



Selected Aspects of Functioning of Rail Transportation in Europe

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Abstract: The fundamental focus of this paper is on theoretical and empirical analysis of selected aspects of functioning of rail traffic in European countries. The principal benefits and drawbacks of rail transport were emphasized. Analysis of rail transport concerned two stages. The first stage was used to illustrate the degree of development of line infrastructure of rail transport in the EU member states (including rail lines adapted to rail modes of transport that reach the speeds of 250kmph. Further, the index of concentration of rail transport was evaluated in individual member states. The computation was based on the data concerning the length of rail lines and transport performance in modes of rail transport. Empirical examinations were carried out based on the statistical data published by the European Statistical Office and the Office of Rail Transport. Period of the study was the years 2009-2012

Keywords: rail transportation, passenger transport, transport of cargo

1 Introduction

Moving and flow of people and goods are performed by various forms of transport. Transport is one of the most important sectors of national economy. It enables to meet the transport needs of managing entities (such as enterprises) or households. These

needs results from the demand for transporting both persons and cargo [22] and can be met using different sectors of transport.

Key criteria of division of transport which are the most popular in contemporary literature are the sectors which emphasize transport by road, rail, inland waterway and sea transport, aviation and pipeline transport [2]. The natural tendency is presence of non-uniform services offered by these sectors and varied coordination of transport markets that belong to a specific sector. This means that all types of transport area characterized by different quality of connections and system organization [3]. While adopting the above classification of the sectors of transport, it should be emphasized that individual modes of transport are connected with different transport opportunities costs of transport and means of transport and transport infrastructure.

2 Principal benefits and drawbacks of rail transport

During selection of a route and means of transport for transporting passengers or cargo, essential factors include speed, frequency, technical capabilities, reliability, access and costs. The choice of a particular mode of transport has essential effect on the price of transported goods, timely deliveries to recipients, status of goods after transporting and customer satisfaction. In general terms, the most popular means of transport of mass cargo for long distances and with substantial speed is rail transport.

M. Fertsch emphasizes that rail transport is characterized by low costs of transport at medium and longer distances and higher load capacity of means of transport [4]. It is also characterized by fast deliveries, regularity and improved reliability. Furthermore, the literature emphasizes the following features that demonstrate the significance of rail transport: opportunities for transportation of goods with substantial dimensions and tonnage in varied quantities, using relatively low transport rates that results from strong degression of unit costs, presence of relatively broad rail network adjusted to location of main markets of supply and distribution as well as occurrence of favourable offer from the standpoint of time of transport which results from regularity, frequency and rhythm of the connections offered [9].

It should be emphasized that specialized railway rolling stock adjusted to transport of cargo, with varied transport capabilities, is also of great importance. However, the risk of damaging goods sensitive to impact and manipulation is relatively greater in this case. Other essential drawbacks of rail transport include its small flexibility that results from the lack of opportunities for matching the transport to specific place and time. Location and time of transport depend on the railway infrastructure and train timetable. Traffic of vehicles in transport system occurs according to a previously defined schedule that assigns each vehicle a route in the space-time continuum.

The benefits of rail transport also include a relatively less harmful effect on the environment compared to other routes of transport. The effect of rail transport on the environment is connected first and foremost with noise and vibration emissions,

pollution and land management.¹ It is estimated that emission of pollution from rail transport in the European Union is at the level of 1 to 3% of emissions from transport in total [24]. Therefore, it should be emphasized that, compared to other sectors, the scale of unfavourable effect of transport on the environment is smaller.

The degree of safety of this mode of transport is much higher. A. J. Badyda emphasizes that unit events involve relatively many casualties. But globally, almost 30 times fewer people die in rail accidents compared to road transport (compared to the number of passenger-kilometres, rail transport is almost 3 times safer than road transport) [1]. Therefore, this mode of transport of persons and goods is substantially safer.

3 Characterization of line infrastructure of rail transport in the European Union

Undoubtedly, the substantial contribution of road transport to total level of transport affects the increase in environmental pollution and, consequently, its degradation. For these reasons, the countries of the European Union started striving for reduction in the importance of road transport in the member states. Current European policy is aimed at limitation of disproportion of vehicle transport in favour of rail transportation.

In these terms, the most important assumptions were contained in the document published in 2011 in Brussels, titled “White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system”². This document also emphasized the necessity of modernization of present transport infrastructure [25].

Therefore, these aims can be met as a result of increased contribution of rail in total level of transport³. Therefore, it is justified to diagnose the status of rail infrastructure of the countries of the European Union. Figure 1 presents contribution of the length of rail lines in individual member states to overall length of railway lines in the European Union in 2012.⁴

¹ More on the dangers of road transport in the European countries can be found in e.g. [13].

² Access to the publication is available at <http://europa.eu>.

³ The future of rail transport, particularly in passenger transport, was discussed in [8].

⁴ Due to the lack of data for the year 2012, comparison was based on the length of railway lines recorded in the previous years when the data were available. The data were not available for Denmark.

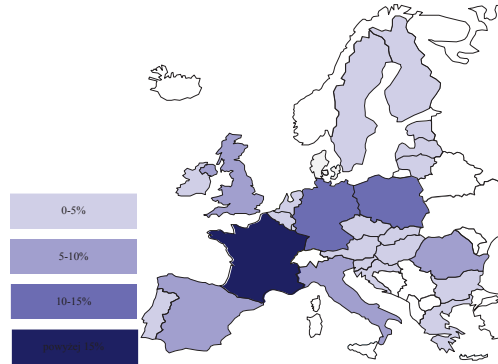


Figure 1
Contribution of railway lines in individual EU member states to total length of railway lines in the European Union in 2012 [20]

However, with regard to statistics presented in 2010, it can be estimated that the length of railway lines in the European Union in 2012 amounts to over 326 707 kilometres. The highest numbers of kilometres of railway lines were recorded in such member states as France, Germany and Poland. Total contribution of railway lines in these countries accounted for 39.88% of total length of railway lines in the European Union. The greatest concentration of the line-related infrastructure of rail transport can be observed in Czech Republic (12.1 km/100 km²), Germany (11.6 km/100 km²) and Luxembourg (10.6 km/100 km²).

In order to improve competitiveness of rail transport compared to other modes of transport in 1985-2012, the length of high-speed railway lines in the EU was extended from 643 km to 6 879 km [16]. Diagram 1 presents the length of high-speed lines at the end of a particular year that allows for moving with speeds that extend 250 km/h in individual countries of the European Union.

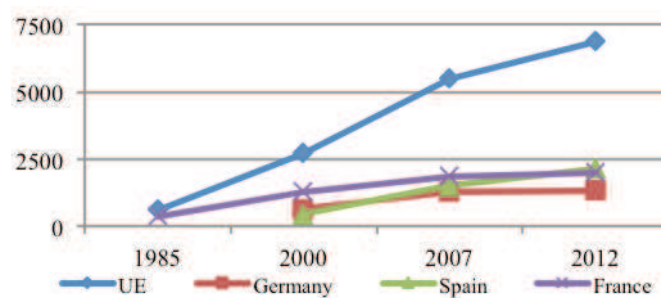


Diagram 1
High-speed railway lines in individual EU countries in 1985 – 2012 (in km) [16]

Analysis of the above data demonstrates a regular increase in the length of high-speed railway lines in individual European countries. The leaders in building this type of

infrastructure included: Spain, France and Germany. The dynamic increase in the length of rail lines of this type reflects the increasing popularity of rail as a means of transport and improving competitiveness of high-speed trains. Comparison of the data which illustrate the length of railway lines and high-speed railway lines leads to the conclusion that the countries which have a well-developed railway line infrastructure are France and Germany.

Poor interest in transport of goods by rail can be caused by insufficient spatial availability of this type of transport. The necessity of delivery and receiving the cargo contributes to increased costs of transport. In many cases, the enterprises cannot afford these costs. In order to utilize this type of transport more effectively, the continuous infrastructural development should be ensured. This concerns mainly modernization of the previous and building new railway lines. Development of railway lines that allow for reaching high speeds will also allow for improving competitiveness of railway compared to other modes of transport. Consequently, extension of rail infrastructure will undoubtedly allow for meeting the assumptions of the European Union contained in the White Paper from 2011 and will contribute to increased share of rail transport in transporting goods and passengers.

4 Analysis of the market of rail transport in the EU member states

The highest percentage of total transport in the most of EU member states is transport of goods and passengers by means of rail transport. Therefore, the attempts were recently made to liberalize rail transport. These initiatives are aimed at creating transport so that the contribution of rail transport should be increased. This is supposed to improve rail transport infrastructure and, consequently, reduce environmental pollution and improve transport safety.⁵

In 2012, average contribution of rail transport to total number of tonne-kilometre-s of transported goods in the European Union was 18.2%. Only 42% of member states reached the result over the average in the European Union, whereas 57% remained below this value (see Diagram 2).

⁵ Ways to improve rail and road transport and safety aspects of rail traffic have also been described in [14].

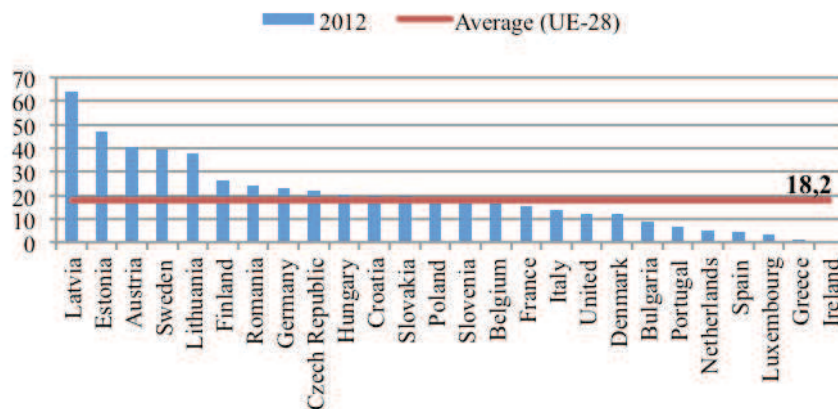


Diagram 2
Contribution of rail transport to total number of tonne-kilometres of goods transported in 2012 in the EU member states [11]

Situation in the market of rail passenger transport is more and more worrying. Only 7.4% of overall transport performance in 2012 expressed in passenger-kilometres was covered with means of rail transport. In this case, 32% of the countries of the European Union member states reported contribution of rail transport in the number of goods over the average, whereas 68% of the countries were below the European average (see Diagram 3).

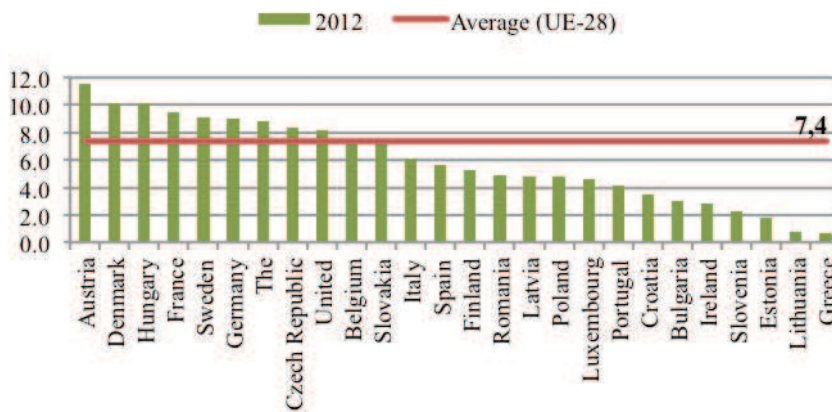


Diagram 3
Contribution of rail transport to total number of passenger-kilometres in 2012 in the EU member states [12]

Undoubtedly, low contribution of rail transport to total level of transport results from drawbacks of this type of transport. This concerns in particular infrastructural

inadequacy in this mode of transport. This is particularly noticeable in the countries characterized by low contribution of rail transport in the total transport. It should be also noted that, in the countries such as Malta or Cyprus, transport was mainly dominated by road transport. This results from the fact that rail transport infrastructure in these areas actually does not exist.

One of the economic measures which allow for determination of the level of concentration of rail transport in the European Union is e.g. Herfindahl–Hirschman Index (equation 1). This measure allows for determination of the level of concentration of a variable measured in the market. The level of the index of below 0.1 points to the lack of concentration of the variable measured. The results from 0.1 to 0.18 suggest moderated concentration, whereas the level over 0.18 points to a very high concentration of the variable.⁶

$$HH = \sum_{i=1}^n u_i^2$$

where:

u_i is contribution of the variable measured for i object in total value of the variable for all the units analysed

Equation 1

Herfindahl–Hirschman Index [10]

The index (Equation 1) allows for determination of e.g. degree of concentration of railway line infrastructure in the European Union (including high-speed trains) and degree of concentration of transport of goods and passengers on the area indicated. The calculation of individual indices was based on the data published by EUROSTAT in 2012. The data obtained from the study were presented in the table below.

<i>Variable studied</i>	<i>Herfindahl–Hirschman Index</i>	<i>Type of concentration</i>
Length of railway lines [kilometre]	0.120533	moderate
Length of high-speed railway lines [kilometre]	0.017311	N/A
Transport of passengers [million passenger-km]	0.152278	moderate
Transport of cargo [million tkm]	0.117682	moderate

Table 1

Herfindahl–Hirschman Index evaluated for individual variables that describe rail transport in the European Union [18, 19, 21, 23]

As results from the data presented in the Table 1, concentration of the infrastructure of railway line transport, volume of transport performance in transport of passengers and goods in the European Union is moderate. This means that the market of rail transport

⁶ The measures of concentration have been described by e.g. Mesjasz-Lech A. in her study [10].

in the area indicated is moderately competitive.⁷ Therefore, no country is reported among the European Union countries to have a particularly well-developed rail transport infrastructure or a country with predominance in rail transport. Different situation occurs in the case of high-speed railway. Herfindahl–Hirschman Index calculation for the length of railway lines of this type points to lack of concentration. Therefore, it can be concluded that this market is competitive. The most advanced network of high-speed railway lines was observed in: Germany (41 427 km), Poland (20 094 km) and Italy (16 742 km).

Low level of rail transport in the transport of passengers and goods forced the authorities of the European Union to implement specific regulations. Their purpose is to increase the importance of rail transport. However, it should be noted that introduction of specific regulations might not produce the expected results. The cause of this phenomenon is the fact that development of rail transport infrastructure and increase in rail transport depends on the level of the economy (see Diagram 4).

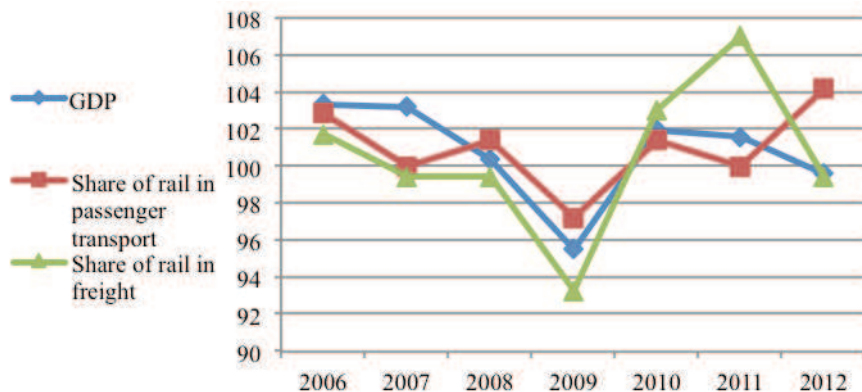


Diagram 4

Dynamics of rail transport with respect to changes in Gross Domestic Product [5, 6, 17]

Looking at the Diagram 4 leads to the conclusion that changes in GDP in the years 2007-2012 affected the volume of rail transport. With the onset of the economic crisis in 2008, which affected the most of the member states, the level of rail transport in the European Union reduced. The reduction of the dynamics of all the presented variables was particularly noticeable in 2008-2009. The highest decline was observed in transport of goods by rail (by 6.74%) compared to the previous year and in the GDP and transport of passengers. The declines in these cases were 4.5 and 2.78 respectively. A substantial increase in transport of goods occurred in 2011. Its dynamics was maintained at the level of 107.02. This might result from the regulations introduced by the European Union and the fact that the level of transport by rail is relatively low compared to other

⁷ Analysis of concentration of rail transport infrastructure in Europe might be found in publication: [15].

mode of transport. In order to reduce the costs of operation, enterprises were able more often choose this mode of transport.

5 Conclusion

In conclusion, the demand for passenger rail transport services in general terms did not change substantially over the period of the analysis. Furthermore, a declining tendency can be observed for goods rail transport services. However, there is a noticeable tendency for development of infrastructure adjusted to high-speed trains. As illustrated by the empirical analysis, competition in a particular market is intensive. Therefore, further development of the competition can be expected in the nearest years. It can be assumed that the essential factor that determines this decline is time and comfort of travelling, which in this case are characterized by more beneficial parameters compared to vehicle transport.

In view of the initiatives taken by the European Union, it can be expected that the transport by rail will be increasing in the near future. However, it should be also remembered that development of railway, and, consequently, increasing the transport performance using mode of rail transport, is affected by the external factor. This factor is the economy in the domestic and foreign markets. Conducive market conditions will undoubtedly allow for meeting these assumptions.

References

- [1] Badyda A.J., *Zagrożenie środowiskowe ze strony transportu*, Nauka 4/2010, p. 120.
- [2] Bendkowski J., Kramarz M., Kramarz W.: *Metody i techniki ilościowe w logistyce stosowanej. Wybrane zagadnienia*. Wydawnictwo Politechniki Śląskiej. Gliwice 2010, p. 114.
- [3] Coyle J. J., Bardi J. E., Langley J. C. Jr.: *Zarządzanie logistyczne*. Polskie Wydawnictwo Ekonomiczne. Warsaw 2010, p. 411.
- [4] Fertsch M.: *Podstawy logistyki. Podręcznik do kształcenia w zawodzie technik logistyk*. Co-authored study edited by M. Fertsch. Biblioteka Logistyka. Poznań 2006, p. 84.
- [5] *GDP and main components - volumes*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 08-09-2014).
- [6] *Goods transport by rail*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 24-10-2014).
- [7] <http://europa.eu>.
- [8] Kadłubek M., *Nowadays and Future Public Railway Transport in Europe. Chapter 7*, [in:] "Problems of Transport Logistics" monograph, eds. Marek Fertsch, Agnieszka Stachowiak, Wyd. Pozn. Univ. Techn., Poznan 2010.

- [9] Kwaśnikowski J., Granza G., Medwid M.: *Transport kolejowy a system logistyczny Polski*, Czasopismo logistyka. Prace Naukowe Politechniki Warszawskiej, 2010, Zeszyt 76 *Transport*, p. 77.
- [10] Mesjasz-Lech A., *Koncentracja rynku energii elektrycznej w Polsce*, [w:] „Koniunktura gospodarcza a funkcjonowanie rynków”, praca zbiorowa pod redakcją Rafała Żelaznego, Wydawnictwo Akademii Ekonomicznej, Katowice 2009.
- [11] *Modal split of freight transport*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 24-10-2014).
- [12] *Modal split of passenger transport*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 24-10-2014).
- [13] Nowakowska-Grunt J., Strzelczyk M., *Influence of Road Transport on the Environment - Poland Against the European Union*, [in:] The Publications of the MultiScience - XXVIII. microCAD International Multidisciplinary Scientific Conference. Miskolc 2014.
- [14] Nowicka-Skowron M., Kott I., *Problems of Development in Rail and Road Freight Transport in Poland*, [in:] XXIII. microCAD International Scientific Conference. Section O: Material Flow Systems. Logistical Information Technology. Miskolc, 2009.
- [15] Nowicka-Skowron M., Mesjasz-Lech A., *Globalization and the Development of Logistics Infrastructure of the Freight Transport by Road*, Regional Integration: Europe, the Mediterranean and the World Economy. 53rd ERSA Congress. 27-31 August 2013, Palermo, Italy.
- [16] *Ocena funkcjonowania rynku transportu kolejowego i stanu bezpieczeństwa ruchu kolejowego w 2012*, Urząd Transportu Kolejowego, Warsaw 2013, p. 11.
- [17] *Rail transport of passengers*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 24-10-2014).
- [18] *Railway transport - Goods transported, by type of transport*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 08-10-2014).
- [19] *Railway transport - Length of lines, by maximum speed*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 16-06-2014).
- [20] *Railway transport - Length of tracks*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 16-06-2014).
- [21] *Railway transport - Total annual passenger transport*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 16-10-2014).
- [22] Rucińska D., *Potrzeby transportowe*, [in:] „Transport” edited by W. Rydzkowski, K. Wojewódzka-Król, Wydawnictwo Naukowe PWN, Warsaw 2010, p. 30.
- [23] *Total length of railway lines*, Eurostat; online access: <http://epp.eurostat.ec.europa.eu> (last update: 24-10-2014).
- [24] Uherek E., Halenka T., Borken-Kleefeld J., et al.: *Transport Impacts on Atmosphere and Climate: Land Transport*; Atmospheric Environment 44 (2010), p. 4777.
- [25] *Zrozumieć politykę Unii Europejskiej – Transport*, Komisja Europejska, Dyrekcja Generalna ds. Komunikacji Społecznej, Luksemburg 2014, p. 5.