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## Railway Communication as a Measure of Spatial Relations of Polish Cities in 2023

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**Abstract:**

**Purpose:** The aim of the article is to analyse the spatial connections of the railway network, including volume and frequency of connections, from two perspectives: an intra-regional aspect, considering voivodeships as regions and examining links between the urban centres within a given voivodeship and its capital; and an inter-regional aspect, focusing on the links between provincial cities.

**Design/Methodology/Approach:** The study employed simple statistical analysis and cartographic methods to present its findings. These methods enabled the determination of the interconnectedness of rail transport among the surveyed settlement units. Indicators were used that illustrate the accessibility and quality of the railway network in the study area, such as the density of the railway network, the degree of its electrification or the frequency of direct connections between towns.

**Findings:** The results clearly demonstrate the spatial differentiation of rail accessibility at both the intra-regional and inter-regional levels. The importance of intra-regional connections is considerably lower, which is evident in the eastern part of the country. Direct connections between voivodeship cities do not exhibit such stark disparities, with Gorzów Wielkopolski as an exception, and are relatively well-developed, highlighting the significance of railways in interregional transport.

**Practical Implications:** The development of the railway network is an important factor in determining the attractiveness of regions for settlement. The spatial distribution and functionality of the network affect not only regional connectivity but also connections with the broader environment. The transport network is designated to meet the transport needs of the population and goods in a particular area, but it also stimulates the area. Thus, it can be inferred that communication is an essential link between socio-economic processes.

**Originality/Value:** The originality of this research lies in the use of practical indicators to identify rail accessibility in terms of both quantity and frequency, which are of particular importance for potential passengers. The analysis provides a foundation for planning future developments in rail connections at both regional and national levels.

**Keywords:** Rail transport, rail accessibility, capitals of administrative regions, Poland.

**JEL codes:** L92, O1, Y10.

**Paper type:** Research article.

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## **1. Introduction**

One of the principal factors influencing the socio-economic development of spatial units is communication in its broadest sense. The degree of its development and the quality of its functioning are pivotal for both intra-regional and inter-regional connections.

Since the end of the Second World War until the political transformation in 1989, rail transport in Poland was predominantly developed for the raw materials and heavy industry sectors, which meant that at present it does not fully meet the current needs of the economy, but above all of the society (poor condition of the railway infrastructure and means of transport, poor level of interconnection of individual branches of transport, etc.).

Following a significant decline of the railways in the 1990s and early 2000s, a noticeable revival in rail transport, particularly in passenger services, has been observed recently.

The subject of the study is the regular railway network connections within Poland in 2023 (as of October 31, 2023). Due to the fact that the railway network is of particular importance for Poland's urban centres, the study omits rural localities. The aim of the study is to analyse the spatial connections of the railway network in two aspects:

- intra-regional, where voivodeships were assumed as regions and links between the urban centres of a given voivodeship and its capital were presented,
- interregional, where links between voivodship cities are presented.

## **2. Literature Review**

The presented research is part of the current Polish scientific literature related to the transformation of the transport network and its impact on the socio-economic development of Poland's regions. Although the literature on transport accessibility is very rich, it is largely presented in terms of economic development or the quality of life of the inhabitants of specific regions or settlement units (Warakomska, 1992; Koźlak, 2012; Komornicki *et al.*, 2013).

Issues related to the development of the transport network in the context of its accessibility are presented in studies by, among others, Sobczyk (1985), Taylor (2007), Komornicki *et al.* (2010), or Komornicki (2019). Most of the work in this

area is geared towards examining accessibility from a regional perspective, e.g., Kozanecka (1996), Rydzewski (1999), Kwarciński *et al.* (2019), Parol (2021). There are far fewer studies examining various aspects of transport accessibility by provincial cities, e.g., Ratajczak (1992), Rydzewski (2002), Bocheński, Rydzewski (2020), Garbacz *et al.* (2020), Kadlubek *et al.* (2022).

### 3. Research Methodology

The study employed simple statistical analysis to present the findings. These methods made it possible to determine mutual transport links between the studied settlement units in terms of railway accessibility, both in the intra-regional aspect (links between cities within voivodships and the voivodship capital) and the interregional aspect (connections between voivodship cities).

For this purpose, indicators proposed by Bocheński (2020), and Bocheński and Rydzewski (2020), as well as those illustrating the accessibility and quality of the railway network in the study area, such as the density of the railway network, the degree of electrification, and the frequency of direct connections between cities (connection matrix), were used.

Materials from various sources were utilised in the study: statistical data from the Central Statistical Office (CSO), train timetables, and cartographic materials.

### 4. Research Results

#### 4.1 Intra-Regional Rail Network Connections

The distribution of urban centres across Poland is distinctly uneven, with considerable disparities between south-western areas and the north-eastern and eastern regions. The density indicator of cities per 1000 km<sup>2</sup> in the Śląskie voivodeship is 5.9 and in the Dolnośląskie voivodeship, it is 4.7, while the Lubelskie and Podlaskie voivodeships represent the other extreme with 2.0.

Of the total number of urban centres in 2023 (979 cities), as many as 419 cities (42.8%) lacked access to railway connections, and this figure is increasing (in 2000, the proportion was 33.3%). The Pomorskie (79.6%), Śląskie (68.5%), and Dolnośląskie (67.7%) voivodeships have a high percentage of cities with railway network access, while the Warmińsko-Mazurskie (40.0%), Kujawsko-Pomorskie (41.5%), and Świętokrzyskie (41.7%) voivodeships have the lowest (Table 1).

This spatial arrangement results from several factors. The most important of these can be considered the differing economic levels that influence the development of this form of transport and the historical past of the area, as mentioned earlier. An important factor in the declining accessibility of the rail network, particularly

evident after 1985, is the closure of little-used and therefore economically unviable routes.

**Table 1.** Accessibility of cities to the railway network by voivodeship in 2023

Voivodeship	Number of cities	Number of cities with a railway network	Percentage of cities with a railway network
Dolnośląskie	93	63	67.7
Kujawsko-pomorskie	53	22	41.5
Lubelskie	51	26	51.0
Lubuskie	43	25	58.1
Łódzkie	52	29	55.8
Małopolskie	64	41	64.1
Mazowieckie	99	54	54.5
Opolskie	36	24	66.7
Podkarpackie	52	30	57.7
Podlaskie	40	19	47.5
Pomorskie	42	33	78.6
Śląskie	73	50	68.5
Świętokrzyskie	48	20	41.7
Warmińsko-mazurskie	50	20	40.0
Wielkopolskie	117	68	58.1
Zachodniopomorskie	66	36	54.5

*Source:* Own elaboration based on: <https://rozklad-pkp.pl> (retrived October 31, 2023).

Being directly located on a railway route does not equate to good rail accessibility for an urban centre. The railway system in Poland, during its heyday at the turn of the 19th and 20th centuries, was developed within three separate political entities (the Prussian, Austrian, and Russian partitions). After 1918, when Poland regained its independence, the three independent railway systems had to be integrated. This process was not successfully completed everywhere.

The post-war administrative changes also did not support the optimal development of the railway network (as a result of the last administrative change, the number of voivodeships decreased from 49 to 16). Many railway lines are local, making access to provincial cities much more difficult and usually requiring one or more changes.

Thus, the most important aspect for the cities in the individual voivodeships is the possibility of fast and at the same time direct access by the rail network to the provincial centres. Of the 560 cities that had access to the railway network in 2023, only 440 towns (78.6%) had at least one direct connection to the capital of the voivodeship in which they are situated (Table 2).

The highest percentage of such cities is in the Warmińsko-Mazurskie (95.0%), Zachodniopomorskie (91.7%) and Podlaskie (89.5%) voivodeships. The voivodeships, characterised by a relatively underdeveloped railway network, with a low percentage of cities with railway access, have most of their urban centres

located along routes oriented towards the region's largest city - the voivodship's capital. On the other hand, the lowest percentage of towns with a direct railway connection to the voivodship centre, among all the towns which can be reached by rail, is in the Opolskie voivodship, where only half of the towns meet the above criterion.

**Table 2.** Direct city connections by rail network to the provincial capital in 2023

Vojvodeship	Number of cities with a direct railway connection to the voivodeship capital	Share of cities with a direct railway connection to the voivodeship capital	
		Number of cities = 100	Number of cities with a railway network = 100
Dolnośląskie	52	55.9	82.5
Kujawsko-pomorskie	17	32.1	77.3
Lubelskie	19	37.3	73.1
Lubuskie	20	46.5	80.0
Łódzkie	21	40.4	72.4
Małopolskie	35	54.7	85.4
Mazowieckie	43	43.4	79.6
Opolskie	12	33.3	50.0
Podkarpackie	23	44.2	76.7
Podlaskie	17	42.5	89.5
Pomorskie	24	57.1	72.7
Śląskie	39	53.4	78.0
Świętokrzyskie	13	27.1	65.0
Warmińsko-mazurskie	19	38.0	95.0
Wielkopolskie	53	45.3	77.9
Zachodniopomorskie	33	50.0	91.7

*Source:* Own elaboration based on: <https://rozklad-pkp.pl> (retrived October 31, 2023).

The situation differs when considering all cities in the analysed areas. In such a comparison, the highest accessibility percentages of cities with voivodeship centres, exceeding 50.0%, are found in the following voivodeships: Pomorskie (57.1%), Dolnośląskie (55.9%), Małopolskie (54.7%) and Śląskie (53.4%). In contrast, the aforementioned Opolskie voivodeship (33.3%), alongside Kujawsko-Pomorskie (32.1%) and Świętokrzyskie (27.1%), ranks at the bottom.

The fact that the Opolskie voivodeship ranks so low, despite a fairly high network density ratio per unit area (8.3 km/100km<sup>2</sup>), may seem puzzling. This is mainly due to Opole's location on the main Oder River railway line, between Wrocław and the cities of the Upper Silesian Industrial Area, along which few towns in the described region are located.

The majority of towns in the Opole region, mainly situated in the southern part of the voivodeship, do not have a direct railway connection with Opole but do have such connections with other nearby voivodeship towns, including Wrocław and Katowice. It is worth noting that the mere absence of a rail connection to the capital

of individual voivodeships does not automatically equate to poor transport accessibility. In many cases, cities within particular voivodeships have connections to other voivodeship centres and to other voivodeship centres, as well as to other cities in the region that serve as major railway junctions, such as Koszalin in the Zachodniopomorskie voivodeship, Częstochowa, Gliwice, Chorzów in Śląskie or Radom in Mazowieckie.

## 4.2 Interregional Rail Network Connections

The issue of interregional railway connections was examined through the system of 18 cities with the status of voivodeship centres, using a matrix of connections (Kozanecka 1996; Warakomska 1992; Rydzewski 2002) (Table 3). To determine the level of connections, individual settlement units were categorised in ranges, depending on the number of voivodeship cities with which they have direct railway connections (Table 4).

**Table 3.** Matrix of direct railway connections between Polish voivodeship cities in 2023

Cities	Białystok	Bydgoszcz	Gdańsk	Gorzów Wlkp.	Katowice	Kielce	Kraków	Lublin	Łódź	Olsztyn	Opole	Poznań	Rzeszów	Szczecin	Toruń	Warszawa	Wrocław	Zielona Góra	Number of cities	Sum of calls
Białystok	-	-	2	-	1	-	1	-	3	2	1	1	-	2	-	10	3	-	10	26
Bydgoszcz	-	-	19	1	5	-	5	5	4	2	4	14	2	1	38	9	7	2	15	118
Gdańsk	2	19	-	1	11	1	15	-	6	8	3	11	2	6	4	23	6	2	16	120
Gorzów Wlkp.	-	1	1	-	-	-	-	2	-	-	-	5	-	-	1	3	-	6	7	19
Katowice	1	5	11	-	-	5	39	5	4	2	15	9	12	4	2	18	17	4	16	153
Kielce	-	-	1	-	5	-	13	5	-	4	3	-	-	1	-	8	3	1	10	44
Kraków	1	5	15	-	39	13	-	3	5	4	14	12	16	4	2	29	15	5	16	172
Lublin	-	5	-	2	5	5	3	-	4	-	4	3	7	3	4	13	6	3	14	67
Łódź	3	4	6	-	4	-	5	4	-	1	-	9	-	-	7	30	6	-	11	79
Olsztyn	2	2	8	-	2	4	4	-	1	-	-	4	-	5	8	10	2	1	13	53
Opole	1	4	3	-	15	3	14	4	-	-	-	8	9	3	-	6	49	7	13	126
Poznań	1	14	11	5	9	-	12	3	9	4	8	-	3	14	9	18	22	9	16	151
Rzeszów	-	2	2	-	12	-	16	7	-	-	9	3	-	3	1	4	10	4	12	75
Szczecin	2	1	6	-	4	1	4	3	-	5	3	14	3	-	1	7	4	7	15	65
Toruń	-	38	4	1	2	-	2	4	7	8	-	9	1	1	-	9	2	1	14	89
Warszawa	10	9	23	3	18	8	29	13	30	10	6	18	4	7	9	-	13	3	17	213
Wrocław	3	7	6	-	17	3	15	6	6	2	49	22	10	4	2	13	-	16	16	181

Zielona Góra	-	2	2	6	4	1	5	3	-	1	7	9	4	7	1	3	16		15	71
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*Source:* Own elaboration based on: <https://rozkład-pkp.pl> (retrived October 31, 2023).

**Table 4.** Railway links between Poland's voivodship cities in 2023

Direct connection level	Number of voivodship cities	Provincial cities
Optimum	17	Warszawa
High	14-16	Lublin, Toruń, Bydgoszcz, Szczecin, Zielona Góra, Gdańsk, Katowice, Kraków, Poznań, Wrocław
Average	11-13	Łódź, Rzeszów, Olsztyn, Opole
Low	<11	Gorzów Wielkopolski, Białystok, Kielce

*Source:* Own elaboration.

In 2023, only Warsaw showed an optimal level of connections to the other voivodship cities in Poland (direct rail connections to all voivodship centres). Warsaw's dominant position is unsurprising, given its role as the administrative capital and its convenient central location in the network of intersecting railway routes (8 outgoing lines), making it as one of the most crucial railway junctions in Poland.

The second tier of connectivity includes the cities of Katowice, Kraków, Wrocław, Poznań, and Gdańsk (16 direct connections), Bydgoszcz, Szczecin, and Zielona Góra (15), and Lublin and Toruń (14). For the first three cities, the absence of a direct connection is with Gorzów Wielkopolski, whereas Gdańsk has a direct link with Lublin, and Poznań with Kielce. It is often not the distance between cities that determines the absence of these connections, but rather the imperfections and poor cohesion within the railway network.

Cities like Poznań and Wrocław, despite being in the second tier, are considered major railway junctions in Poland (9 lines each starting from the city). The inclusion of Szczecin is notable, given its peripheral position in the northwest of the country, away from the main rail routes, does not favour the development of rail links. It should be noted, however, that Szczecin has only one or two direct connections per day with several cities (Bydgoszcz, Kielce, Toruń and Białystok). Certainly, a major advantage for Szczecin is the relatively nearby (about 200 km) city of Poznań.

The third tier features Olsztyn and Opole (13 links), Rzeszów (12), and Łódź (11). Opole and Rzeszów benefit from their location on one of the two principal parallel railway lines in Poland, connecting the state border with Germany (border crossing in Zgorzelec) and the state border with Ukraine (border crossing in Medyka)<sup>2</sup>.

<sup>2</sup>The second important latitudinal rail route is the E20 line belonging to the 2nd Pan-European Transport Corridor, which connects Berlin (Germany) with Moscow (Russia), via Poznań and Warsaw.

The E30 route is part of the 3rd Pan-European Transport Corridor, which links these three countries. Moreover, both transport hubs are situated near significant railway junctions – Rzeszów near Kraków and Opole between Wrocław and Katowice. You can be puzzled by the very low position of Łódź, one of the largest cities in the country and located in its centre, which balances on the border between an average and low level of direct connections with other regional centres.

The main reason for this is Łódź's location near Warsaw, which, following the modernisation of the railway line between the two cities, can now be reached in just over 70 minutes (distance 126 km, average speed including stops - approx. 106 km/h).

The final tier, with a low level of connections, includes Białystok and Kielce (10 connections) and Gorzów Wielkopolski (7). The peripheral location can only explain the low ranking of Białystok, which, however, similar to the previously mentioned Łódź, has good communication with the country's capital, which means that the connections of this city with others are not so disadvantageous. For Gorzów Wielkopolski and Kielce, the primary reason for their transport isolation is their location away from the main railway lines, even though Kielce, for instance, lies almost in the country's heart.

The frequency of direct connections between provincial cities within the country is an extremely important factor in transport relations. It is a vital criterion for assessing the convenience or difficulty rail communication presents in serving the various needs of the population (Kozanecka 1996) (Table 5).

**Table 5.** *Frequency of direct train connections between Polish voivodship cities in 2023*

Call frequency	Number of train connections per day	Provincial cities
Very high	>160	Warszawa, Wrocław, Kraków
High	111-160	Bydgoszcz, Gdańsk, Opole, Poznań, Katowice
Average	60-110	Szczecin, Lublin, Zielona Góra, Rzeszów, Łódź, Toruń
Low	<60	Gorzów Wielkopolski, Białystok, Kielce, Olsztyn

*Source:* Own elaboration.

The highest frequency of direct connections per day is seen in the capital of the Mazowieckie voivodeship and Poland - Warsaw, with a notable lead (213 connections). As a city of significance beyond its province, this status is to be expected. Numerous connections depart from Warsaw to most cities (Łódź - 30 connections, Kraków - 29, Gdańsk – 23, Poznań and Katowice – 18 each), whereas for the Lubuskie voivodeship cities - Gorzów Wielkopolski and Zielona Góra - there are merely 3 connections daily.



The other two cities - Wrocław and Kraków - offer a considerably lesser frequency of direct connections than Warsaw (181 and 172, respectively). Both are situated in the southern part of Poland. The greatest number of connections from both cities is directed to the nearest neighbouring city; for Kraków, this is Katowice (39), and for Wrocław, it is Opole (49), which constitutes a record achievement on a national scale. As can be seen from the above comparison, the number of connections is, on the one hand, a result of the close proximity of the cities to each other, and on the other, of their mutual location along important railway routes.

The second category, defined as having a high frequency, includes Bydgoszcz, Gdańsk, Opole, Poznań, and Katowice, with daily connections ranging from 118 (Bydgoszcz) to 153 (Katowice). These urban centres are significant industrial and administrative hubs, advantageously situated at the crossroads of the country's main railway lines. In this group, Opole is distinguished from its counterparts by its socio-economic potential, owed primarily to its positioning between two railway nodes – Wrocław and Katowice. Opole boasts 64 daily connections to these two urban centres, constituting over half of its total connections with provincial cities.

The third, relatively largest group comprises cities with a medium frequency of connections (6 cities). The highest frequencies within this group are found in Toruń (89 connections) and Łódź (79), with the lowest in Szczecin (65 connections). Apart from Toruń and Łódź, the rest are situated peripherally in Poland. Despite having the fewest connections in this category, Szczecin is distinguished by the greatest number of direct rail links with other voivodeship centres (15 cities).

The final group, with a low frequency of direct connections, includes cities clearly located in the country's peripheral areas (Gorzów Wielkopolski, Białystok, Olsztyn) or those distanced from the primary railway lines (Kielce). In this comparison, Gorzów Wielkopolski is particularly prominent, with 11 out of its 19 connections heading to Poznań and Zielona Góra.

## 5. Discussion

The analysis has demonstrated that in 2023, interregional connections, especially between the larger voivodeship cities, have taken precedence in the context of the railway network. The importance of intra-regional connections is considerably lower, which is compensated for by bus connections. This is particularly evident in the eastern part of Poland, where buses have taken over most intercity travel due to their flexibility and accessibility.

This state of affairs has been heavily influenced by the closure and subsequent dismantling at the turn of the 20th and 21st centuries of numerous unprofitable railway lines of local importance. Despite several issues, rail transport in Poland remains significant. Although the situation of intra-regional connections has not

shown significant progress, yielding to bus transport, the importance of long-distance connections between major cities continues to rise.

## **6. Conclusions**

The voivodeships with the highest proportion of cities with direct access to the railway network in 2023 were the Pomorskie, Śląskie and Dolnośląskie voivodeships, and those with the lowest – the Warmińsko-Mazurskie, Kujawsko-Pomorskie and Świętokrzyskie voivodeships.

On the other hand, if we consider cities with a direct rail connection to the capital city of a given voivodeship, the following voivodeships are in the lead: Pomorskie, Śląskie and Dolnośląskie, as well as Małopolskie, and at the opposite end: Kujawsko-pomorskie, Świętokrzyskie and Opolskie.

Direct connections between voivodeship cities have become more equitable (with the exception of Gorzów Wielkopolski) and are relatively well-developed, affirming the role of railways in interregional transport. Of all the voivodeship cities, only the capital, Warsaw, is characterised by an optimal level of connections.

## **References:**

- Bocheński, T. 2020. Voivodship centres in Poland as transport hubs. In: Bocheński, T. (ed.), *Provincial centres in Poland - an alternative view. Part I, Urban Surveys*, vol. 1, Scientific Publishing House of the University of Szczecin, Szczecin, pp. 38-63.
- Bocheński, T., Rydzewski, T. 2020. Capital cities of former 49 voivodeships in Poland – selected city development issues. *City Analyses*, vol. 3. Scientific Publishing House of the University of Szczecin.
- Kadłubek, M., Thalassinou, I.E., Noja, G.G., Cristea, M. 2022. Logistics customer service and sustainability-focused freight transport practices of enterprises: Joint influence of organizational competencies and competitiveness. *J. Green Econ. Low-Carbon Dev.*, vol. 1, no. 1, 2-15. <https://doi.org/10.56578/jgelcd010102>.
- Komornicki, T., Śleszyński, P., Rosik, P., Pomianowski, W. 2010. Spatial accessibility as a premise for shaping the Polish transport policy. *PAN KPZK, Bulletin*, 241, Warsaw.
- Komornicki, T., Korcelli, P., Siłka, P., Śleszyński, P., Świątek, D. 2013. Functional links between Polish metropolises. *IGiPZ PAN*, Warsaw, pp. 45-59.
- Komornicki, T. 2019. Transport infrastructure and accessibility. In: Gorzelak, G. (ed.), *Social and economic development in Central and Eastern Europe: Stability and change after 1990*. Routledge, London.
- Koźlak, A. 2012. *Modern transport system as a factor of regional development in Poland*. University of Gdansk Publishing House, Gdańsk.
- Kwarciański, T., Załoga, E. 2019. *Passenger regional transport*. PWN Scientific Publishers, Warsaw.
- Kozanecka, M. 1996. Bus communication as a measure of spatial linkages of the przemyskie voivodeship. In: Lijewski, T., Kitowski, J. (ed.), *Proceedings of the Commission for the Geography of Communication PTG*, vol. 1, Warsaw - Rzeszów.
- Local Data Bank of the Central Statistical Office 2022.

- Parol, A.R. 2021. Transport accessibility of selected urban centres of Central Pomerania taking into account the phenomenon of traffic exclusion. *Proceedings of the Commission for the Geography of Communication PTG*, 24(3), pp. 19-35.
- Railway timetable. Retrieved from: <https://rozkład-pkp.pl>.
- Ratajczak, W. 1992. Communication accessibility of voivodship cities of Poland in the years 1948-1988. *Contemporary problems of social and economic geography of Poland. Geografia SS series*. UAM Scientific Publishers, Poznań.
- Rydzewski, T. 1999. Rail accessibility of cities in Szczecin Voivodship in 1994. *Marine Sciences*, No. 5, Szczecin, 207-235.
- Rydzewski, T. 2002. Communication as a measure of spatial connectivity on the example of the Polish railway network. In: Wendt, J. (ed.), *Selected issues in transport geography*, Szczecin, pp. 34-42.
- Sobczyk, W. 1985. *Communication accessibility in urban settlement systems*. KBRU PAN, Warsaw.
- Taylor, Z. 2007. *Development and regression of the railway network in Poland*. Monographs, 7, IGiPZ PAN, Warsaw.
- Warakomska, K. 1992. The issue of accessibility in transport geography. *Geographical Review*, vol. LXIV, 1-2.