# THE IMPACT OF TRANSPORT SUPPLY
# ON PASSENGER VOLUME CHARACTERISING
# REGIONAL RAIL TRANSPORT IN LOWER SILESIA

**Wojciech Jurkowski** iD **, Mateusz Smolarski** iD
Department of Spatial Management, Institute of Geography and Regional Development
University of Wrocław
Kuźnicza 49-55, 50-138 Wrocław: Poland
wojciech.jurkowski@uwr.edu.pl • mateusz.smolarski2@uwr.edu.pl

**Abstract.** Factors affecting passenger behaviour can be divided into the internal (relating to transport supply) and the external (which are independent of carriers). The literature emphasises that, as rail transport develops, supply becomes comparable along many routes, leaving external factors to be regarded as increasingly important. In contrast, the authors of this article consider that deregulation and transformation of the rail transport system in Poland have ensured that internal factors continue to exert the primary influence on passenger behaviour in this country. The work detailed in this article has thus sought to demonstrate the impact of transport supply on passenger volume at individual stations in those towns and cities of the region of Lower Silesia that have access to rail passenger transport throughout the year.

**Key words**: transport supply, travel behaviour, passenger volume, rail transport.

## Introduction

The rapid development of the automotive industry in Poland and increasing public mobility are giving rise to many problems primarily related to inefficient transport systems (Komornicki 2011). It is therefore extremely important to increase the role and importance of public transport – and rail transport in particular – as this may be considered the backbone of the transport system (Sheller & Urry 2006; Banister 2008). The region of Lower Silesia (NUTS 2 – Dolnośląskie voivodeship) has favourable conditions for the development of this mode of transport due to the continued presence of a very dense network of rail lines. However, the full potential of this has not been used, because the aforesaid "backbone" role for rail transport often looks more theoretical than real. This is largely due to neglected infrastructure and the resulting low-quality supply of transport, which discourages passengers from using rail services. This circumstance leaves analysis of the correlation between transport supply and passenger volume as one of the key issues that to be addressed by those researching rail transport. Thus, in the case of Lower Silesia also, a determining of the nature and direction to any dependent relationships between the aspects in question may prove to be of help in shaping regional policy more appropriately, as indeed may the indication of any spatial regularities to be found.

The purpose of the work detailed in this article has been to answer a question as to how rail-transport supply influences passenger volume in towns and cities in the Lower Silesian region. This is particularly important in the context of Polish transport policy, which has undergone a significant transformation in recent years (Taylor 1998, 2004). The work envisaged has allowed for identification of factors relating to transport supply that generate rail-passenger volume in particular towns and cities.

As noted above, the Lower Silesian region is an area with a high degree of saturation with railway infrastructure (Lijewski 1985; Rosik 2009). The area in question was connected with both the initial, intensive development of the railway network (Lijewski 1985; Jerczyński & Koziarski 1992; Taylor 2007) and the later period of suspension of passenger traffic (Taylor 2007; Potocki 2014; Smolarski & Raczyk 2017). But, following years of transformation, further reactivation of passenger transport is now planned (e.g. in the cases of the Wrocław-Sobótk and Lubin-Wrocław lines). A factor here has been the leading role played by a carrier run by the regional authorities here (*Koleje Dolnośląskie*). The result of its activity has been a steady increase in the level of transport performance, as well as the servicing of more and more routes.

## Research assumptions

The study was conducted within the Lower Silesian region, by reference to local analysis. The units of observation were towns and cities with access to passenger rail transport over a full year (Fig. 1). From among the 91 towns and cities recognised in this area, 51 were found to meet the above criterion, and selected. However, several key premises spoke for the exclusion from the analysis of Wrocław, as the capital city of the region. Firstly, passenger volume in Wrocław is largely generated by the *PKP Intercity* long-distance trains not included in the study on account of the lack of data on passenger volume. Secondly, Wrocław is a city whose population and economic potential are at a level several times higher than those characterising the area's other urban centres. A role as capital city of the region and most important railway junction is also played, with the result of all these factors being an incomparably greater passenger volume generated, albeit not merely as a consequence of the city's endogenous potential. This article therefore focuses on the remaining urban centres in the region.

The scope of this paper embraces characteristics of the demand for and supply of railway transport, as well as disparities typical for these between working days and weekend days, plus analysis of the association between the two elements. Various methods have been used to address this research issue, such as: statistical and cartographic techniques and analysis of linear correlations using Pearson's correlation coefficient.

The demand for rail passenger transport was assessed by reference to passenger volumes in towns and cities, as broken down into working and non-working days. This made possible the estimation of numbers of passengers in a given town or city making use of rail transport (Kepaptsoglou et al. 2017). The index includes passenger embarkations and disembarkations at given stations[1]. In other words, the value of the index is the sum of passengers embarking at the station in a given town or city (Table 1). The data concerning working days were divided by 5, and the data for weekend days by 2. The data on passenger flows and train timetables in the period from 3-9 April 2017 were used (fast and express train connections were excluded from the study due to the lack of data). The data were collected by regional passenger rail operators *Koleje Dolnośląsk-*

---

[1] There are also other approaches to passenger flows, e.g. the study of passenger flows between specific locations ('Station-to-station ridership'; Kepaptsoglou et al. 2017).
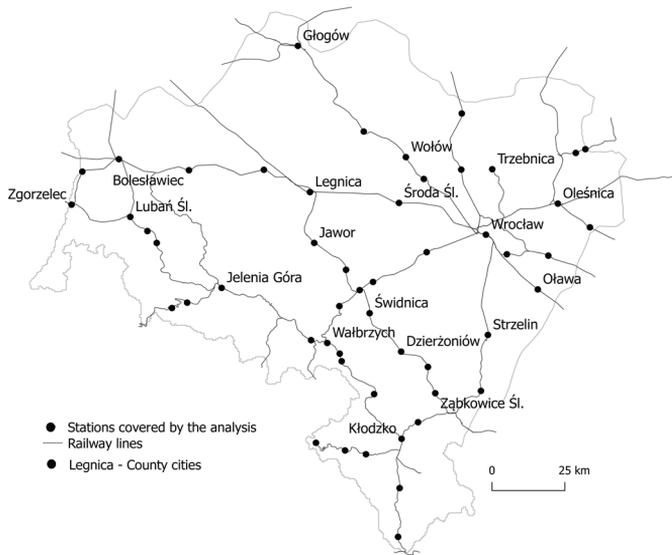
**Figure 1.** The area under analysis
Source: author's own elaborationn

*ie* and *Przewozy Regionalne*, and obtained from the Office of the Marshal of Lower Silesia, i.e. an institution of the regional administration that owns the companies in question. Rail passenger flows used in the study can be considered a derivative of 'mobility' – understood as 'the actual (…) movement of individuals in space' (Taylor 1999: 10).

The transport supply was assessed on the basis of numbers of pairs of trains departing from the main station in a given city (Lijewski & Sujko 1993: 7)[2]. According to the authors, this is the most important internal factor providing for the most reliable assessment of supply determinants where rail transport in a given town or city is concerned. A station in a given urban centre was identified as that locality's main station if its name contained the word 'main'/'central' (Polish: *główny/główna/główne*), e.g. Wałbrzych Główny, Kłodzko Główne; or if the name of the station was identical to the name of the town or city, e.g. Legnica, Jelenia Góra[3]. In every city or town, most pairs of trains departed from the main stations, and all trains stopped at the main stations. Consideration of every pair of trains departing from other stations in the same town or city would therefore serve only to duplicate data. As the passenger volume data were confined to passengers carried by the companies *Przewozy Regionalne* and *Koleje Dolnośląskie*, the study was limited to pairs of train connections provided by these rail carriers. Every possible disparity between numbers of train arrivals and of departures, e.g. when a train terminated at a given station, was considered as one-half of a pair of train connections. Hence the values are not always integers. For example, if 10 trains left from and 11 arrived at a given station, the number of pairs of train connections was 10.5.

The disparity index showing differences between the weekend and working-day supply of transport and passenger volume was calculated as the quotient of the number of pairs of trains running

---

[2] When examining the concentration of bus transport, Lijewski & Sujko (1993) emphasised that 'the number of bus departures (…) defines the intensity of traffic, and the importance of the city (p. 25).
[3] The choice of the largest station in a city as the destination and source of travel in rail transport has also been proposed by Rosik & Kowalczyk (2015).

and the number of passengers travelling on non-working days and working days [this is a derivative of the disparity index used by Małek (1977)] (Table 1). Values above 1 denoted more pairs of trains on a working day and values below 1 more pairs of trains on a non-working day. A stable transport supply may be a response to everyday mobility, identified by Nutley (2003), and occurring on non-working and working days. Authors also emphasise that the frequency of trains through a week is an extremely important factor where the attractiveness of transport supply is concerned (Lierop et al. 2017). Potrykowski & Taylor (1982: 32-36) have defined three types of fluctuation in passenger flows in the context of the disparity index: i.e. daily, weekly and seasonal.

It is worth noting that the data on passenger flows used in this analysis are very difficult to access and have been used in very few analyses. Usually, these data are inaccessible to the public, making it necessary for the relevant provider of passenger transport to be contacted. Another problem is that data collected by Marshal's Offices are often illegible, making it difficult for empirical analyses on their based to be carried out. The part of the study concerning the supply and organisation of public transport (analysis of timetables, etc.) would undoubtedly be even more accurate if additionally based on passenger flows. Rosik et al. (2017) stress the issue of the inability to use data on actual passenger transport demand[4] in scientific research. Moreover, Wiśniewski (2015: 27) found examination of the volume and structure of transport (collective transport) to be impossible, on account of the lack of data.

**Table 1**. Indicators used in the research

| | |
|---|---|
| Passenger volume (working day) | $\dfrac{\text{sum of passenger getting on the train at station (working day)}}{5 \text{ days}}$ |
| Passenger volume (weekend) | $\dfrac{\text{sum of passenger getting on the train at station (weekend)}}{2 \text{ days}}$ |
| Passenger volume disparity index | $\dfrac{\text{weekend day passenger volume}}{\text{working day passenger volume}}$ |
| Transport supply disparity index | $\dfrac{\text{number of weekend day train connections}}{\text{number of working day train connections}}$ |

Source: author's own elaboration

# Literature review

Reference literature divides factors affecting the demand for passenger transport into internal and external groups (Pan et al. 2017). The internal factors include the number of rail connections, the frequency of trains, travel time and punctuality. The external factors are in turn connected with the surrounding environment, for example concerning numbers of inhabitants; numbers of people in work; unemployment rate; land use in the context of Transit Oriented Development (Cervero 2006); as well as Park & Ride and Bike & Ride systems. It is considered that, as rail transport develops, the offer on most routes becomes comparable, implying an increasing role for external factors in studies related to demand for passenger transport (Yim et al. 2005; Sung et al. 2014; Chakour & Eluru 2016). Nevertheless, transport supply does seem to be a decisive ele-

---

[4] Other sources that can be used to examine actual passenger flows can include card logins for ticket gates (Pan et al. 2017) and smartphone logins (Gadziński 2018).

ment affecting passenger volume in Poland, on account of major spatial disparities when it comes to the development of rail transport and the condition of railway infrastructure.

Transport connections are also among the elements determining the rank of the largest urban centres. In his analysis of the typology of cities, Śleszyński (2017) concludes that the rank of a city declines with any deterioration of its accessibility to transport. This is particularly found to be the case in peripheral areas. Moreover, Śleszyński used this basis to describe urban centres in the Sudety region as 'stagnant' (Śleszyński 2017: 582-583). Kuć-Czajkowska (2007: 57) states that 'a metropolis ought to be connected through a system of motorways, fast railways, (…) frequent and direct transport connections'. Similarly, in studies of small towns in the area of Czech Moravia, Vaishar (2003, 2005) emphasises the phenomenon of impeded access to the smallest, peripheral urban centres, and further states that 'public transport played the primary role in the traffic connection' (Vaishar 2005: 56). Kistowski (2005) examined the correlation between geographical location and regional development, including the accessibility of a city centre and the costs of transport and the maintenance of infrastructure among the criteria affecting this correlation.

Assuming that transport accessibility is connected with socio-economic development, it is undoubtedly influenced by the infrastructure of a given region[5] (Kowalczyk & Rosik 2015). Indeed, the impact of road investments on socio-geographical development and changes in transport accessibility has been addressed in recent research (Komornicki et al. 2015). Transport accessibility can be perceived quantitatively (e.g. in the form of spatial or demographic density) and qualitatively (e.g. the share of roads and the rail network achieving specific technical parameters) (Rosik 2009: 509). Koziarski (2017) carried out an analysis of current changes in the Polish rail network. In turn, in their analysis of the southern part of Europe, Bogataj & Bogataj (2007) note that improving the quality of road infrastructure may lead to increased mobility and employment. They also point out that transport connections should provide access, not only to the central city, but also to smaller urban centres. Michniak (2007) examined connections between Slovakian cities and noted that the rank of regional centres depended on the quality of transport infrastructure (Michniak 2007: 99). When referring to the issue of the rail network, Michniak (2010) points to it being the backbone of the transport system in the region[6]. Investments[7] may constitute a 'factor increasing access to opportunities' (Domański 1980: 8). The manifestations of increasing mobility and accessibility are increased passenger flows and numbers of people using rail transport in urban centres. The revitalisation of railway lines may give rise to better transport connections between metropolises. Jurkowski & Smolarski (2017) note that the transport supply was improved following the revitalisation of the so-called '*proteza koniecpolska*' (a planned rail link in southern Poland), and consider this a stimulus to the development of public transport. Improving the quality of transport infrastructure may also increase the accessibility of the capital cities of provinces, such as Poznań (Bul 2016).

The study of dynamics to the changes in the sector of public transport is particularly important, given the transformation of the relevant market in Poland, a country in which particularly important changes took place to affect both rail transport[8] (Taylor 2007; Taylor & Ciechański 2010, 2011)

---

[5] The relationship between transport infrastructure and economic development has become more complex than ever' (Wegener et al. 2005: 27).

[6] The existing rail network is also important for the accessibility of the territory in question and consequently its development' (Michniak 2010: 164).

[7] Domański (1980: 24) points out that 'defining the proportion between investments aimed at creating new opportunities (…) and investments aimed at improving transport is therefore a very important problem of land development policy'.

[8] Komornicki (2008: 62) stresses the role of trade unions and writes about 'depreciation of railway transport, which transformation went under dictate of a trade union'.

and bus transport (Taylor & Ciechański 2009, 2013). Research on the development of rail and bus networks in the post-war period was carried out by Lijewski et al. (1967). The Polish transport sector underwent major changes in the 1990s, in the period of socio-economic transformation (Lijewski 1997). One of the more significant problems that affected rail passenger transport was the process of suspending passenger volume, which excluded many cities from rail-transport supply (Koziarski 1993; Taylor 2006, 2007, 2008; Bocheński 2016).

## General characteristic of transport supply and passenger volume

On average, 13 pairs of trains per working day (Fig. 2) and 11 pairs per weekend day (Fig. 3), departed from each town and city surveyed. The highest value for working days was recorded in Jaworzyna Śląska (30.5 pairs per day), the lowest value, i.e. five pairs per day, was in turn noted in seven of the towns and cities (13.5%). The most urban centres (9 out of 51) were served by seven pairs of trains per working or weekend day, indicating a low-quality offer. Furthermore, in 35% of the surveyed urban centres, the transport supply proved to be below eight pairs of trains per day. According to Majewski (2006: 146), this may be considered an 'insufficient offer'. On a non-working day, the number of pairs of trains was generally proportionally smaller, reaching the highest value in Legnica (24.5 pairs of trains). There is a tendency to create a transport supply based on a large number of rail connections, particularly on the main sections of the rail network. Railway lines characterised by worse technical parameters (e.g. a lack of electrification on the Legnica-Kamieniec Ząbkowicki section, or low speeds on the Kłodzko-Kudowa-Zdrój section) have fewer pairs of train connections.
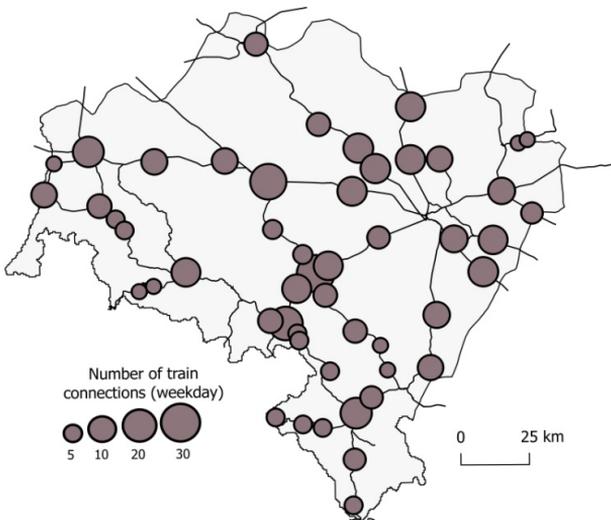


**Figure 2.** Numbers of train connections on working days
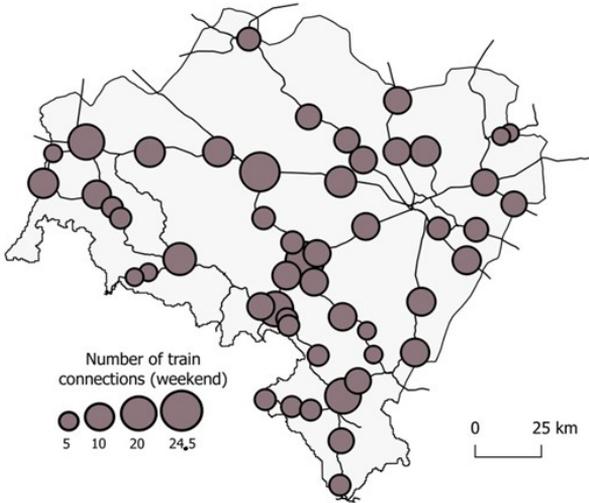Source: author's own elaboration

**Figure 3.** Numbers of train connections at weekends
Source: author's own elaboration

As for the passenger volume on working days (Fig. 4) and weekend days (Fig. 5), on average 643 people (working day) and 447 (day off) used rail transport on a daily basis in the studied towns and cities. The largest traffic generators on working days are located in the main hubs and around Wrocław. Moreover, passenger volume is tending to grow in the case of some lines, as is particularly noticeable on the Wrocław-Węgliniec route, on which the largest traffic generator of all the discussed towns and cities is located (Legnica). Other towns making a notable contribution to the generation of passenger flows are Bolesławiec and Węgliniec. Location proves to be a very important aspect as weekly passenger volumes on working and weekend days are differentiated.
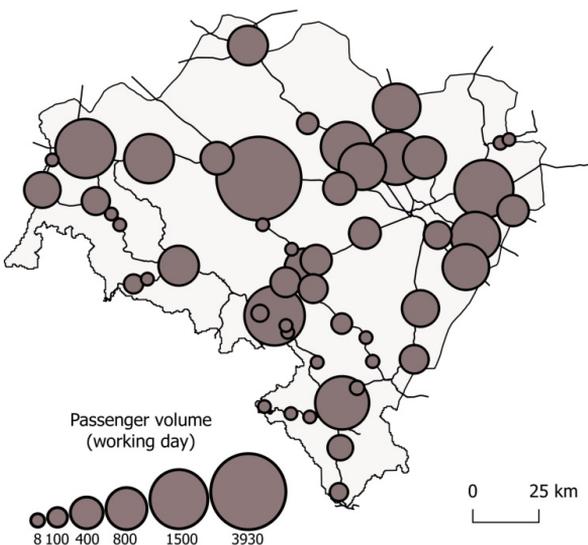


**Figure 4.** Passenger volume on working days
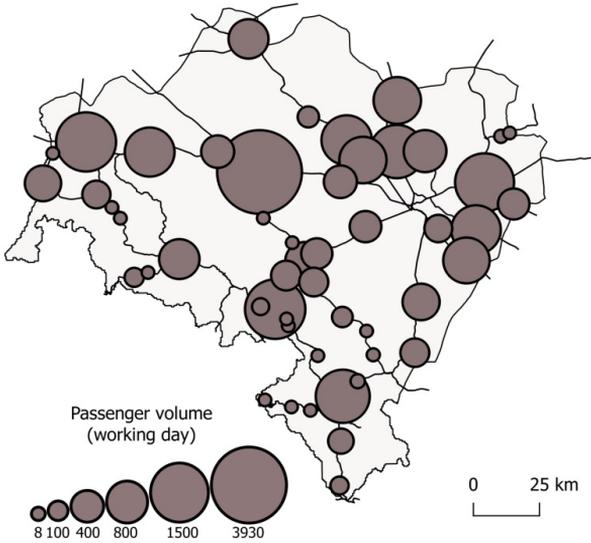Source: author's own elaboration

**Figure 4.** Passenger volume
on working days
Source: author's own elaboration

The drop in passenger volume on weekend days compared with working days is particularly notice-able on railway routes around Wrocław, given that passenger volume in the agglomeration is main-ly generated by daily commuters travelling to and from work and schools. In general, local lines do not show such significant differentiation, in extreme cases generating more traffic at weekends than on working days (e.g. Bardo and Jedlina Zdrój). The lowest working-day passenger volume amounting to 8 passengers was recorded at Jedlina Zdrój. The lowest number of weekend passen-gers in turn used the station at Międzybórz Sycowski (11 people a day).
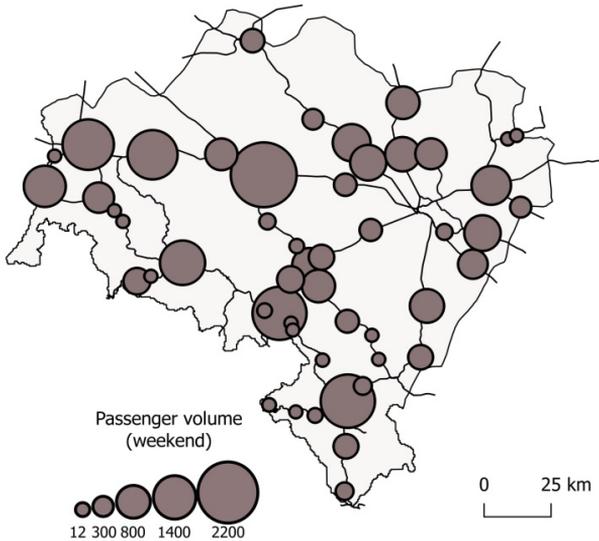


**Figure 5.** Passenger volume
at weekends
Source: author's own elaboration

## Transport supply and passenger volume disparities

There are different methods for assessing passenger potential and the transport supply. An index that describes the two elements in a qualitative manner may reflect the disparity between working- and weekend-day passenger volumes and the transport supply. The analysis of differences between weekend and working day train timetables showed that no town and city had more train connections on weekend days than on working days. Equally, the transport supply was the same throughout the whole week in 47% of the analysed towns and cities. Furthermore, no weekend offer was at a level below 50% of that available on a working day. The average value of the disparity index for all towns and cities was 0.88.

The spatial distribution of disparities between individual transport supplies proves very interesting (Fig. 6), with a stable transport supply characterising the entire western part of the province (located far from the capital Wrocław and delimited by the Legnica-Kamieniec Ząbkowicki line). In turn, western peripheral parts of the region do look to be at risk of transport exclusion. At most stations, the drop in the number of train connections at weekends compared with working days was relatively small. This may indicate that rail transport supports the public transport system in this area.

The situation is different in the eastern part of Lower Silesia, with the most major drop in numbers of pairs of trains at weekends as opposed to weekdays observable along six routes starting in Wrocław (i.e. the lines leading from there to Głogów, Żmigród, Oleśnica, Jelcz-Laskowice, Oława and Kąty Wrocławskie). These are agglomeration lines in which the supply of transport is adapted to the activity of residents, who basically travel to and from Wrocław on working days. However, it should be noted that the largest drop of all (a disparity index of 0.5) was recorded for the route to Jelcz-Laskowice, with the authors of the analysis in this case regarding such a major disparity as likely to affect the attractiveness of rail transport, which ought to be the backbone of the transport system in this region. This is to say that, in their considered view, the disparity between weekend and working-day offers should definitely be smaller than it is at present.
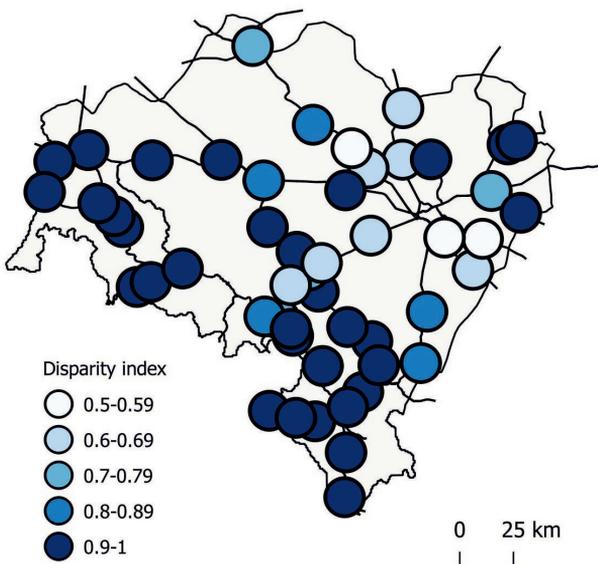


**Figure 6.** Disparities between transport supply
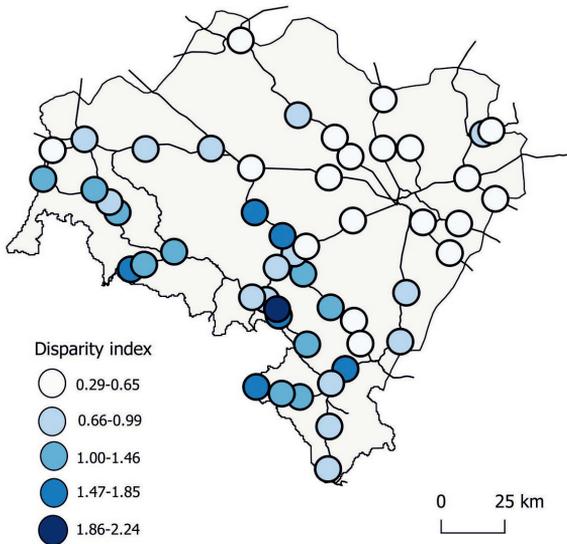Source: author's own elaboration

**Figure 7.** Disparities between passenger volume
Source: author's own elaboration

Analysis of differences between weekend and working-day passenger volumes (Fig. 7) showed significant quantitative and spatial diversity. The mean value for all analysed urban centres was 0.9, with the range being from the lowest value of 0.29 characterising Międzybórz Sycowski to the highest value of 2.24 noted in the case of Jedlina Zdrój. At 33% of the stations analysed, the weekend passenger volume was found to be higher than that on working days.

This proved mainly to be a feature of urban centres located in western parts of the region. Towns and cities showing the most marked disparities are located in highly attractive tourist areas, with increased traffic at weekends thus tending to reflect tourism[9]. Localities involved include Szklarska Poręba, Polanica Zdrój, Kudowa-Zdrój, Jedlina Zdrój and Głuszyca. Equally, the area around Wrocław stands out very strongly with respect to the discussed indicator, as here we find towns showing the lowest relative weekend passenger volumes as compared with those on working days. The Legnica-Kamieniec Ząbkowicki section can thus be considered a kind of border separating the province into two different parts.

## The relationship between transport supply and passenger volume

The study analysed the impact of the supply of transport on passenger volume in individual towns and cities. Moreover, the correlation between transport supply and weekend v. working-day disparities in passenger volumes was determined, against the background of those two elements. In other words, an answer was sought to a question regarding possible interactions between a drop in numbers of trains on weekend days as opposed to working days and passenger volumes associated with particular towns and cities.

---

[9] When analysing the role of transport in areas proving highly attractive to tourists, Dickinson and Robbins (2008) stated that journeys in such areas 'are not part of daily routine' (p. 1113).

The examined features were measurable and showed a linear correlation. The strength of that could then be assessed using the Pearson correlation coefficient. The values of features were first normalised, hence the use of the terms 'transport supply index' and 'passenger volume index'. There was found to be a strong connection between the transport supply index and passenger volume index in the towns and cities of the region of Lower Silesia province, on both working days and weekend days. The values of the Pearson linear correlation coefficient were 0.78 and 0.82 for working days and weekend days respectively, attesting to significance at $p < 0.01$ (Table 2).

**Table 2.** Pearson correlation coefficients

|  | Working day transport offer | Weekend transport offer | Disparity transport offer | Working day passenger volume | Weekend passenger volume | Disparity passenger volume |
|---|---|---|---|---|---|---|
| Working day transport offer | 1 | 0.894** | -0.619** | 0.781** | 0.748** | -0.434** |
| Weekend transport offer | 0.894** | 1 | -0.211 | 0.730** | 0.825** | -0.219 |
| Disparity transport offer | -0.619** | -0.211 | 1 | -0.438** | -0.203 | 0.591** |
| Working day passenger volume | 0.781** | 0.730** | -0.438** | 1 | 0.904** | -0.418** |
| Weekend passenger volume | 0.748** | 0.825** | 0.203 | 0.904** | 1 | -0.189 |
| Disparity passenger volume | -0.434** | -0.219 | 0.591** | -0.418** | -0.189 | 1 |

** – significance level of 0.01
Source: author's own elaboration

The fact that the value is greater for weekend days may imply a transport supply with fewer train connections at weekends affecting passenger behaviour to a greater extent. This is also confirmed by another correlation indicating that the greater the disparity between weekend and working-day train connections, the more disproportional the passenger volume. The graphic representation of the two-dimensional distribution points to the positive and linear nature of the correlation between the indices for transport supply and passenger volume, on both working days and weekend days (Fig. 8). Most towns and cities are grouped in the lower parts of the chart, indicating low values for both the transport supply and passenger volume. In both charts, the position of Legnica stands out, as it has the highest score in nearly every respect. Jaworzyna Śląska is an interesting case, given its recording of high scores for transport supply, but low scores for passenger volume,
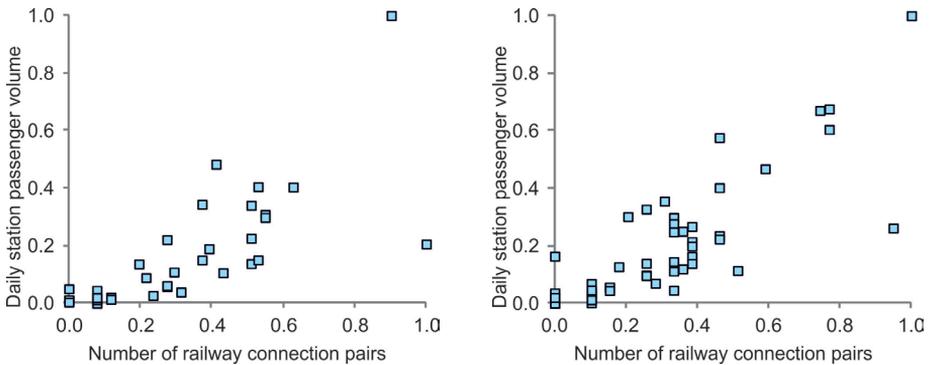


**Figure 8.** Correlations between the transport supply index and the passenger volume index
(working days – left; weekends – right)
Source: author's own elaboration

on both working and weekend days. This is primarily because the town in question is one of this region's main railway hubs. Thus many pairs of trains leave in various directions, while the town itself lacks the residents needed to ensure equally high passenger volume. Hence the disproportions referred to.

Interestingly, there are no towns and cities in the upper left part of the chart; indicating that in no case does a poor-quality transport supply translate into high passenger volume.

## Conclusions

The study allowed for a determination of the most important regularities to the operation of rail transport in Poland's Lower Silesian region. The results offer clear confirmation that a good-quality transport supply (as based on numbers of rail connections) translates into high flows where passenger volume is concerned. The acceptable threshold above which volumes in towns and cities increased markedly was about 8-9 pairs of trains per day – a value that can therefore be considered the necessary minimum for potential passengers. Majewski (2006) also emphasises the need to create a high-quality transport supply (of at least 5-6 pairs of trains per day). It is symptomatic that no low-quality transport supply translated into high passenger volume.

These correlations also confirm the status of number of rail connections as a basic criterion upon which to assess transport supply. Other modelling factors, such as intervals between departures, travel comfort, the quality of possible interchanges, a high frequency of trains and promotions, etc., seem to be important only when the number of rail connections is anyway comparable.

The authors investigated transport disparities by reference to two types of data: on transport supply and on passenger volume. While disparities between working-day and weekend supplies of transport are relatively small, those between working-day and weekend passenger volumes are much greater. This is manifested in both spatial and qualitative aspects. While the disparities are high at stations close to Wrocław, they prove to be far more limited in the western part of the region. Moreover, there are centres in which weekend passenger volume prevails.

There is thus a basis for distinguishing two types of passenger volume in Lower Silesia, i.e. highly irregular agglomeration traffic generated primarily by daily commutes to and from work and schools, as well as regional and tourist traffic proving to be more regular throughout the week.

Conclusions from the study, as set against those obtained in similar studies abroad, make clear the great importance of internal factors in Poland. However, planning should be based primarily on regular and stable timetables. Depending on the rail line and the technical possibilities, transport supply should entail a minimum of 8-9 pairs of train connections per day on local routes, as well as more *pro rata* on major routes.

It is also crucial to pursue an appropriate transport policy based, in particular, around integrated transport systems. If the Office of the Marshal (as head of the regional administration) is responsible for regional rail transport, it should also take on the task of developing an integrated rail and bus system. Although rail transport is indeed considered the transport backbone, this does not mean it should be the only element to the solution. A bus network should be added so that passengers can be carried to local interchange nodes. This solution would complement the railway network, and make it more accessible in areas at risk of transport exclusion.

# Aknowledgement

# References

Banister D., 2008. *The sustainable mobility paradigm*. Transport Policy, vol. 15, no. 2, pp. 73-80.

Bocheński T., 2016. *Dostęp wybranych miast w Polsce do kolei*. Prace Komisji Geografii Komunikacji PTG, vol. 19, no. 4, pp. 62-71.

Bogataj B., Bogataj M., 2007. *Free zones on the EU borders as the response on reduction of daily commuting through the southern EU border*. Europa XXI, vol. 16, pp. 109-129.

Bul R., 2016. *Wpływ infrastruktury transportowej na zmiany dostępności czasowej Poznania z obszaru województwa dolnośląskiego w latach 2010-2016*. Prace Komisji Geografii Komunikacji PTG, vol. 19, no. 2, pp. 16-30.

Cervero R., 2006. *Alternative approaches to modelling the travel-demand impacts of smart growth*. Journal of the American Planning Association, vol. 72, no. 3, pp. 285-295.

Chakour V., Eluru N., 2016. *Examining the influence of stop level infrastructure and built environment on bus ridership in Montreal*. Journal of Transport Geography, vol. 51, pp. 205-217.

Dickinson J., Robbins D., 2008. *Representations of tourism transport problems in a rural destination*. Tourism Management, vol. 29, no. 8, pp. 1110-1121.

Domański, R., 1980. *Dostępność, efektywność i przestrzenna organizacja*. Przegląd Geograficzny, vol. 52, no. 1, pp. 3-39.

Gadziński J., 2018. *Perspectives of the use of smartphones in travel behaviour studies: Findings from a literature review and a pilot study*. Transportation Research Part C: Emerging Technologies, vol. 88, pp. 74-86.

Jerczyński M., Koziarski S., 1992. *150 lat kolei na Śląsku.* Opole-Wrocław: Instytut Śląski.

Jurkowski W., Smolarski M., 2017. *Koniecpol prosthesis as a stimulant of railway transport development*. Przegląd Komunikacyjny, vol. 4, pp. 20-24.

Kepaptsoglou K., Stathopoulos A., Karlaftis M.G., 2017. *Ridership estimation of a new LRT system: Direct demand model Approach*. Journal of Transport Geography, vol. 58, pp. 146-156.

Kistowski M., 2005. *The geography and sustainable development – a new approach*. Europa XXI, vol. 12, pp. 7-17.

Komornicki T., 2008. *ESPON 1.2.1 results and the future of Polish transport infrastructure*. Europa XXI, vol. 18, pp. 59-77.

Komornicki T., 2011. *Przemiany mobilności codziennej Polaków na tle rozwoju motoryzacji*. Prace Geograficzne, vol. 227, Warszawa: Instytut Geografii i Przestrzennego Zagospodarowania, Polska Akademia Nauk.

Komornicki T., Wiśniewski R., Baranowski J., Błażejczyk K., Degórski M., Goliszek S., Rosik P., Solon J., Stępniak M., Zawiska I., 2015. *Wpływ wybranych korytarzy drogowych na środowisko przyrodnicze i rozwój społeczno-ekonomiczny obszarów przyległych*. Prace Geograficzne, vol. 249, Warszawa: Instytut Geografii i Przestrzennego Zagospodarowania, Polska Akademia Nauk.

Kowalczyk K., Rosik P., 2015. *Wykorzystanie infrastruktury przez przewoźników kolejowych w obsłudze połączeń międzyaglomeracyjnych*. Logistyka, vol. 3, pp. 5350-5357.

Koziarski S., 1993. *Sieć kolejowa Polski w latach 1918-1992*. Opole: Państwowy Instytut Naukowy – Instytut Śląski.

Koziarski S., 2017. *Kierunki modernizacji sieci kolejowej w Polsce*. Prace Komisji Geografii Komunikacji PTG, vol. 20, no. 3, pp. 7-31.

Kuć-Czajkowska K. A., 2007. *Warsaw, Prague, Budapest – metropolitan functions comparison*. Europa XXI, vol. 39, pp. 39-62.

Lierop V. D., Bagami M.G., El-Geneidy A.M., 2017. *What influences satisfaction and loyalty in public*

*transport? A review of the literature*. Transport Reviews, vol. 38, no. 1, pp. 52-72.

Lijewski T., 1985. *Układy komunikacyjne województw.* Dokumentacja Geograficzna, vol. 1, Wrocław-Warszawa-Kraków-Gdańsk-Łódź: Zakład Narodowy im. Ossolińskich. Wydawnictwo Polskiej Akademii Nauk.

Lijewski T., 1997. Stan i potrzeby rozwoju sieci komunikacyjnej Polski w procesie integracji Europy. Europa XXI, vol. 1, pp. 5-20.

Lijewski T., Lenk J., Piotrowska H., 1967. *Rozwój komunikacji kolejowej I autobusowej w Polsce w okresie 1946-1965*. Dokumentacja Geograficzna, vol. 5, Warszawa: Instytut Geografii, Polska Akademia Nauk.

Lijewski, T., Sujko E., 1993. *Koncentracja aktywności gospodarczej i społecznej w 150 większych miastach Polski*. Dokumentacja Geograficzna, vol. 1, Warszawa: Instytut Geografii i Przestrzennego Zagospodarowania, Polska Akademia Nauk.

Majewski J., 2006. *Koleje regionalne w nowych warunkach społeczno-ekonomicznych w świetle badań potoków podróżnych*, Prace Komisji Geografii Komunikacji PTG, vol. 12, pp. 137-148.

Małek P., 1977. *Ekonomika transportu*. PWE: Warszawa.

Michniak D., 2007. *Direct international public transport connections of regional centres in Slovakia*. Europa XXI, vol. 16, pp. 87-100.

Michniak D., 2010. *Accessibility of selected boundary regions in Slovakia*. Europa XXI, vol. 20, pp. 161-173.

Nutley S., 2003. *Indicators of transport and accessibility problems in rural Australia*. Journal of Transport Geography, vol. 11, no. 1, pp. 55-71.

Pan H., Li J., Shen Q., Shi C., 2017. *What determines rail transit passenger volume? Implications for transit oriented development planning*. Transportation Research Part D, vol. 57, pp. 52-63.

Potocki J.,2014. *Znaczenie transportu kolejowego w dostępności komunikacyjnej miast sudeckich*. Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzenia, vol. 3, no. 37, pp. 235-245.

Potrykowski M., Taylor Z., 1982. *Geografia transportu: zarys problemów, modeli i metod badawczych*. Warszawa: PWN.

Rosik P., 2009. Syntetyczna *ocena drogowego i kolejowego wyposażenia infrastrukturalnego województw.* Przegląd Geograficzny, vol. 81, no. 4, pp. 507-526.

Rosik P., Kowalczyk K., 2015. *Rozwój infrastruktury drogowej I kolejowej a przesunięcie modalne w Polsce w latach 2000-2010*. Prace Geograficzne, vol. 248, Warszawa: Instytut Geografii i Przestrzennego Zagospodarowania, Polska Akademia Nauk.

Rosik P., Pomianowski W., Goliszek S., Stępniak M., Kowalczyk K., Guzik R., Kołoś A., Komornicki T., 2017. *Multimodalna dostępność transportem publicznym gmin w Polsce (MULTIMODACC)*. Prace Geograficzne, vol. 258, Warszawa: Instytut Geografii i Przestrzennego Zagospodarowania, Polska Akademia Nauk.

Sheller M., Urry J., 2006. *The new mobilities paradigm*. Environment and Planning A, vol. 38, no. 2, pp. 207-226.

Śleszyński P., 2017. *Wyznaczenie i typologia miast średnich tracących funkcje społeczno-gospodarcze*. Przegląd Geograficzny, vol. 89, no. 4, pp. 565-593.

Smolarski M., Raczyk A., 2017. *Przestrzenne zróżnicowanie wykluczenia komunikacyjnego w transporcie kolejowym na przykładzie województwa dolnośląskiego*. Studia Miejskie, vol. 22, pp. 9-25.

Sung H., Choi K., Lee S., Cheon S., 2014. *Exploring the impacts of land use by service coverage and station-level accessibility on rail transit ridership*. Journal of Transport Geography, vol. 36, no. 2, pp. 134-140.

Taylor Z., 1998. *Polish transport policy: An evaluation of the 1994/5 White Paper*. Journal of Transport Geography, vol. 6, no. 3, pp. 227-236.

Taylor Z., 1999. *Przestrzenna dostępność miejsc zatrudnienia, kształcenia i usług a codzienna ruchliwość ludności wiejskiej*. Prace Geograficzne, vol. 171, Warszawa: Instytut Geografii i Przestrzennego Zagospodarowania, Polska Akademia Nauk.

Taylor Z., 2004. *Recent changes in Polish transport policy*. Transport Reviews, vol. 24, no. 1, pp. 19-32.

Taylor Z., 2006. *Railway closures to passenger traffic in Poland and their social consequences*. Journal of Transport Geography, vol. 14, pp. 135-151.

Taylor Z., 2007. *Rozwój i regres sieci kolejowej w Polsce*. Monografie IGiPZ PAN, 7, Warszawa: Instytut Geografii i Przestrzennego Zagospodarowania, Polska Akademia Nauk.

Taylor Z., 2008. *The dismantling and removal of railway lines by Soviet Red Army troops on present-day Polish territory 1944-1948*. Journal of Transport Geography, vol. 16, pp. 217-228.

Taylor Z., Ciechański A. 2011. *Niedawne przekształcenia organizacyjno-własnościowe przedsiębiorstw transportu kolejowego w Polsce – część II*. Przegląd Geograficzny, vol. 83, vol. 2, pp. 205-231.

Taylor Z., Ciechański A., 2009. *Przekształcenia własnościowe przedsiębiorstw transportu miejskiego w Polsce – część II*. Przegląd Geograficzny, vol. 81, no. 2, pp. 205-236.

Taylor Z., Ciechański A., 2010. *Niedawne przekształcenia organizacyjno-własnościowe przedsiębiorstw transportu kolejowego w Polsce – część I*. Przegląd Geograficzny, vol. 82, no. 4, pp. 549-571.

Taylor Z., Ciechański A., 2013. *Organizacyjno-własnościowe przekształcenia narodowych przewoźników drogowych w Polsce, Czechach i na Słowacji – część II*. Przegląd Geograficzny, vol. 85, no. 4, pp. 515-547.

Vaishar A., 2003. *Small towns as a specific phenomenon of the settlement system. Case study Moravia*. Europa XXI, vol. 10, pp. 25-34.

Vaishar A., 2005. *Small towns as a centres of rural micro regions*. Europa XXI, vol. 12, pp. 53-62.

Wegener M., Komornicki T., Korcelli P., 2005. *Spatial impacts of the trans-European networks for the new EU Member States*. Europa XXI, vol. 13, pp. 27-43.

Wiśniewski S., 2015. *Powiązania miast województwa łódzkiego w systemie kolejowego transportu zbiorowego w świetle potencjału komunikacyjnego*. Prace Geograficzne, vol. 140, Warszawa: Instytut Geografii i Przestrzennego Zagospodarowania PAN.

Yim K. K., Wong S. C., Chen A., Wong C. K., 2005. *A reliability-based land use and transportation optimization model*. Transportation Research Part C, vol. 19, no. 2, pp. 351-362.