

Supply of public transport connections to commuters in the region of Wrocław - a quantitative analysis

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Abstract. Aim. Wrocław, as a regional center, impacts many communes in the Lower Silesian Voivodeship and neighboring voivodeships. One measure of such influence is the number of daily commuters to the city. Organizing sustainable mobility and responding to the existing demand is a significant challenge for local and regional policies. The study aims to define the level of supply of public transport connections in the region of daily commutes to Wrocław in regard to the estimated demand for commuting.

Results and conclusions. The study includes the analysis of data obtained from the 2021 National Census, research made using the original RTCP indicator, and classifications of the analyzed communes by the supply of and demand for transport connections. The insufficiencies indicated in these analyses were addressed by proposing solutions developed in the PTV Visum transport planning software.

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1. Introduction

Wrocław is one of the largest cities in Poland, constantly developing its resources based on the influx of people and the development of an entrepreneurial environment. It is a renowned academic, research and development center as well as the seat of many companies, which has such consequences as the highly intense flow of people in the city space and its agglomeration. However, most of them choose to commute by car, which often causes traffic jams on the entrance roads towards the city during morning and afternoon rush hours. Transport congestion is one of the distinguishing negative traits of mobility in Wrocław, which requires intervention. Therefore, providing a competitive, complementary public transport connections, especially regional passenger rail transport, is crucial in effectively reducing congestion in the city. This paper aims to delimit the area of daily commuting to Wrocław and, on this basis, to assess the adjustment of the public transport supply to the theoretical demand for daily mobility towards Wrocław. The result of the work is to indicate the communes in which public transport should be mainly developed based on regional trains and buses. The final stage of the study is to present a sample of new connections for the identified area of intervention based on precise calculations regarding the effective economical organization of regional public transport.

2. Research materials and methods

2.1. Literature review

The issue of daily mobility between an urban center and the region of its socio-economic influence in the context of metropolitanism and the concept of daily urban systems appears repeatedly in scientific literature (Berry, 1973; Korcelli, 1976; Hołowiecka and Szymańska, 2008). Areas from which daily journeys from lower-level centers to central cores occur

are defined as urban functional areas (Śleszyński, 2014). The functional area can be identified with the range of influence of the labor market, referring to the classic works of Christaller and Lösch (Gruchociak, 2012, 2013). Mobility within such areas may also be a concern when commuting to school (Keseru, 2013). Analyses of flows in functional terms at the county level in Poland were also carried out, including analyzing permanent movements, i.e., migrations (Ilnicki & Janc, 2021). Such connections, sometimes referred to as functional connections, are therefore significant evidence indicating a system of spatial mobility within

a single economic region (Korenik, 2011). Among them, commuting to work is particularly important due to its impact on the entire region and benefits for the location of the workplace, which also enables investments in transport systems (Vandyck & Proost, 2012).

Transport behavior is the subject of research, among others, by geographers, spatial and urban planners, economists, and sociologists. The motivations for traveling can generally be divided into business (33%), family (25%), and education (25%) (Komornicki et al., 2013). Numerous surveys enable the determination of social preferences in the context of choosing the optimal transport mode for travel. Most journeys worldwide are made by private car (Lee et al., 2011; Suchanek, 2019, Giménez-Nadal, Molina & Velilla, 2022). In the Netherlands, the share of public transport in commuting is the highest when the travel time is 30-40 minutes. It remains at a high level in commuting which takes 60 minutes (Ooserhaven & Elhorst, 2003). On the other hand, the example of Montreal shows that even at a distance of 60 km from the city center, it is possible to provide as many as 20 connections per hour on a given line, which results in a 30% usage of public transport (Vemesch, Boisjoly & Lachapelle, 2021). Furthermore, in terms of passengers, the primary users of regional buses in Brazil were middle-income people and women (Silva et al., 2013; De Miranda & Domingues, 2010). Moreover, as an additional competition for public transport, researchers often indicate active commuting using a bicycle or other private ways of transport other than a car (like scooters), pointing to, among others, the example of Ontario, Canada (Buttazzoni et al., 2019). Due to the indicated conditions, the share of public transport as a chosen transport mode is generally determined at around 30% (Litman, 2025). Certain factors are particularly decisive for selecting the appropriate mode, and transport demand modeling is significantly related to travel time. The demand depends on the journey's length and the time spent on the route (Balcombe et al., 2004).

The principles of transport organization in the regions are described from a legal perspective (Drewnowski, 2019; Misiejko, 2020). Practical approaches presenting the organizational models used in Poland and globally are another common scientific topic (Wąsowicz, 2018). Particular attention should be paid here to the specific system of regional transport in rural areas (Kwarciński, 2016; Firlej, Olejniczak and Pondel, 2019). An example from Czechia shows that the coverage of public transport is never even, and four categories can be distinguished: the first two, in which the demand for commuting is low and the supply of public transport is either high or low, the third category, in which both the demand and the supply are high, and least desirable, fourth category, in which the demand is high, but the supply of public

transport connections is insufficient (Ivan & Horak, 2015). It is worth emphasizing that the minimum number of public transport connections per day ensuring adequate daily mobility service should be considered seven (Zajfert, 2020). However, it is essential that the places served by public transport connections should be rationally selected, resulting in overall system reliability (Hansson, 2022). Coordination is a particular consideration, as it determines the importance of public transport as a convenient alternative, and in the case of unforeseen changes and traffic disruptions, specifically when commuting both by one's own means of transport and public transport, there may be an increased overall level of stress, which has many negative consequences (Murphy et al., 2022).

In the context of the supply of connections to the demand for commuting, based on the example of Wrocław, it is worth paying attention to examples from other regions of Europe. The example from Slovakia shows that the use of cars for longer journeys is much more frequent (Gábor and Prego, 2023). Authors note that in the peripheral areas of Slovakia's public transport is important in commuting, but not always fully satisfactory. Furthermore, suburbanization determines the demand for transport, which is often not adequate to expectations. Public transport is considered to be efficient in larger cities like Bratislava or Košice. Burian et al. (2018) describe examples of commutes in Czechia on the examples of Olomouc and Ostrava, in which public transport is chosen by up to 45% of commuters and the node region of Ostrava is significantly larger. However, in less urbanized areas, cars are chosen in over 40% of cases. Travel time and comfort are mentioned as decisive factors in choosing a mode of transport. The French example described by Liang and Laurent (2025) indicates that cars are preferred for commuting to Paris in journeys from outside its region (6.5%). However, multimodal passenger transport is chosen by commuters within the agglomeration. Authors point out that the influence of Paris clearly exceeds the administrative boundaries of the region (NUTS 2), which, in the context of regional transport planning, may be a significant factor in developing the offer. An example from northern Sweden described by Sandow and Westin (2010) indicates that if the time spent on the route exceeds 45 minutes, the willingness to travel distinctly decreases. Cars are clearly preferred in areas with a limited public transport network and most residents in those areas prefer shorter commutes. All of the above-mentioned studies also point to important, often difficult to measure, social issues which determine the choice of transport and the willingness to travel.

Polish examples of commuting systems within agglomerations are essential in theoretical and practical

studies. The organization of connections in the context of commuting within regions is discussed by, among others: Ciechański (2023) – regarding limitation of the public transport offer for transporting children to schools; Kołoś, Król, Taczanowski (2017) – the impact of regionalization on changes in the rail transport offer; Smolarski (2022) – on the role of the voivodeship (as a term usually defining NUTS 2 in Poland) border in the organization of passenger rail connections; Jurkowski and Smolarski (2017) and Małysz et al. (2024) – on organization of public transport in commutes to Wrocław before 2025. In the case of the whole agglomeration, the research referred to the choice of transport modes depending on the Euclidian distance from the core. In the case of a distance of over 100 km, the car is chosen in 50% of the cases, but in the case of a distance of 50-100 km, the number is reduced to 30% (Paradowska, 2011). At the same time, the functional area of Wrocław itself, delimited based on Śleszyński's research (2014), is relatively narrow (Kuć-Czajkowska, 2019). It may suggest that the area of daily commuting should be considered within a radius of 100 km from Wrocław. However, some places do not have adequate access to public transport, including those not located within the rail network. One way to integrate public transport to create an effective system is the system of multimodal solutions, based on connecting trains and buses at multimodal nodes and then traveling to the destination by train (Kowalczyk, 2019). It is worth paying attention to the possibilities of using the potential of bus connections as connecting rail nodes and allowing connections with them to provide convenient changes of modes. This may also be one of the development methods. However, it requires a certain social acceptance in the context of mode changes, which could occur in the longer term.

The literature review revealed various cases and issues related to the use of public transport for commuting. Factors that repeatedly emerged as decisive in influencing the demand of mobility included, for example, the availability of a connection, time, distance, and travel comfort.

A specified level of public transport use was also consistently observed, but it did not exceed a certain threshold. Therefore, it is advisable to develop those types of commuting methods, especially if we want to effectively reduce the congestion which limits effective mobility within the city.

2.2. Research methods and sources

Data used to delimit the area of daily commutes to Wrocław come from the 2021 National Census regarding declared commutes to work, primary schools, and secondary schools specified for all communes in

Poland. The timetable data come from various sources as the rail connections are published by PKP Polskie Linie Kolejowe (PKP PLK) and bus connections come mainly from E-podróżnik.pl, supplemented with data from bus operators and organizers published on the official websites of each commune. It ought to be emphasized that the availability of rail connection data is significantly higher as it comes from a singular official source. Fragmentation of sources and lack of regulation and convenient information are particular disadvantages to providing information on the operation of bus connections.

The delimitation of the study area of daily commutes to Wrocław was based on three criteria. Two of the criteria involved the number of people who declared they were commuting to work or school, respectively. The third criterion took into account the area that is the sum of the areas designated based on the first and second criteria according to the following principle: the area classified for the study should include a commune in which at least 50 commuting trips were declared. If the neighboring commune has a number of declarations between 30 and 50, it is considered a boundary commune constituting the periphery of the study area, and the further located communes are not included in the study. For the purpose of preserving its integrity, the study area included any isolated 'islands', i.e., communes with the number of declarations below 30 but surrounded by communes with a sufficient number of declarations. Consequently, the number of communes in the study area is 174 and includes communes located in three voivodeships: Lower Silesia, Opole and Greater Poland.

To analyze the potential of demand for mobility and efficiency of public transport in service of commuting, the authors propose the Regional Transport Commuting Performance (RTCP) indicator with the following structure:

$$RTCP = \frac{(0,5b+r)0,3c}{t}$$

where:

c – the number of declarations of commuting to work/school in Wrocław

b - number of bus connections

r - number of train connections

t – time of the journey (in minutes)

The RTCP indicator takes into account both the demand side (commuting) per each commune and the supply side in terms of connections per commune. Time is defined as spatial resistance and is based on timetables or theoretical forecasts provided by Google, and is described also for each commune. The RTCP value is positively influenced primarily by more commuting

declarations and the appropriate number of rail connections (which is a distinguishing feature of sustainable mobility), with bus connections assuming half a much importance. On the other hand, a longer travel time has an unfavorable effect on the indicator value. Dividing the number of declarations by 3 assumes that approximately one-third of commuters chose public transport. This assumption was made based on the aforementioned literature review, in particular the survey results contained in the literature. The demand assumption states that for every 300 declared commutes, 100 people would choose public transport. The minimum capacity of public transport vehicles operating on roads (buses) is approximately 20, and the minimum number of connections per day should be 8 in a clock-face timetable (05:00, 07:00, 09:00, 11:00, 13:00, 15:00, 17:00, 19:00). This is the absolute minimum transport supply. Furthermore, assuming that the minimum demand for a trip is half the capacity of the smallest bus (like Ford Transit), which gives 3-4 seats, the absolute minimum demand for transport is 25. Taking into account the example of commuting to Wrocław from the two largest cities in the region, i.e. Legnica and Wałbrzych, in approximately 100 minutes, this time value was also determined as the maximum acceptable daily commuting time.

The general interpretation of the indicator is as follows. Values of 0 indicate no commutes or no connections, clearly indicating a lack of public transport use for commuting to work/school. Values below 1 represent a situation below the acceptable minimum in terms of both the number of connections and the number of declarations justifying the provision of public transport connections. The remaining thresholds depend on the combination of demand and supply. Table 1 shows examples of combinations of supply and demand levels with interpretation of RTCP values.

An RTCP above 100 generally represents a range of situations that indicate a favorable situation in terms of both demand and supply, as shown in Table 2.

It is clear that values around 100 indicate frequent public transport and a relatively large number of potential passengers. It is expected that the indicator will have high values for those communes from which commuting will be significant, the public transport offer will be extensive, and the travel time will be acceptable. Index values below 1, and especially 0, with declared commuting times will indicate areas (communes) requiring intervention in the field of public transport, ensuring convenient commuting to work/school in Wrocław.

3. Research results

Wrocław is the largest city in southwestern Poland. Its influence range exceeds its agglomeration, the Wrocław

Table 1. RTCP indicator interpretation thresholds

Number of commuting declarations	Number of bus connections	Number of train connections	Time of journey	RTCP	Interpretation
75	8	0	100	1	Just 25 passengers and minimum rational bus offer with long journey time
300	8	8	60	20	100 passengers with bus and train every two hours with an hour journey
300	16	16	60	40	100 passengers with bus and train in an hour with an hour journey
750	8	8	30	100	250 passengers with bus and train every two hours and 30 minute journey
1500	16	16	30	400	500 passengers with bus and train in an hour and 30 minute journey
4500	16	32	30	2000	1500 passengers with bus in an hour and train every 30 minutes and 30 minute journey
7500	32	32	15	8000	2500 passengers with bus and train every 30 minutes and only 15 minute journey

Source: own study

Functional Area (WrOF) described in the literature (Warczevska, Mastalska-Cetera, 2018), and even the whole voivodeship (NUTS 2). Data indicate a tendency for the range of daily commuting to shift eastward to the area of the Lower Silesian Voivodeship. Figure 1 shows the delimited area of the commute to Wrocław. All classes were defined using the Jenks method as the three best, the middle, and the three worst.

The figure shows the number of commuters to Wrocław in each commune divided by the number of inhabitants of the given commune. It is visible that the largest commuting is observed in the first three commune rings around Wrocław in its immediate surroundings, as well as in communes in the Sudetes. In exact values, the largest number of commuters comes from the Długołęka commune, directly adjacent to Wrocław to the east, with over 11,000 workers or students in Wrocław. What must be emphasized is the area of commuting includes communes located in other voivodeships, namely Opole and Greater Poland, and

does not include some communes in Lower Silesia, such as Głogów or Zgorzelec.

The number of rail connections per commune refers to the towns through which a given railway runs. Nevertheless, the commune is responsible for ensuring convenient transport within its area to connect nodes, creating multimodal solutions. As a result, a whole commune can be well communicated with the multimodal node servicing local and regional transport. There are clearly visible areas, some located close to Wrocław, that lack rail connections, which usually run parallel to the presence of bus connections. However, there are also Communes with very poor rail connections without any substitutions. This is particularly observed in the north and west of the voivodeship, as well as a few communes south of Wrocław. In the case of the north-west direction, rail connections are theoretically very developed, but railway lines serve only a very limited area of the communes.

Table 2. Examples of situations described by the value 100 of RTCP

Number of passengers	Number of bus connections	Number of train connections	Time of journey	Interpretation
250	8	8	30	Bus/trains every 2 hours
125	16	16	30	Bus/trains every hour
250	16	16	60	
150	16	32	60	Bus every hour, trains every 30 minutes
225	16	32	90	

Source: own study

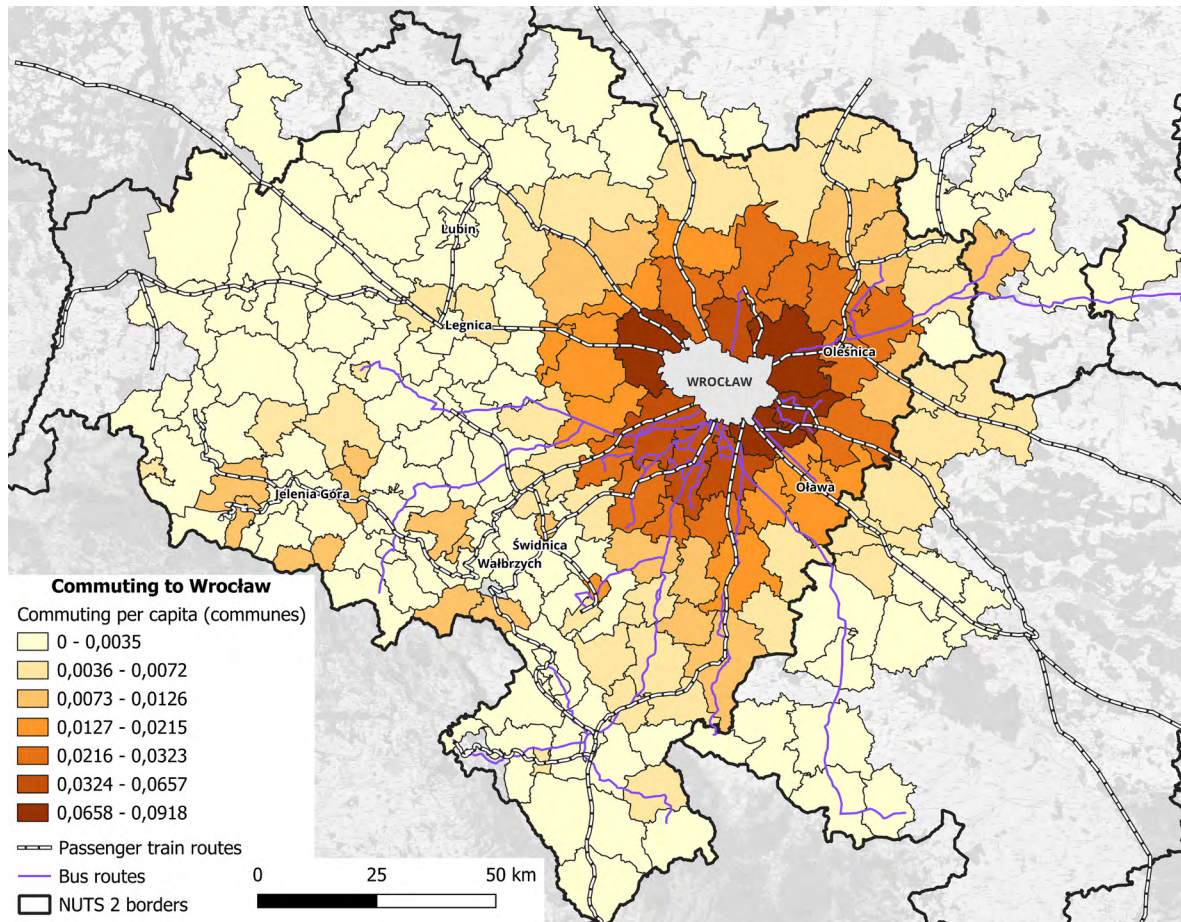


Fig. 1. Area of daily commutes to Wrocław as demand and public transport connections as supply
Source: Census 2021 and timetables

Figure 3. shows spatial differentiation of the intensity of bus connections among the inhabitants of given communes.

In some communes serviced by bus connections and rail transport, both are simultaneously well developed, but in most cases bus transport is the only public transport mode. This situation occurs in the south of Wrocław towards Ząbkowice Śląskie along the E67 European road to Kłodzko and to the north-east to Syców. Communes located on the north-west of Wrocław are not serviced by bus transport, despite not all areas having proper accessibility to railways.

As the product of the demand and supply factors described above, which is then the dividend in the quotient, the RTCP should be presented, the differentiation of which in relation to the number of inhabitants of the communes is shown in Figure 4.

It is clearly visible that RTCP per capita is highest in the Wrocław agglomeration, with some exceptions requiring attention. While high values are visible in the first ring of communes, the second ring includes cases of values 0 in Zawonia (north-east), Kostomłoty

(south-west) and the neighboring communes of Domaniów, Wiązów and Kondratowice, located to the south. Several communes with a value of 0 also form a larger area in the western part of the region, for example: Lwówek Śląski, Świerzawa, and in the north of the region, such as Polkowice and Góra.

Figure 5 shows the raw values of the indicator without conversion to the number of inhabitants for better interpretation.

Values of 0 and below 1 reflecting a negative situation occur primarily in the western and northern parts of the voivodeship, but also in individual communes located relatively close to Wrocław to the south and less frequently to the north and east. Some of the communes with values 0 are located in the Opole Voivodeship, but are spatially still not far from Wrocław. Index values between 1 and 40 indicate moderate demand and supply, which may manifest as, for example, a sufficient supply of connections relative to the declared commutes, or a number of declarations that do not require a significantly expanded transport offer. Index values above 100, illustrating already high demand and supply, occur in

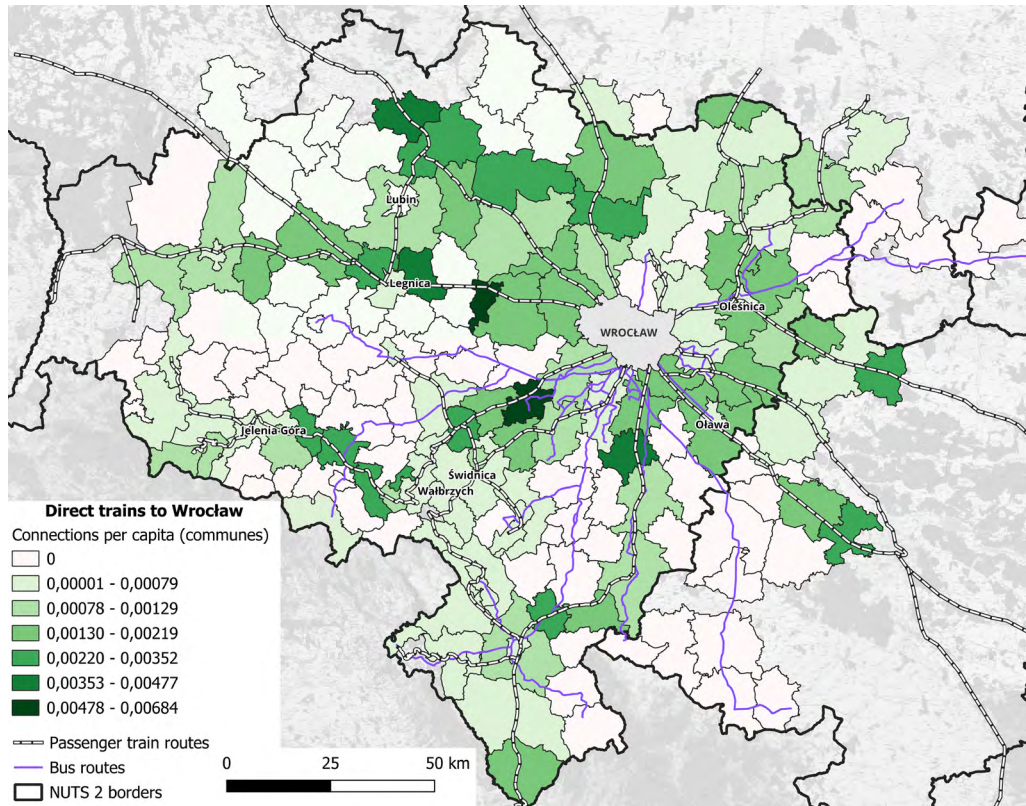


Fig. 2. Spatial differentiation of the intensity of rail connections among the inhabitants of given communes
Source: own study based on timetables and the 2021 National Census data

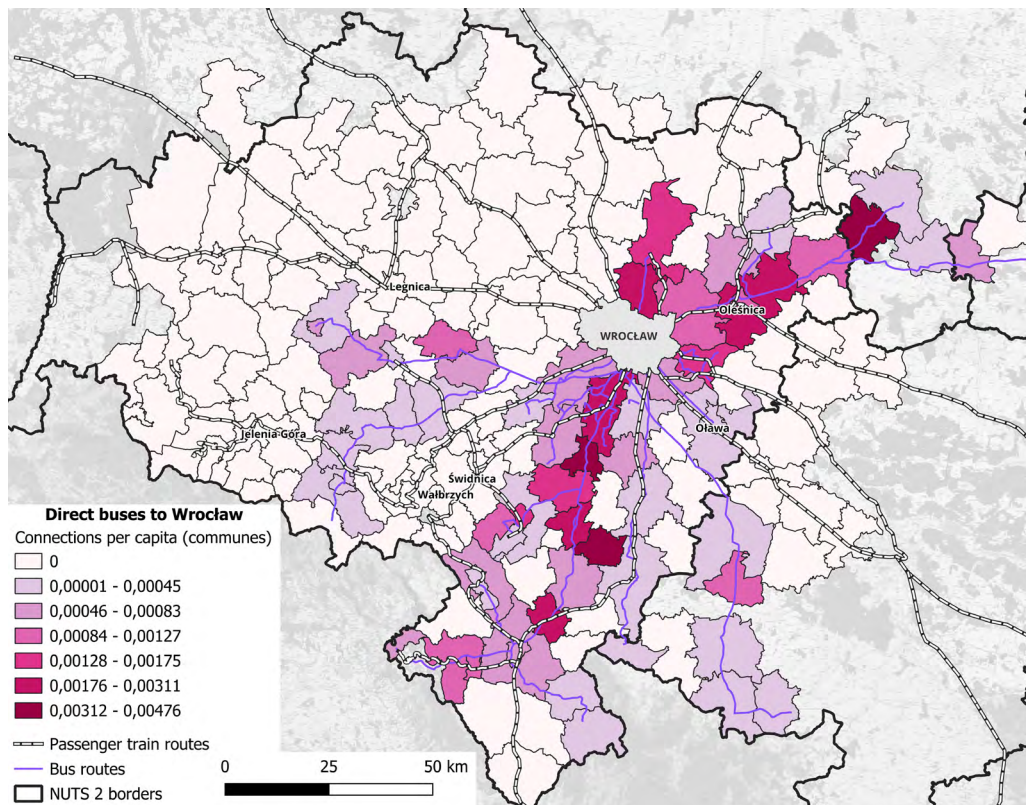


Fig. 3. Spatial differentiation of the intensity of bus connections among the inhabitants of given communes
Source: Own study based on timetables and the 2021 National Census data

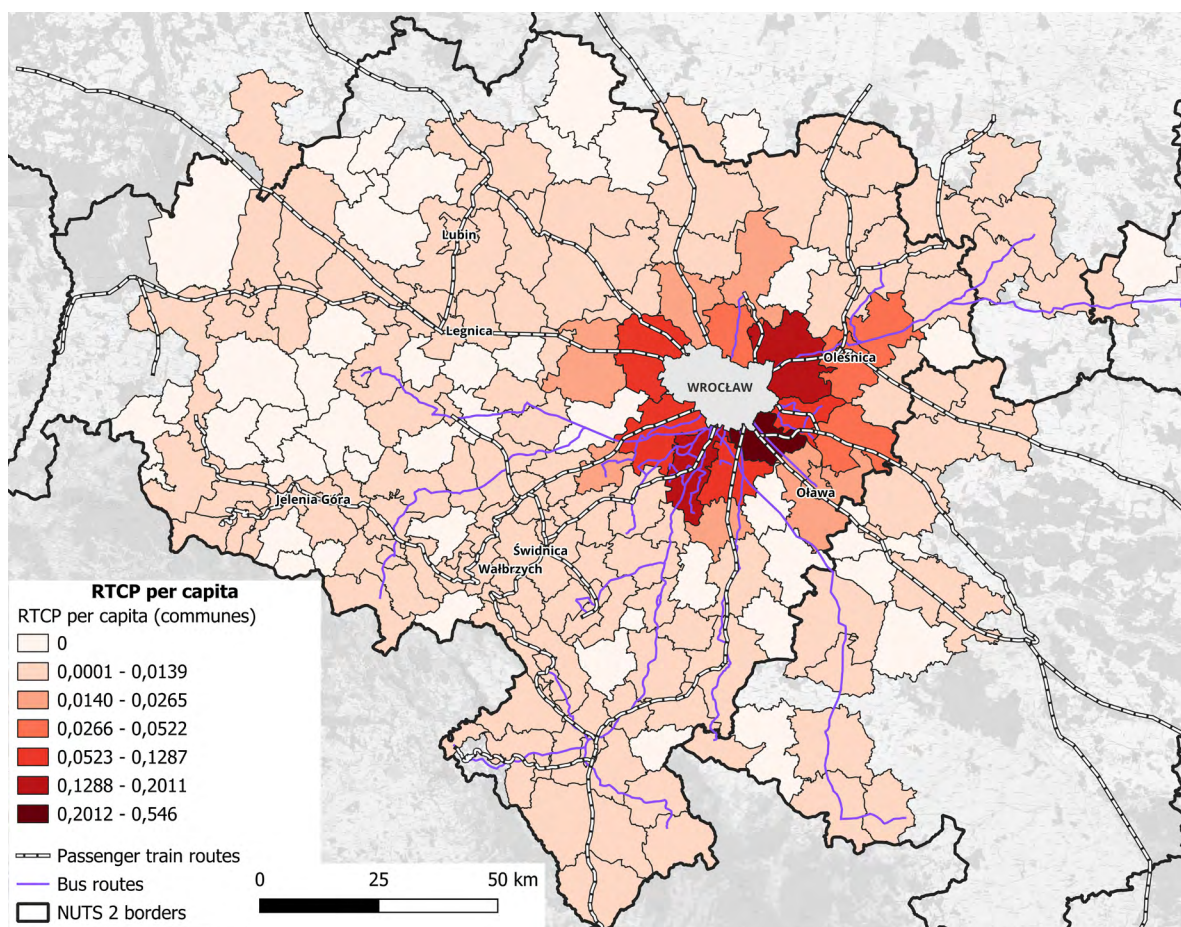


Fig. 4. RTCP results for each commune divided by the number of inhabitants (per capita)

Source: Own study based on timetables and the 2021 National Census data

communes further afield than the immediate first ring of communes, creating an area significantly beyond the Wrocław agglomeration and extending along transport routes, particularly railways.

In summary, the indicator allowed us to identify communes in which public transport allows travel to Wrocław directly as a substitution for individual transport and also to areas with lower demand for journeys to work and those that may require intervention, especially if commuting is declared, but there are no favorable conditions for traveling by public transport.

4. Discussion

The RTCP indicator revealed communes characterized by low key factors, i.e., demand for transport or supply of public transport connections. Furthermore, if the time distance to Wrocław was beyond the limit, RTCP also assumed lower values. However, analysis of the indicator itself does not reveal which communes

are actually problematic in terms of connectivity with Wrocław. Since the indicator may also have low values due to a lack of interest in commuting, the potential lack of direct public transport connections is not a significant problem. This may be due to gravitation in other directions to lower-order subregional centers in the settlement hierarchy. A significantly worse situation is when high demand appears simultaneously with low supply of connections. To identify areas requiring intervention, it is necessary to compare the RTCP results with the number of declarations of commuting by determining the lowest indicator values and the highest factors related to transport demand. Table 3 presents communes with declared commuting numbers exceeding 100, which simultaneously translates to more than 30 potential passengers.

The first three cases, illustrating the 100-150 potential passengers lost due to the lack of connections to Wrocław from Zawonia, Kostomłoty, and Domaniów, particularly require intervention. The time of the journey to Wrocław is just over 40 minutes and between 317

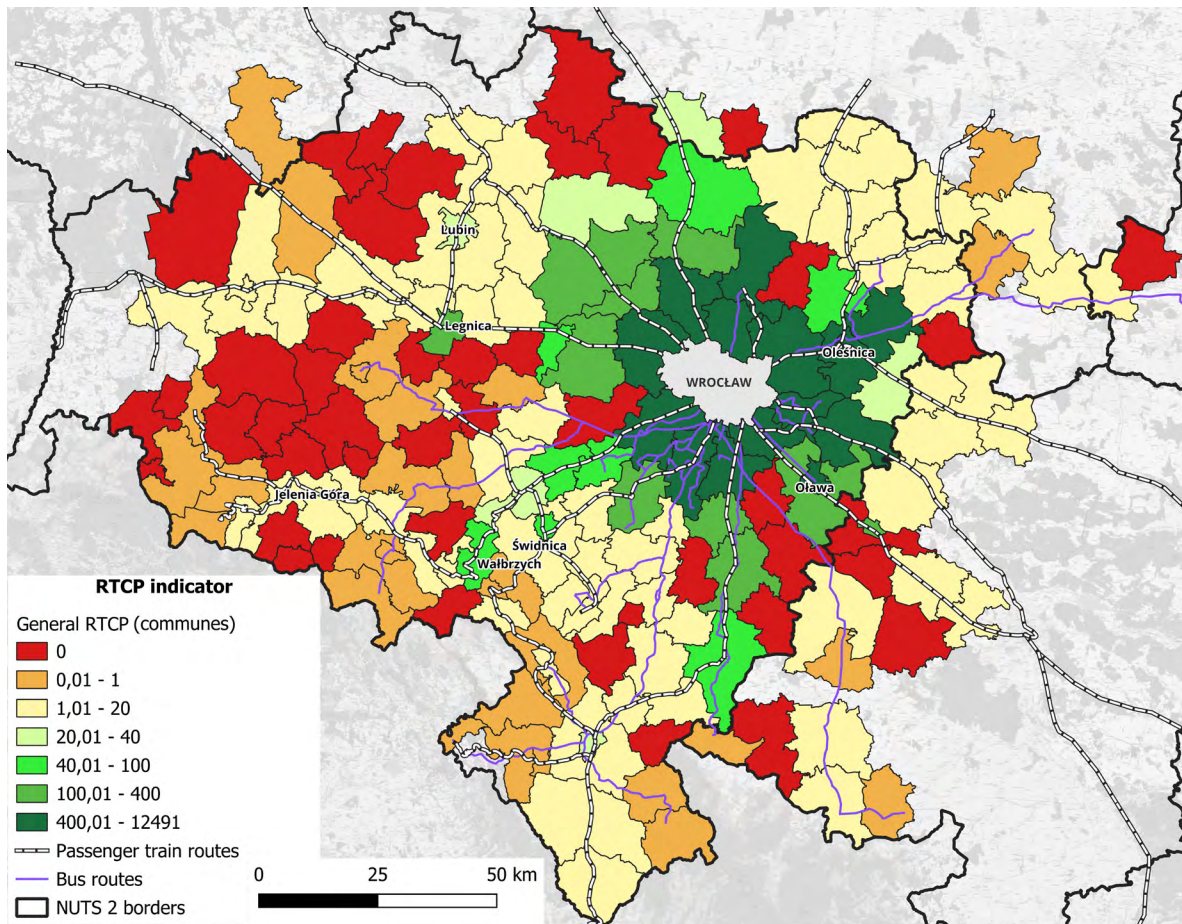


Fig. 5. RTCP indicator as demand and supply divided by the time of journey to Wrocław from each commune
 Source: Own study based on timetables and the 2021 National Census data

and 521 workers and students commuting to Wrocław. Among the communes within the 100-minute isochrone with potentially high passenger numbers, it is also worth mentioning Skarbimierz, located in the Opole Voivodeship, Wiązów located nearby, and the aforementioned Domaniów, but already in the Lower Silesian Voivodeship. Kondratowice, located on the other side of the commune of Strzelin (with a very high RTCP thanks to rail connections), is supposed to be classified as the area of intervention requirement. Polkowice, in turn, is the only city in the settlement system of the Legnica-Głogów Copper Belt with virtually no direct connection to Wrocław by regional transport. Kowary, Mioszów and Stare Bogaczowice are examples of communes located far from Wrocław and much closer to subregional centers like Jelenia Góra or Wałbrzych. Nevertheless, the potential passenger numbers could also range from 54 to 82. Góra, Lwówek Śląski, Wojcieszów, and Świerzawa, on the other hand, are examples of communes with generally limited accessibility, especially in the context of rail transport. Furthermore, they are not located on major road routes.

Synthesis of the comparison between lower RTCP and higher commuters made it possible to establish the areas requiring urgent intervention in developing public transport connections to Wrocław, presented in Figure 6.

Communes requiring improvements in the area of public transport towards Wrocław often form clusters, which provide specific opportunities to find solutions to the identified problems for further discussion. Areas with an RTCP greater than 0 but less than 1 and a number of commute declarations exceeding 100 include the communes of Lądek-Zdrój, Kamienna Góra, Stara Kamienna, Złotoryja, and Prudnik (Opole Voivodeship). However, all of those communes have the time of the journey exceeding 100 minutes, although in the case of Złotoryja, this threshold is slightly exceeded. In terms of connection supply, all communes except Stara Kamienna have a single bus connection to Wrocław, ranging from two (Lądek-Zdrój, Kamienna Góra), four (Złotoryja), to six (Prudnik) connections per day. Only one direct train runs from Stara Kamienna. It is also worth noting the RTCP value is close to 1, which the indicator assumed for Głuszyca and Glucholazy. This

Table 3. RTCP indicator interpretation thresholds

Commune	Commutes	30% of commutes	Theoretical time of journey
Zawonia	521	156.3	41
Kostomłoty	491	147.3	42
Domaniów	317	95.1	42
Kowary	275	82.5	113
Mieroszów	254	76.2	106
Stare Bogaczowice	180	54	80
Skarbimierz	179	53.7	34
Wiązów	156	46.8	46
Polkowice	139	41.7	84
Góra	137	41.1	67
Karpacz	133	39.9	124
Wojcieszów	123	36.9	95
Lwówek Śląski	122	36.6	104
Kondratowice	110	33	57
Świerzawa	110	33	91

Source: own study

example and the rest of the results around the crucial thresholds are presented in Table 4.

Significantly, if demand or supply is too low, RTCP has low values, but when the number of connections corresponds with higher demand and means at least one connection in two hours, the indicator takes clearly higher values, as in the example of Twardogóra. The cases of Marciszów and Ostrzeszów show how a difference in the number of commuting declarations compared to the number of connections can impact RTCP. Despite 15 connections, the number of potential passengers is about just 10, which lowers the indicator. The examples of Rawicz and Żarów show a very comfortable number of connections with around 100 potential passengers, which means RTCP is around 40–50. Much higher values are observed in case of Trzebnica, Siechnice, Długołęka, and Kobierzyce from the immediate surroundings of Wrocław. In such cases, RTCP shows very high values, describing the intensity of mobility in the area with high public transport efficiency. Summarizing this part of discussion, RTCP effectively describes each case and indicates three demand-supply combinations: high-high, high-low/low-high and low-low, in which high-low is the main case which requires urgent intervention.

In order to improve the role of public transport in mobility towards Wrocław, it is important to create solutions for more than one commune at once. When problematic communes create clusters, it is much easier to create a proper route. Those connections should be rational, consistent with sustainable mobility principles, and at the lowest possible cost. Planning can be supported by software like PTV Visum, which allows the estimation of the timetables and planning routes in accordance with the above assumptions. As a result, it was possible to propose solutions to some of the

identified problems. Those connections are included in Table 5.

The proposed connections adhere to the principle of minimal cost, as they require only two vehicles throughout the day (buses or rail multiple units). Furthermore, the number of daily connections is no less than the seven connections per day proposed in the literature by Zajfert (2020). Increasing this number would be difficult due to the need to adjust rolling stock flows. Nevertheless, using just four direct connections served by six vans and two diesel/hybrid rail units would improve accessibility in as many as twenty-four communes. As a result of the proposed connections, the following communes from the analysis area would gain additional ways of commuting to Wrocław by public transport: Milicz, Trzebnica, Zawonia, Długołęka, Brzeg, Skarbimierz, Wiązów, Domaniów, Żórawina, Głuchołazy, Nysa, Grodków, Olszanka, Oława, Siechnice, Lwówek Śląski, Pielgrzymka, Świerzawa, Wojcieszów, Bolków, Dobromierz, Strzegom, Kostomłoty and Kąty Wrocławskie. This connection would not only allow direct access to Wrocław from Wiązów and Domaniów, but would also allow commuters to reach the important multimodal node of Brzeg.

An example of the graphic timetable of the Brzeg line – Wrocław via Skarbimierz, Wiązów and Domaniów is presented in Figure 5.

Changes in the RTCP indicator after the implementation of the above-mentioned five connections are presented in Table 6.

As it can be seen, the absolute minimum number of bus connections could increase the RTCP index from 0 to over 10 in the case of Zawonia, Kostomłoty, and Domaniów, and over 1 in the case of Wiązów, Olszanka, Wojcieszów, Świerzawa, and Lwówek Śląski. Głuchołazy,

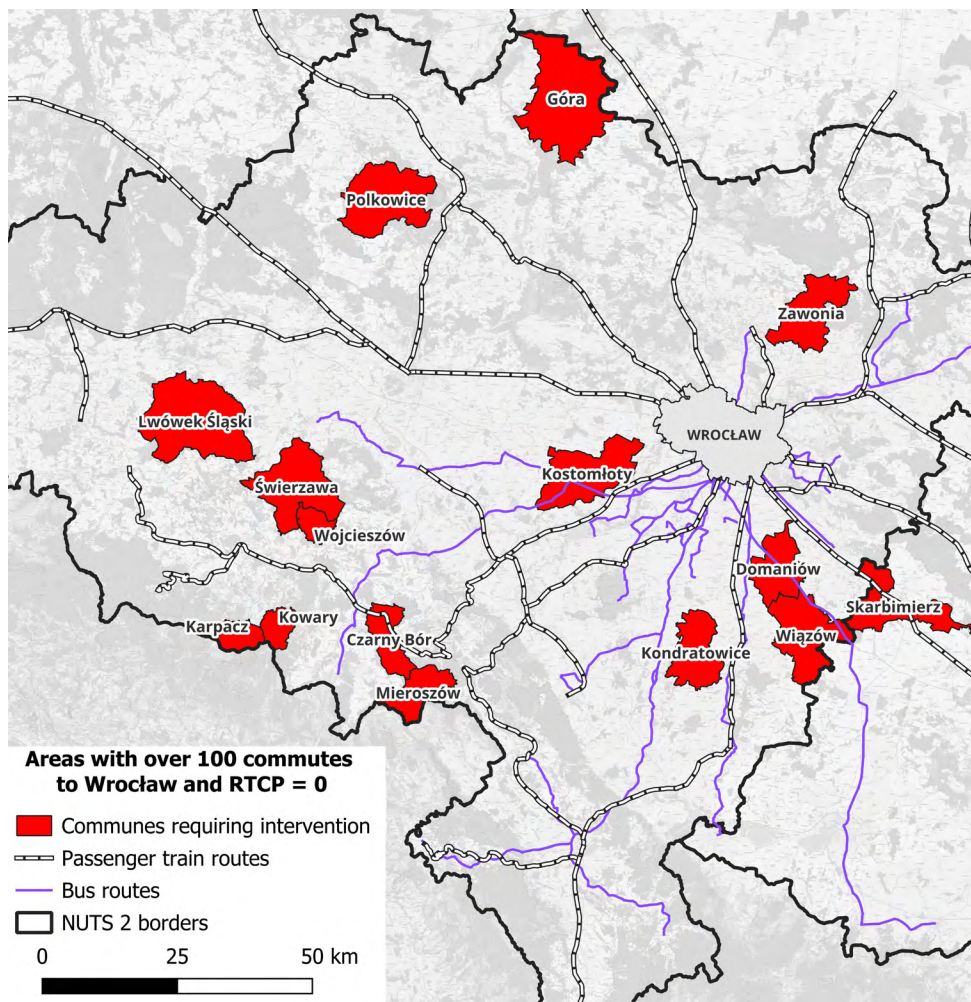


Fig. 6. Areas of intervention due to the need to develop public transport regarding connections to Wrocław
 Source: Own study

Table 4. Examples of communes with RTCP around crucial thresholds

Commune	Commutes	Connections	Time of journey	RTCP
Głuszycza	309	1	92	1,00
Głucholazy	128	6	110	1,05
Marciszów	42	15	113	1,56
Ostrzeszów	130	9	113	1,55
Twardogóra	463	11	60	19,68
Rawicz	334	22	58	38,00
Żarów	264	25	40	49,5
Wołów	722	23	45	110,7
Trzebnica	2017	54	45	470,63
Siechnice	6998	69	10	12491,43
Długołęka	11438	73	24	7220,24
Kobierzyce	4821	82	16	4429,29

Source: own study

Table 5. Proposals for public transport connections for identified areas of intervention

Connection	Number of runs	Number of rolling stock units
Bus: Milicz - Zawonia - Wrocław	11	2
Bus: Brzeg - Skarbimierz - Wiązów - Domaniów - Wrocław	9	2
Train: Głuchołazy - Nysa - Grodków - Brzeg - Wrocław	7	2
Bus: Lwówek Śląski – Świerzawa – Wojcieszów – Bolków – Strzegom – Kostomłoty – Kąty Wrocławskie - Wrocław	7	2

Source: own study in PTV Visum

Grodków, and Strzegom would also benefit significantly, and significant changes to the offer would also apply to Nysa and Milicz. Other communes on the routes would gain even more on top of the existing offer, which is also reflected in the RTCP index, demonstrating the impact of new connections on the development of the offer.

Other communes with low RTCP naturally also require support. Cooperation between local government units is crucial in this regard, and could involve classic cooperation between neighboring voivodeships, the creation of an inter-commune association, or cooperation between communes. The indicator presented in this paper can not only identify problem areas in terms of transport supply versus demand, but also allow for

the designation of functional areas. It is worth noting the significant convergence between the aforementioned WrOF and the area with the highest RTCP values around Wrocław, of course excluding exceptions related to the lack of connections.

5. Conclusions

The presented study showed that the area of daily commutes to Wrocław for work or school is not only identical to its immediate surroundings, but is a slightly eastward shifted area the size of the Lower Silesian

Table 6. Changes of RTCP in intervention areas

Commune	New RTCP	Δ	RTCP without intervention	Time of journey
Zawonia	20.97	20.97	0.00	41
Kostomłoty	12.28	12.28	0.00	42
Domaniów	10.19	10.19	0.00	42
Skarbimierz	7.11	7.11	0.00	34
Wiązów	4.58	4.58	0.00	46
Olszanka	3.05	3.05	0.00	44
Wojcieszów	1.36	1.36	0.00	95
Świerzawa	1.27	1.27	0.00	91
Lwówek Śląski	1.23	1.23	0.00	104
Pielgrzymka	0.26	0.26	0.00	84
Dobromierz	0.50	0.35	0.14	70
Bolkow	0.70	0.50	0.20	85
Głuchołazy	3.49	2.44	1.05	110
Grodków	4.71	3.30	1.41	56
Strzegom	6.09	3.38	2.71	55
Nysa	14.22	9.96	4.27	85
Milicz	28.64	10.86	17.78	65
Brzeg	231.24	72.86	158.38	34
Trzebnica	544.59	73.96	470.63	45
Olawa	820.80	166.54	654.26	23
Żórawina	1514.24	243.36	1270.88	15
Corners of Wrocław	2100.00	100.00	2000.00	30
Długołęka	8006.60	786.36	7220.24	24
Siechnice	13961.01	1469.58	12491.43	10

Source: own study

Voivodeship. The vast majority of nearby communes are very well connected to Wrocław, which is also justified by intense mobility. However, inhabitants of some communes, even those located closer, do not have any alternatives to a private car. The analysis showed that communes with access to rail connections have more possibilities to commute to Wrocław by public transport, and bus connections cannot always adequately complement the offer of rail transport. In some cases, the number of public transport connections is not satisfying, although there are indications of demand for transport. The RTCP indicator originally presented in this paper allowed the detection of possible situations of demand and supply comparison and can be useful in examinations in other regions. The included proposed ideas of new public transport connections could constitute specific solutions, strengthening the role of public transport in commuting to work or school in Wrocław following the concept of regional sustainable mobility, as well as a further subject of discussion on the topic of effective reduction of congestion in favor of effectively functioning eco-friendly public transport. The indicator can be tested in other functional areas using the example of commuting declarations, as well as indicate areas requiring improvement of the transport offer within the nodal region of the core city.

References

- Balcombe, R., Mackett, R., Paulley, N., Preston, J., Shires, J., Titheridge, H., Wardman, M., & White, P. (2004). *The demand for public transport: A practical guide*. https://discovery.ucl.ac.uk/id/eprint/1349/1/2004_42.pdf
- Berry, B.J.L. (1973). *Growth centres in the American urban system: Community development and regional growth in the sixties and seventies*. Balinger Publishing Company.
- Burian, J., Zajíčková, L., Ivan, I., & Macků, K. (2018). Attitudes and motivation to use public or individual transport: A case study of two middle-sized cities. *Social Sciences*, 7(6), 83. <https://doi.org/10.3390/socsci7060083>
- Buttazzoni, A., Clark, A.F., Seabrook, J.A., & Gilliland, J.A. (2019). Promoting active school travel in elementary schools: A regional case study of the school travel planning intervention. *Journal of Transport & Health*, 12, 206–219. <https://doi.org/10.1016/j.jth.2019.01.007>
- Ciechański, A. (2023). *Regres sieci transportu publicznego w powiatach Beskidu Niskiego i Bieszczad a wykluczenie transportowe młodzieży uczącej się (Regression of the public transport network in the Beskid Niski and Bieszczady counties and the transport exclusion of young people studying – in Polish)*. Institute of Geography and Spatial Organization named after Stanisław Leszczycki.
- De Miranda, R.A., & Domingues, E.P. (2010). Commuting to work and residential choices in the metropolitan area of Belo Horizonte, Brazil. *Urban Public Economics Review*, 12, 41–71. <https://www.redalyc.org/pdf/504/50414006002.pdf>
- Drewnowski, A. (2019). Organizational and legal aspects of the functioning of regional passenger transport. In: E. Załoga & T. Kwarciański (eds.), *Regional passenger transport*. PWN Scientific Publishing House.
- Firlej, K., Olejniczak, J., & Pondel, H. (2020). *Wyzwania rozwojowe obszarów wiejskich (Development challenges of rural areas – in Polish)*. Wydawnictwo Naukowe Scholar.
- Gábor, Š., & Pregi, L. (2023). Spatial differentiation of daily commuting to work in Slovakia by modes of transport. *Geographia Cassoviensis*, 17(2), 150–175.
- Giménez-Nadal, J., Molina, J., & Velilla, J. (2022). *School commuting behaviors: A time-use exploration* (GLO Discussion Paper Series No. 1194). Global Labor Organization (GLO).
- Gruchociak, H. (2012). Delimitation of local labor markets in Poland. *Przegląd Statystyczny, Special Issue 2*, 277–297.
- Gruchociak, H. (2013). Delimitation of local labor markets in Poland based on data from the study of employment-related population flows. *Scientific Papers of the Wrocław University of Economics. Taxonomy*, 20, 343–350.
- Hansson, J. (2022). *Regional public transport: The balancing act of service planning*. Department of Technology and Society, Lund University.
- Hołowiecka, B., & Szymańska, D. (2008). The changes in the functional urban region in the new socio-economic conditions in Poland: The case of Toruń. *Bulletin of Geography: Socio-economic Series*, 9(9), 63–78. <https://doi.org/10.2478/v10089-008-0006-6>
- Ilnicki, D., & Janc, K. (2021). Areas of strong functional linkage of Polish cities granted county status in Poland – The authors' own method of delimitation. *Przegląd Geograficzny*, 93(2), 141–160. <https://doi.org/10.7163/PrzG.2021.2.1>
- Ivan, I., & Horák, J. (2015). Demand and supply of transport connections for commuting in the Czech Republic. In: I. Ivan, I. Benenson, B. Jiang, J. Horák, J. Haworth, & T. Inspektor

- (eds.), *Geoinformatics for intelligent transportation*. Lecture Notes in Geoinformation and Cartography, 214, 137–147. Springer.
- Jurkowski, W., & Smolarski, M.** (2017). Multimodal solutions in public transport on the example of feeder lines in Wrocław. *Prace Komisji Geografii Komunikacji PTG*, 20(4), 51–61.
- Keserű, I.** (2013). Commuting patterns of secondary school students in the functional urban region of Budapest. *Hungarian Geographical Bulletin*, 62(2), 197–219.
- Kołoś, A., Król, M., & Taczanowski, J.** (2017). Regionalization as a factor of change in the railway transport offer in Poland on the example of four voivodeships. *Prace Komisji Geografii Komunikacji PTG*, 20(4), 37–50.
- Komornicki, T., Korcelli, P., Siłka, P., Śleszyński, P., & Świątek, D.** (2013). *Powiązania funkcjonalne pomiędzy polskimi metropoliami (Functional connections between Polish metropolises – in Polish)*. Sedno Wydawnictwo Akademickie.
- Korcelli, P.** (1976). Urban agglomerations in settlement systems: Selected hypotheses and research perspectives. *Przegląd Geograficzny*, 48, Warszawa.
- Korenik, S.** (2011). *Region ekonomiczny w nowych realiach społeczno-gospodarczych (Economic region – in Polish)*. CeDeWu.
- Kowalczyk, K.** (2019). *Pasażerski transport kolejowy na obszarach aglomeracyjnych w Polsce a rozwiązania multimodalne w codziennych dojazdach do pracy (Passenger rail transport in agglomeration areas in Poland and multimodal solutions in daily commuting – in Polish)*. UMCS Publishing House.
- Kuć-Czajkowska, K.** (2019). *Obszary funkcjonalne miast wojewódzkich w Polsce: przestrzeń współpracy i konkurencji samorządów terytorialnych (Functional areas of provincial cities in Poland: Space of cooperation and competition of local governments – in Polish)*. UMCS Publishing House.
- Kwarciański, T.** (2016). *Accessibility of public transport in rural areas in Poland: Methodological and pragmatic aspects (in Polish)*. Wydawnictwo Uniwersytetu Szczecińskiego.
- Lee, B., Gordon, P., Moore, J.E., & Richardson, H.W.** (2011). The attributes of residence/workplace areas and transit commuting. *Journal of Transport and Land Use*, 4(3), 43–63. <https://doi.org/10.5198/jtlu.v4i3.310>
- Liang, K., & Leurent, F.** (2025). Commuting patterns and emissions in Paris-Île-de-France: A comparative study of interregional and intraregional travel. *Transportation Research Record: Journal of the Transportation Research Board*, 2679(12), 188–200. <https://doi.org/10.1177/03611981251352507>
- Litman, T.** (2025). *A business case for improving interregional bus services: Why and how to provide efficient and affordable long-distance transit services*. Victoria Transport Policy Institute. <https://vtpi.org/bcit.pdf>
- Małysz, M., Tomczak, P., Szmytkie, R., & Jurkowski, W.** (2024). Spatial differentiation of access to bus transport on the example of core-immediate surrounding connections in the Wrocław agglomeration. *Transport Problems*, 19(1), 69–82. <https://doi.org/10.20858/tp.2024.19.1.06>
- Misiejko, A.** (2020). *Publiczny transport zbiorowy: Przewodnik dla organów samorządu terytorialnego (Public transport: A guide for local government bodies – in Polish)*. Wolters Kluwer.
- Murphy, L.D., Cobb, H.R., Rudolph, C.W., & Zacher, H.** (2022). Commuting demands and appraisals: A systematic review and meta-analysis of strain and well-being outcomes. *Organizational Psychology Review*, 13(1), 11–43. <https://doi.org/10.1177/204138662211314>
- Oosterhaven, J., & Elhorst, J.P.** (2003). *Effects of transport improvements on commuting and residential choice*. ERSA conference papers, European Regional Science Association.
- Paradowska, M.** (2011). *Rozwój zrównoważonych systemów transportowych polskich miast i aglomeracji w procesie integracji z Unią Europejską (Development of sustainable transport systems of Polish cities and agglomerations in the process of integration with the European Union: The example of the Wrocław agglomeration – in Polish)*. *Studia i Monografie 457*. University of Opole.
- Sadow, E., & Westin, K.** (2010). Preferences for commuting in sparsely populated areas: The case of Sweden. *Journal of Transport and Land Use*, 2(3/4), 87–107. <https://doi.org/10.5198/jtlu.v2i3.21>
- Silva, K.S., Lopes, A.S., Hardman, C.M., Cabral, L.G., Da Silva, S.G., & Nahas, M.V.** (2013). Commuting to school and to work among high school students in Santa Catarina state, Brazil: A comparative analysis between 2001 and 2011. *Journal of Physical Activity and Health*, 11(8), 1458–1467. <https://doi.org/10.1123/jpah.2012-0410>
- Smolarski, M.** (2022). Voivodeship border and connections with regional rail transport on the

- example of Wielkopolska. *Rozwój Regionalny i Polityka Regionalna*, 62, 217–237.
- Sojka, E., Przybylska-Mazur, A., Sączewska-Piotrowska, A., & Wolny-Dominiak, A.** (2020). *Elementy statystyki i ekonometrii w analizach szeregów przestrzennych (Elements of statistics and econometrics in the analysis of spatial series – in Polish)*. University of Economics in Katowice Publishing House.
- Suchanek, M.** (2019). *Decyzje transportowe mieszkańców w zakresie codziennych podróży a jakość życia (Residents' transport decisions regarding daily travel and quality of life – in Polish)*. University of Gdańsk.
- Śleszyński, P.** (2013). Delimitation of urban functional areas of voivodeship capitals. *Przegląd Geograficzny*, 85(2), 173–197.
- Vandyck, T., & Proost, S.** (2011). *Inefficiencies in regional commuting policy*. SSRN. <https://doi.org/10.2139/ssrn.1932562>
- Vermesch, P., Boisjoly, G., & Lachapelle, U.** (2021). Commuting mode share and workplace-based public transport services: An equity perspective. *Case Studies on Transport Policy*, 9(3). <https://doi.org/10.1016/j.cstp.2021.02.013>
- Warczevska, B., & Mastalska-Cetera, B.** (2018). Wrocław functional area (WrOF) – Characteristics in terms of potential absorption capacity of areas, infrastructure and ecology of rural areas. *Infrastruktura i Ekologia Terenów Wiejskich*, 1(1), 211–224. <https://doi.org/10.14597/INFRAECO.2018.1.1.014>
- Wąsowicz, K.** (2018). *Efficiency of local public transport utilities (in Polish)*. Foundation of the University of Economics in Krakow.
- Zajfert, M.** (2020). *Efektywność kontraktowania usług kolejowych przewozów regionalnych na przykładzie Polski (Efficiency of regional rail transport in Poland – in Polish)*. Institute of Economics of the Polish Academy of Sciences.

