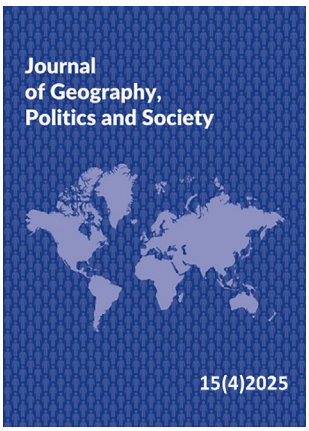

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ASSESSMENT OF TRANSPORT BEHAVIOUR: THE EXAMPLE OF RESIDENTS OF THE BYDGOSZCZ REGION IN POLAND

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Abstract
The aim of the study is to identify the transport habits of residents living in the chosen area, assess these behaviours, determinants shaping them, their effects and to gauge the scale of transport exclusion. The main objective is to develop a set of recommendations for modelling sustainable transport and mobility planning. Specific objectives include multi-criteria, qualitative and quantitative data analysis, spatial analysis using GIS tools, and the application of the author's analytical matrix to assess transportation behavior. The research findings provide an insight into the framework for assessing transport behaviour which shows significant dependency on cars and the importance of public transport. It is indicated that accessibility to the public transport affects daily life of the residents. The research procedure and analytical matrix used have theoretical and practical implications for a wide audience. The results indicate which areas of public transport require improvements.

Key words
transport behaviour, transport, mobility, strategic planning, transport planning, spatial analysis.

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1. Introduction

In Poland, significant changes in the field of public transport (PT) took place after the political and economic transformation in the 1990s. At that time, the state-owned bus company (PKS) was privatised. Competition between private operators resulted in limiting services to destinations characterised by a smaller passenger flow. Meanwhile, the railway system continued to decline in the country. The process of closing less profitable routes, initiated in the mid-1980s, continued. The restructuring of the Polish Railway Lines (PKP) began in 2000. Many localities in Poland were cut off from PT, affecting residents' quality of life. Poland's accession to the European Union (EU) created an opportunity to improve the state of PT in the country (Żukowska et al., 2023.

Transport behaviours are determined by transport needs and accessibility to means of

transport, including PT and micromobility. Reduced accessibility may contribute to difficulties in meeting basic transport needs. As Lucas (2012) noted, this is conducive to social exclusion. A lack of PT results in the phenomenon of 'forced car ownership'. The increased number of vehicles on the road has negative environmental and social consequences. The solution to these problems is the creation of a well-functioning PT system responding to the needs of the local population.

The aim of the study was to assess the transport behaviours of the residents of the Bydgoszcz region, taking into account the effects of PT presence in the area. The obtained results made it possible to determine the transport preferences of the residents. The findings allowed the authors of the study to develop a set of recommendations for shaping sustainable transport planning in the Bydgoszcz region, especially in urban-rural and rural municipalities, in order to increase transport accessibility for residents and to promote more sustainable mobility habits.

The study is original and innovative because of its interdisciplinary nature – it brings together different aspects of the social sciences. The local approach to the problem (concerning the Bydgoszcz region in Poland and its inhabitants) allows the focus to be placed on transport problems on a micro-scale, which makes it possible to better define the directions for the development of PT. The integrated approach of the study focuses on both the connectivity of the municipalities of the Bydgoszcz District with the region's central hub – Bydgoszcz – and the transport behaviour of its residents. The proposed approach allows the identification of areas where PT connections should be developed. The central theme of the study is transport exclusion. It is of significant social importance, contributing to a better understanding of the problem and proposing effective solutions. The identification of areas affected by transport exclusion and the analysis of the impact of PT connections on the behaviour of residents provide the basis for the development of public PT policies. The study can be replicated in other regions of Poland, in municipalities located in the satellite of large cities (municipalities of urban functional areas, MOFs), facing similar PT problems.

The study conducted has limitations that are encountered in other studies related to transport exclusion (e.g. Ciechański, 2020; Guzik, Kołoś, 2021; Orchowska, 2022). One of these is access to timetable data. Numerous PT bus service providers often do not post all the information on their websites, or it may not be up-to-date due to multiple schedule changes throughout the year (Ciechański, 2020; Guzik, Kołoś, 2021; Orchowska, 2022). This may have affected the lack of comprehensive analyses of PT operating in the Bydgoszcz region. A second limitation was encountered during the survey. Due to limited financial resources, it took the form of a CAWI technique. Therefore, people without access to a smartphone or a computer with an Internet connection could have been excluded. There was also the possibility of falsification of responses by respondents (Andrałojć, 2006).

2. Literature review

Developing a transport policy is the responsibility of authorities at various levels, the most detailed one falling under the jurisdiction of responsibilities of local-level decision-makers. In the case of cities, they are obliged to organize PT for residents and to mitigate the negative effects of transportation. One of the key objectives of the EU's transport policy is sustainable development, which should be understood as increasing the share of travel using PT as well as promoting environmentally friendly modes of transport. Regional transport plays a crucial role in achieving this goal in moderately urbanised areas.

Research questions have been formulated: RQ1: What factors influence the transport behaviour of regional transport users; RQ2: How critical is the problem of transport exclusion in this context; RQ3: What challenges does the Bydgoszcz region face. Subsequently, the PRISMA analysis method was applied using Mendeley's publication categorisation tool and MS Excel for detailed Systematic Literature Review (SLR) (Mańkowski et al., 2022; Denyer, Tranfield, 2009). One hundred and eighty-one scientific articles sourced from the Web of Science and Google Scholar databases were analysed for the purposes of this publication (tab. 1). Key phrases used were: (1) 'transport* policy AND passenger AND rural', (2) 'transport* AND region* OR rural', and (3) 'transport* AND Bydgoszcz OR Bydgoski'. The timeframe 2004-2023 was taken into account due to Poland's accession to the EU. Furthermore, the publications had to be available in open access in English or alternatively Polish. Articles that focused on different research topics (n=95) were excluded from the analysis based on their abstracts.

The formulation of adequate transport policies is necessary due to the increasing share of car travel and the associated problems (Bole et al., 2012; Johansson et al., 2017, Karu et al., 2007). A key element in developing policies and strategies is the study of transport users' behaviour. Analyzing their behavior enables the modification of existing patterns (fig. 1).

Tab. 1. Key characteristics and meanings in postmodern cultural narratives

Number of publications	Input phrases		
	(1)	(2)	(3)
Total	67	64	50
Included in the abstract review	49	61	33
Included in full text analysis	29	42	14

Source: own elaboration.

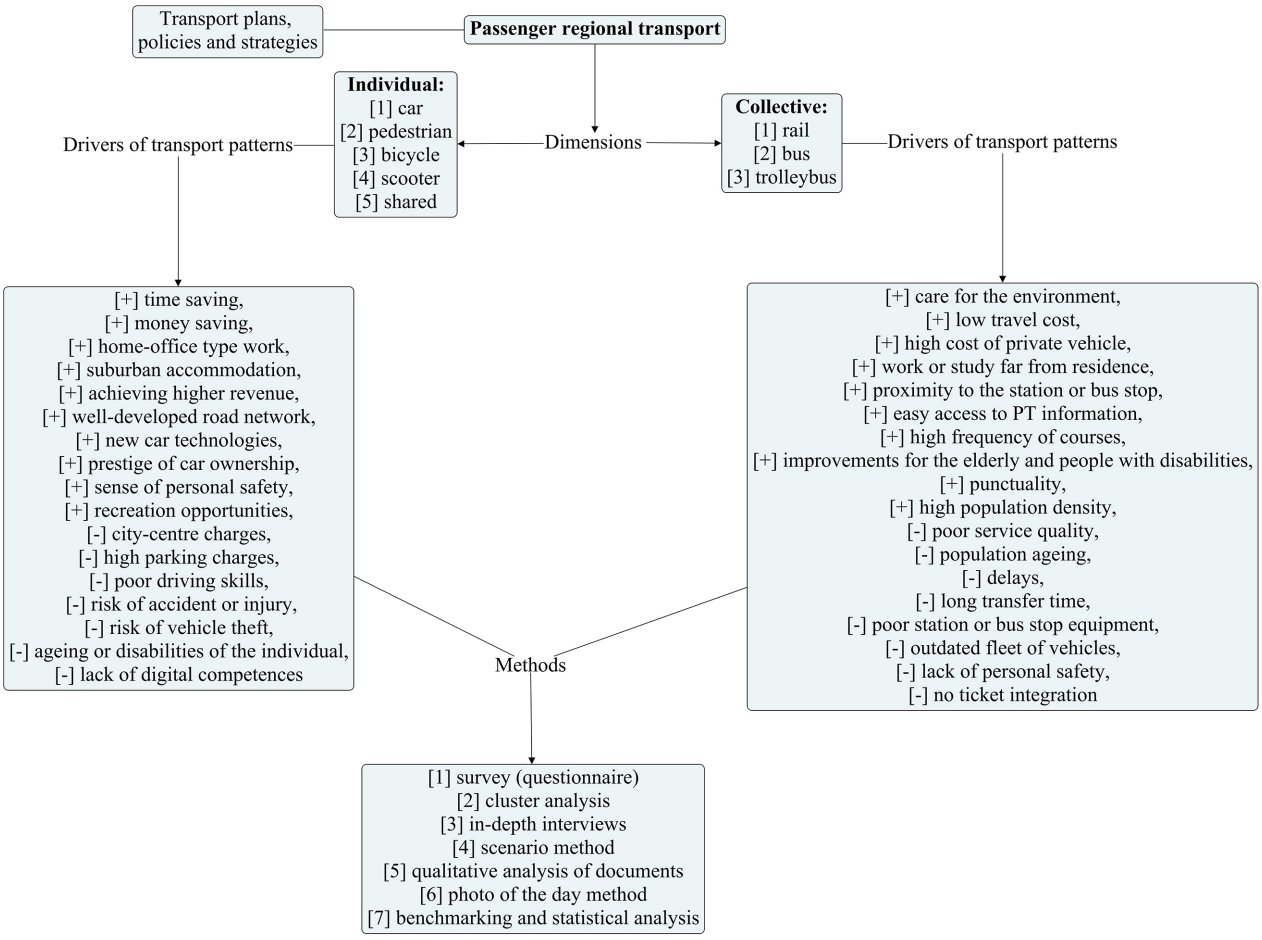

Fig. 1. Regional transport with motivating factors [+] and demotivating factors [-] influencing its usage.
Source: own elaboration based on SLR.

The primary transport requirements include punctuality, directness, and service frequency (Safronova et al., 2020; Tirachini, Cats, 2020). Transport behaviours can be defined as the requirements regarding transport use reported by users. These behaviors depend on factors such as the degree of urbanisation, age, psycho-physical condition or wealth of users (Safronova et al., 2020; Mittal et al., 2017; Hansson et al., 2019). The three methods that are most commonly used to study transport behaviour are survey questionnaires, cluster analysis and in-depth interviews.

Significant time savings and absence of transfers are the main reasons people choose private transport. Although cost savings are frequently cited as a benefit, they are often misleading in the case of cars, as their users do not include compulsory insurance, parking fees or potential repairs in their daily cost of travel. Private vehicles are more likely to be chosen by people who work from home (Kuźmicz et al., 2022), have higher incomes (Safronova et al., 2020), live in suburban or rural areas (Martin et al., 2010; Leetmaa, Tammaru, 2007) and use private vehicles for recreational purposes (Bermudez-Hernandez et al., 2022). In contrast, PT is most often used by people who work outside their place of residence, live close to stops or stations (Lantseva, Ivanov, 2018), have lower income (Mittal et al., 2017), and are more concerned about environmental sustainability (Koźlak, 2020).

Factors that discourage the use of private vehicles

include additional fees, lack of driving skills or reduced physical capacity (Kuźmicz et al., 2022; Bell et al., 2021). In the case of PT, these include poor quality of service, lack of improvements for the elderly, delays and long waiting times for transfers, inadequate infrastructure at bus stops and a low sense of security (Tirachini, Cats, 2020; Karu et al., 2007).

Determining users' needs and expectations with the aid of spatial analyses ensures the effective development of PT (Pavlyuk et al., 2020). At the regional level, low population density could indicate a lack of economic justification to maintain PT, which makes it impossible to achieve the overarching goal of sustainable transport, i.e. namely, reducing the number of car journeys. In the region of Bydgoszcz, the biggest challenge related to PT is suburbanisation and the outflow of residents from Bydgoszcz – the region's central city – to suburban municipalities. This causes problems of inadequate transport infrastructure, congestion and transport exclusion as a result of the mismatch between the region's PT offer and the needs of its residents.

A particular challenge is the phenomenon of transport exclusion. It is defined in the literature as a limitation in the ability to meet needs due to inadequate mobility as a result of the absence or limited network of PT links (e.g. Kamruzzaman et al., 2016). Transport exclusion affects transport behaviour, which can be defined as the choice of travel mode to meet mobility needs (Arnott et al., 2014). In Poland, the reduction of public transportation links is linked to the socio-economic changes that occurred in the late 1980s and early 1990s, including those affecting PT (Taylor, 2006; Šťastná, Vaishar, 2017; Taylor, Ciechański, 2018; Ciechański, 2021). Major changes in mobility occurred due to the outbreak of the Covid-19 pandemic, during which transport behaviour was reoriented (Wielechowski et al., 2020; Koehl, 2021; Przybylowski et al., 2021). The use of PT was discouraged due to its identification as a potential vector for pathogen transmission. In addition, many PT companies reduced the network of connections, and in most cases, these services did not return to their pre-pandemic levels once the health threat had subsided. The individuals most vulnerable to the phenomenon of transport exclusion are residents of peripheral areas within the region, situated near the borders of municipalities and counties, and residing far from the primary transport route (Chmielewski, Szczuraszek, 2016; Guzik et al., 2021; Taylor, Ciechański, 2018; Żukowska et al., 2023). In these areas, PT networks are limited or do not function at all. This makes it difficult for residents to reach educational, health or cultural facilities. It also reduces employment opportunities, making it harder to secure better-paid jobs or any employment at all (Guzman et al., 2017). Among young people, there is a noticeable tendency to choose lower-quality secondary schools with better transport links is evident, as well as an exodus to larger urban centres. The phenomenon of transport exclusion can contribute to social exclusion or even poverty, affecting individuals and entire communities (Delbosc, Currie, 2011; Velaga et al., 2012).

Poland's population is ageing, which is a key factor that decision-makers and planners should consider. Ageing affects transport behaviour (Urbanek et al., 2023). Older adults, as well as individuals with disabilities, have specific transport needs (Chaisomboon et al., 2020; Ryan et al., 2023; Urbanek et al., 2023). These include the availability of adapted low-floor PT vehicles, the removal of architectural barriers in surrounding infrastructure, and the proximity of PT stops to residential areas (Papa et al., 2018; Cirella et al., 2019; Chaisomboon et al., 2020). Transport exclusion can affect the perception of a region's competitiveness and the failure to realise its full potential (McDonagh, 2006). The poorer an area's connectivity, the less attractive it becomes for investors (Guzman et al., 2023; Lavadinho, 2017). Challenging commutes discourage individuals living in remote areas from traveling daily, reducing the effectiveness of investments. In addition, regions with tourism potential remain underutilized due to limited accessibility. Coordinating PT services would enhance accessibility and promote these areas, ultimately generating more income for the local community (Tóth et al., 2014; Kołodziejczyk, 2020; Hansson et al., 2019).

3. Materials and methods

The study was based on complementary qualitative and quantitative analyses with a particular emphasis on case studies (Czarniawska, 2014). Stage (I) involved the review and analysis of planning documents and local strategies, (II) w involved conducting a survey using the CAWI technique with non-random sampling based on the snowball method; this stage was divided into a pilot study and the main survey, (III) comprised the synthesis and processing of the results.

The subject of the research was the case of the Bydgoszcz region in Poland, which serves as a representative example (a larger city as the core and smaller settlements functioning as satellites). The functional-spatial structure of interconnected localities in a regional arrangement is a common example also observed in other countries, particularly in Central and Eastern Europe (CEE).

The qualitative methods used included an analysis of the scientific literature on transport behaviours and preferences, as well as spatial-temporal accessibility (Czarniawska, 2014). A critical analysis of strategic and planning documents was conducted for Bydgoszcz County, the Bydgoszcz-Toruń Functional Area (B-TOF) and the individual municipalities within the county. The research examined 23 studies, which were screened for information on challenges and initiatives related to the development of transport and mobility, with a focus on improving the quality of life for local residents. The materials were obtained from the publicly accessible online Public Information Bulletin (PIB) database of the individual municipalities covered by the study.

Preliminary analyses and a literature review made it possible to formulate research hypotheses. It was found that the areas of the Bydgoszcz region are characterised by different transport accessibility. Peripheral areas located further away from Bydgoszcz (the core city) tend to be less well connected to PT due to their geographical position. Residents of the Bydgoszcz region may be at risk of transport exclusion.

In parallel with the literature review, a remote survey was conducted (Czarniawska, 2014). The questionnaire was active between March and September 2023. A pilot study was carried out in January 2023 on a group of 30 respondents. Based on the pilot results, the final version of the questionnaire was developed and structured into the following sections: (1) respondent's particulars, (2) transport behaviours, and (3) accessibility and quality of transport.

The main survey included 486 people. The ratio of the research sample to the number of questions was 5 to 1 (5:1). According to social research methodology, this ratio is considered sufficient for scientific exploration and provides a reliable estimate of the studied phenomenon (Memon et. Al., 2020). Assuming a 95% confidence level for the study population (458,000 inhabitants of the region), the minimum representative sample is 384 respondents, with a maximum margin of error of 4%. Therefore, it can be assumed that the response rate of 486 questionnaires allows for valid inferences about the entire population of the Bydgoszcz region. The online questionnaire was created using Microsoft Forms tool, chosen for its financial accessibility and under-friendly interface. The survey consisted of 25 closed and open-ended questions and was fully anonymous. The use of a mixed-response format (open-ended, closed, single-, and multiple-choice) enabled a more comprehensive understanding of the research topic.

The analysis and visualisation of GIS spatial data were conducted in this study using the open-source software QGIS version 3.28 LTR (Neutens, 2015). The spatial analyses included: administrative distribution, the transport network (road, rail), and the modelling of connectivity for the studied municipalities on weekdays and weekends (Ballas et al., 2017). Spatial data from the Topographic Database (BDOT10k) in the scale of 1:10 000 were utilized, along with quantitative data sourced from the Central Statistical Office and PT timetables operating within the research area.

An analytical matrix of transport behaviour was developed for the study (presented in part "Recommendations and directions for intervention"). It constitutes the result of previously conducted analyses. It was divided into 5 categories: travel time, travel planning, ease of travel, travel costs, and environmental impact. Each category contained three subcategories and between three and five areas of intervention. The matrix adopted the following scale: * – for a situation not requiring intervention, ** – for a situation requiring intervention and *** – for a situation where intervention is a must. The analytical matrix of transport behaviors formed the basis for identifying the directions of PT development in the Bydgoszcz region and formulating the study's conclusions.

4. Results

4.1. Characteristics of the study area

The Bydgoszcz region is located in the central part of the Kujawsko-Pomorskie province and is part of the B-TOF. It consists of Bydgoszcz, a city with county rights, and eight municipalities within Bydgoszcz County. Six of these are rural, while two are urban-rural (fig. 2A). The region comprises 220 localities, three of which have city status (Bydgoszcz, Koronowo, Solec Kujawski). The Bydgoszcz region covers an area of ca. 157,000 km2. The largest municipality is Koronowo (41,150 km2), while the smallest is Osielsko (10,200 km2) (Central Statistical Office, 2023).

The Bydgoszcz region is home to approximately 458,000 people. The most populous municipalities – after Bydgoszcz (334,026) – are Białe Błota (25,012), and Koronowo (23,516). The least populated areas are the rural municipalities of Solec Kujawski (1,130) and Dąbrowa Chełmińska (8,509) (Central Statistical Office, 2023). In recent years, localities in close proximity to Bydgoszcz have experienced a noticeable population increase due to migration from the city center. The phenomenon of central city depopulation and suburbanisation poses a challenge both local and regional authorities. Bydgoszcz serves as a daily commuting destination of the surrounding municipalities, which is evident in the high traffic volumes on main roads leading into the city during peak hours.

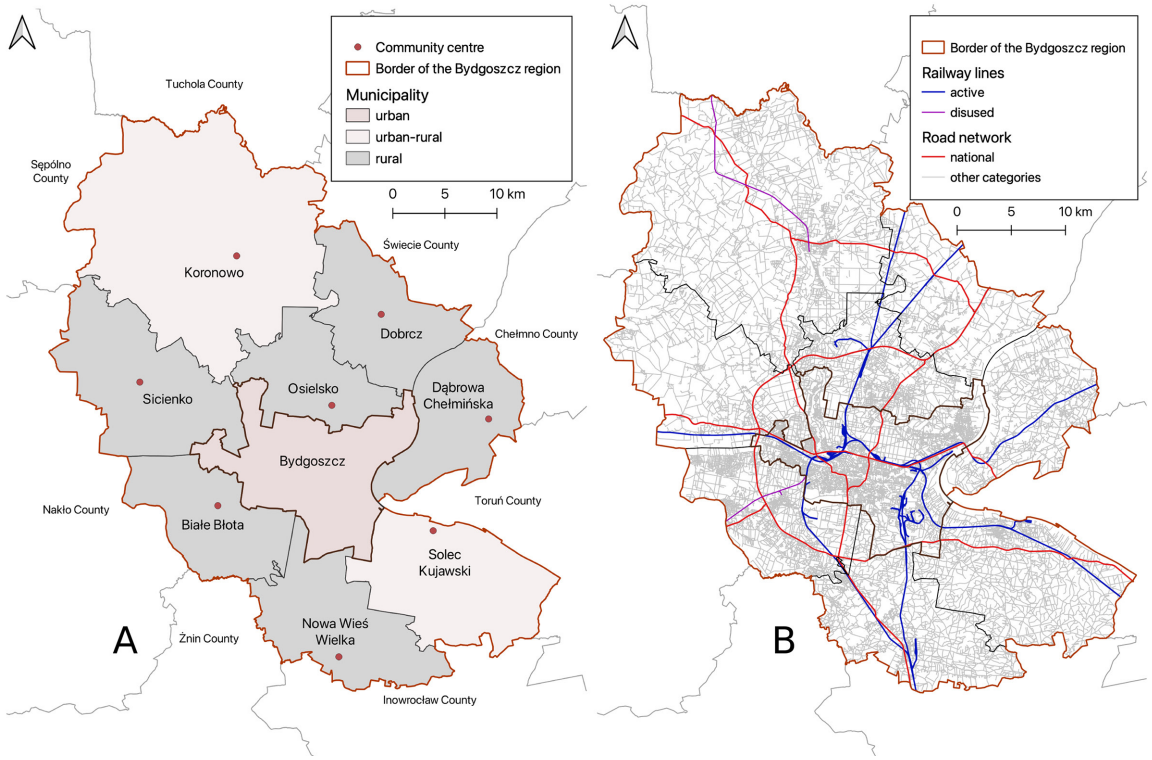

Fig. 2. Municipalities (A) and the road and rail network in the Bydgoszcz region in 2021 (B).
Source: own elaboration.

Major traffic routes run through Bydgoszcz and the municipalities of Bydgoszcz County (fig. 2B). The primary transport axis consist of the S5 and S10 expressways, as well as national roads no. 5, 10 (later S10), 25, 56, and 80. This network is complemented by provincial, county, and local road infrastructure (Matusewicz, Harłoziński, 2016). Bicycle paths are located near major traffic routes, with the total length of approximately 293 km, accounting for 20% of the entire network in the Kujawsko-Pomorskie province (Central Statistical Office, 2023). The Bydgoszcz region is served by four active railway lines: nos. 18,131, 201, and 209 (fig. 2B). Additionally, rail traffic has been suspended on two routes: nos. 241 and 356.

4.2. Public transport in the Bydgoszcz region

PT in the Bydgoszcz region is based on rail and bus services. Rail services is provided by both regional and national operators, while bus transport is handled by eight private operators and an urban transport provider. Additionally, a citywide bicycle rental system, the Bydgoszcz Agglomeration Bicycle, operates in Bydgoszcz.

Despite the presence of a PT system in the region, the local municipalities are connected to varying degrees. Some municipalities – Białe Błota, Dąbrowa Chełmińska, Dobrcz, Osielsko, and Nowa Wieś Wielka – have entered into agreements with the Bydgoszcz local government to establish inter-municipal routes. As of September 2023, thirteen such connections are in operation. Furthermore, these municipalities, along with the village of Sicienko have launched the Metropolitan Toddler and Student Card program. The municipalities of Koronowo and Solec Kujawski have not signed any agreements with the Bydgoszcz authorities. Instead, these areas rely on private bus operators and, in the case of Solec Kujawski, also on the Polish National Railways.

Bydgoszcz itself has a well-developed urban PT system, consisting of a bus, tram, and bicycle network. It is estimated that Bydgoszcz buses and trams carry approximately 350,000 passengers daily.

4.3. Connecting municipalities in Bydgoszcz County by out-of-town public transport services

In areas where out-of-town PT operates, a variation in the number of services is evident. On weekdays (i.e. Monday to Friday), the majority of routes serve community centres and localities connected by inter-municipal lines (fig. 3A). This applies to the municipalities of Białe Błota, Osielsko, Dobrcz, and Nowa Wieś Wielka, where a significant portion of services provides direct access to Bydgoszcz. In contrast, municipalities located near the periphery of the Bydgoszcz region have more limited connections. Most transport services operate primarily on school days, leading to a reduced network of connections during other periods of the year.

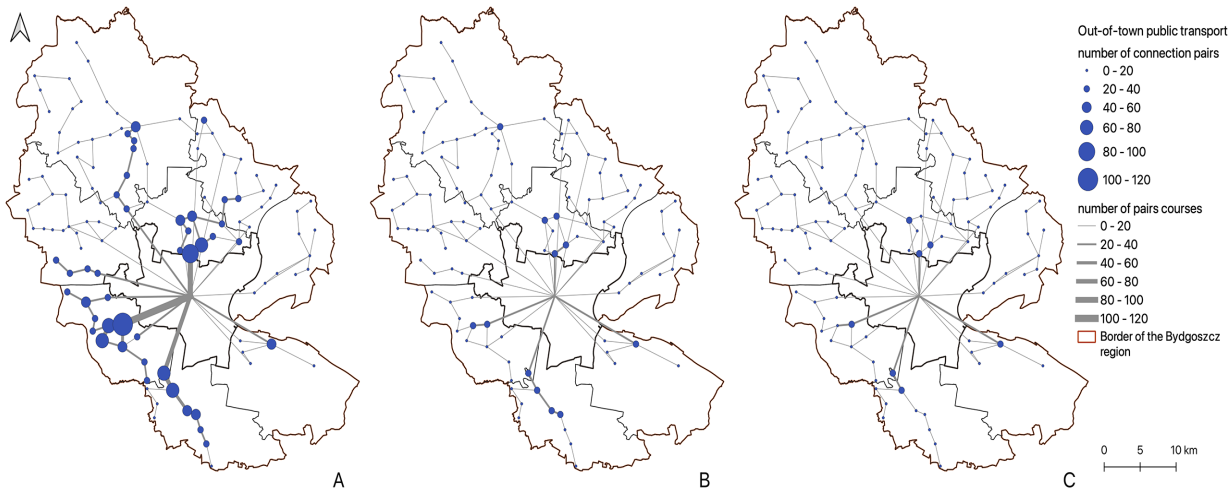

Fig. 3. Municipalities (A) and the road and rail network in the Bydgoszcz region in 2021 (B).
Source: own elaboration.

On weekends, the PT network outside Bydgoszcz is significantly reduced, with a 65% decrease in services on Saturdays (fig. 3B) and nearly 69% on Sundays (fig. 3C). Transport services primarily operate on routes connecting major municipal centres. Better accessibility is observed in localities with rail services (e.g. Solec Kujawski) and in areas where inter-municipal connections are maintained. However, a significant portion of Bydgoszcz County remains unconnected. This results in limited access to PT and contributes to the phenomenon of transport exclusion.

4.4. Transport in strategic and planning policies

Transport issues concerning the Bydgoszcz region are addressed in its planning and strategic documents. These include those relating to B-TOF (2 documents), Bydgoszcz County (2), and individual municipalities (19).

One of the key transport challenges in the Bydgoszcz region is its insufficient PT network, which is not adequatly tailored to the needs of the population. The documents indicate that localities situated farther from the core city of the functional area (in this case Bydgoszcz), have a less developed PT network. However, this does not imply that the large city, serving as a daily commuting destination for residents from neighbouring municipalities, has well developed connections to these areas, as highligted in the Bydgoszcz 2030 Development Strategy. Moreover, the fragmented nature of transport operators exacerbates the issue. The existing inter-municipal and regional PT system is typically of low quality and primarily serves larger municipal centers, making access difficult for residents of more remote localities. The analysed documents also highlight the challenge of integrating different modes of transport within individual municipalities. Road infrastructure is another obstacle to PT development in the municipalities surrounding Bydgoszcz. In many cases, it remains underdeveloped, and a significant proportion of roads in rural areas lack paved surfaces. Conversely, in the cities of the Bydgoszcz region, transit through the central areas raises concerns due to increased wear and tear of road infrastructure. Additionally, the negative environmental impact of transport is particularly problematic, especially in areas located along major traffic routes.

Regional authorities are actively taking steps to address the identify challenges. The most frequently raised issue is the development of a properly functioning inter- and intra-municipal PT system. One of the key pillars of joint efforts is an agreement between municipalities to organise inter-municipal PT services. The long-term objective for the municipalities of Białe Błota and Koronowo is the restoration of rail connections. Additionally, steps are being taken to integrate different modes of transport to facilitate movement within the region. Another priority is improving road infrastructure, with efforts focused on enhancing road surface quality. Furthermore, new road sections, including ring roads, are being constructed to alleviate congestion on roads leading to major community centers and to reduce transit traffic in town centers. An equally important initiative is the standarization of cycle routes. Additionally, newly installed illuminated pavements are expected to enhance road safety.

4.5. Mobility of the Bydgoszcz County residents – research results

The majority of respondents were women (62.3%), aged 21–60 (88.9%), with a university degree (76.2%) and residing in Bydgoszcz (45.1%). The lowest response rates were recorded among individuals over 61 years of age (4.9%), those with vocational education (1.6%) and residents of the municipality of Dąbrowa Chełmińska (0.8%).

The survey results indicated that residents of the Bydgoszcz region most frequently commute to work/school by car (54.9%) or by PT: buses and trams (38.5%). Among car owners, 23.8% use their vehicles for all trips, while 23% rely on them for most journeys. Meanwhile, only 20% of PT users travel regularly: several times a week or daily. Additionally, 25% of respondents opt for active mobility: cycling or walking, with micromobility frequently used for short-distance travel. For residents of the Bydgoszcz region, access to reliable and affordable transport is a crucial factor (70.9%). Cost remains the primary determinant travel decision (86.9%). Respondents also demonstrate a high level of awareness regarding the environmental impact of their transport choices (56.6%). Over the past year, 52% of respondents have modified their transport habits, primarily due to health benefits (37.3%) and financial savings (32%). Nevertheless, as many as 62.7% of respondents are willing to pay extra for travel in a more modern and comfortable vehicle.

One of the key components of transport accessibility is the distance to the nearest stop from which any means of PT departs. As many as 67.2% of respondents reported having a stop located within close proximity to their home (less than 500 m), while 25.4% cited a distance of ca. 1 km. Limited transport accessibility is experienced by 14.8% of respondents, who must travel between 3 to 5 km or more than 5 km to reach the nearest PT stop. A total of 83% of residents have the option of using PT to reach their municipal, county, or provincial city office. The average PT commute to work or school most frequently (56%) takes between 30 minutes and 1 hour, while for 14% respondents, it exceeds 1 hour. These factors influence overall satisfaction with PT services. Only 3% of residents reported very high satisfaction levels.

Transport accessibility impacts the daily lives of surveyed residents to a small extent (33.6%) or a significant (33.2%) extent. For nearly 10% of respondents, it restricts their daily functioning. Moreover, 41% believe that there is a lack of alternative transport options in their area, while 19.3% have never encountered difficulties in accessing PT. Reduced transport accessibility in the region is most often attributed to an insufficient number of available services (56.6%) and vehicle overcrowding (45.5%), which occurs frequently (36.1%) or sporadically (25%). The majority of respondents (83.6%) reported not experiencing discrimination or prejudice during their PT trips. Among those who did, the most commonly cited issues were related to limited spatial, financial, and informational accessibility.

Respondents identified key changes needed in the operation of PT to enhance quality of life, ncluding improving the network of connections and increasing service frequency (80.3%), as well as reducing ticket prices (38.5%). Only 11.1% of respondents emphasized the need to increase the number of low-floor vehicles in PT.

4.6. Recommendations and directions for intervention

The result of previous analyses related to the literature review, spatial analyses and a social survey is a matrix for assessing the transport situation in the Bydgoszcz region (tab. 2). The adopted method allowed for the identification of areas requiring specific interventions, including where interventions are necessary to improve the transport situation. A derivative of this was to propose specific forms of intervention, drawn from the good practices of other Polish regions with similar conditions.

Aspects related to “travel time” mostly do not require urgent intervention (“***’). Only the “service frequency” can be mentioned, which is assessed negatively from the perspective of the region’s inhabitants as well as ongoing investments. “Directness” and “proximity to bus stops” should necessarily be improved by carrying out new investments. For the most part, the planned strategic measures do not need to be revised. On the other hand, in the “planning a journey” category, measures should be taken to improve the correlation of timetables, especially in connection with the provision of services by many private operators, as well as to increase the availability of micromobility – in the peripheral areas of the region (outside Bydgoszcz). Necessary interventions require the introduction of facilities for people with disabilities, as well as the equipment of PT stops and vehicles. Aspects relating to the “travel cost” were among the most poorly rated elements. This is related to the lack of discounted tickets for private bus operators, as well as limited possibilities to integrate ticket fares, which indirectly affects affordability. In the opinion of residents and according to current activities in the study area, sustainable mobility and environmental education, indirectly related to mobility, must be undertaken.

Tab. 2. Matrix for assessing the transport situation in the Bydgoszcz region.

SUBCATEGORY	**Travel time**				
AREA OF INTERVENTION	Service frequency	Punctuality	Directness	Proximity to bus stop	
Residents' evaluation	***	**	**	*	
Ongoing investment projects	***	**	***	***	
Planned strategic operations	*	*	**	*	
SUBCATEGORY	**Planning a journey**				
AREA OF INTERVENTION	Availability of passenger information	Mobile apps for purchasing tickets	Ease of transfer	Correla-tion of timetables	Accessibility to micromo-bility
Residents' evaluation	**	***	**	***	**
Ongoing investment projects	**	***	**	***	***
Planned strategic operations	*	**	*	**	**
SUBCATEGORY	**Ease of travel**				
AREA OF INTERVENTION	Architec-tural barriers	Improvements for the elderly and people with disabilities	Bus stop equpment	Vehicle equi-pment	Safety
Residents' evaluation	***	***	**	**	**
Ongoing investment projects	**	**	***	***	**
Planned strategic operations	*	***	***	***	**
SUBCATEGORY	**Travel costs**				
AREA OF INTERVENTION	Affordability	Integrated ticketing		Discounts and concession fares	
Residents' evaluation	***	***		***	
Ongoing investment projects	***	***		***	
Planned strategic operations	***	**		***	
SUBCATEGORY	**Environmental impact**				
AREA OF INTERVENTION	Sustainable forms of mobility	Cycling and pedestrian infrastructure	Pro-environ-mental attitudes of users	Hybrid/ electric vehic-le propulsion	Environmental education
Residents' evaluation	***	**	**	***	***
Ongoing investment projects	***	*	**	**	***
Planned strategic operations	*	*	**	*	**

Source: own elaboration.

The diagnosis of the Bydgoszcz region in terms of PT travel has made it possible to identify lines of intervention aimed at improving accessibility in the region and making travel more convenient. Specific actions should be implemented in the areas of intervention listed in each subcategory. A key element is to increase the number of journeys, especially on routes with higher demand for services. Additionally, ensuring an adequate network of connections on weekends is crucial for reducing the transport exclusion in the region. The introduction of shuttle bus lines will improve movement within the municipal areas, especially in the context of the municipal centre and neighbouring villages. Great potential is seen in the reactivation of disused railway lines, such as no. 241 between Tuchola and Koronowo and the extension of the section towards Bydgoszcz. This would improve travel due to much shorter journey times and lower ticket prices, compared to bus services. Increasing the availability of timetable information would be possible through the creation of a dedicated website, which would bring together all timetables for PT connections operating in the Bydgoszcz region. This measure would increase the efficiency of planned travel. Educational measures on sustainable mobility should also be introduced, which would also translate

into more conscious transport choices. The most important elements that would improve the PT situation in the Bydgoszcz region are (1) extending cooperation at individual levels (voivodeship, county, and municipality) and by creating inter-municipal or county-municipal associations, and (2) obtaining funds for PT development from the EU. This would be particularly important from the perspective of (1) coordinated transport measures, and (2) improved transport infrastructure and investment in modern rolling stock. Intervention activities would increase the attractiveness of LRT in the region and create a network of connections that meets the needs of the population.

5. Discusion

PT is the most important tool for achieving sustainable transport in the EU. Car ownership is often associated with a sense of freedom, agency, and prestige, particularly among affluent residents of suburban areas in large conurbations. Conversely, PT, is generally perceived as a mode of mobility primarily used by less well-off urban and rural residents. Despite this, the number of private cars continues to rise across EU countries, contributing to issues such as pollution, traffic congestion, and transport exclusion. Additionally, the coverage of PT is gradually decreasing, particularly in CEE countries, where investment in PT development is remains insufficient. B-TOF, which faces evident challenges in PT operations, serves as a representative case for the CEE region. A qualitative analysis of planning documents highlights a key issue in the Bydgoszcz region: a disconnect between the transport needs of local inhabitants and the existing network. Therefore, it is essential to identify strategic directions for remedial action, known as interventions, using an assessment matrix for the transport situation.

In the Bydgoszcz region, just over 80% of residents have access to PT connections to the county town, yet private cars remain the predominant mode of transport. The conclusions drawn from the matrix indicate the need for interventions such as increasing service frequency and the number of direct routes, implementing mobile apps for travel planning, integrating ticketing systems across different carriers, eliminating architectural barriers, investing in fleet and infrastructure, reducing travel costs, and implementing solutions related to shared mobility and micromobility.

A collapse of PT services is evident in the Bydgoszcz region, reflecting the broader nationwide situation. This decline is linked to the large number of private transport providers or the reduction of service networks during and after the Covid-19 pandemic (e.g. Taylor, 2006; Ciechanski, 2021; Przybylowski et al., 2021). In the context of RQ1, it is important to note that transit behaviour in the Bydgoszcz region is influenced by suburbanization, which has led to reduced accessibility, as also observed by Guzik et al. (2021). Another critical issue related to PT in the Bydgoszcz region is the lack of connectivity between towns and cities located outside major traffic routes, particularly the limitation of services on weekends and non-school days. These findings are corroborated by studies conducted by Guzik et al. (2021) and Chmielewski, Szczuraszek (2016). Cost remains a key factor in transport decisions, as confirmed by research from Safronova et al. (2020). Additionally, transport behaviour is shaped by environmental and health concerns, as highlighted in the analysis by Bermúdez-Hernández et al. (2022). The increasing suburbanization exacerbates these issues, a trend also observed in other CEE countries (e.g. Leetmaa, Tammaru, 2007). Infrastructure development, including roads network, has not kept pace with the rapid population growth in suburban areas. Daily population flows from the periphery to the city centre for work and education contribute to transport congestion, pollution, and noise. However, this trend is also observed in other CEE regions (e.g. Hansson et al., 2019). This contributes to reduced accessibility of services and thus the phenomenon of transport exclusion. In the Bydgoszcz region, nearly 15% of residents consider themselves transport excluded, while for 10%, the lack of access to transport makes daily life impossible. In the context of RQ2, it can be concluded that transport exclusion in the Bydgoszcz region is present but does not affect a large proportion of residents.

Nonetheless, the region has underutilized potential, particularly in tourism, which is constrained by insufficient PT infrastructure, as indicated by resident survey results and connectivity analysis using GIS tools. However, this aspect has not been examined in the analyses undertaken by other researchers. GIS-based analyses are commonly applied in urban policy development, but are less frequently used for non-urban areas, especially transport policy planning. The proposed case study demonstrates the usefulness of this tool in this context. Numerous authors emphasize the necessity of using the case studies as a basis for extrapolating theoretical considerations (e.g. Swanborn, 2010; Longhofer et al., 2017). The approach presented in this study validates the use of case studies as a research method.

PT in regions at risk of exclusion should address the needs and expectations of the population. Using the proposed methods and tools, a matrix was developed to identify specific areas for intervention. Thus, when analyzing the challenges associated with regional transport development (RQ3), particular attention should be given to improving accessibility to stops, punctuality, and service frequency. Additionally, necessary changes should include facilitating transfers, enhancing passenger information accessibility, removing architectural barriers, and promoting sustainable forms of mobility.

These findings align with those of other researchers (Lantseva & Ivanov, 2018; Tirachini, Cats, 2020; Chaisomboon et al., 2020; Urbanek et al., 2023, Lavadinho, 2017). A detailed case study analysis can serve as a model for other researchers, enabling them not only to examine, but also to assess the transport behaviour of the residents of the selected areas, and identify key intervention areas for local decision-makers. It is also suggested that future researchers utilizing the matrix presented in this study could propose further modifications. While the current version is designed for universal application, a more tailored approach may be developed in the future.

6. Conclusions

Transport policy plays a crucial role in ensuring sustainability and social inclusion, with PT being the significant contributor. Recognizing transport behaviours and their determinants provides the foundation for planning and implementing interventions. Analyses indicate that the central city – Bydgoszcz has an extensive rail and road transport network, while other localities within its functional zone rely either on inter-municipal agreements for PT service or on private carriers. This dependency is particularly evident in peripheral towns. A similar situation applies to the route network, where an analysis of connectivity reveals that a significant portion of the municipalities in the Bydgoszcz region lack adequate transport links. The conclusions drawn from the in-depth analysis indicate that interventions are needed in the following areas: frequency of services, network of connections, use of ITS solutions, and integrated ticketing. Other changes that should be made include eliminating architectural barriers, investing in an upgraded fleet and infrastructure, reducing travel costs, implementing solutions related to shared mobility and micromobility. Enhancing these areas can play a decisive role in fostering regional, sustainable growth and increase the quality of life for residents.

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