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ANALYSIS OF THE PROBLEM OF TRANSPORT EXCLUSION IN POLAND

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Purpose: The main aim of the article was to conduct a comparative analysis of transport availability divided into voivodeships in Poland. For this purpose, data on the number of regular, urban, suburban and long-distance lines from all voivodeships in Poland was collected and analyzed in terms of changes over the years and existing correlations.
Design/methodology/approach: The research used basic data analysis, sign test and correlation study.
Findings: The problem of transport exclusion in Poland is noticeable. It especially concerns residents of villages and small towns. Research results indicate that this problem has become more serious in recent years due to the reduction in the number of available connections.
Originality/value: The article presents original research on the change in the number of connections over the years and the correlation between the number of inhabitants and the number of bus connections.
Keywords: transport exclusion, passenger transport, city logistics.
Category of the paper: Research paper.

Introduction

Public transport is one of the most essential elements for the dynamic development of the economy. Omissions and neglect of proper organisation of public transport generate a number of problems of transport exclusion. These problems constitute one of the most acute obstacles facing society today. Despite the great importance of public transport and such a significant impact on the quality of life of the inhabitants, the problems of transport exclusion are often overlooked in public discussions.

The aim of this paper is to carry out a comparative analysis of transport accessibility by voivodeship in Poland. The paper was written based on data made available by the Central Statistical Office. The literature research covers the genesis of the concept of the transport

exclusion problem, the concept of passenger transport and issues related to the organisation of passenger transport. The first part of the paper presents a theoretical outline of the problem of transport exclusion in Poland, followed by identification of its potential causes and the effects it may have on society. The research part of the paper includes a comparative analysis of transport accessibility, taking into account the division into individual voivodeships.

Literature review

Public transport as part of meeting the basic needs of society

The role of public transport is one of the key elements in providing mobility to society. It plays an important role in social and economic development. It generates new jobs in the transport services sector, in the industrial sector and influences the development of tourism and trade. Free access to public transport levels existing social inequalities and those generated by its absence, and has a positive impact on social inclusion and poverty reduction. It intensifies the accessibility of cities, suburban and rural regions (European Environment Agency, 2014). It also influences the accessibility of goods and services, thus contributing to the competitiveness of a region. From an urban perspective, it minimises the phenomenon of road congestion, increases the capacity of the road network, has an impact on air quality, greenhouse gas emissions and, consequently, on climate change, public health and the environment (Bastiaanssen, 2021).

From a public transport perspective, the concept of mobility, which is considered to be the ability and freedom to move people, goods or information within a given space, is extremely important. Mobility also refers to the ways in which the public moves from one point to another (International Energy Agency, 2019). Public transport is substitutable to individual transport, and the extent of substitution varies depending on national transport policies (Ustawa z dnia 16 grudnia 2010).

One of the legal acts regulating the operation of public transport in Poland is the Act of 16 December 2010 on public collective transport. The act entered into force on 1 March 2011 and defines the rules for the organisation and operation of regular passenger transport in public collective transport on the territory of Poland, in the following transport modes: road, rail, cable, cable and railway, sea and inland navigation.

Based on the Public Road Transport Act, individual local government units prepare a plan for the sustainable development of public transport. Such a plan specifies, among other things: the transport network on which transport is planned, the assessment and forecast of transport needs, the issues of financing transport services, the principles of organisation of transport,

the expected standard of transport services and the manner of organisation of the passenger information system.

The existence and operation of public transport is a response to existing transport needs. Within the settlement pattern, people's mobility needs related to their daily social, cultural or recreational life are predominant. The sources of transport needs vary widely and depend on many variables. In the case of passenger transport, factors such as demographic structure or ownership of individual means of transport may be important. An analysis of transport needs is important. The information from the analysis can and should provide the basis for the authorities to act on the transport plan (Rucińska, 2012).

Well-organised public transport has a direct impact on society's living conditions. Its proper organisation has a direct or indirect impact on, among other things (Rydzykowski, 2008):

- reducing unemployment through infrastructure investment,
- reducing the disparities in socio-economic development between regions,
- an increase in the need for associated investment,
- growth in construction investment,
- boosting international cooperation.

One of the most important advantages of public transport is its positive impact on minimising the external costs of transport, e.g. the reduction of CO_2 emissions, pollutants and noise. It is estimated that the use of individual car transport to carry one passenger requires almost three times more energy than a bus journey and about six times more than a train journey (Jakubowski, 2021).

The National Inventory Report 2022 prepared by KOBiZE (Krajowy Ośrodek Bilansowania i Zarządzania Emisjami - the National Balancing and Emissions Management Centre) showed that transport in Poland is responsible for as much as 16.8% of greenhouse gas emissions.

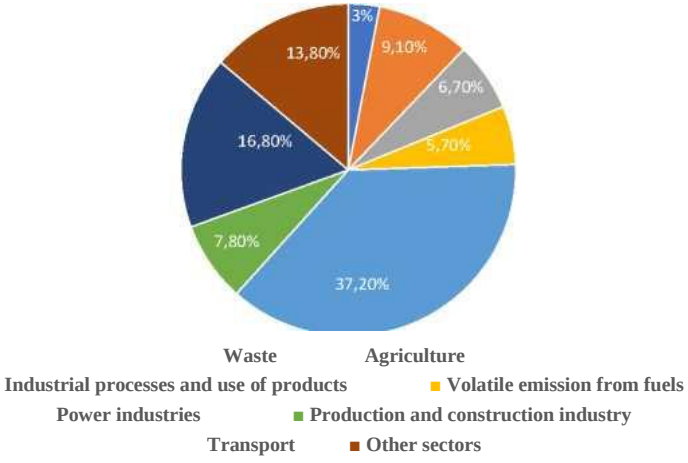

Figure 1. Share of individual source categories in total national greenhouse gas emissions in 2020.

Source: KOBiZE, National Inventory Report 2022 - Synthetic Report, Inventory of greenhouse gas emissions and absorption in Poland for 1988-2020.

According to a 2018 report by the International Energy Agency, public transport is one of the key elements in the fight against climate change and the improvement of air quality especially in urban agglomerations. The study emphasises that the use of public transport, as opposed to individual transport, contributes to the reduction of greenhouse gas emissions and other pollutants (International Energy Agency, 2018). The means of transport used for collective urban transport take up much less space on road networks. It is estimated that there are only around 1.2 to 1.5 passengers per passenger car. This high use of individual means of transport results in a drastic reduction in road capacity. Figure 2 shows the amount of space occupied by individual means of transport for the transport of 30 persons, assuming that there is 1.5 passengers in a passenger car, one bicycle is travelled by one cyclist and one bus is only 75% full.

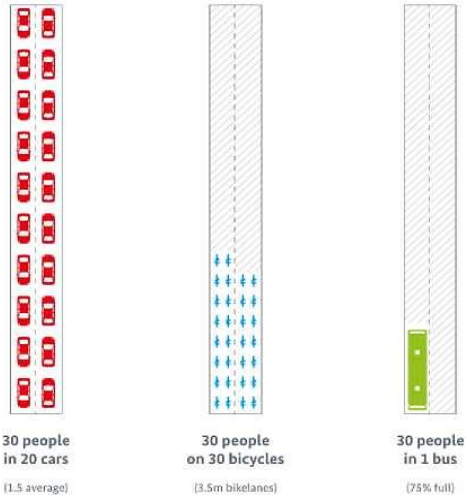

Figure 2. Road space requirements for individual transport modes.

Source: Transformative Urban Mobility Initiative (TUMI), *Road Space Requirements 30 people in 20 cars, 30 people on 30 bicycles*, 30 *people in 1 bus.*

Public transport and transport exclusion

The inheritance of poverty, lack of access to education, lack of access to adequate health care or unemployment are often cited as causes of various types of social inequality. In view of such serious social problems, it is seldom mentioned that the use of, for example, good educational facilities to obtain the right education or qualifications, attractive jobs or the best health facilities requires adequate transport accessibility. Inadequate access to adequate means of transport disqualifies part of the population from accessing such public services. Transport exclusion is neglected in discussions about the causes of social inequalities, and is undoubtedly one of the reasons behind their occurrence (Komornicki, 2019).

Ombudsman Marcin Wiącek has noted that the problem of transport exclusion is a real obstacle to the realisation of citizens' constitutional rights and freedoms, such as freedom of movement, the right to health care, the right of persons with disabilities to assistance from public authorities in social communication, the right to education and the right to benefit from

public services guaranteeing a decent standard of living. The further away from larger towns or metropolitan areas one travels, the more often rural residents point to the numerous inconveniences related to the lack of an adequate transport connection. Organising and managing public transport is the responsibility of the organisers at the various levels of local government (Starzewski, 2021). In the context of the problem of transport exclusion, the notion of accessibility is extremely important; it refers to the degree of ease with which one can get to a given place, thanks to the existence of appropriate infrastructure and transport services. A particular area is more accessible in terms of transport, the more points it can be reached quickly and efficiently (Ministry of Transport, 2020) Figure 3 shows the distribution of transport accessibility when using bus services for long-distance travel. There is considerable variation between the different regions of Poland. The greatest accessibility is characteristic for large urban agglomerations, and the least for regions distant from these agglomerations.

Transport exclusion is understood as depriving the inhabitants of a given area of the possibility of using public transport. This phenomenon includes mainly limited access to roads, but also to railways, pavements or cycle paths (Dulak, 2018).

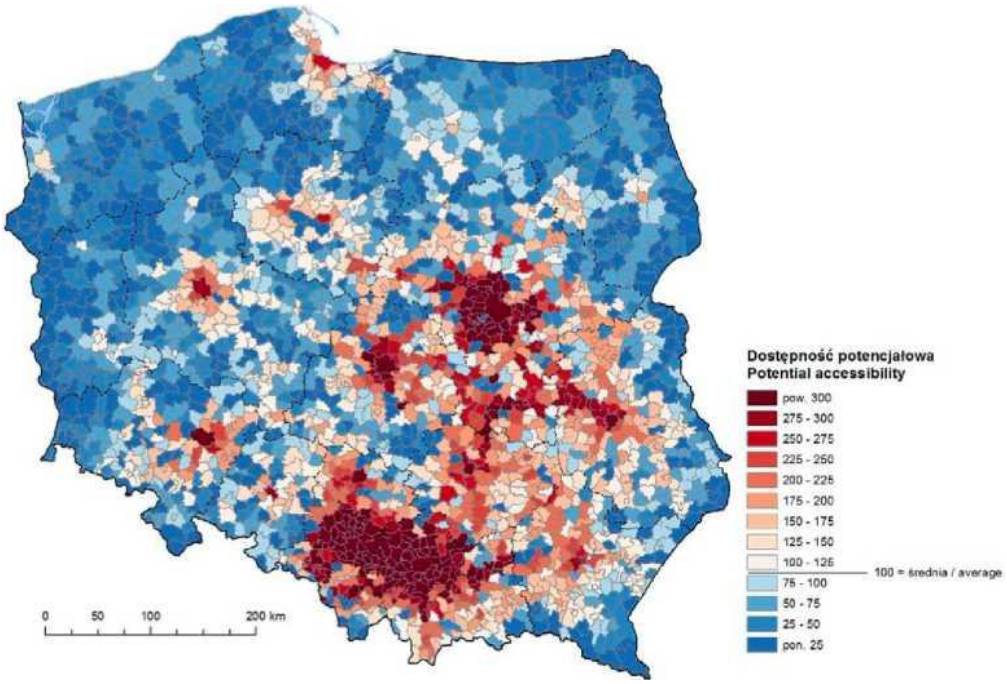

Figure 3. Availability of bus transport for long journeys in Poland in 2018.

Source: Rosik, Pomianowski, Kołoś, Guzik, Goliaszek, Stępniak, Komornicki, 2018 .

Demographic changes and the depopulation of society in mainly rural areas, but also in smaller towns, were also one of the factors contributing to the widening of the problem of transport exclusion. The process of depopulation of rural areas has been ongoing in Poland for several decades. The pace and scale of this process was directly dependent on the economic development of individual regions. Rural depopulation contributed to a decrease in the number of passengers on rural routes, which resulted in their closure. The dispersion of buildings in Poland did not facilitate the optimisation of routes. Rural depopulation and reduced

accessibility of public transport significantly hindered and still hinders daily life for rural residents (Wesołowska, 2016).

The effects of the problem of transport exclusion in Poland are widespread. The Jagiellonian Club estimated that transport organised by local authorities does not exist in an area currently inhabited by around 13.8 million people, which gives us around 36.54% of the Polish population. The scale of the problem is enormous, and it is very often overlooked in social discussions related to social exclusion. According to Jagiellonian Club estimates, between 1993 and 2016 non-urban regular bus transport lost about 75% of its customers, with a reduction of about 50% in the availability of the offer. Since 2004, the average filling of buses has decreased by 40% (Dulak, 2018).

The effects of transport exclusion are often the stories of the people affected. In her reportage book *Nie zdążę* Olga Gitkiewicz presents stories of people affected by transport exclusion. The society affected by this problem mentions that the lack of adequate transport forces people to give up their jobs, better educational facilities, extra-curricular activities, doctor's appointments, office visits and much more. Transport exclusion contributes to permanent unemployment for people who find it unprofitable to work in remote areas if public transport is not provided in the municipal area. It also proves impossible to get to work if the last return fare is at 3 pm or if it only runs on school days. The removal of direct transport to larger towns also removes the possibility of choosing better educational facilities or taking advantage of the extra activities that often take place in the afternoon. The lack of adequate transport accessibility thus restricts the life choices of young people of school age. A significant effect of the decommissioning is also the functional degradation of smaller towns or district towns, which used to serve as local centres to which residents travelled by public transport. The removal or reduction of connections may result in residents being deprived of access to basic services that enable them to function properly. The lack of a connection to the nearest health centre can result in reduced health. Removal of connections takes away the ability to get to an office, post office or bank, leaving non-motorised people relying solely on the goodwill of those with cars. Lack of access to basic services results in social isolation and reduced quality of life. This problem very often affects older people who do not have a car. The elimination of connections also results in migration from smaller to larger towns. Centralisation forces people to change their place of residence or work. This phenomenon also influences the spatial degradation of smaller towns. The answer to the lack of access to public transport is the choice of individual transport, most often in the form of a purchased personal car. This form of transport is very often chosen by the public, as can be seen in the statistics showing the number of cars per number of inhabitants (Gitkiewicz, 2019; Kaczorowski, 2019).

The lack of well-developed public transport also affects the country's economic development and tourism. Well-developed communication enables tourists to move freely and reach their destination. Highly developed public transport has a direct impact on the living conditions of the population. Public transport assists in generating a higher national income and

supports economic development through its direct impact on unemployment levels, the reduction of social disparities, the need for accompanying and construction investments, and international cooperation.

Methodology of the study

The analysis carried out below aims to present the accessibility of transport in Poland by voivodeships for the period 2014-2021. The data adopted for the analysis was taken from the official website of the Central Statistical Office in Poland. The research focuses on road transport, as it is the most commonly used transport mode in Poland.

The analysis was carried out using mathematical methods, the sign test, forecasting and correlation. The mathematical methods made it possible to determine the percentage decrease/increase in the number of connections and the distances over which connections are made. The sign test is based on the sign of the differences between successive pairs of results. It involves determining the number of pluses and minuses and comparing them with the theoretical value given in the relevant tables. The sign test made it possible to determine whether the hypothesis that there was a significant decrease in the number of connections in most voivodeships was true. Correlations between the population of a province and the number of connections were then examined. The sequence of analysis steps is shown in Figure 4.

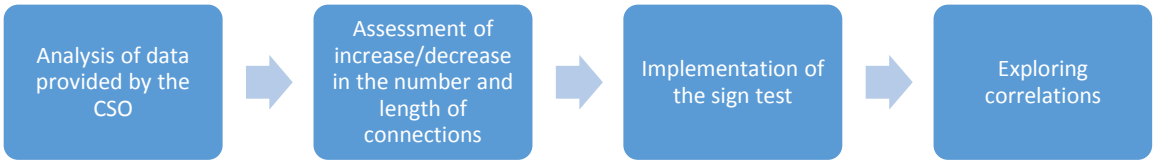

Figure 4. Subsequent stages of the study.
Source: own work.

Analysis of the problem of transport exclusion- results

The comparative analysis began with the collection and organisation of data available from the Central Statistical Office (CSO), followed by the creation of a table which included the number of inhabitants in the region, the number of regular lines and the length of regular lines in the years 2014 and 2021 respectively. The results are presented in Table 1.

Table. 1.
Regular lines in 2014 and 2021 by voivodeship

	Number of inhabitants		Regular transport lines in total [pcs]		Difference		Regular transport lines in total [km]		Difference	
Voivodeship	**2014**	**2021**	**2014**	**2021**			**2014**	**2021**		
Dolnośląskie	2909997	2897700	1 243	782	-461	-37%	61 840	30 551	-31 289	-51%
Kujawsko-Pomorskie	2092564	2912200	2 148	904	-1 244	-58%	95 689	35 304	-60 385	-63%
Lubelskie	2156150	2038300	1 218	646	-572	-47%	67 412	31 425	-35 987	-53%
Lubuskie	1021470	1178600	743	543	-200	-27%	30 369	16 797	-13 572	-45%
Łódzkie	2513093	1821895	865	567	-298	-34%	45 252	23 103	-22 149	-49%
Małopolskie	3360581	3430400	252	118	-134	-53%	10 533	5 447	-5 086	-48%
Mazowieckie	5316840	5512800	2 390	890	-1 500	-63%	132 715	58 316	-74 399	-56%
Opolskie	1004416	948600	393	512	119	30%	12 417	14 264	1 847	15%
Podkarpackie	2129294	2085900	674	799	125	19%	30 999	35 378	4 379	14%
Podlaskie	1194965	1148700	642	364	-278	-43%	38 793	27 079	-11 714	-30%
Pomorskie	2295811	2358700	815	588	-227	-28%	39 455	22 489	-16 966	-43%
Śląskie	4599447	4375900	693	335	-358	-52%	35 799	11 006	-24 793	-69%
Świętokrzyskie	1268239	1187700	411	238	-173	-42%	24 891	9 572	-15 319	-62%
Warmińsko-Mazurskie	1446915	1374700	759	335	-424	-56%	44 345	13 943	-30 402	-69%
Wielkopolskie	3467016	3500000	1 262	884	-378	-30%	54 093	30 324	-23 769	-44%
Zachodniopomorskie	1718861	1650000	990	800	-190	-19%	64 010	33 913	-30 097	-47%

Source: own work.

In 2014, Mazowieckie Province had the highest number of regular communication lines (2390 pcs), while Malopolskie Province had the lowest (252 pcs.). In 2021, no voivodeship had more than one thousand connections, with the highest number (904 pcs.) in the Kujawsko-Pomorskie voivodeship and the lowest (118 pcs.) in the Małopolskie voivodeship. As can be seen from Table 1, fourteen out of sixteen voivodeships saw a decrease in the number of regular transport lines in 2021 compared to 2014. The largest decrease amounted to 63% and concerned the Mazowieckie voivodeship, in which the number of regular connections decreased over the period under study from 2390 in 2014 to 890 in 2021. Only in two voivodeships can an increase in the number of connections be observed, by 30% in the Opolskie voivodeship and 19% in the Podkarpackie voivodeship. The situation is similar for the length of regular transport connections. Here, too, a decrease in the length of routes was recorded in 87.5% of the voivodeships, with the greatest decrease of almost 70% in the Śląskie and Warmińsko-Mazurskie voivodeships, which means that the length of routes decreased by 30402 km in the Śląskie voivodeship and 24 793 km in the Warmińsko-Mazurskie voivodeship, respectively. An increase in the length of regular transport routes was recorded in the Opolskie and Podkarpackie voivodeships. The collected data was then sorted out and the number and length of long-distance bus routes in the individual provinces were analysed (Table 2).

Table. 2.
Long-distance lines in 2014 and 2021 by voivodeship

	Number of inhabitants		Long-distance lines [km]		Difference		Regional lines [km]		Difference	
Voivodeship	2014	2021	2014	2021			2014	2021		
Dolnośląskie	2909997	2897700	21 673	4 626	-17 047	-79%	10 518	3 518	-7 000	-67%
Kujawsko-Pomorskie	2092564	2912200	16 298	624	-15 674	-96%	25 684	4 982	-20 702	-81%
Lubelskie	2156150	2038300	18 185	6 711	-11 474	-63%	17 150	6 284	-10 866	-63%
Lubuskie	1021470	1178600	5 105	0	-5 105	-100%	10 666	4 820	-5 846	-55%
Łódzkie	2513093	1821895	12 081	1 767	-10 314	-85%	13 225	5 357	-7 868	-59%
Małopolskie	3360581	3430400	495	275	-220	-44%	4 178	1 854	-2 324	-56%
Mazowieckie	5316840	5512800	42 188	28 972	-13 216	-31%	31 553	8 073	-23 480	-74%
Opolskie	1004416	948600	507	0	-507	-100%	2 814	1 090	-1 724	-61%
Podkarpackie	2129294	2085900	7 376	5 853	-1 523	-21%	6 347	6 819	472	7%
Podlaskie	1194965	1148700	15 497	5 291	-10 206	-66%	9 227	4 146	-5 081	-55%
Pomorskie	2295811	2358700	8 056	370	-7 686	-95%	10 616	7 161	-3 455	-33%
Śląskie	4599447	4375900	11 048	1 179	-9 869	-89%	5 694	2 207	-3 487	-61%
Świętokrzyskie	1268239	1187700	11 431	4 337	-7 094	-62%	4 232	373	-3 859	-91%
Warmińsko-Mazurskie	1446915	1374700	13 604	2 118	-11 486	-84%	13 773	3 515	-10 258	-74%
Wielkopolskie	3467016	3500000	6 954	0	-6 954	-100%	14 359	3 641	-10 718	-75%
Zachodniopomorskie	1718861	1650000	17 963	432	-17 531	-98%	22 324	7 570	-14 754	-66%

Source: own work.

Table 2 shows that all the voivodeships surveyed recorded a decrease in the number of longdistance bus lines; moreover, in as many as three voivodeships (Opolskie, Lubuskie and Wielkopolskie) the decrease reached 100%, which means that the lines, all the lines that existed in 2014, were removed completely. Not much better, is the question of the length of regular longdistance lines, only in one of the sixteen provinces a small 7% increase in the length of routes can be seen. Moreover, in 87.5% of the provinces, the decrease was more than 50% over just seven years. The next stage of the analysis was to collect and organise data on the number of urban and suburban lines in each voivodeship in the years 2014 and 2021. The results are presented in Table 3.

Table. 3.
Suburban lines and urban lines in 2014 and 2021 by voivodeship

	Number of inhabitants		Suburban lines [pcs]		Difference		Urban lines [pcs]		Difference	
Voivodeship	2014	2021	2014	2021			2014	2021		
Dolnośląskie	2909997	2897700	1 004	687	-317	-32%	25	17	-8	-32%
Kujawsko-Pomorskie	2092564	2912200	1 723	845	-878	-51%	7	0	-7	-100%
Lubelskie	2156150	2038300	900	566	-334	-37%	0	0	0	-
Lubuskie	1021470	1178600	567	436	-131	-23%	9	0	-9	-100%
Łódzkie	2513093	1821895	674	486	-188	-28%	12	15	3	25%
Małopolskie	3360581	3430400	193	98	-95	-49%	15	0	-15	-100%
Mazowieckie	5316840	5512800	1 864	736	-1 128	-61%	32	1	-31	-97%
Opolskie	1004416	948600	332	487	155	47%	9	11	2	22%
Podkarpackie	2129294	2085900	566	700	134	24%	4	0	-4	-100%
Podlaskie	1194965	1148700	462	303	-159	-34%	6	4	-2	-33%
Pomorskie	2295811	2358700	631	466	-165	-26%	20	5	-15	-75%
Śląskie	4599447	4375900	569	271	-298	-52%	16	26	10	63%
Świętokrzyskie	1268239	1187700	332	222	-110	-33%	0	0	0	-
Warmińsko-Mazurskie	1446915	1374700	482	285	-197	-41%	32	0	-32	-100%
Wielkopolskie	3467016	3500000	1 048	824	-224	-21%	6	0	-6	-100%
Zachodniopomorskie	1718861	1650000	676	678	2	0%	15	3	-12	-80%

Source: own work.

Suburban lines are lines within 50-60km connecting rural settlements with municipal, district and provincial centres. In both 2014 and 2021, Kujawsko-Pomorskie voivodeship had the highest number of suburban lines (1723 pcs. in 2014, 845 pcs. in 2021). Unfortunately, over the years, all voivodeships have seen a significant decrease in the number of suburban lines, which in the extreme case was as high as 61%. The Mazowieckie (32 pcs.) and Warmińsko-

Mazurskie (32 pcs.) voivodeships had the largest number of urban bus lines, understood as lines within cities with possible crossing of city boundaries to the nearest catchment area with a length of 5-10 km, in 2014. From 2014 to 2021, 5 voivodeships have completely eliminated urban lines. No city lines are in place in the Świętokrzyskie and Lubelskie voivodeships. The Śląskie voivodeship, on the other hand, recorded a 63% increase in the number of urban lines, which may be due to the reduction in the length of transport routes and the conversion of suburban lines into urban ones.

The next step in the analysis of the problem of transport exclusion in Poland was to perform a sign test. The sign test made it possible to verify the null hypothesis that there was no significant decrease in the number of regular bus lines in total in individual voivodeships over the study period. This test consists of determining the number of pluses and minuses between successive pairs of results and comparing them with table values. The test was performed using Statistica and the analysis was carried out for the years 2014 and 2021. The result is shown in Table 4.

Table. 4
The result of the Statistica program's sign test

	Sign test (number of regular bus lines) The indicated results are significant p <.5000			
Pair of variables	**Number of voivodeships**	**Percentage v < V**	**Z**	**p**
Year 2014 and 2021	16	12.50000	2.750000	0.005960

Source: compiled using Statistica.

Sixteen groups (voivodeships) took part in the test. The number of variables for which the difference has a negative value was 12.5%, and the value of the sign test was 2.75. The significance level of the test was 0.005960, which means that $p<0.05$, so there are grounds for rejecting the null hypothesis, and this means that there is likely to have been a significant decrease in the number of regular bus routes.

The next stage of the research involved examining the correlation between the population in the voivodeships and the number of connections. The analysis was carried out first for the year 2014 and then for the year 2021, both using the Ststistica programme. The results are shown in Figures 6, 7 and table 6, 7.

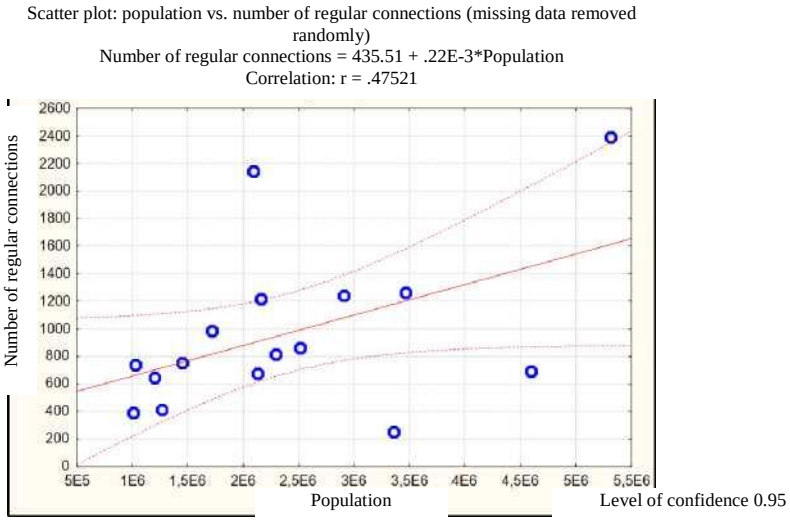

Figure 6. Study of the correlation between population and number of connections in 2014 - scatter plot.

Source: compiled using Statistica.

Table 6.

Study of the correlation between population and number of connections in 2014

X variable and Y variable	**Correlations (correlation study) Identified correlation indexes are significant p < .05000 (missing data randomly removes)**						
	Average	**St. deviation**	**r(X, Y)**	**r2**	**t**	**p**	**Significant**
Population	2405979	1261494					
Regular connections	969	588	0.475215	0.225829	2.020857	0.062848	16

Source: compiled using Statistica.

As can be seen from table 6, the 42nd value of the correlation coefficient is 0.475 indicating a moderate linear relationship, population to number of regular connections in 2014. The coefficient of determination is 0.2258, which means, the number of regular connections is only explained by 22.58% of the variation in population. The significance coefficient p, is greater than 0.05, which means that, the correlation coefficient is not significantly different from 0.

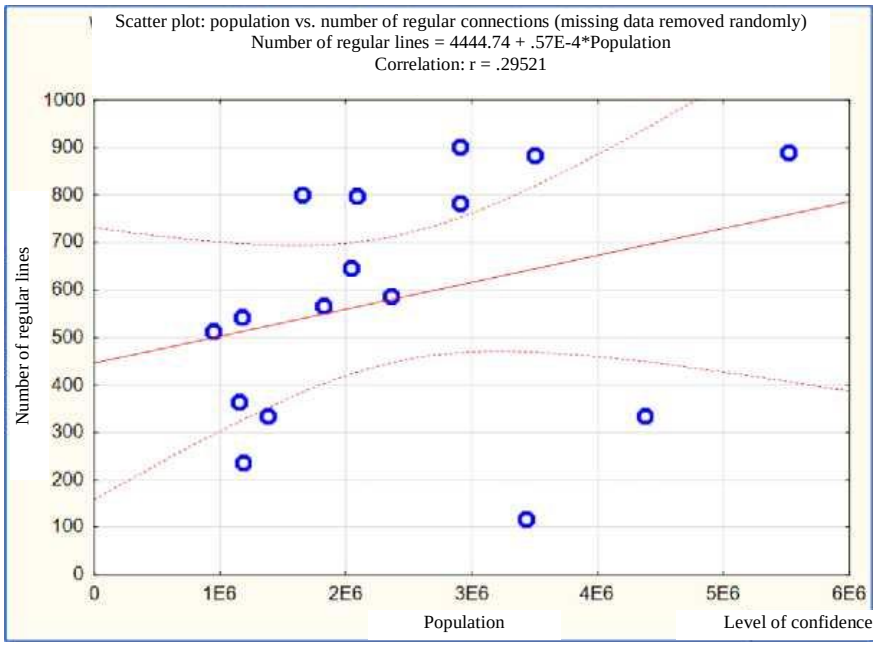

Figure 7. Study of the correlation between population and number of connections in 2014 - scatter plot. Source: compiled using Statistica.

Table 7.
Study of the correlation between population and number of connections in 2014

X variable and Y variable	**Correlations (sheet 5) Identified correlation indexes are significant p < .05000 (missing data randomly removes)**						
	Average	**St. deviation**	**r(X, Y)**	**r2**	**t**	**p**	**Significant**
Population	2401381	1295850					
Regular connections	582	250	0.295211	0.087149	1.156101	0.266988	16

Source: compiled using Statistica.

As can be seen from Figure 29, the 42nd value of the correlation coefficient is 0.2952 indicating a weak linear relationship, population to number of regular connections in 2021. The coefficient of determination is 0.0871, which means, the number of regular connections is explained only in 8.71% by the variation in population. The significance coefficient, p, is greater than 0.05, which means that, the correlation coefficient is not significantly different from 0.

Conclusions

The problem of transport exclusion is not a new one, but over the years, we can observe its escalation and how its impact on the surrounding area is changing. The extent of the occurrence of the transport problem depends on the level of transport accessibility, which has changed a lot over the years analysed. Undoubtedly, from 2014 to 2021 the number of regular bus routes,

the length of transport routes, the number of urban and suburban transport lines in each province is decreasing. The results show that the number of inhabitants has a weak influence on the number of regular transport connections in the regions concerned. It should therefore be considered which factors, criteria should be taken into account when organising a network of connections in individual voivodeships. In order to counteract transport exclusion, it is necessary to study the transport needs of the inhabitants, especially in less populated regions with dispersed housing, analyse them and then organise public transport in accordance with the results of the study. Adequate financial support is also necessary, especially for less profitable routes. Less densely populated regions should be provided with new connections, enabling their inhabitants to function properly and to have free access to public services such as health, culture or education and to commute to work.

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