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PUBLIC TRANSPORTATION APPS USERS IN SILESIAN METROPOLIS

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Purpose: The purpose of this paper is to assess the subjective preferences of mobile app transportation users who commute in the Silesian Metropolis area.
Design/methodology/approach: The article uses the following methods to achieve the set goal: literature analysis, descriptive and statistical analysis of data obtained in primary research carried out by the authors using the CAWI method.
Findings: Silesian Metropolis has smart transportation potential, according to research. Several apps allow city travel. Local governments and transit coordinators write apps. Passenger-friendly apps need a little adjustment. The software allows quick ticket purchases. Decentralization harms the system. They manage transportation managers or organizational units. Passengers feel the study region should consolidate apps and systems. They would gladly provide market research or application experience data.
Practical implications: The conclusions indicate that passengers are looking for a centralized mobile application to travel around the Silesian Metropolis and they are willing to contribute to its development, according to the findings. This may be the beginning of cooperation between all managers of currently existing applications and their clients.
Research limitations/implications: The CAWI approach has various disadvantages, including the fact that it is dependent on internet access; the target audience may be large but not universal, and it is associated with the risk of losing the respondent's attention.
Originality/value: The article provides insight into the thoughts of users of mobile applications in the Silesian Metropolis.

Keywords: smart mobility, public transportation, apps, GZM.

Category of the paper: research paper.

1. Introduction

Smart solutions are prevalent in each of our daily lives. Using modern information technology, people aspire to improve the quality of life. The rapid development of technology is most obvious in densely populated areas like cities. According to World Bank statistics, cities

host 56% of the world's population (4.4 billion people). This trend is expected to continue, with the urban population more than doubling by 2050, when roughly seven out of ten people will live in cities (World Bank, 2023). With cities accounting for more than 80% of global GDP, urbanization can contribute to long-term growth through greater productivity and innovation if properly managed.

The innovative use of the smart city concept, which is based on the use of contemporary information and communication technologies (ICT), can contribute to the improvement of city inhabitants' life. As a result, most of the Polish cities are attempting to become smart cities. A significant component of a smart city is smart mobility, which is defined as an integrated transport and logistics systems that utilize sustainable energy. The need for smart mobility solutions in Polish cities is primarily a result of the high levels of air pollution caused by automobile emissions, the long wait times in traffic jams, and the high frequency of car accidents, all of which have a detrimental impact on the residents' sense of safety.

These days, a single mobile transportation app can fulfil a wide range of needs in the transportation industry, from ridesharing to GPS location to route planning to navigation to data collecting and analysis on traffic conditions to advice on when to travel. The convenience of having so much data at your fingertips via a smartphone has also accelerated the widespread adoption of this technology.

Several studies have already examined the implementation of mobile technology in the Polish public transportation system. Bojda (2011) reviewed information technologies supporting traveling by public transport operating in Poland and Germany. He outlined the primary features and functions of the systems operating at that time and signaled the emergence of the new Passenger 2.0. Few studies examined the introduction of passenger information system in different Polish cities such as Radom (Grad, Ferensztajn-Galardos, Krajweska, 2013), Krakow (Kędzior, Bryniarska, 2015; Bryniarska Gacek, 2018), Upper Silesian Industrial District (Kos, 2016) and Lublin (Berlińska, Choma, 2018) Three of those studies examined the passenger perspective on the implementation of this system in their cities. Kędzior, Bryniarska (2015) presented the results of a study conducted at public transport stops in Krakow. The aim of the study was to assess the level of passenger information in Krakow based on the opinions of public transport users. Passengers assessed the quality of information available at the journey planning stage, at stops and in vehicles. Later study (Bryniarska, Gacek, 2018) also conducted in Krakow area was aimed at characterizing and evaluating travel planners in terms of their usefulness for passengers of public transport in Krakow. As a result, it was shown to what extent the Internet and mobile applications are used and which information contained therein is the most important, valuable and helpful. Researchers (Berlińska, Choma, 2018) also covered the degree of use of mobile applications to move around the city of Lublin. Especially whether there are significant differences in the degree of use of application data and how the degree of their use relates to the usability of the application and the implementation of the assumptions of the concept of sustainable transport development and the Smart City concept, especially among young people who shape their communication choices.

Other study conducted in 2017 (Kos, Urbanek) focused on another aspect of passenger perspective, namely their attitude to mobile payments on the public transport. The aim of the study was to characterize the electronic payment systems for public transport services functioning in Polish cities, as well as to examine the level of use of modern technologies (Internet and mobile applications) to purchase tickets for public collective transport in cities.

None of these studies focused on Silesian Metropolis passengers' preferences for mobile transportation apps, key existing and potential features, ticket purchases, and app supervision, resulting in a research gap. Therefore, the purpose of this article is to assess the subjective preferences of mobile app transportation users who commute in the Silesian Metropolis area. To achieve its objective, the study employs the following methods: literature analysis, descriptive and statistical analysis of data acquired from primary research conducted by the authors utilizing the CAWI method.

2. Literature review

2.1. Smart city

The smart city concept is currently one of the liveliest discussed topics on the forums of politicians, economists, architects, urban planners, lawyers as well as IT and web specialists. Despite the immense interest and recognition in the scientific community, the main definition of a smart city concept has not yet been established. According to numerous academics, the concept of a smart city began to gain popularity in the early 1990s. (i.a Caragliu, Del E Nijkamp, 2011; Albino, Berardi, Dangelico, 2015; Mora, Bolici, Deakin, 2017; Mora, Deakin, Reid, 2017; Komninos, Mora, 2018; Yigitcanlar et al., 2018; Krysiński, 2020; Ochojski 2022) and evolved on the premise that there should be integration of systems connected to services that help people live in cities, integrating human and technology capital, and researching ways to improve the city's relationship with its people (Pinochet et al., 2019).

The Smart City concept involves the use of IT and digital data transfer to rationalize the management of urban resources, improve the efficiency of urban logistics, and achieve sustainable development, as well as other positive aspects - social, ecological and economic (Szewc, 2020, p. 89). Moreover, these areas can be integrated to obtain a holistic approach and development of the city (Appio et al., 2019; Höjer, Wangel, 2015; Jonek-Kowalska, Wolniak, 2019; Kaźmierczak, 2019; Kuzior, Sobotka, 2019) and reduce its operating costs (Anttiroiko et al., 2014)

This concept allows integrated operations of digitally connected city infrastructure and service systems by deploying different communication technologies, real-time data collection infrastructure and data analytics and intelligence platforms to improve the efficiency of city

services and improve quality of life (Dey, Fries, Ahmed, 2018, p. 267). The goal of smart city implementation is to minimize the issues of continuing urbanization development and the effects of climate change in urban areas (Zhihua Zhang, Jianping Li, 2020). However, thanks to the technology used in smart cities they are also thought to be hubs of innovation and economic development (Manoharan et al., 2023, p. 71).

Depending on the deployment cost, funding availability and maturity of technologies, any combination of various Smart City infrastructure systems and service systems can be implemented (Silva et al., 2023). The success of Smart City implementations is primarily dependent on an emphasis on the adoption of new technology-based infrastructure and service systems, broader community participation in the development–deployment–operations of such systems, strong leadership, and effective resource management (Mbonu et al., 2022; He et al., 2021). Depending on available resources, different cities throughout the world can implement Smart City ideas on varying scales.

Authors of Smart Cities - Ranking of European Medium-Sized Cities (Giffinger et al., 2007) introduced six characteristics and their assigned factors (Figure 1), that characterize the most important functional and organizational areas of the city as well as its human, tangible and intangible resources.

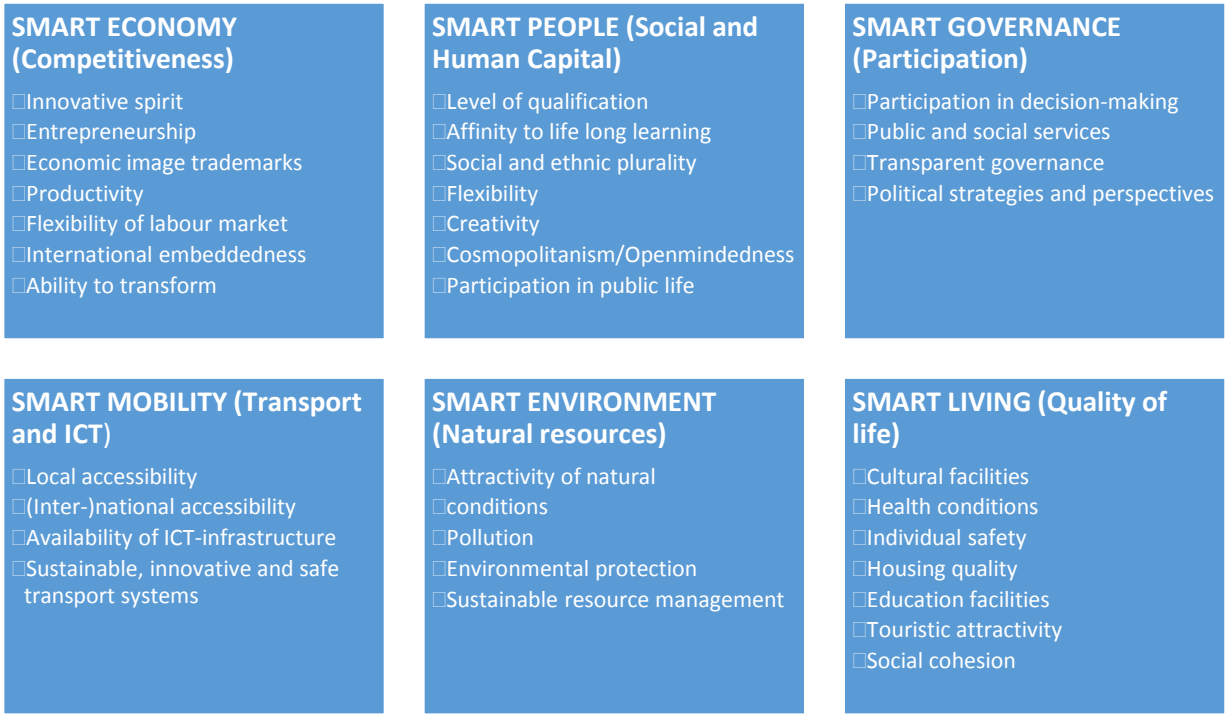


Figure1. Characteristics and factors of a smart city.

Source: Giffinger et al. 2007.

The smart economy (competitiveness) is frequently regarded as the most essential dimension. In the modern world, it is founded on the creation of new jobs, the encouragement of entrepreneurship with a focus on small and medium-sized businesses, the systematic development of competitiveness through the development of innovative products and services,

and the increase in productivity through the use of new techniques and technologies supported by disciplined management. It is also the ability to notice emerging trends and adjust or transform accordingly (Muraszkiewicz, 2016)

Smart people's value (human and social capital) is an organic product developed by successive generations of city residents, with whom new, highly skilled, and creative specialists eventually blend. This approach requires a constant strategy of openness and social and, in some cases, ethnic heterogeneity. Many smart city theorists and practitioners, particularly those who are sceptical of technocratic solutions, regard human capital and its more advanced form, social capital, as the beginning of everything important in a smart city, as the quintessence and necessary condition but sadly, not sufficient to constitute such a city (Muraszkiewicz, 2016).

Smart governance (participation) refers to the democratisation of decision-making processes, including access to the data required for these processes. In the case of cities, it is about inhabitants', producers', and service providers' engagement not only in making decisions on specific issues concerning the city's operation but also in the task of developing a plan for its development. Transparency in management systems has become unquestionably the rule in modern, prosperous cities (Muraszkiewicz, 2016).

Smart mobility (transportation and ICT) focuses on physical mobility, which is supported by both "hard" communication infrastructure (roads, streets, bridges, viaducts, parking lots, etc.) and the "soft" communication layer in cyberspace. This involves issues such as universality and accessibility to this infrastructure and layer, as well as simplicity of usage, such as access to local offices, services, and municipal resources (Muraszkiewicz, 2016).

Smart environment (natural resources), which refers to the city's natural environment, cleanliness, and attractiveness for living, working, and active enjoyment, has become one of the most essential aspects of attracting investors, new inhabitants, and tourists. In the face of the city's usually expanding growth needs, sustainable management of natural urban resources is now a constant component of its strategy, clearly distinguishing successful cities from troubled ones (Muraszkiewicz, 2016).

Until recently, smart living (quality of life) was applied to rich communities; today, this topic is permanently on the agenda of nearly all major cities throughout the world. Improving the quality of life is at the heart of presidents', and city mayors' initiatives in India, China, South America, and Africa. The safety of people and commercial entities operating within an urban agglomeration has become a fundamental and universal requirement for its development. Efforts to enhance living conditions, education level and accessibility, decent health conditions, appealing amenities and cultural events have become regular elements of the activities carried out by local officials. All of this is designed to form the social cohesion of the population and foster a sense of affiliation with the city, its history, identity, and fate (Muraszkiewicz, 2016).

2.2. The concept of smart mobility

Some researchers suggest that smart mobility is a cornerstone of the smart city concept, mostly because its deployment has the potential to reduce road congestion, commute times, and road accidents while allowing passengers to personalise their travels (Bıyık et al., 2021).

To this day, researchers around the world have not agreed upon a definition of smart mobility. Some define it simply as one of the elements of a smart city plan (Yigitcanlar, Kamruzzaman, 2019). Others consider this concept to be the apex of a smart city, which is tied to municipal decisions and strategies based on communication, data, and technology tools (Tomaszewska, Florea, 2018). Others see it as a group of numerous actions that enhance users' mobility by foot, public or private transportation, or any other means of transport and eventually allow for the reduction in economic costs that are incurred by the environment and time (Aletà, Alonso, Ruiz, 2017). Some suggest that smart mobility is more than just incorporating technology into urban infrastructure; it also requires inhabitants to explore and interact with their urban environment thoughtfully and reasonably (Allam, Newman, 2018). Others focus on its broad meaning in connection to city improvement, where smart mobility is a broad method to reduce the toxic gases sent into the atmosphere by automobiles and human congestion and contributes to improving transportation quality while being ecologically friendly (Gabryś, 2014). The true essence of smart mobility includes but is not limited to, the use of intelligent transportation systems, open-data and open-source transport applications, applications for big data analytics, citizen engagement, and crowd-sourcing strategies from the ground up (Bıyık et al., 2021).

Smart mobility is portrayed as both a major challenge and a potential source of inspiration for transforming city operations. What is becoming apparent is the need to improve infrastructure to fulfil long-term needs of 50 years or more, rather than just immediate or short-term demands, and the need to treat smart mobility as a tool for improving economic, social, and environmental well-being (El-Sheruf, 2021). Key benefits of smart urban mobility were outlined in detail by The Climate Group (2019), and they include:

- Quality of life: improving the efficiency and accessibility of public transportation enhances the inhabitants' quality of life, saves money, and makes a city more appealing to tourists.
- Reduced pollution: smart systems encourage the usage of public transportation by providing access to different modes of transportation as well as real-time schedules and delays. This reduces the use of private cars while encouraging eco-friendly habits such as bike sharing and carpooling.
- Public transport safety and security: improved public transportation monitoring can aid in the detection and response to emergencies, accidents, and terrorist attacks. It can also lower the number of accidents in a city at an advanced stage of implementation.

- Mobility marketplace: the availability of open data regarding transportation and movement in the city generates a market for mobile apps that can assist consumers in travelling and consuming transportation services throughout the city.
- Smart parking solutions: cities can alleviate the problem of parking in congested urban areas by providing the necessary infrastructure, sensors, security cameras, and internet access. Cities can share data about available parking, and consumers can access this data through mobile apps and web interfaces.

According to El-Sheruf (2021, p. 101), smart mobility goods cannot fulfil their full potential to manage operational efficiency and user demand if any of their components are missing. Numerous infrastructure components are required for the smart mobility system, such as physical infrastructure, operational technology, and information and communication technologies (ICT). Coordinating and integrating across organizational levels boosts operational efficiency and paves the way for innovative demand management products.

The physical infrastructure of urban mobility, which includes roads, railroads, bike lanes, walkways, and other physical assets that allow transportation to operate, underpins the whole system. Data and information that assist smart mobility are continually created from dynamic patterns of human activity as individuals move the city using existing infrastructure (El-Sheruf, 2021).

Operational technologies generate data for smart solutions. They enable real-time capture and sharing of raw data from physical infrastructure and services and quick infrastructure management adjustments to provide capacity where needed. Many cities use such technology to guide travellers and maintain traffic flows, improving network efficiency (El-Sheruf, 2021; The Climate Group, 2019) Intelligent transport systems (ITS) are promoting sustainable and sensible urban mobility. This strategy includes electronic tickets and payments, traffic management, trip information, access control, demand management, and smart cards for urban transit in airports, railway stations, and bus terminals. These new technologies will allow citizens to access new services, enhance real-time traffic and capacity management, and track and monitor transport flows for environmental and safety concerns (Herrero, 2011). ITS equipment generates fresh transport network data and helps transport operators immediately control traffic and travel (El-Sheruf, 2021).

ICT is an umbrella term for any communication device or application, including radio, television, mobile phones, computer and network hardware and software, satellite systems, and so on, as well as the various services and applications that go with them, such as videoconferencing and distance learning (Huth, Vishik, Masucci, 2017).

With many new businesses presenting creative ideas to affect trip management, the software response to urban mobility is currently the most dynamic sector of growth in the urban mobility field. Channels such as Wi-Fi, 3G, 4G, 5G, and Bluetooth are crucial for real-time location-based data transfer from machine to machine, as well as between human operators, data processors, and information consumers (El-Sheruf, 2021). According to Statista (2023), the current global smartphone user population is 6.92 billion, which means that 86.29% of the

world's population possesses a smartphone. According to the Founding Research of the National Media Institute, 75.8% of Poles use a smartphone (Krajowa Rada Radiofonii i Telewizji, 2022). Users of smartphones are also Internet users - among the users of mobile phones with a touch screen, 90.7% have used the Internet in the last 12 months Krajowa Rada Radiofonii i Telewizji, 2022). In ITC systems data is acquired and aggregated by public and private actors. These data handlers create user-friendly applications and interfaces by combining city data and operational technology data. Communications networks deliver different apps to users, providing useful data that influence network operations and demand (El-Sheruf, 2021).

While many municipal governments and transport operators are already familiar with and use operational technology, its importance in giving data for software innovation is only now being recognized. Many cities are only now realizing the possibilities of software solutions.

2.3. The state of smart mobility in the Silesian Metropolis

Silesian Metropolis (Górnolsko-Zagbiowska Metropolia, GZM) is a metropolitan union in southern Poland, in the Silesian Voivodeship, established on July 1 (Rozporządzenie Rady Ministrów z dnia 26 czerwca 2017 r.). It consists of 41 cities and communes (Figure 1) with a total area of 2.5 thousand square kilometres, inhabited by 2.3 million inhabitants and 240 thousand companies and enterprises operating in it, generating about 8% of Poland's GDP (Metropolia GZM, 2023).

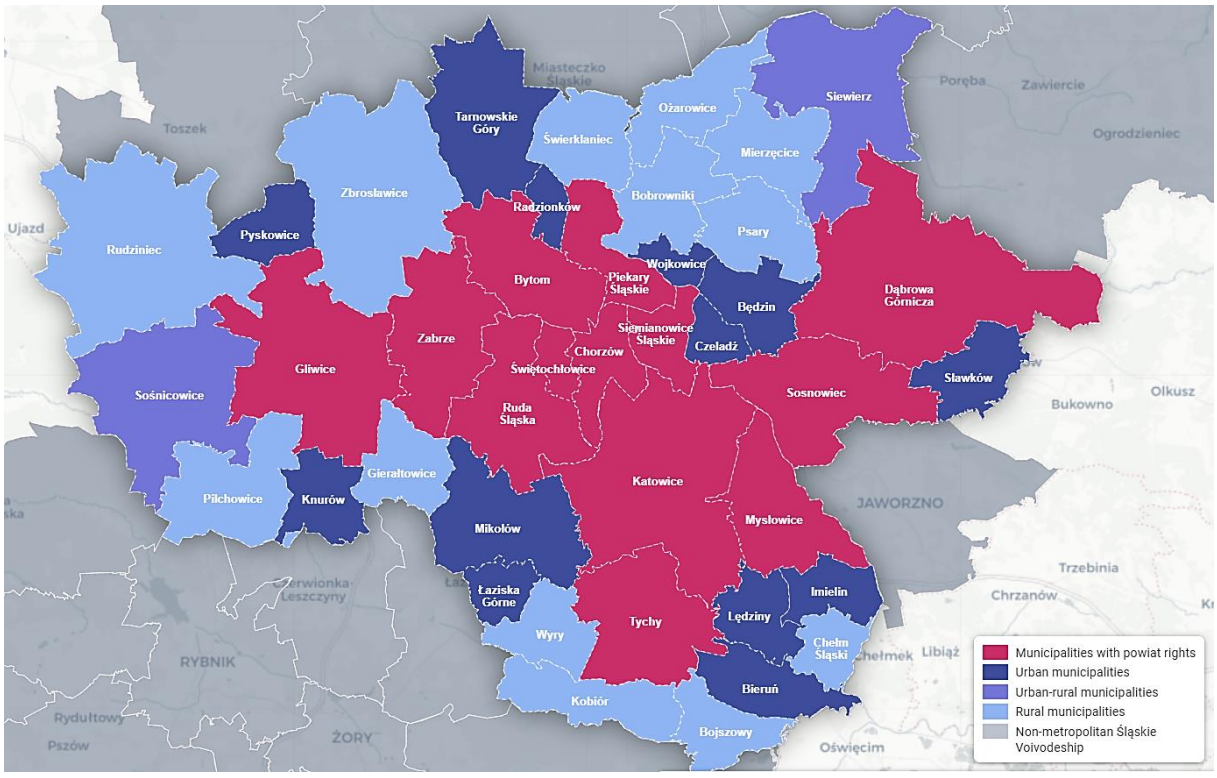


Figure 2. Map of Silesian Metropolis.

Source: https://infogzm.metropoliagzm.pl/infomapa.html.

Every day, around 1,500 public transportation vehicles with over 6,700 stops cross the Metropolis' streets. Over the last five years, metropolitan managers have undertaken numerous activities aimed at improving the urban transport strategy. One of the most important actions occurred in 2019 when the Metropolitan Transport Authority (Polish: Zarzd Transportu Metropolitalnego, ZTM) merged three existing transport organisers (KZK GOP, MZK Tychy, and MZKP Tarnowskie Góry) into one. As a result, the three organizers carried the same ticket policy. The consolidation of ZTM enabled the creation of a cohesive and uniform service, as well as the management of public transportation throughout the Metropolis (Metropolia GZM, 2023).

By establishing and changing routes, ZTM has been consistently increasing the quality of public transportation in the Metropolis. ZTM placed a passenger counting device in every vehicle to precisely determine the number of individuals who use each bus route and stop. The inauguration of the METROTICKET in 2019—a joint offer for buses, trams, trolleybuses, and Koleje Śląskie trains—was a major step forward for public transit in the Metropolis (Metropolia GZM, 2023).

Additionally, ZTM attempts to expand the availability of public transportation tickets. The existing operational "Silesian Card of Public Services" (ŚKUP) project will be changed, and new features will be added to make it more user-friendly and convenient for travellers. In almost 150 vehicles, the ability to pay for a ride with a credit card has been introduced, and shortly all sorts of tickets will be available for purchase through the ZTM mobile application. Eventually, the system will be expanded to include ZTM cars, railroads, and the metropolitan bicycle system. Additionally, the number of ticket vending machines is growing (Metropolia GZM, 2023).

One of the major priorities included in the development strategy for Silesian Metroplly focuses on the planning, coordination, integration, and development of public transport, including road and railroad transportation, as well as sustainable urban mobility (GZM, 2022) (Table 1).

Table1.
Strategic arrangements for mobility and accessibility in Silesian Metropolis

Goal	Direction activities
Developing sustainable urban mobility and popularizing public transport as the primary choice for everyday commuting	– Creating and implementing solutions to reduce individual transportation and improve pedestrian safety. – Integrating mobility and transportation communities.
Developing infrastructural and organizational conditions for the improvement of public and road transport	– Optimizing the operation of public transportation with the integration of operators and the tariff-ticketing system as well as the development of the ticketing network. – Expanding infrastructure related to public transportation and traffic management, including smart solutions. – Developing an information system on public transportation system solutions and implemented changes. – Supporting the development of priority metropolitan transport routes.

Cont. table 1.

Developing railway transport	– Developing rail infrastructure and fleet, taking into account the connection with the Katowice Airport in Pyrzowice. – Cooperation with institutions of the legislative and executive branch on changes in the mechanisms of financing railroad passenger transport and statutory discounts. – Promoting micromobility, including cycling and the principle of sharing – Building a coherent system of cycling connectivity and existing, and planned infrastructure. – Popularization of individual and shared micromobility for "last mile" travel.

Source: GZM (2023) Development Strategy of the GZM Metropolis for 2022-2027, with an outlook to 2035 Executive Summary.

GZM defines "smart mobility" as modern, remotely operated, and digitally operated mobility services consisting of making a trip from point A to point B using one or more means of transport, most often using a mobile application by the user. GZM is aware of the role of intelligent mobility in the Metropolis; it notes examples of single implementations of modern mobility services around the world, including in Gothenburg, Vienna, Dundee, London, and Warsaw. The goal of GZM is to create a diverse offer of smart mobility services and favourable conditions for the development of services on a competitive and free market basis, ensuring that a local monopoly (and preferences) for a selected service do not arise at the expense of others (Jędrzejewski, 2018).

3. Research methodology

For the purposes of this paper, a survey of Silesian Metropolis passengers was conducted. The computer-assisted web interviewing method was used to conduct the research, and the tool was a survey questionnaire, which consisted of 14 basic questions and 4 sociodemographic questions. The survey was conducted at the turn of April and May 2023, using Google Forms. The survey was conducted completely anonymously. The selection criteria were the usage of mobile applications to navigate the Metropolis and the willingness to participate in the study, which required the employment of a systematic sampling technique. 200 properly filled-out questionnaires were received (Table 2).

Table 2.
Characteristics of respondents (N = 200) in %

Sex				
Men		Women		
29.0		71.0		
Age Group				
15-18 yo	19-25 yo	26-40 yo	41-60 yo	above 60 yo
8.5	36.5	42.5	11.5	1

Cont. table 2.

Status			
Students	Employed	Unemployed	Pensioners
29.5	65.0	4.0	3.0
Education			
Primary education	Vocational Qualification	Secondary education	Higher education
7.0	3.5	43.5	46.0

Source: Own calculations based on data from the survey.

4. Results

The first four questions were intended to extract generic information on Silesian Metropolis public transit users. The very first question revealed how often the group surveyed uses public transit (Figure 3).

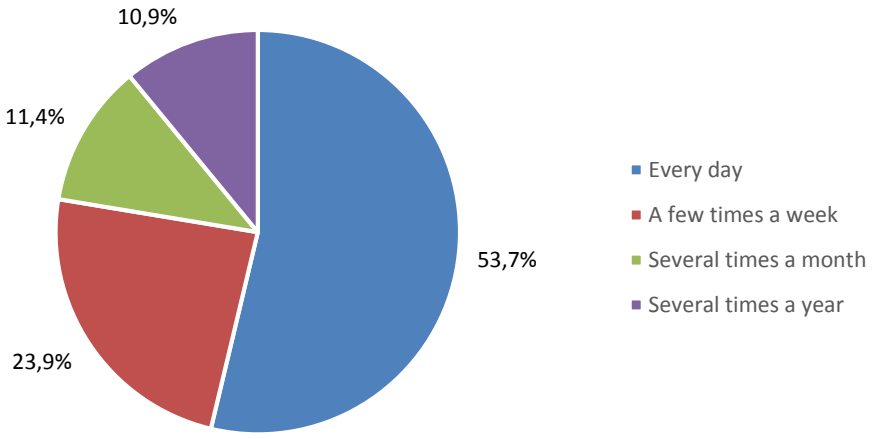


Figure 3. Frequency of travelling by public transport.

Source: Own calculations based on data from the survey.

More than half of the respondents use public transit daily (53.73 %). Almost a quarter (23.88%) do so multiple times per week. One-fifth (11.4%) do it multiple times each month, and slightly less (10.9%) do it multiple times every year. Men are more likely than women to utilize public transportation on a daily basis. People aged 15 to 18 make up the largest segment of daily travellers (82.1 %). Pensioners (54,3 %), working individuals (54,3 %), and students (44,2 %) travel more frequently than unemployed individuals.

The respondents were then asked about the most popular place reached by public transport (Figure 4). The majority of participants utilize public transportation to get to work (65.8 %). Social gatherings with family or friends (45,4 %) and errand-running (41,5 %) were also frequently cited reasons for travel. Shopping (31.6 %) and commuting to college or university were among the less popular answers (29.9 %).

It comes as no surprise that school or university is a top destination for young people aged 15 to 18. (45.6%). Equally, people of working age usually travel to work. Elderly individuals (those over the age of 60) use public transportation to run errands in the city (42.3%). People with primary education travel to school/university the most frequently (39.6 %), followed by those with vocational education (36.8 %), secondary education (28.1 %), and higher education (35.5 %).

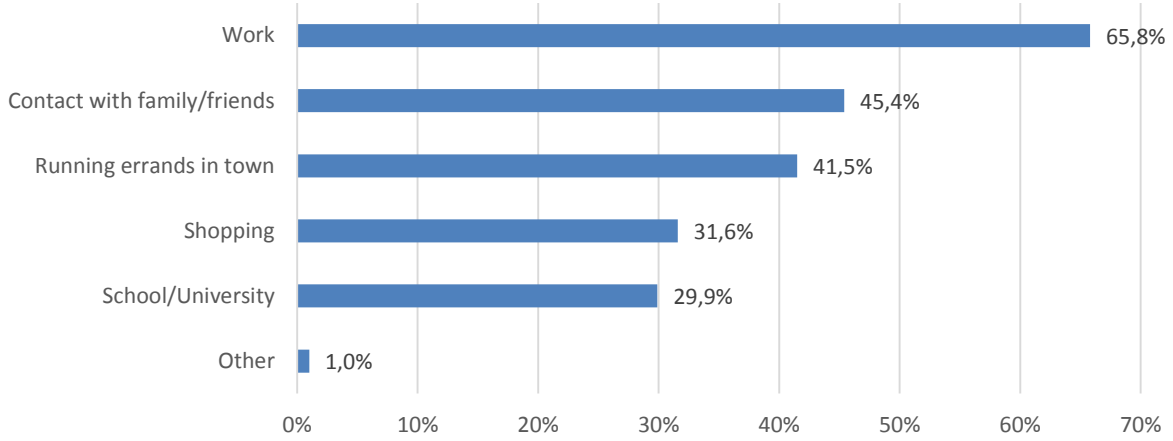


Figure 4. Most common travel destinations.

Source: Own calculations based on data from the survey.

Most frequently, respondents travel 6 to 10 kilometres by public transit (37.5%). Every third of them (29.8 %) goes between 11 and 20 kilometres, while every fifth travelers beyond 21 kilometres (20.2 %).

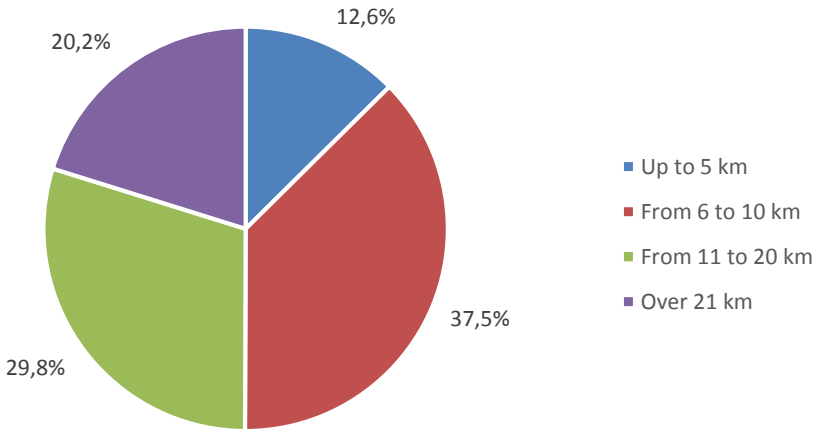


Figure 5. Distance travelled by public transportation.

Source: Own calculations based on data from the survey.

Surprisingly, the age group 41 to 60 has the highest frequency of travel above 21 km. Similar patterns can be noticed among the unemployed.

The bus was the most popular mode of transportation across all groups polled (83.2%). (Figure 6). The importance of other means of transport available in the Metropolis turned out to be marginal.

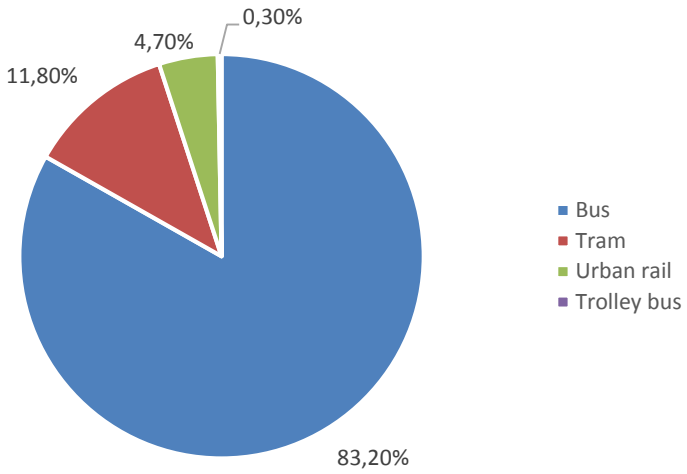


Figure 6. The most popular means of public transportation.

Source: Own calculations based on data from the survey.

The subsequent series of questions relates directly to mobile applications utilized for public transit in the region. The first question helped us to identify which mobile applications are the most popular among passengers (Figure 7).

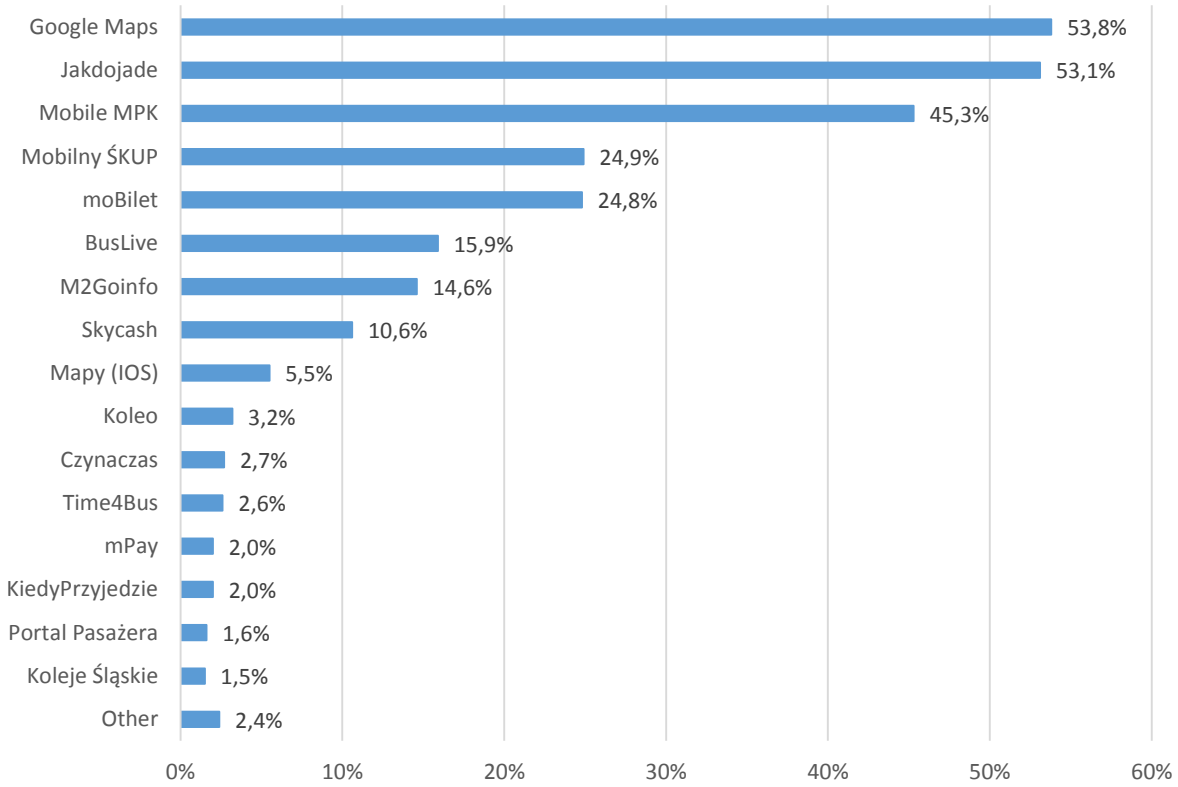


Figure 7. Most popular mobile applications among travellers.

Source: Own calculations based on data from the survey.

The study revealed that Google Maps is the most popular application for using public transportation, followed by Jakdajade. The application submitted by the body in charge of transport coordination ranks third (MPK). The specific features of each application are described below (Table 3).

Table 3.
Characteristics of apps used by respondents

App name	Manager	Features
BusLive	Private developer	– real-time transportation tracking on the map, – radar of means of public transport nearby, – timetable, – route planning, – allows adding routes to favourites, – possibility to rent vehicles from the rental company, – indicates bike-sharing stations, – indicates the amount of traffic on the streets on the map.
Czynaczas	Private developer	– real-time transportation tracking on the map, – timetable change announcements, – allows to search for lines and stops, – blog.
Google Maps	Private developer	– various public transport options, – live trip planning from where you are to your final address, – live view orientation in the environment, – allows to include of certain vehicle features in route planning, such as choosing uncrowded routes, vehicles accessible for disabled individuals, the temperature in the vehicle, and monitoring, – traffic monitoring, – carrier information, – possibility to plan your trip in the calendar.
KiedyPrzyjedzie	Private developer	– real-time transportation tracking on the map, – timetable, – allows adding routes to favourites, – timetable change announcements.
M2Goinfo	Transport coordinating organization (ZTM)	– real-time transportation tracking on the map, – timetable, – finding and presenting information about a selected transport line and selected vehicle, – timetable change announcements, – route planning, – quick search in terms of a communication line and a stop or stand, – allows adding routes to favourites.
Maps (for IOS)	Private developer	– route planning, – timetable, – allows adding routes to favourites, – check ticket prices, – the ability to pay for tickets using Apple Pay, a public transport card.
Mobile MPK	Transport coordinating organization (MPK)	– route planning, – real-time transportation tracking on the map, – timetable, – allows checking where city bikes are stationed, – coordinate sharing, – allows for determining the conditions in the vehicle - e.g., low-floor vehicles.

Cont. table 3.

moBilet	Private developer	– parking payments, – tickets for public and long-distance transport, – prepaid account funded by: Blik, Przelewy24 and Klarna, – controlling active tickets and payment history.
Mobilny ŚKUP	Local government (GZM)	– ŚKUP (city card) card registration, – Purchase of a single/group ticket via ŚKUP or a prepaid account associated with ŚKUP, – timetable, – timetable change announcements, – allows for sending a complaint, – allows for notifying false vehicles.
Skycash	Private developer	– route planning, – allows to purchase tickets for: tickets for parking, public transport tickets, highways, Taxi, PKP intercity tickets, railways, flight tickets, coach tickets, cinema, parking, entertainment and shopping, Tatra National Park tickets, top-up GSM and bills, – purchase can be made by a prepaid account funded by bank transfer, promotional code, payment card, PayU and Przelewey24 (BLIK), – allows to save payments to favourites.
Time4Bus	Private developer	– real-time transportation tracking on the map, – route planning, – timetable, – locating stops, – filtering vehicles on the map.
Jakdojade	Private developer	– route planning – allows to purchase of tickets using a prepaid account powered by: BLIK, Google Pay, card, – timetables, – possibility to save routes to favourites, – allows to determine the conditions in the vehicle and transfers, – radar that determines access to the nearest stop.
mPay	Private developer	– allows to purchase: PKP Intercity tickets, highways, public transport, parking, – route planning, – timetables, – allows to purchase insurance for travel, vehicle insurance and accidental death and dismemberment insurance, – methods payments: transfer, loan.
Portal Pasażera	Transport coordinating organization (PKP Polskie Linie Kolejowe S.A.)	– route planning for all of the railway carriers in Poland, – timetable, – real-time transportation tracking on the map, – current messages from the infrastructure manager and carriers, – "Quick connections" section with your selected relationships, – possibility to configure favourite stations and relations, – online map with the route of your connection, – three language versions - Polish, English and Ukrainian.
Koleje Śląskie	Transport coordinating organization (Koleje Śląskie)	– allows to purchase single and season tickets for Koleje Śląskie connections and combined tickets which change, – allows to purchase of tickets using cad, quick transfer and BLIK transfer, – allows to use of map navigation while travelling.

Cont. table 3.

Koleo		– timetable, – ticket price list, – allows to purchase tickets for the following carriers: PKP Intercity (TLK, IC, EIC, EIP), POLREGIO (PR), Arriva RP (ARRIVA), Koleje Dolnośląskie (KD), Koleje Małopolskie (KMŁ), Koleje Śląskie (KŚ), Koleje Wielkopolskie (KW), Łódzka Kolej Aglomeracyjna (ŁKA), PKP SKM w Trójmieście (SKM-T), – available ways of payment: KOLEO account, card, BLIK or GPay.

Source: Own elaboration.

In the next question, respondents were asked to rank the importance (on a six-point Likert scale: unimportant, somewhat important, rather important, very important, and essential) of the most prevalent functions of the applications currently in use. (Table 4).

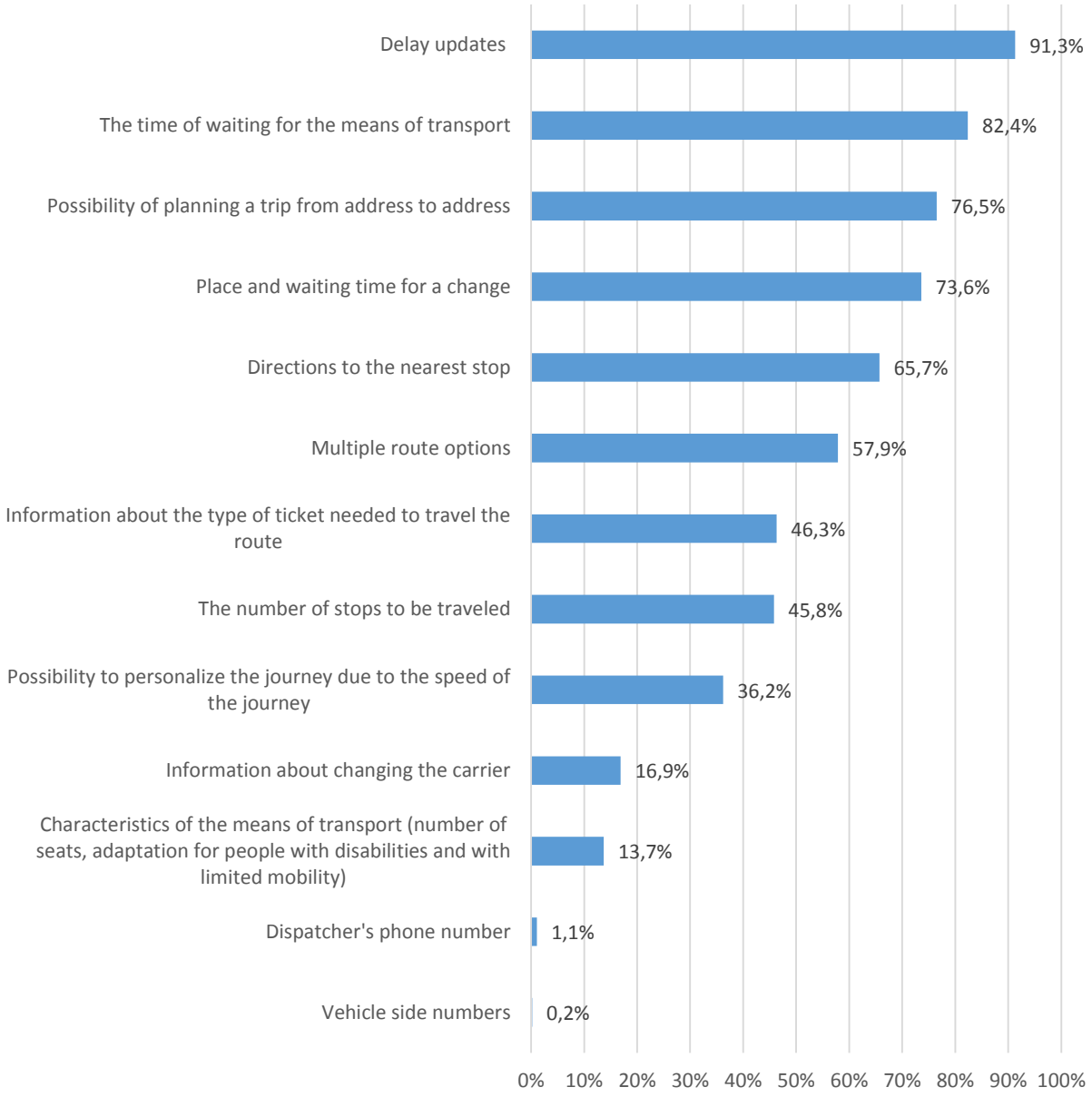
Table 4.
The importance of the features available in the application

Features	**Assessment**				
	Unimportant	**Somewhat important**	**Rather important**	**Very important**	**Essential**
Intuitive operation	2%	5%	24%	38%	31%
Current timetable	1%	3%	7%	9%	79%
Ability to work offline	10%	25%	20%	26%	19%
Automatic detection of the traveller's location	8%	18%	21%	32%	22%
Tracking means of transport in real time along with determining the delay	3%	5%	15%	21%	55%
Route planning, considering the necessary transfers and changes of means of transport	2%	4%	16%	27%	52%
Information about the type and price of the ticket necessary	9%	14%	22%	26%	29%
Possibility to buy a ticket	8%	11%	20%	24%	36%
Possibility to save the route to favourites	23%	28%	24%	12%	12%
Information about vehicles adapted for people with disabilities and reduced mobility	30%	20%	21%	20%	9%
Carrier information	35%	27%	19%	11%	9%
Ongoing information about changes in the functioning of public transport	2%	3%	21%	28%	45%
Searching for alternative connections	1%	6%	17%	31%	45%

Source: Own calculations based on data from the survey.

Respondents considered features such as real-time transportation tracking, real-time timetables, and route planning to be essential. It was also crucial to them to supply current information about changes in the operation of public transportation and to search for alternate connections. It turns out that adding routes to favourites, providing information on vehicles adapted for those with impairments and limited mobility, and providing information about the operator is not necessary for respondents.

To determine which functionalities should be included in such an essential feature as route planning, participants were asked to identify the application's major features in this area (Figure 8).



Total response %ages exceed 100% because responders were allowed to select multiple answers at once.

Figure 8. Factors relevant to route planning.

Source: Own calculations based on data from the survey.

Delay updates (91.3%) have proven to be the most important factor in route planning in the app. Information about the waiting time for a means of transport (82.4), planning a trip from one address to another (76.5%) and the waiting time for a change (73.6%) turned out to be of little less crucial. On the other hand, functions such as the side number of the vehicle (0,02%), and the dispatcher's telephone number (1.1%) are the least important.

Respondents were also asked to rate the importance of other possible app features (Table 5).

Table 5.
The importance of additional features in the application

Features	Assessment				
	Unimportant	Somewhat important	Rather important	Very important	Essential
Information on alternative means of transport available nearby, such as city bikes and scooters	27%	35%	26%	9%	3%
Possibility to rent alternative means of transport using the application	29%	31%	23%	13%	4%
Possibility to order a taxi or car transport services	37%	26%	17%	20%	0%
Possibility to pay for parking	32%	26%	14%	21%	7%
Reporting a vehicle breakdown	18%	26%	21%	20%	15%
Possibility to assess the conditions of the trip	20%	23%	24%	19%	15%
Direct contact with the carrier	30%	26%	22%	9%	12%
Possibility to share the route of travel with third parties	17%	25%	19%	23%	16%
Indication of overcrowded means of transport	11%	20%	20%	30%	21%
Information about vehicles that have charging ports and Wi-Fi	33%	24%	20%	11%	13%

Source: Own calculations based on data from the survey.

Travellers positively commented on the possibility of checking overcrowded means of transport. In the case of the possibility of reporting vehicle breakdowns, assessment of travel conditions and making the route available to third parties, opinions were divided. The rest of the features didn't turn out to be relevant enough.

The next section of questions concerned preferences in making public transport payments in the application. Almost four out of every five app users (78.6%) decide to buy tickets with its assistance. More women (85.8%) than men (59.0%) prefer this form of payment. Most age groups, except those over 60, agree. Especially people who study (87.7%) and work (74.2%), but also the unemployed (100%) take advantage of this privilege. From the standpoint of their education, individuals with primary (88.4%), secondary (73.6%), and higher education (78.6%) are generally more willing to use this option, as opposed to people with vocational education, who are less enthusiastic (58.1%).

When it comes to preferred payment methods, the vast majority of respondents favour instant payments (78.15%). Some opt for overpaid accounts (19.0%). The least liked ways include via a city card (1.49%), and banking app (1,38%).

Respondents were also asked about several issues regarding the management strategy of public transport applications. In the opinion of the respondents, local governments (70,3%) should be fully responsible for the operation of the application (Figure 9).

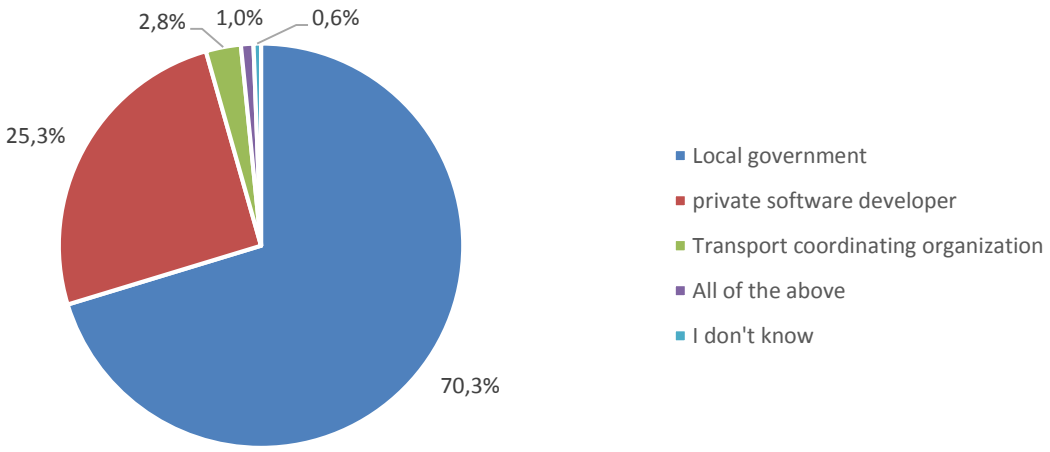
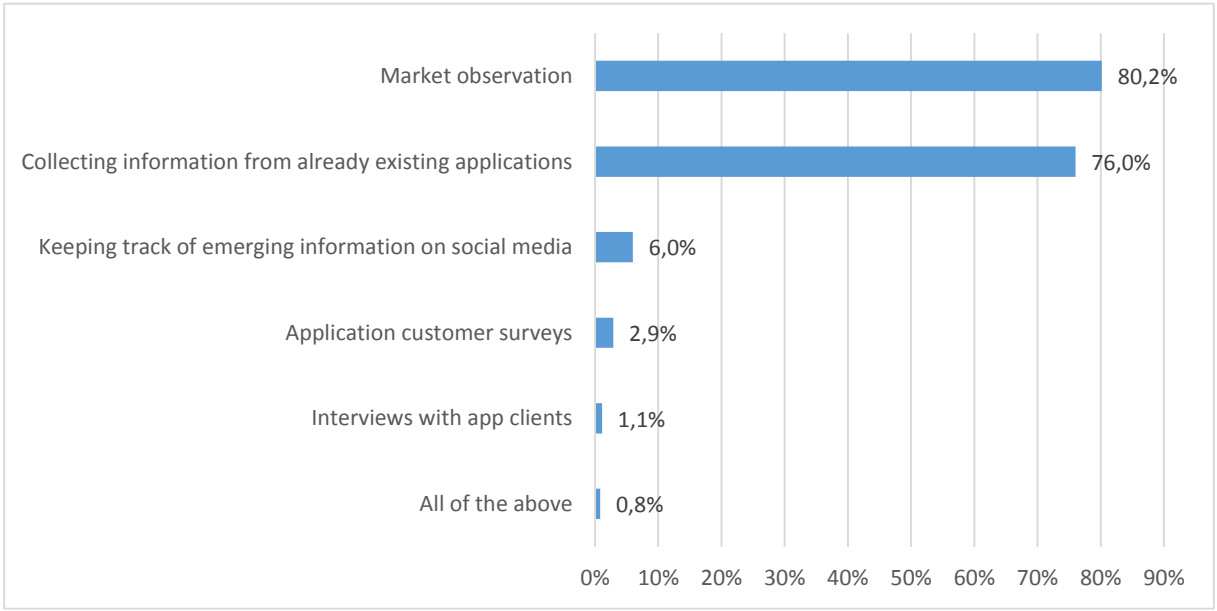


Figure 9. Entities that, in the opinion of the respondents, should supervise the operation of the local urban transport application.

Source: Own calculations based on data from the survey.

The results indicate that respondents are bothered by a wide range of functionalities in a variety of applications. As many as four out of five (81.7%) feel the need to centralize mass transit applications and systems.

They were also asked to indicate how the manager of the application should obtain information allowing it to be adapted to the needs and expectations of users (Figure 10).



Total response %ages exceed 100% because responders were allowed to select multiple answers at once.

Figure 10. Opinion of the respondents on the ways of obtaining information by the manager to adapt the application to the expectations of users.

Source: Own calculations based on data from the survey.

Users would prefer the manager to use such sources of information as market observation (80.2%) and analysis of data obtained from functioning applications (76.0%).

5. Discussion

The purpose of this study was to gain a better understanding of the subjective preferences of mobile app transportation users who commute in the Silesian Metropolis area. The results of the present study suggest that the average transportation app user is a passenger who travels frequently, usually every day, which comes to no surprise when they mainly commute to work by bus on medium distances from 6 to 20 kilometers.

The vast majority of passengers assist their travel with three major apps: Google Maps, Jakodojade and Mobile MPK. This pattern of results is consistent with the previous literature, the same set of most preferred apps have been pointed out in the study conducted in Lublin (Belińska, Choma, 2018). In Krakow (Bryniarska, Gacek, 2018) Jakdojade and Mobile MPK have been proven to be the most useful. The high proportion of replies to Google Maps could be ascribed to the app's accessibility of use and adaptability. Google Maps is one of the world's largest, if not the largest, easily accessible, and free online map services. Most respondents' confession of using the Jakdojade app is not surprising. This application has been around for a very a while, and in addition, it is continually updated, has a rich interface and a wide range of functionalities. Mobile MPK is the only application that is not handled by a private developer but rather by the Transport Coordinating Organization (MPK). The increasing popularity of local government-provided applications may signal a power shift among application developers.

Given the variety of app features and alternatives, app users consider real-time transportation tracking, real-time timetables, and route planning to be critical. They do not see the need to expand the range of features, apart from the one that indicates overcrowded means of transport. Implementing such a function will be as simple as tracking the activity of app users, as is already done in Google Maps that can detect traffic jams. Consequently, we may assume that the application user's needs are currently being addressed properly.

In our study, app users in route planning value the most the ability to detect delays, as well as time of waiting and detailed planning. This pattern of results is consistent with the previous study from Krakow, where planning from point A to B, including time of travel, change and time of waiting are the most crucial features (Bryniarska, Gacek, 2018). Route planning requirements and preferences are thus a universal and provable set of characteristics in different cities.

Our findings highlight that users of public transport applications are very enthusiastic about buying a ticket using their mobile phone. Other studies (Kos-Łabędowicz, Urbanek, 2017) indicate an entirely different approach, where both the Internet and mobile applications are not popular distribution channels for public transport tickets, even among young consumers. This gap in outcomes may be the result of a variety of factors. Undoubtedly, the recent rapid increase in the number of non-cash transactions corresponds to an increase in the number of

locations accepting non-cash payments. Based on the study "Payment habits in Poland in 2020" carried out by the National Bank of Poland, it was found that 46.4% of transactions were made with cash (NBP, 2020, p. 10). In the case of remote payments (on the Internet), the share of non-cash payments was 97.8% the number of all transactions and 97.9% their values (NBP, 2020, p.17). The results indicate that society is undergoing a noticeable transformation to reduce cash payments in favour of cashless payments, as evidenced by the payment for a ticket via a mobile application.

Finally, we learned that app users prefer that their local governments manage all aspects of their public transportation apps. This approach is part of the smart mobility doctrine, which guides the goals set by the Silesian Metropolis. What's more, application users are willing to take an active part in improving the application by sharing data from their own devices with the manager.

There are at least three potential limitations concerning the results of this study. The first limitation concerns the chosen CAWI method only reaches those who have an internet connection and a PC or mobile device. Many people are not always willing to fill out online questionnaires. According to studies, the population that answers to online questionnaire invitations is biased toward younger individuals. The second one concerns the sample size limitation. In the area of Silesian Metropolis live 2,143 million people (Metropolia GZM, 2023). The chosen sample may not represent the variety and the complexity of the considered population. The third limitation concerns the limited scope of factors considered in this study. The chosen method restricted the in-depth research and considered problem. Despite these limitations, these results suggest several implications. The results can aid in the development of improved applications, as well as encourage local governments to create and manage those applications according to user preferences. In addition, this study enables the continued investigation of smart city features within the smart mobility strategy of Silesian Metropolis. In future research, it would be beneficial to compare and contrast results using alternative survey instruments or to adopt a quantitative approach to better understand the motivation and characteristics of mobile app transportation users.

6. Conclusions

Public transport applications are a revolution, embodying the essence of the smart city idea. Applications that largely encourage people to travel by public transport are breaking the barrier of ignorance about the public transport offer and bring hope for a smart city future. Smart mobility appears to be a necessity in this period of fast economic development, rising social demands for quality of life, and increased environmental consciousness. The Silesian

Metropolis (Górnolsko-Zagbiowska Metropolis GZM) has a chance of becoming its forerunner, not only on the scale of Poland but also of a significant portion of Europe.

Research has demonstrated that the Silesian Metropolis has tremendous potential for smart transportation applications. Passengers can use several different applications with different functionalities to move around the Metropolis. Apart from commercial developers, local government entities and transportation organizers are prospering among the app's authors. Since the currently available applications already cater to the tastes of passengers, there is no desire to make fundamental improvements to how they operate. They have no issue purchasing the ticket within the app, and they often use instant payment methods.

They do, however, point out that the system's decentralization works against it. They prefer that certain bodies, such as organizational units or transportation managers, be in charge of oversight and operation. Passengers also believe that efforts should be made throughout the study region to centralize applications and systems. They would be glad to share their insights as part of market research or as part of gathering data on their experiences with existing applications.

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