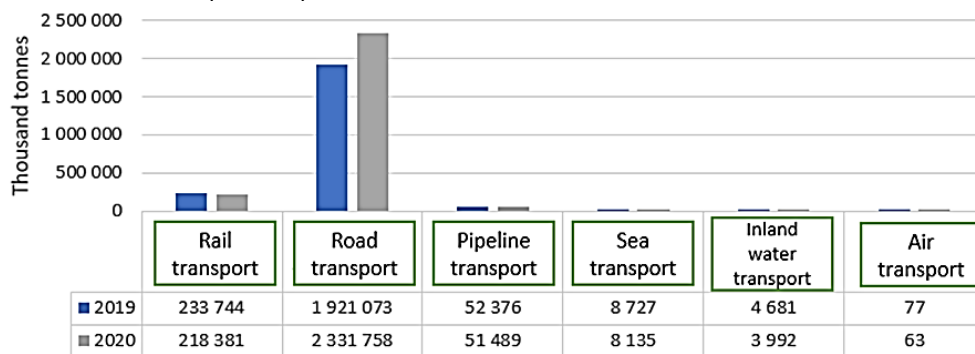


Fig. 4. Transport of cargo by different modes of transport at the turn of 2019–2020, Source: Based on [15, 24]

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In 2019-2020, road transport continued to grow. Based on the analysis, it was observed that road transport accounted for 89.2% of total freight transport in 2020. Compared to 2019, when the indicator was 86.5% of total transport, there was a 2.7% increase in the share of road transport, which translated into an increase in the number of goods transported by 410,685 thousand tonnes. The second most significant means of transport was rail transport, which accounted for 10.5% of total transport in 2019. The following year saw a 4.5% decline, which translated into a decrease in the number of goods transported by 15,363 thousand tonnes (Fig. 4).

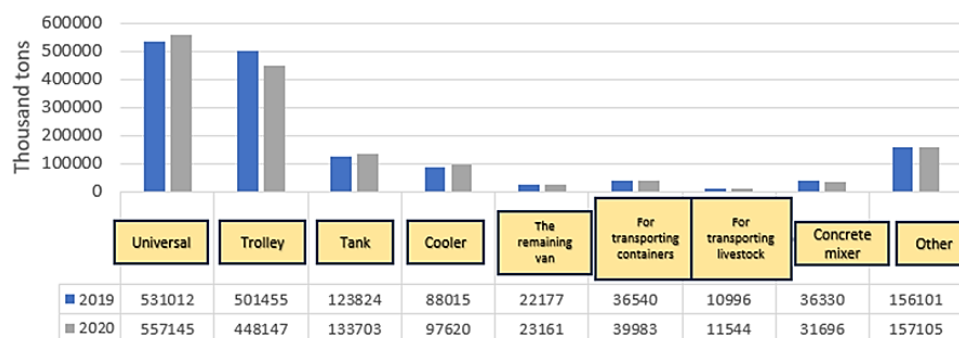


Fig. 5. Road freight transport by vehicle body type in domestic transport at the turn of 2019-2020, Source: Compiled on the basis of [15, 25-26]

In 2019-2020, universal bodies and tippers accounted for 68.5% and 67% of the total freight transport by universal bodies, tippers, tankers, refrigerated trucks, concrete mixers, containers, livestock trucks, other vans, and other bodies. The changes in 2019-2020 were as follows:

- universal bodies - an increase of 4.9%,
- tippers - a decrease of 10.6%,
- tankers - an increase of 8%,
- refrigerated vehicles - an increase of 10.9% (Fig. 5).

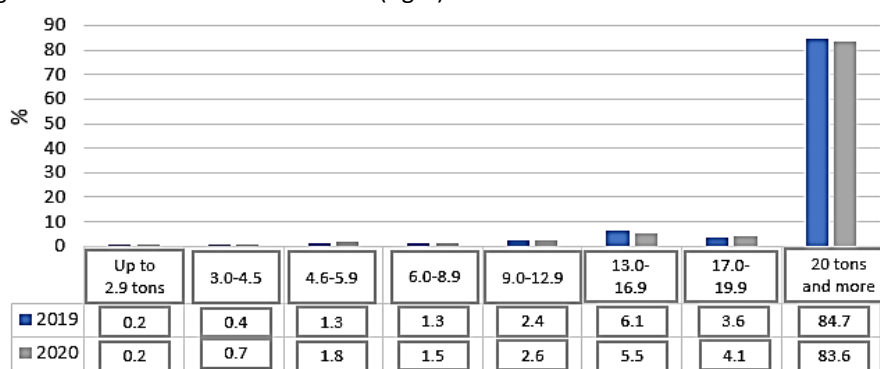


Fig. 6. Structure of domestic road freight transport by load capacity at the turn of 2019-2020, Source: Based on [15, 25-26]

As a result of an analysis of domestic road freight transport by load capacity groups at the turn of 2019-2020, it was observed that the Polish transport services market was primarily based on vehicles adapted to transport heavy loads. In 2019-2020, domestic transport companies most often used bodies with a load capacity of over 20 tonnes for transport. The choice of bodies was determined by technical aspects that allowed for the transport of heavier loads and larger quantities of goods. The value of the above groups in 2019 totaled 94.4%, of which the group above 20 tonnes alone accounted for 84%. In 2020, there was a decrease of 0.6% in the 13.0-tonne to 16.9-tonne groups and 1.1% in the 20-tonne and above groups. This had a slight impact on the increase in the share of the other groups (Fig. 6).

2. ANALYSIS OF CARGO TRANSPORT IN TRANSPORT

Transport is an inherent link in the entire supply chain, responsible for maintaining a high level of supply networks. The types of cargo in trade significantly affect the organization of transport in transport networks. The formation of cargo volumes is presented in Table 1.

Table 1. Transport of cargo by cargo group in domestic and international road transport at the turn of 2019-2020 [thousand tonnes] Source, Compiled on the basis of [15, 25-26]

Type of cargo	Domestic transport 2019	Domestic transport 2020	International transport 2019	International transport 2020
Agricultural, hunting and forestry products	76170	87233	17067	19267
Hard coal and lignite; crude oil and natural gas	32777	22273	1500	1242
Metal ores and other mining products	383306	345834	7403	9088
Food products	116063	134988	38466	43873
Textile products	2620	1766	3221	2565
Wood, wood products, paper and related products	52408	56659	35585	35959
Coke and petroleum refining products	44156	44293	2964	3187
Chemical products	38939	41324	35060	35599
Other non-metallic mineral products	177315	158500	18881	20055
Metal products	48190	41807	38951	33104
Transport equipment	15668	18020	19933	18843
Furniture and products not classified elsewhere	6624	13847	9831	19393
Recyclable materials	98568	108910	6912	6234
Freight transport equipment	13853	17639	10571	8224
Goods not classified elsewhere	72310	65751	57845	60686
Machinery not classified elsewhere	12458	14477	10834	9821

The analysis revealed that in domestic transport at the turn of 2019-2020, the most frequently transported cargoes were (Table 1):

- metal ores and other mining products,
- other non-metallic mineral products,
- food products,
- secondary raw materials,
- agricultural and hunting products.

It was also noted that in 2020, changes in the volume of transport of major cargoes became apparent:

- metal ores and other mining products—a decrease of 9.8%,
- other non-metallic mineral products—a decrease of 10.6%,
- food products—an increase of 16.3%,
- secondary raw materials—an increase of 10.5%,
- agricultural and hunting products—14.5%.

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Based on the analysis, changes resulting from the Covid-19 virus were observed in relation to the most frequently transported cargo. The partial closure of the economy at that time caused a decline in demand for metal ores, mining products, and minerals. The increase in demand for basic food and industrial products was caused by the population buying up goods en masse for fear of restrictions on movement. An analysis of international freight transport in 2019-2020 showed that the most frequently transported goods were goods not classified elsewhere, whose value increased by 4.9%; metal products, which recorded a 15% decline; food products, which recorded a 14.1% increase; wood and wood products, which remained at a similar level in 2019-2020, with a slight increase of 1.1%; and chemical products, which recorded a 1.5% increase. Furthermore, there was a decline in demand for metal ores and other mining products, which translated into a decrease in the volume of cargo transported by tipper trucks by 53,308 thousand tonnes (10.6%). The increase in transport by universal bodies by 26,133 thousand tonnes (4.9%) and refrigerated bodies by 9,879 thousand tonnes (10.9%) was caused by an increase in demand for basic food and industrial products.

3. ANALYSIS AND EVALUATION OF FREIGHT TRANSPORT ROUTES IN THE TRANSPORT NETWORK - CASE STUDY

The subject of the analysis and assessment is selected transport routes carried out by the transport company under investigation in May 2024. Transport operations carried out on fixed routes were selected for analysis. The source data is presented in a sectional layout (Table 2).

The research revealed an exceptionally long loading time on section 23, amounting to 3 hours and 55 minutes. The longest unloading time was observed on section 22, amounting to 1 hour and 45 minutes. Furthermore, the maximum distance covered was observed on route 2, section 3, i.e., 670 km, and the shortest on route 5, section 14-27 km.

In international relations, there is a limitation in the number of border crossings available for freight traffic. There are only two such crossings on the Polish-Slovak border: Barwinek and Chyżne. For the company under study, this means that no other border crossing than the one in Barwinek can be considered for the Jasło-Bystre/Humenne/Michalovce route. The routes operated by the company in question must largely use lower-category roads, which affects both the speed parameters and the range of the route. There are two significant route options for the Jasło-Straszyn route (Fig. 7):

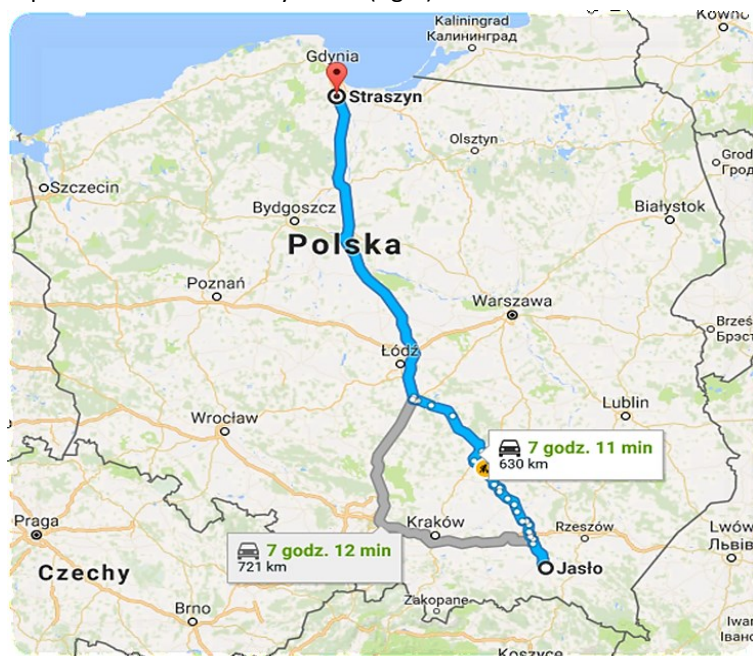


Fig. 7. Variants of the Jasło - Straszyn route

Table 2. Analysis of transport processes for May 2024

ROUTE	EPISODE NUMBER	DEPARTURE DATE	DEPARTURE TIME	PLACE OF DEPARTURE	DISTANCE [km]	LOAD [t]	ARRIVAL DATE	TIME OF ARRIVAL	LOADING TIME [h]	UNLOADING TIME [h]	PAUSE TIME ON THE ROUTE SECTION [h]	DAILY REST [h]	TOTAL FUEL CONSUMPTION [litres]
1	1	2024-05-04	07:57	JASŁO - BYSTRE (SK)	120	0	2024-05-04	12:00	0:42		0:52		32
	2	2024-05-04	12:42	BYSTRE (SK) - JASŁO	120	24	2024-05-04	15:36				13:39	40
2	3	2024-05-05	05:15	JASŁO - STRASZYN	670	24	2024-05-05	16:45		1:00	1:50	13:45	200
	4	2024-05-06	07:30	STRASZYN - GDYNIA	36	0	2024-05-06	08:00	1:40				10
	5	2024-05-06	09:40	GDYNIA - WIELKA WIEŚ	605	24	2024-05-06	18:10			1:00	11:10	193
	6	2024-05-07	05:20	WIELKA WIEŚ - JASŁO	172	24	2024-05-07	09:20		0:45			52
3	7	2024-05-11	09:40	JASŁO - MICHALOVCE (SK)	150	0	2024-05-11	13:39	0:56		1:00		39
	8	2024-05-11	14:35	MICHALOVCE (SK) - JASŁO	150	18	2024-05-11	17:35				13:30	45
4	9	2024-05-12	07:05	JASŁO - OLSZYNA	605	18	2024-05-12	16:15			1:05	13:05	180
	10	2024-05-13	05:20	OLSZYNA - NAUEN (D)	215	18	2024-05-13	08:45		0:35	0:45		65
	11	2024-05-13	09:20	NAUEN (D) - GUBIN	203	0	2024-05-13	12:35	2:00			10:25	50
	12	2024-05-14	01:00	GUBIN - JASŁO	626	24	2024-05-14	13:00			2:00	18:11	200
5	13	2024-05-15	07:11	JASŁO - HUMENNE (SK)	110	24	2024-05-15	10:30		1:10	0:50		34
	14	2024-05-15	11:40	HUMENNE (SK) - MICHALOVCE (SK)	27	0	2024-05-15	12:20	2:00				6,6
	15	2024-05-15	14:20	MICHALOVCE (SK) - JASŁO	150	15	2024-05-15	17:00					45
6	16	2024-05-17	09:10	JASŁO - OLSZYNA	605	15	2024-05-17	19:10			1:10	11:00	182
	17	2024-05-18	06:10	OLSZYNA - BERLIN (D)	150	15	2024-05-18	08:55		0:35	0:45		45
	18	2024-05-18	09:30	BERLIN (D) - ŻARY	186	0	2024-05-18	12:25	1:35			12:00	38
	19	2024-05-19	02:00	ŻARY - JASŁO	573	24	2024-05-19	11:00			1:25	19:00	184
7	20	2024-05-20	06:00	JASŁO - PREŠOV (SK)	120	24	2024-05-20	09:20		1:00	1:00		35
	21	2024-05-20	10:20	PREŠOV (SK) - JASŁO	120	0	2024-05-20	12:30	2:30				30
8	22	2024-05-23	05:00	JASŁO - ŁÓDŹ	350	18	2024-05-23	12:45		1:45	0:45		105
	23	2024-05-23	14:30	ŁÓDŹ - STRYKÓW	35	0	2024-05-23	15:05	3:55			9:00	7,2
	24	2024-05-24	04:00	STRYKÓW - JASŁO	375	6	2024-05-24	11:30			0:50	18:30	95
9	25	2024-05-25	06:00	JASŁO - HUMENNE (SK)	120	6	2024-05-25	08:30		0:50			25
	26	2024-05-25	09:20	HUMENNE (SK) - MICHALOVCE (SK)	28	0	2024-05-25	11:05	1:45		0:55		7
	27	2024-05-25	12:50	MICHALOVCE (SK) - JASŁO	150	18	2024-05-25	15:50					45
10	28	2024-05-28	04:30	JASŁO - ŁÓDŹ	350	18	2024-05-28	12:15		1:10	0:45		135
	29	2024-05-28	13:25	ŁÓDŹ - RADOMSKO	90	0	2024-05-28	14:45	2:15			9:05	25
	30	2024-05-29	02:05	RADOMSKO - JASŁO	257	9	2024-05-29	06:30		1:00			70

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Option 1: Jasło - DK 73 - Kielce - DK 74 - Piotrków Trybunalski and then the A1, approximately 640 km long, and **option 2:** Jasło - DK 73 - Tarnów - A4 - Katowice - S1 - DK 1 - Piotrków Trybunalski and then A1, with a length of approximately 720 km. The travel times for both routes are similar. Option 2, although longer, provides more favorable working conditions for the driver (only a small part of the route is in built-up areas). Both options require a journey time of almost 10 hours, which means that in the event of difficult road conditions, e.g., in winter, or traffic disruptions, it may not be possible to reach the destination within the daily working time limit. Therefore, it would be advisable to consider modifying this route, which is a continuation of the transport from Bystre in Slovakia, so that on the day of loading, the vehicle does not end its journey in Jasło but continues for about 2 hours, e.g., to the Szczucin area, where it takes a daily rest. The next day, there would be about 570 km left, which should allow us to reach our destination in less than 9 hours without using the additional driving time that would be reserved for unforeseen circumstances. This is important because the return journey from Gdynia requires the car to be delivered on time for loading. When looking for a car park in the Szczucin area, however, it is necessary to take into account the safety of the car and its load, i.e., a car park that guarantees security. Also, on the return journey from Gdynia to Jasło, which takes two working days - the first within the maximum range and the second covering the remaining section - a more balanced division and a change of car park to one located closer to Piotrków Trybunalski can be considered.

There is no alternative route between Jasło and Nauen or Jasło and Berlin other than Jasło - Tarnów A4 - A18, which is approximately 810 km long (Fig. 8). However, this is too long a distance to cover in one day, so an overnight rest is taken in the area of the border crossing in Olszyna. However, the journey to Olszyna is also at the maximum range, and as on the previous route, it is worth considering continuing the journey the day before so that the overnight rest can be taken in the Krakow area.

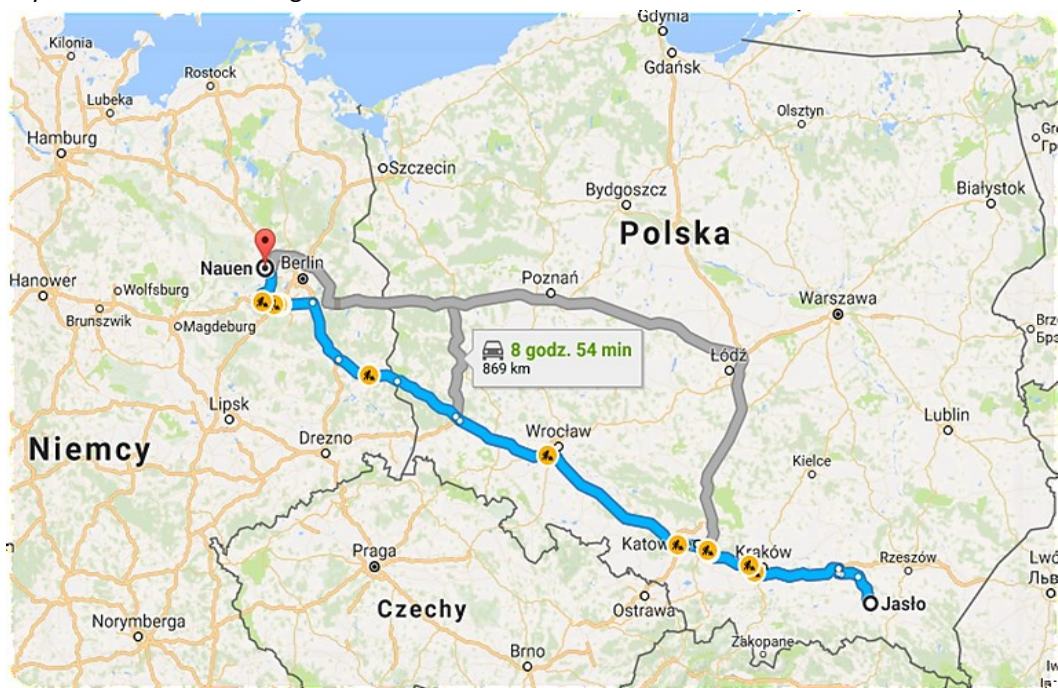


Fig. 8. Variants of the Jasło–Nauen route

Further restrictions that must be taken into account when planning routes are related to strict deadlines for loading work. This applies in particular to loading in Gdynia and routes to Nauen and Berlin. In addition, it is necessary to comply with general standards for professional drivers' working time, including in particular standards for driving time and breaks.

CONCLUSIONS

It should be emphasized that transport services are a fundamental element of the supply chain. For this reason, transport companies wishing to gain a competitive advantage must be prepared to constantly strive to adapt to ever-changing market needs. Market integration forces freight forwarders to intensify their efforts to follow the global trend of organization and implementation of the logistics chain. Therefore, focusing on the issues related to the activities of transport companies has become important for the proper planning of transport corridors in the global supply chain.

In transport companies, freight forwarders organize transport processes according to established patterns, while the continuous transformation of the supply chain allows for the expansion of management skills in the context of both current and long-term strategy. Therefore, the relational capacity of existing business models is a significant factor in transport network planning. As a result, the close relationship between the objectives of the transport company and market expectations determines the efficiency of the entire supply chain. Therefore, the authors demonstrated that the research and analysis conducted are an effective element in improving the implementation of processes in a transport company in the international chain.

ANALIZA I OCENA ŁAŃCUCHA DOSTAW W LOGISTYCZNEJ SIECI TRANSPORTOWEJ

Konkurencja na zintegrowanym rynku przewozowym w Unii Europejskiej jest niezwykle silna. Dlatego istotne jest, aby realizacja procesów transportowych nie była postrzegana jedynie przez pryzmat efektywności usługi, lecz efektywności dostaw w całym łańcuchu dostaw. Dynamiczny rozwój gospodarki wywarł ogromny wpływ na transport, który stał się nieodzownym elementem funkcjonowania przedsiębiorstwa na rynku dóbr i usług. Biorąc pod uwagę powyższe celem artykułu jest ukazanie znaczenia transportu drogowego w gospodarce krajowej i międzynarodowej. Ponadto autorzy przeprowadzili analizę tras przewozu ładunków w kontekście sieci transportowej, która przyczynia się nie tylko do zintegrowanego zarządzania przedsiębiorstwem, ale również do sprawnego funkcjonowania łańcucha dostaw.

Słowa kluczowe: łańcuch dostaw, proces transportowy, transport drogowy, sieć transportowa.

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