

---

## Analysis of the Rail Transport Market in Poland

---

Submitted 17/07/20, 1st revision 25/08/20, 2nd revision 11/10/20, accepted 12/11/20

Agata Marcysiak<sup>1</sup>

### **Abstract:**

**Purpose:** The study's objective is to evaluate the changes observed in the rail transport market in Poland. The analysis covers both the market of freight services and the conditions of passenger transport. The materials used in the analysis consist of records of the Central Statistical Office (GUS) and record sheets and reports of the Railway Transport Office (UTK). The studied period covers the years 2010-2019.

**Design/Methodology/Approach:** A two-step process undertook the research. The first step involved an analysis of changes in the market of freight services. The analysis was performed via an evaluation of freight's total mass, the volume of transport activity (performance), and the volume of train operations. The scope of changes on the market of intermodal freight transport was analyzed in detail. The second step was an examination of changes in the market of passenger transport. Here, the assessment involved the number of passengers carried and individual rail carriers' involvement in the execution of the transport process. Also, the drivers of rail utilization rate differentiation were investigated.

**Findings:** Concerning rail freight transport, an area of particular intensity is intermodal transport. Over the period 2010-2019, there was an over the four-fold rise in the total mass of freight and the number of transport units. The analysis conducted in the field of passenger transport showed its growing importance. The rail utilization rate demonstrated that, statistically, every Polish resident traveled by train more than 8 times per year. The above results tended to increase year by year.

**Practical Implications:** The conducted analysis indicates that thanks to intermodal freight transport, rail transport can be highly competitive when it comes to other modes of transport. It is becoming an interesting alternative also to road trips. Rail popularization is in the hands of public transport associations in individual regions. By developing regular timetables and frequency of transport services, the purchase and retrofitting of rolling stock can contribute to the industry's growth.

**Originality/Value:** The study presents the core factors affecting rail freight and passenger transport development. The analysis of rail utilization in individual regions could provide a basis for strategic decision-making regarding rail transport policy development directions. This may pertain not only to state-wide but also to local activities.

**Keywords:** Rail transport, intermodal transport, rail utilisation rate, level of differentiation.

**JEL:** R4, R1, D2, L9, L2.

**Paper type :** Research article.

---

<sup>1</sup>Faculty of Social Science, Siedlce University of Natural Sciences and Humanities, Poland, [agata.marcysiak@uph.edu.pl](mailto:agata.marcysiak@uph.edu.pl);

## **1. Introduction**

Economic growth boosts trade, which in turn increases transport volumes. Contemporary economies become global, and it is crucial to develop effective logistic chains that allow for uninterrupted and timely deliveries. This requires efficient transport systems that provide for a cost-effective and convenient export and import of a variety of goods (Wang *et al.*, 2018).

One of the most important areas of transport operations is passenger and freight transport. The supply of goods is done via various means of transport. When selecting a transport method, one needs to consider its speed, frequency, reliability, accessibility, and cost (Mendyk, 2009). If the decisive factor is speed, the best solution will be air or road transport. However, if the main criterion is reliability or low cost, rail transport is an option worth consideration (Zhang *et al.*, 2018; 2019).

A transport service provider offering transport services for the benefit of a company impacts the performance of the supply chain items it owns (Zitrický *et al.*, 2017). Company competitiveness and demand for company products depend on the service provider. The choice of transport means greatly affects products' price, timely delivery, and condition of goods post-shipment (Gołębska, 2009).

Rail transport is an area of activity that in the 20th century contributed to the development of industry and trade and participated in the formation of contemporary economies. At the beginning of the 21st century, however, rail transport reached the stage where it had to start competing and fight for survival. In the period 2002 – 2019, the share of rail transport in transported goods' total weight dropped from 21.4% to 10.5%. The pressure was mainly on the part of road transport. Its share in the same period increased from 72.2% to 86.5% (Dymitrowicz-Życka, 2020).

The object of the study is to evaluate the changes observed in the rail transport market in Poland. The analysis covers both the market of freight services and the conditions of passenger transport. The issue was investigated not only from the national but also the regional (by Province) point of view.

## **2. Literature Review**

Concerning the subject matter, transport is a targeted conveyance of people or goods from place to place, technically, organizationally, and economically separated from other activities. Therefore, transport is closely related to the use of specific means of transport, necessary infrastructure, and the presence of specific business entities, which provide transport services and generate financial outcomes of the said activities (Jarašūnienė, 2016).

Separation of transport activities is observed when transport services occur independently and are pursued with the application of means specific for individual branches of transport (Jarašūnienė *et al.*, 2017; Słowiński, 2008). Concerning the

---

material scope, transport should be treated as the movement of humans or goods (the so-called transport objects) in space and time using suitable means (Rydzkowski, Wojewódzka-Król, 2008).

Another definition presents transport as a total of means and activities used to move cargo, people, and news from one place to another. This approach may be referred to as a process-material one. One more approach, known as the economic approach, claims that transport is a process through which people under the conditions of limited resources have humans, things, and energy moved in space to satisfy various needs (van Vuuren, 2002; Khodakivskyi *et al.*, 2019).

Rail transport has certain intrinsic characteristics that constitute the core of its advantages and limitations. A factor that determines railway development is the ability to transport large volumes of passengers or freight at any given time (Štefancová *et al.*, 2017). This branch's transport features relatively limited external effects via a relatively low energy consumption and low emissions of hazardous compounds (Nedeliaková *et al.*, 2014). Also, the railway features a low area occupancy (López Peláez *et al.*, 2012).

An important aspect of the railway is safety, high traffic management, and track organization (Santarremigia *et al.*, 2018). Some of the adverse factors are uneven distribution of infrastructure and its various parameters limiting country-to-country compatibility. What is more, railway transport does not allow door-to-door deliveries either. Thus, it requires support concerning cargo by road transport almost regularly (Skrucany *et al.*, 2017). Replacement infrastructure is also limited, so the railway is susceptible to impediments during renovation and modernization, which determines its low flexibility (Otto *et al.*, 2019).

In the market context, barriers to railway development are posed by the difficulties faced by new railway carriers trying to enter the market – high cost, licenses, infrastructure access permits, and low rolling stock availability (Mašek *et al.*, 2016; López Peláez *et al.*, 2012). Although railway transport is considered to be more environmentally friendly than road transport, it is also a source of emissions, noise, and vibrations, and it limits the use of areas adjacent to track to some elements of railway infrastructure (Dolinayova *et al.*, 2016; Antonowicz, 2016). Even though the railway features high capacity, it is often treated as a road transport substitute (Wang *et al.*, 2020).

An answer to the search for new, more effective, cost-effective, and environmentally friendly modes of transport is intermodal transport (Abbassi *et al.*, 2019). It largely relies on rail transport as a safer, more environmentally oriented, and potentially more effective alternative on long distances (Costa *et al.*, 2017; Dedík *et al.*, 2020).

Intermodal transport can carry large freight volumes long distances and are less exposed to weather conditions and other disruptions (Mindur and Gašior, 2006). A

key issue is that intermodal transport avoids limitations typical of road transport (e.g., the prohibition of circulation during weekends, limitation of circulation at night, limitation of drivers' working hours). Its more common use fights the surge in the circulation of heavy goods vehicles on roads and at border crossings, which undoubtedly plays a major role in transit countries. All of the above translates into benefits in the form of cost reduction of the entire transport process, an increase in delivery time, timely deliveries, and enhanced cargo security (Zajac and Swieboda, 2017; Suzuki and Li, 2012). The final effect is a rise in the level of provided transport services. Intermodal transport is becoming a form of transport oriented at a holistic approach to the entire supply chain (Šakalys and Batarlienė, 2017).

### **3. Material and Methodology**

The object of the study is to evaluate the changes observed in the rail transport market in Poland. The analysis covers both the market of freight services and the conditions of passenger transport. The materials used in the analysis consist of records of the Central Statistical Office (GUS) and record sheets and reports of the Railway Transport Office (UTK). The studied period covers the years 2010-2019.

A two-step process undertook the research. The first step involved an analysis of changes in the market of freight services. The analysis was performed via an evaluation of freight's total mass, the volume of transport activity (performance), and the volume of train operations. The scope of changes on the market of intermodal freight transport was analyzed in detail.

The second step was an examination of changes in the market of passenger transport. Here, the assessment involved the number of passengers carried and individual rail carriers' involvement in the execution of the transport process. Also, the drivers of rail utilization rate differentiation were investigated. The rail utilization rate was defined as the number of journeys by passenger trains times the total population of a given area. Upon a factual and logical verification and a review of the subject literature, the factors selected for the analysis of correlation were, amongst others: rail network density per 100 km, GDP per capita, unemployment rate, and participation of local transport. Provinces conducted the statistical analysis.

### **4. Results**

The level of cargo transport expressed by the volume of transport activity (performance) places Polish rail transport second among the European Union states, between Germany (1st) and France (3rd). The Polish market for rail freight services differs from other European markets. Currently, there are 60 rail carriers on the market. Despite high diversification, the market share of three major carriers, PKP Cargo, DB Cargo Polska, and Lotos Kolej, in the year 2019, was 90%.

PKP Cargo is the largest rail freight service operator in Poland and the fourth largest in the EU. It is a European rail enterprise listed for trading on an exchange. Its main shareholder is PKP S.A. PKP Cargo's share in the market of rail freight transport in comparison by cargo weight was 40.3% in 2019. The situation concerning transport activity (performance) was even better, with its share of 43.9%. Such a strong market position was a consequence of a professionally managed, integrated chain of logistic services.

**Table 1.** Changes in rail freight services in Poland over the period 2010-2019

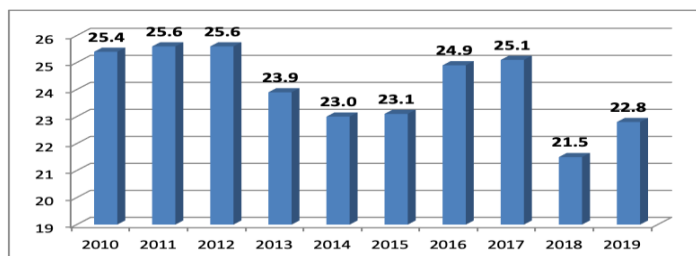
Year	Volume of rail freight in million tons	Performance in billion tkm	Train operations in million train-km	Average service distance
2010	235,3	48,8	71,5	207,4
2011	249,2	54,0	79,3	216,5
2012	234,3	51,1	74,4	212,1
2013	233,2	50,9	74,3	218,1
2014	228,9	50,1	74,9	218,9
2015	224,8	50,6	74,8	225,1
2016	222,2	50,6	74,0	227,8
2017	239,9	54,8	80,0	228,6
2018	250,3	59,6	88,0	238,3
2019	236,4	55,9	82,3	236,6

**Source:** Own study compiled on the basis of: *Statystyka przewozów towarowych/ Freight traffic statistics UTK* [www.utk.gov.pl](http://www.utk.gov.pl).

The analysis of the carried freight volume shows that growth was observed over the period 2010-2011. The same was seen in the case of transport activity (performance) and train operations (Table 1). From 2012 to 2016, there was a time of reduction in the volume of carried freight. A significant increase had not been observed until 2017, when the volume of rail freight, performance (transport activity), and train operations rose significantly (by ca. 8%) compared to the previous year. This upward tendency continued throughout the year 2018. The above positive change resulted from a favorable economic situation, increased production volumes, and a real launch of infrastructural investment as part of EU funds from the new financial perspective 2014-2020. In 2019, 236 million tons of cargo were transported. This signifies a year-to-year drop by 5.5%. Due to a decreased interest in bulk product transport, it mostly affected the second half of the year.

An important issue limiting the growth of freight service volumes is the speed of cargo circulation. Modifications in the average commercial speed of freight trains in the years 2010-2019 are presented in Figure 1.

**Figure 1.** Average commercial speed of freight trains in the years 2010-2019 in km/h



**Source:** Own study compiled on the basis of: *Statystyka przewozów towarowych/ Freight traffic statistics UTK* [www.utk.gov.pl](http://www.utk.gov.pl) (14.06.2020).

The calculation of freight trains' average commercial speed was based on the method whereby the commercial speed equals the distance of service (in kilometers) multiplied by the time in which the distance was covered (in hours). The annual average commercial speed in freight services provided by individual carriers was converted into their market share expressed by performed train operations. The number of trains indexed commercial speed in intermodal freight transport. Over the period 2010-2012, the average commercial speed was over 25 km/h. In 2014, the commercial speed decreased to 23.9 km/h. This was related to a cumulation of infrastructural improvements by the end of the European Union's previous budget perspective and resultant impediments. In 2015, the 2007-2013 settlement period ended. The number of limitations and detours fell. The years 2016 and 2017 saw an improvement in the average, but it continued to be lower than in 2012. The total speed in freight services in 2018 dropped by over 3 km/h compared to 2017. This reduction of freight train speed in Poland was affected by two key factors. First of all, railroad modernization. Secondly, the rise in transport activity. Low commercial speed harms rail transport competitiveness and makes many logistic operators choose another branch of transport (Shi *et al.*, 2014).

The presence of intermodal transport enhances the situation on the market of rail freight services. Operations carried out as part of intermodal freight transport allow one to establish modern transport chains that combine two or more transport modes in a concise system (Tawfik and Limbourg, 2019; Kumar and Anbanandam, 2020). Intermodal transport employs terminals that connect multiple modes of transportation. Freight circulation is done without changing the transport unit (Kurtuluş and Çetin, 2020). The higher the number of land and land-sea terminals, the easier the access to the connection network (Rydzkowski, 2015). An intermodal terminal provides a fast and safe transshipment of transport units between transportation means of two different transport types (Stokłosa, 2011).

The data analysis shows that in the years 2010-2019, there was a growth in the quantity of intermodal rail freight services. In 2019, 19.5 million tons of cargo were transported, compared to 17 million tons in 2018. This means an increase of 14.7%.

The share of intermodal transport in the entire market of rail services expressed by the carried cargo volume reached 8.3% and was higher by 1.5 percentage points than in 2018. Positive changes affected all transport parameters. In total, over the period 2010-2019, there was an over four-fold rise both in the total freight volume and the number of transport units (Table 2).

**Table 2.** Changes in intermodal rail freight services in Poland over the period 2010-2019 Number of transport units in thousands of items

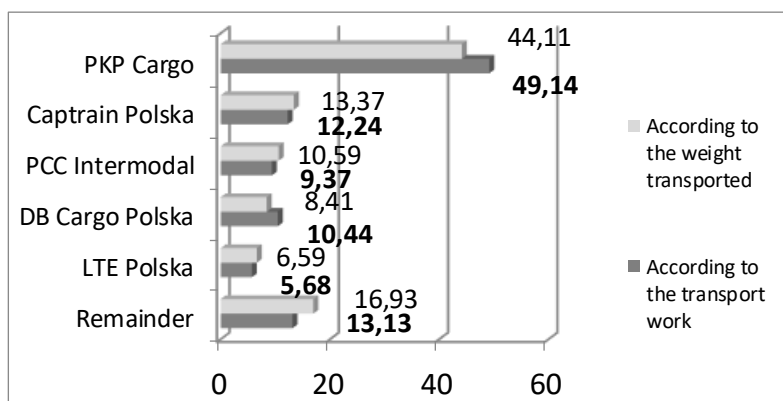
Rok	Volume of rail freight in million tons	Performance in billion tkm	Number of loading units in thousands	Number of TEU in thousands of units
2010	4,4	1,9	345	570
2011	5,9	2,4	489	799
2012	8,1	3,0	645	1054
2013	8,6	3,1	689	1123
2014	9,6	3,4	700	1114
2015	10,4	3,7	745	1152
2016	12,8	4,4	951	1436
2017	14,7	5,4	1081	1667
2018	17,0	6,2	1259	1894
2019	19,5	7,1	1394	2137

*Source:* Own study compiled on the basis of: *Przewozy intermodalne w 2019 roku, Raport/ Intermodal transport in 2019, Report UTK Warszawa 2020*

In the case of intermodal rail services, the expansion of this market segment is also illustrated by the number of rail carriers offering such services. In 2010, only 7 rail carriers dealt with intermodal transport. In 2012, this number reached 9, and in 2016 – 13 entities. In 2019, there were already 20 operators on the intermodal transport market. However, participation in the market of different carriers varied (Figure 2).

As in previous years, in 2019, PKP Cargo had the largest share in intermodal transport. This pertained to the volume and activity (performance) (44.1% and 49.1% of market share, respectively). Nonetheless, year by year, the importance of other participants of this market segment has been growing. Among other rail carriers, the following entities recorded a significant share in terms of masses carried by intermodal transport in 2019: Captrain Polska, PCC Intermodal, DB Cargo Polska, and LTE Polska. Their total market share, given the volume of freight served, was approximately 39.0%. In the case of transport activity (performance), the relation was 37.8%, respectively. Due to its geographic location, Poland can further develop the market of intermodal transport. Two European transport corridors are found here: RCF 5 and RCF 8. The first one is the north corridor connecting Polish harbors with the hinterland and (to a small extent) the neighboring countries.

**Figure 2.** Carriers' shares in the market of intermodal rail transport by cargo volume in 2019 (%)



**Source:** Own study compiled on the basis of: *Przewozy intermodalne w 2019 roku, Raport/ Intermodal transport in 2019, Report UTK Warszawa 2020*

The Baltic Sea marks the beginning. Freight is then transported mainly hinterland to land terminals. Due to, amongst others, insufficient rail infrastructure connecting Poland, Czech and Slovakia, most trains end running at the Upper and Lower Silesia terminals, whereas freight intended for delivery to Czech and Slovakia is then shipped by road transport. The situation at the country's southern border needs to be improved, and border crossings must be adapted to higher trains, with a minimum length of 750 m and 22.5 tons of axle load.

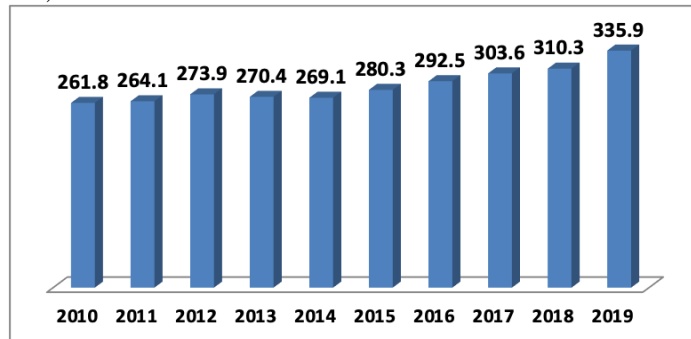
The south corridor, RFC 8, features freight transport as part of the New Silk Road and the circulation of cars from plants located across Czech and Slovakia to Russian assemble plants. Poland's role as a transit country has been growing due to China – Western Europe transport expansion.

From the East, Poland is at the interface between two rail systems (1435/1520). Although cargo reloading time between the different systems' cars does affect delivery time, it is not the key factor affecting transport time. What is needed for intermodal transport to expand at the Polish eastern borders is the smooth operation of customs, photo-sanitary conditions, and forwarding trade.

Another key aspect of rail transport activity is passenger transport (Abramović *et al.*, 2020; Bartosik and Wiak, 2016). In 2019, 335.9 million passengers used the services of rail carriers in Poland. This means that the growth which began in 2015 continues, despite the falls in 2013 and 2014. In 2019, compared to the previous year, the number of passengers grew by over 25 million, i.e., by 8.2%. A comparison with the year 2010 is even more favorable – the rise there was by over 74 million travelers, i.e., by 28.1% (Figure 3).



**Figure 3.** The number of passengers carried by rail transport in the period 2010-2019 (in million)



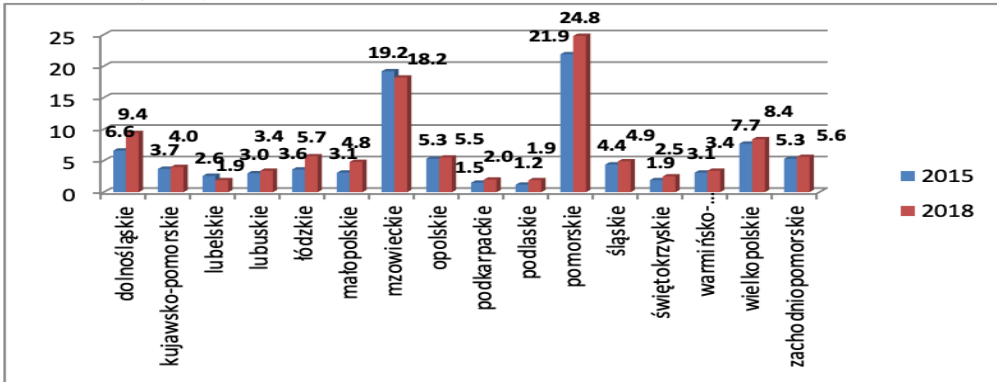
**Source:** Own study compiled on the basis of: *Statystyka przewozów pasażerskich. Przewozy pasażerskie w 2019 roku/ Passenger transport statistics. Passenger transport in 2019* UTK [www.utk.gov.pl](http://www.utk.gov.pl).

In 2019, transport operations (performance) increased concerning the previous year by 4.8%. It amounted to 22.1 billion passenger-kilometers and was higher by 23.1% than in 2010. A clearly higher dynamics of growth of the number of passengers than transport activity (performance) means that the largest rise was observed in local travel. The average distance covered in the period 2010-2019 decreased from 68.3 km to 65.7 km. The volume of rail transport demonstrated pronounced regional variations. In 2018, in the Mazowieckie Province (voivodship), 98.1 million passengers were served. Even though due to infrastructure renovations, we could observe the first drop in years in the number of carried passengers (by 1.4 million), the participation of this Province in the market of passenger transport was 31.6%. The second-largest Province in the transport structure was Pomorskie Province (18.6%), with 57.7 million passengers.

The scope of rail utilization in individual regions of the country is also characterized by the number of trips per one inhabitant of a given Province. In Poland, the rate in 2018 was 8.1 trips per inhabitant. The highest rates were noted in the Pomorskie (24.8), Mazowieckie (18.2), and Lower Silesia Provinces (9.4). The fourth position was occupied by the Wielkopolskie Province, with a rate of 8.4 trips per one resident. The top-level rate was observed in Provinces with well-developed regional and urban rail networks. Passengers selected rail transport over individual passenger car transport. This directly impacted a decrease of the transport congestion phenomenon (Bai *et al.*, 2020; König and Schön, 2020).

The lowest rail utilization rates were recorded in the following Provinces: Podlaskie, Lubelskie, and Podkarpackie, with around two rail trips per one resident. This situation is a consequence of myriad factors, such as the quality of infrastructure and rail connections availability. What is more, the above regions feature lower population density (Figure 4).

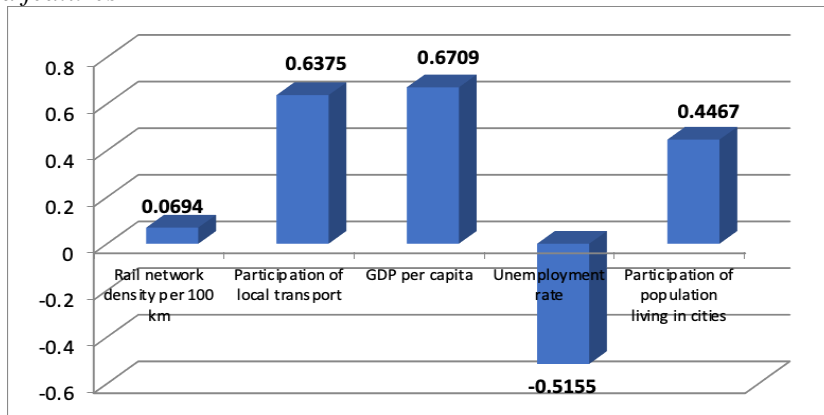
**Figure 4.** Changes of the rail utilisation rate in Poland by Provinces in the period 2015-2018 (in %)



**Source:** Own study compiled on the basis of: *Kolej w województwach – wykorzystanie i polityka transportowa./ Railway in voivodships - use and transport policy.* UTK Warszawa 2019.

The analysis of the rail utilization rate changes shows that interest in this means of transport grew in most Provinces. Nonetheless, even though passengers are more willing to travel by rail, there is still limited rail access and not always satisfactory connection operation (Lingaitis and Sinkevičius, 2014). Rail is available in every Polish capital of a Province. However, many cities that are crucial to regions have indirect or unlimited train access. (Pietrzak and Pietrzak, 2019). The system of factors having an impact on the extent of rail utilization in Poland is multifaceted. The factors selected for the analysis of the degree of mutual correlation were, amongst others: rail network density per 100 km, GDP per capita, unemployment rate, and participation of local transport. Provinces conducted the entire statistical analysis (Figure 5).

**Figure. 5** The value of correlation coefficients between the rail utilisation rate and selected features



**Source:** Own study compiled on the basis of data of the Central Statistical Office in Warsaw

The average rail network density for Poland is 6.2 km/100 km<sup>2</sup>. Comparing the density of rail lines and the rail utilization level by travelers in a given Province shows that a correlation between the two parameters is not always present. A higher rail line density does not directly translate into a high level of rail utilization. Two provinces – Pomorskie and Mazowieckie – feature outstanding utilization rates (24.8 and 18.2, respectively), given the rail network density of 6.6 and 4.8 km/100 km<sup>2</sup>. High efficiency of rail utilization in the above Provinces coincides with, amongst other things, extensive systems of commuter rail within and around both agglomerations. Rail lines are modernized, and, additionally, both regions have dependent segments of linear infrastructure, i.e., Pomorska Kolej Metropolitalna and Warszawska Kolej Dojazdowa.

The largest density of rail lines (as many as 15.8 km of lines per 100 km<sup>2</sup>) can be found across the Silesian Province. However, the region's rail utilization rate is merely 5 trips per resident, three trips less than the all-Poland average. On the other hand, Provinces with the lowest density rates also had the lowest utilization rates. These are Podlaskie and Lubelskie Provinces, where only 2 trips per average resident per annum were recorded, with a line density of 3.6 km per 100 km<sup>2</sup>.

A highly significant correlation coefficient was noted, though, between the rail utilization rate and the GDP per 1 resident in individual Provinces. In more affluent regions, the number of rail trips per 1 resident was higher. The negative correlation regarding the unemployment rate demonstrates that the population's economic activity positively impacted rail utilization. In Provinces featuring high unemployment rates, rail demand was lower.

A significant scope of correlation was further detected between the rail utilization rate and the percentage of local transport and participation of the urban population. This is evidenced by the fact that a higher number of trips per passenger often corresponded to short-distance travel domination in a given Province. At the same time, more urbanized areas generated higher rail utilization as a means of transport.

## 5. Conclusions

The market for rail transport operated under the strong pressure of road transport. The volume of cargo transported by rail in the period 2010-2019 fluctuated between 222 and 251 million tons. A major barrier to rail transport progress is low commercial speed. In the analyzed period, it was less than 26 km/h. The situation on the market for rail freight services is improved by intermodal transport. Positive changes affect all transport parameters. In total, over the period 2010-2019, there was an over four-fold rise both in the total freight volume and the number of transport units.

However, the situation is significantly better on the market for passenger transport. In 2019, 74 million passengers (i.e., 28.1% more) were carried by rail in the year

2019 than in 2010. At the same time, performance (transport activity) grew by 23.1%. Clearly, higher growth rates of the number of passengers than transport activity mean that the largest rise was observed in local travel, which has grown significantly.

Poles are more and more willing to travel by rail. The rail utilization rate also grew progressively. In 2018, statistically, every Polish resident traveled by train over 8 times. This result is better than in the past years, but still below the EU average (20 trips per annum). In France, the rate was 21, in Germany – 35, and in Switzerland – 69. This provides evidence that Polish rail transport has powerful potential. What is typical for Poland is high regional diversification concerning rail use as a means of transport. Individual Provinces differ in terms of rail network parameters, the methods and scope of its use, rail line density, and railway station distribution. The statistical analysis demonstrated that a high degree of economic and social activity of the population favored better rail utilization, which means that we can register a feedback phenomenon. This, in turn, has a positive impact on GDP rise for the region and counteracts social exclusion and unemployment. Provinces which carry out attractive activities to promote and reinforce railway are Pomorskie, Lower Silesia, Wielkopolskie, and Łódzkie Provinces. Among some good practices implemented by the Provinces, favoring popularization of rail transport, are reinstating rail connections at liquidated sections, revitalizing unused infrastructure, investment in comfortable, state-of-the-art rolling stock, commitment to the creation of a cyclic transport timetable, and cooperation with other self-governments. However, a frequent barrier to cooperation is the absence of efficient communication between the managers of rail infrastructure and local authorities.

#### **References:**

- Abbassi, A., Alaoui, A. E. hilali, Boukachour, J. 2019. Robust optimisation of the intermodal freight transport problem: Modeling and solving with an efficient hybrid approach. *Journal of Computational Science*, 30, 127-142.
- Abramović, B., Šipuš, D., Ontl, L. 2020. Analysis of Exploitation Indicators in Passenger Railway Transport in Sisak-Moslavina County. *Transportation Research Procedia*, 44, 327-331.
- Antonowicz, M. 2016. Uwagi na temat konkurencyjności kolejowego transportu towarowego w stosunku do transportu samochodowego. (Comments on the competitiveness of rail freight transport in relation to road transport). *Problemy Transportu i Logistyki* nr 3.
- Bai, X., Jin, Z., Chiu, Y.H. 2020. Performance evaluation of China's railway passenger transportation sector. *Research in Transportation Economics*, 100859.
- Bartosik, M., Wiak, S. 2016. Multi-annual Program "By Railway to the 21st Century" as Key Factor in the Development of Rail Transport in Poland. *Transportation Research Procedia*, 14, 518-527.
- Costa, B.J.A., Martins, R., Santos, M., Felgueiras, C., Calçada, R. 2017. Weighing-in-motion wireless system for sustainable railway transport. *Energy Procedia*, 136, 408-413.

- Dedík, M., Čechovič, L., Gašparík, J. 2020. Methodical Process for Innovative Management of the Sustainable Railway Passenger Transport. *Transportation Research Procedia*, 44, 305-312.
- Dolinayova, A., Loch, M., Camaj, J. 2016. Liberalization of the Railway Freight Market in the Context of a Sustainable Transport System. *Transportation Research Procedia*, 14, 916-925.
- Dymitrowicz-Życka, K. 2020. Przewozy ładunków i pasażerów w 2019 r. (Freight and passenger transport in 2019). GUS, Warszawa.
- Gołębska, E. 2009. *Logistyka w gospodarce światowej. (Logistics in the world economy)*. Wydawnictwo C.H. Beck, Warszawa.
- Jarašūnienė, A. 2016. Advanced Technologies Used by Lithuanian Railways. *Procedia Engineering*, 134, 263-267.
- Jarašūnienė, A., Sinkevičius, G., Mikalaukaitė, A. 2017. Analysis of Application Management Theories and Methods for Developing Railway Transport. *Procedia Engineering*, 187, 173-184.
- Khodakivskiy, O., Khodakivska, Y., Kuzmenko, O., Shcherbyna, M., Kolesnichenko, O. 2019. Improvement of the railway transport system by increasing the level of goal-oriented activity. *Procedia Computer Science*, 149, 415-421.
- König, E., Schön, C. 2020. Railway delay management with passenger rerouting considering train capacity constraints. *European Journal of Operational Research*.
- Kumar, A., Anbanandam, R. 2020. Evaluating the interrelationships among inhibitors to intermodal railroad freight transport in emerging economies: A multi-stakeholder perspective. *Transportation Research Part A: Policy and Practice*, 132, 559-581.
- Kurtuluş, E., Çetin, İ.B. 2020. Analysis of modal shift potential towards intermodal transportation in short-distance inland container transport. *Transport Policy*, 89, 24-37.
- Lingaitis, V., Sinkevičius, G. 2014. Passenger Transport by Railway: Evaluation of Economic and Social Phenomenon. *Procedia - Social and Behavioral Sciences*, 110, 549-559.
- López Peláez, A., Segado Sánchez-Cabezudo, S., Kyriakou, D. 2012. Railway transport liberalization in the European Union: Freight, labor and health toward the year 2020 in Spain. *Technological Forecasting and Social Change*, 79(8), 1388-1398.
- Mašek, J., Kolarovszki, P., Camaj, J. 2016. Application of RFID Technology in Railway Transport Services and Logistics Chains. *Procedia Engineering*, 134, 231-236.
- Mendyk, E. 2009. *Ekonomika transportu. (Economics of transport)*. WSL, Poznań.
- Mindur, L., Gašior, M. 2006. Przewozy intermodalne. (Intermodal transport) *TTS Technika Transportu Szynowego* nr 3.
- Nedeliaková, E., Sekulová, J., Nedeliak, I., Loch, M. 2014. Methodics of Identification Level of Service Quality in Railway Transport. *Procedia - Social and Behavioral Sciences*, 110, 320-329.
- Otto, A., Kellermann, P., Thieken, A.H., Máñez Costa, M., Carmona, M., Bubeck, P. 2019. Risk reduction partnerships in railway transport infrastructure in an alpine environment. *International Journal of Disaster Risk Reduction*, 33, 385-397.
- Pietrzak, K. 2016. Analysis of the Possibilities of Using “Light Freight Railway” for the Freight Transport Implementation in Agglomeration Areas (Example of West Pomerania Province). *Transportation Research Procedia*, 16, 464-472.
- Pietrzak, O., Pietrzak, K. 2019. The role of railway in handling transport services of cities and agglomerations. *Transportation Research Procedia*, 39, 405-416.
- Rydzkowski, W. 2015. Przewozy intermodalne. (Intermodal transport) *ILiM Poznań 2015*.

- Rydzkowski, W., Wojewódzka-Król, K. 2008. Transport (transport). Wydawnictwo Naukowe PWN, Warszawa.
- Šakalys, R., Batarlienė, N. 2017. Research on Intermodal Terminal Interaction in International Transport Corridors. *Procedia Engineering*, 187, 281-288.
- Santarremigia, F.E., Molero, G.D., Poveda-Reyes, S., Aguilar-Herrando, J. 2018. Railway safety by designing the layout of inland terminals with dangerous goods connected with the rail transport system. *Safety Science*, 110, 206-216.
- Shi, R., Hu, Z., Zhou, Y., Liu, P. 2014. Research on Railway Freight Market Share Based on the Whole Process of Transport. *Procedia - Social and Behavioral Sciences*, 138, 298-304.
- Skrucany, T., Kendra, M., Skorupa, M., Grecik, J., Figlus, T. 2017. Comparison of Chosen Environmental Aspects in Individual Road Transport and Railway Passenger Transport. *Procedia Engineering*, 192, 806-811.
- Słowiński, B. 2008. Wprowadzenie do logistyki. (Introduction to Logistics). Wydawnictwo Uczelniane Politechniki Koszalińskiej, Koszalin.
- Štefancová, V., Nedeliaková, E., López-Escolano, C. 2017. Connection of Dynamic Quality Modeling and Total Service Management in Railway Transport Operation. *Procedia Engineering*, 192, 834-839.
- Stokłosa, J. 2011. Transport intermodalny. Technologia i organizacja. (Intermodal transport. Technology and organization) Wyższa Szkoła Ekonomii i Innowacji, Lublin.
- Suzuki, T., Li, G. 2012. An Analysis on the Railway-Based Intermodal Freight Transport in Japan Regarding The Effect of Disasters. *Procedia - Social and Behavioral Sciences*, 43, 111-118.
- Tawfik, C., Limbourg, S. 2019. Scenario-based analysis for intermodal transport in the context of service network design models. *Transportation Research Interdisciplinary Perspectives*, 2, 100036.
- van Vuuren, D. 2002. Optimal pricing in railway passenger transport: theory and practice in The Netherlands. *Transport Policy*, 9(2), 95-106.
- Wang, C., Lim, M. K., Zhang, X., Zhao, L., Lee, P.T.W. 2020. Railway and road infrastructure in the Belt and Road Initiative countries: Estimating the impact of transport infrastructure on economic growth. *Transportation Research Part A: Policy and Practice*, 134, 288-307.
- Wang, R., Yang, K., Yang, L., Gao, Z. 2018. Modeling and optimization of a road-rail intermodal transport system under uncertain information. *Engineering Applications of Artificial Intelligence*, 72, 423-436.
- Zajac, M., Swieboda, J. 2017. Analysis of the ROSCO in the Intermodal Transport Market. *Procedia Engineering*, 187, 371-377.
- Zhang, R., Jian, W., Tavasszy, L. 2018. Estimation of network level benefits of reliability improvements in intermodal freight transport. *Research in Transportation Economics*, 70, 1-8.
- Zhang, R., Li, L., Jian, W. 2019. Reliability analysis on railway transport chain. *International Journal of Transportation Science and Technology*, 8(2), 192-201.
- Zitrický, V., Černá, L., Abramovič, B. 2017. The Proposal for the Allocation of Capacity for International Railway Transport. *Procedia Engineering*, 192, 994-999.