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MOBILE APPLICATIONS AS DIGITAL SUPPORT FOR PUBLIC TRANSPORT PASSENGERS (A POLISH EXAMPLE)

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ABSTRACT

Purpose: *The purpose of this study is to assess the extent to which passengers use mobile applications as digital support in planning and executing public transport trips, as well as to evaluate these applications from the users' perspective.*

Need for the study: Despite the growing role of mobile applications in public transport, there is still a research gap in Poland regarding a thorough understanding of how passengers use these technologies, particularly in the context of the changing management of transport. Transport management systems are becoming increasingly intelligent, utilizing data analytics, automation, and digital technologies to improve service quality. The use of mobile applications within the framework of intelligent transport management can significantly impact the improvement of service accessibility, efficiency, and the overall passenger experience, especially in the face of various technological barriers.

Methodology: *The study employed a nationwide survey using the Computer-Assisted Web Interview (CAWI) method, conducted in 2023. The sample included 1,117 individuals aged 18 and older, residing across Poland, ensuring broad demographic representation. One of the primary objectives of the research was to gather information on passengers' use of mobile applications as digital support in planning and executing public transport trips.*

Findings: *The results of the first part of the study showed that approximately 60% of passengers use mobile applications for ticket purchases, 80% indicated that they use maps and navigation apps, nearly 80% use location services during their trips, almost all passengers check timetables online (96.4%), over 80% check the waiting time for their chosen mode of transport online (84.6%), nearly 70% use the "Jak dojadę" app, while 30% have never used it. The second part of the study focused on the evaluation of mobile applications in railway and bus transport. About 50% of respondents rated websites, ticket purchasing applications, and passenger information apps positively.*

Practical Implications: *The obtained information provides valuable insights that transport operators need to encourage passengers to use modern technologies. It may be useful in improving individual applications, sales channels, and passenger information systems, including those for people with disabilities or limited mobility. Special attention should be given to the evaluations of mobile applications, and strategies should be developed to address the identified weaknesses.*

Keywords: mobile applications; passenger transport; public transport

Jel codes: O32; R40; R49

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1. INTRODUCTION

The early 21st century marks a period of significant change and the emergence of new phenomena in the European and global economy, leading to shifts in the perception of the transport market. The importance of transport in the economy continues to grow due to factors such as globalization, specialization and division of labor, mass consumption, economies of scale in production, cost optimization, increasing competition, shortening product life cycles, the digitalization of society, and changes in sales and customer service models. A particularly transformative period for many market trends occurred between 2019 and 2022, when the world grappled with the escalating COVID-19 pandemic (Impact of COVID-19 pandemic, 2021). These changes were reflected in the management of transport service providers, who have been intensively implementing intelligent management, understood as the integration of information technology, analytical technology, and automation to more effectively manage resources and processes within an organization (Rakhymova et al., 2024; Vredenborg et al., 2025).

These economic transformations are mirrored in changes occurring in society, exemplified by the contemporary concept of Society 5.0: "which utilizes advanced technologies to create a society based on sustainable development, social innovations, and digital transformation." This concept is also reflected in passenger transport. The development of digitalization changes how societies live, expand their knowledge, and travel. Different age groups approach the use of new information technology achievements in varying ways. A particularly important segment of consumers is Generation Z, today's 30-year-olds, who are almost addicted to mobile devices, open to technological innovations, proficient in their use, yet also impatient and impulsive, as well as seniors, often digitally excluded, relying on traditional, timeless solutions (Ilciów, 2023). Additionally, there are cultural factors that hinder the mass acceptance of Transport 5.0, including resistance to adopting technology and generally low levels of digital literacy (Atiku et al., 2024). In many cases, there is a reluctance to transition to automated systems due to a lack of trust in new technologies (Reimann et al., 2017). A low level of digital skills prevents people from using technologies such as mobile applications (Carpentiere et al., 2024; Anuar et al., 2024). Educational programs and awareness campaigns for social purposes can help overcome some of these challenges (Reimann et al., 2017; Etuk et al., 2022). To achieve the goals of Society 5.0, it is particularly important to focus on segments defined by limited digital skills and negative attitudes toward AI-based solutions, which are essential for the development and widespread adoption of these technologies.

The ongoing technological progress presents many opportunities for efficient passenger transport. It facilitates faster information flow, makes service acquisition easier, and can positively impact passengers, whose expectations are also growing. The concept of modern technologies used by passengers is broad and diversely defined. It is most often associated with the Internet (passenger information, ticket sales), mobile apps, smart boards in vehicles and at stops (Wolniak & Secuła, 2024; Ilciów, 2023). Consequently, transport providers are striving to adapt both their product offerings and distribution methods to meet consumer expectations (Chowdhury & Dewan, 2024). The issue of using mobile applications for planning and undertaking public transport trips fits squarely within this scope. In this research area, a knowledge gap exists in Poland, which required the formulation of the following research questions:

- Do passengers use mobile applications in planning and executing public transport trips? How do they evaluate the applications they use?
- Does age differentiate the population using mobile applications for trip planning (do seniors use mobile applications in public transport or are they digitally excluded)?
- Do passengers with disabilities or limited mobility use mobile applications in public transport, or are they digitally excluded?
- Does gender differentiate the population using mobile applications for trip planning?
- Does place of residence differentiate the population using mobile applications for trip planning?

Mobile applications supporting public transport are not merely technological tools but integral components of smart city and public service management. These applications are part of an ecosystem that relies on data, digitalization, and process optimization to improve the efficiency of urban services and enhance the quality of life for citizens. They bridge the gap between users and transport services,

providing real-time information, ticketing systems, and journey planning features, while contributing to the overall infrastructure of a connected and efficient city. As part of an intelligent management strategy, these applications go beyond simple transactional tools; they actively participate in the optimization of urban mobility and contribute to a city's sustainability goals (Yigitcanlar, et al., 2024).

Moreover, such mobile applications can be expanded with components of artificial intelligence (AI), allowing for the prediction of delays, analysis of user movement patterns, and the personalization of messages. AI-powered features could offer predictive analytics regarding transport capacity, and suggest optimal routes in real-time, helping to manage congestion and improve passenger experience. These capabilities would further embed mobile applications into the framework of intelligent transport management, aligning with the broader vision of smart cities, where data-driven decisions guide operational and strategic improvements (Mohsen, 2024).

From the perspective of public transport operators, mobile applications can serve as valuable sources of operational data. This data can be used to support decision-making processes, forecast demand, and manage crises. For instance, real-time data collected from users can help predict peak hours, monitor the effectiveness of specific routes, and identify areas in need of improvement. This operational intelligence supports not only day-to-day management but also long-term planning and strategic development, making mobile applications a crucial element of intelligent management systems within public transport (Abduljabbar et al., 2019). Through such systems, operators can improve efficiency, reduce costs, and provide better services to the public, which is at the core of intelligent management concepts.

The purpose of this article is to determine the level of mobile application usage as digital support by passengers in planning and executing public transport trips and to assess user evaluations of these applications.

The article includes an introduction, a literature review, a discussion of the research methods and results, as well as a discussion and conclusions.

2. LITERATURE REVIEW

The passenger transport market is highly dynamic and undergoes constant transformations, primarily driven by the changes occurring in the transport environment, especially those resulting from the concept of sustainable transport. This trend was disrupted in 2019 with the onset of the COVID-19 pandemic. Passengers, concerned about their health safety and the numerous restrictions in public transportation, increasingly opted for individual transport. The limitation of direct contact between people accelerated the development of their digital skills. Passengers, almost forced to develop digital skills during the pandemic, recognized the benefits and opportunities that these technologies provide. In the field of transport services, technology, and customer relationships (Kos et al., 2020; Kos et al., 2022; Rosa, 2024b; Oszter, 2020), the importance of innovation has increased. The ongoing digitalization process in the modern world, alongside generational changes, has had a significant impact on shaping the passenger transport services market, both for railway operators and passengers. As a result, significant changes in customer expectations have led to the emergence of new preferences alongside traditional ones (Chowdhury & Dewan, 2024). Passengers also have new expectations regarding the equipment of transport services with modern elements (Awad-Núñez et al., 2021). The modern approach to passenger expectations compels companies competing in the passenger transport market to conduct professional analyses of the market and customer preferences to implement values that are most appreciated by customers. These include, first of all, all solutions offered in the areas of innovation, as perceived in both Polish (Góra, 2021; Gontarz, 2021) (Badanie satysfakcji pasażerów – edycja I, UTK, 2020), (Sprawozdanie z funkcjonowania rynku transportu kolejowego w 2019 r., UTK, 2019) and modern technologies (Kozłowski et al., 2020; Mróz, 2021), as well as in foreign literature (Bolobonov et al., 2021; Enoch et al., 2020; Kothari et al., 2016; Zitricky et al., 2015; Chowdhury & Dewan, 2024). Special passenger requirements are also described by Brumercikova et al., 2020; Branda et al., 2020; Awad-Núñez et al., 2021), including the use of social media, Wi-Fi services in vehicles, and tracking the vehicle's current location on its route using a mobile app (Bian et al., 2022). Digital accessibility is an important and new area of accessibility in public transport

(Kamargianni, 2016; Strenitzerova & Stalmachova, 2021). Mobile applications are the most common (Górniak, 2022). Most of them enable ticket purchases and payments for parking in the city. Information is made available to passengers on passenger information boards at bus stops and stations, on the website and in a mobile application for smartphones, and on electronic information boards in buses and trains (Rosa, 2024a). The development of modern technologies and their acceptance by passengers contributes to the emergence of new forms of information and service distribution (Frederico et al., 2021; Javid et al., 2021). Moreover, such innovative solutions are intended to encourage passengers to use collective or shared forms of transport (Filippi et al., 2023; Hlavaty et al., 2021). In this context, the concept of intelligent management emerges, which not only supports these innovations but also creates more integrated and optimized transport systems. Intelligent management is a concept that goes beyond traditional transport planning and encompasses broader city management. It integrates various technological innovations, including the Internet of Things (IoT), artificial intelligence (AI), and big data analytics, to create an integrated system that optimizes resource usage, improves service delivery, and enhances the quality of life for residents. In the context of public transport, intelligent management involves real-time coordination of various modes of transport (buses, trams, trains) through mobile applications and data integration, ensuring that services are not only reactive but also predictive, eliminating problems before they arise (Patil et al., 2024). These applications play a crucial role in making transport systems more adaptive, efficient, and user-friendly, as part of the smart city concept, where each system collaborates to improve the overall functionality of the city. Mobile applications are the most widely used. Already, Stopka (Stopka, 2014) addressed the requirements of users of a mobile application supporting "door-to-door" mobility in public transport. These applications are often created by operators to coordinate timetables, synchronize arrival and departure times of different modes of transport, ticket sales, and passenger information systems (Berrgren et al., 2021; Casquero et al., 2022; Sun et al., 2021). In addition to these core functions, these applications play a crucial role in making transport systems more adaptive, efficient, and user-friendly, contributing to the concept of intelligent city management. By integrating real-time data and communication between different modes of transport, these applications enable a more coordinated and optimized transportation network, improving the overall functionality of the city. Currently, there are many incompatible applications designed to search for passenger information, and it is necessary to integrate them to provide all the relevant travel data across different transport modes (Rodriguez et al., 2021; Saputro & Futurama, 2024). Most of them allow for ticket purchasing and also include additional features, such as payment for city parking (Siyal et al., 2021; Sia et al., 2023). Since the situation during a trip may change (e.g., due to traffic disruptions or congestion), passengers should have clear access to information about their journey while using transport services. The main carriers of information are voice announcements. Additionally, vehicles are equipped with various types of boards displaying real-time travel information: static and dynamic. The variety of communication forms is particularly important when serving passengers with disabilities or limited mobility (Mogaji & Nguyen, 2021; Page & Assa, 2021).

An analysis of available studies and research, to the best knowledge of the author, has shown that there are no comprehensive studies in Poland regarding changes in the use of digital information technologies by public transport passengers and their evaluations. The only available results, in a general context and scope, are presented by the Office of Rail Transport (Jakość usług w sektorze pasażerskich przewozów kolejowych – badanie opinii pasażerów, UTK, 2025; Badanie satysfakcji pasażerów – edycja II, UTK, 2022; Sprawozdanie z funkcjonowania rynku transportu kolejowego w 2019 r., UTK, 2019). The findings presented in this article aim to fill the identified research gap.

3. METHODOLOGY

3.1. Participants

The subject of the cyclical, original research conducted as part of two projects carried out by the University of Szczecin, “Improving the Quality of Research in Economic Sciences with Particular Emphasis on the Service Sector (RID) 2019-2023 and 2024-2028,” was to study the communication behaviors of public transport passengers in Poland. One of the objectives of the research conducted

in 2023 was, among other things, to gather information on the use of mobile applications by passengers in planning and executing trips as digital support for public transport. The criterion for selecting specific applications was based on the results of studies conducted by the Office of Rail Transport and the authors' own observations (Jakość usług w sektorze pasażerskich przewozów kolejowych – badanie opinii pasażerów, UTK, 2025; Badanie satysfakcji pasażerów – edycja II, UTK, 2022). This article presents only some of the results directly related to the issue discussed.

The study population consisted of individuals aged 18 years or older, residing in Poland. A total of 1,117 interviews were conducted. The percentage basis included respondents who had traveled by public transport, with 929 respondents in total. The quantitative method and sample selection used in the study allow for generalizing the results to the entire adult population, with a margin of error of +/- 3.0% (95% confidence level).

Characteristics of the Respondents:

- Gender: women (52.4%) and men (47.6%).
- Age: between 18 and 30 years old (16.9%), between 31 and 60 years old (52.9%) and those over 60 years old (30.2%).
- Residence: About 40% of the respondents were rural residents, while one in five lived in towns with populations between 20,000 and 100,000 (19.1%). Residents of cities with over 400,000 inhabitants made up 13.6% of the sample.
- Health/ability status: 35.5% of respondents were people with disabilities and caregivers of people with disabilities and 64.5% were passengers without disabilities (able-bodied).

3.2. Research Protocol and Stimuli

The study was conducted using the CAWI method on the PBS Sp. z o.o. panel, Poznaj.to, between November and December 2023. The CAWI method was chosen by the research company selected through a competitive process, which has experience in reaching a representative sample in a short period of time. The research tool was designed by the authors and consulted with the research company PBS Sp. z o.o. The questionnaire was preceded by a brief information statement, informing respondents that questions regarding their health status would be asked, and respondents had to provide consent to participate in the study. This procedure was necessary as health status is classified as sensitive personal data under the GDPR.

3.3. Research Apparatus

The study was conducted on a random sample, using a proprietary respondent selection system and a tool for maintaining a participation delay in the research. Based on the randomly selected representative sample from the population, the obtained results were generalized. Furthermore, the sample selected for this purpose was subjected to a weighting procedure to correct the results in relation to the structure of the general population. The study control was carried out in two ways:

- Field control – During the study, the responses received were continuously monitored, which allowed for immediate intervention and the elimination of cases where the data raised doubts, such as when the time taken to complete the questionnaire was too short, or when undesirable patterns, inconsistencies, or discrepancies in responses occurred. The questionnaire script prevented respondents from skipping key questions, such as those presenting content critical to the study.
- Non-field control – A substantive analysis enabled the elimination of incomplete or unreliable data. The quality control process covered 100% of the collected material, during which the consistency of responses, response patterns, and entries for semi-open questions were analyzed.

3.4. Analysis of Measurement Data

Before the analysis began, the dataset was subjected to a weighting procedure aimed at correcting discrepancies in the empirical distribution of results relative to the structure of the general population based on gender, age, and place of residence. Iterative weighting methodology (RIM) was applied using the aforementioned characteristics. To analyze the significance of differences in responses between groups of respondents, statistical analyses were conducted using IBM SPSS Statistics 26. Chi-square tests were performed, and significant differences in column proportions – the percentage of responses

within the specified groups – were compared. A significance level of $\alpha = 0.05$ was adopted. Bonferroni correction was also applied to adjust the significance values.

4. RESULTS

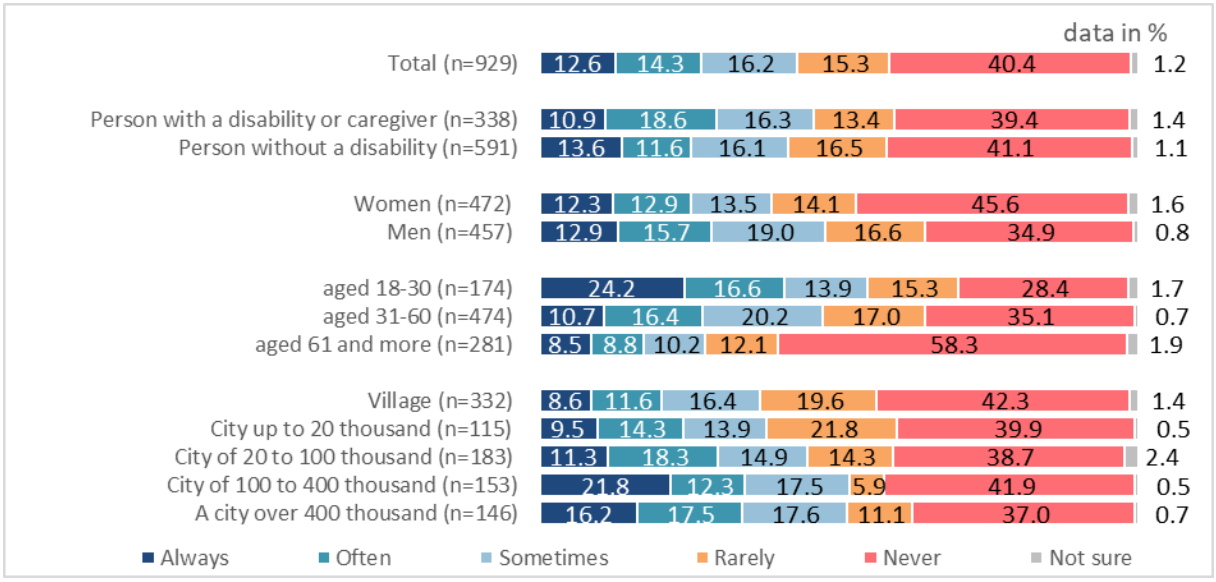
4.1. Use of Selected Mobile Applications

Respondents were asked whether they use several modern technology tools to facilitate traveling by public transport (rail and road transport) before or during their journey. One of the stages of the study involved questions about the use of specific mobile applications. The questions addressed the use of ticket purchasing applications, maps and navigation apps, location services, checking timetables online, checking the waiting time for the chosen mode of transport online, and using the "Jak dojadę" app. The responses are presented in Figures 1-6.

Figure 1 shows the frequency of using mobile applications for public transport ticket purchases. Women significantly more often than men indicated that they never use mobile ticketing apps (45.6% of women selected this answer, compared to 34.9% of men, $p < 0.05$).

This response was also more frequently chosen by individuals older than 60 years (58.3% of responses in this group) than by younger respondents. Among respondents aged 18-30, the percentage was 28.4%, and among those aged 31-60, it was 35.1%.

The size of the respondents' place of residence was also a factor that differentiated responses to this question. Rural residents (19.6% of responses in this group) and residents of towns with populations up to 20,000 (21.8% of responses in this group) significantly more often indicated that they rarely use such apps compared to residents of cities with populations ranging from 100,000 to 400,000 (5.9% of responses in this group, $p < 0.05$).



Percentage basis: respondents who have ever traveled by public transport (bus, minibus, trolleybus, tram, or train).

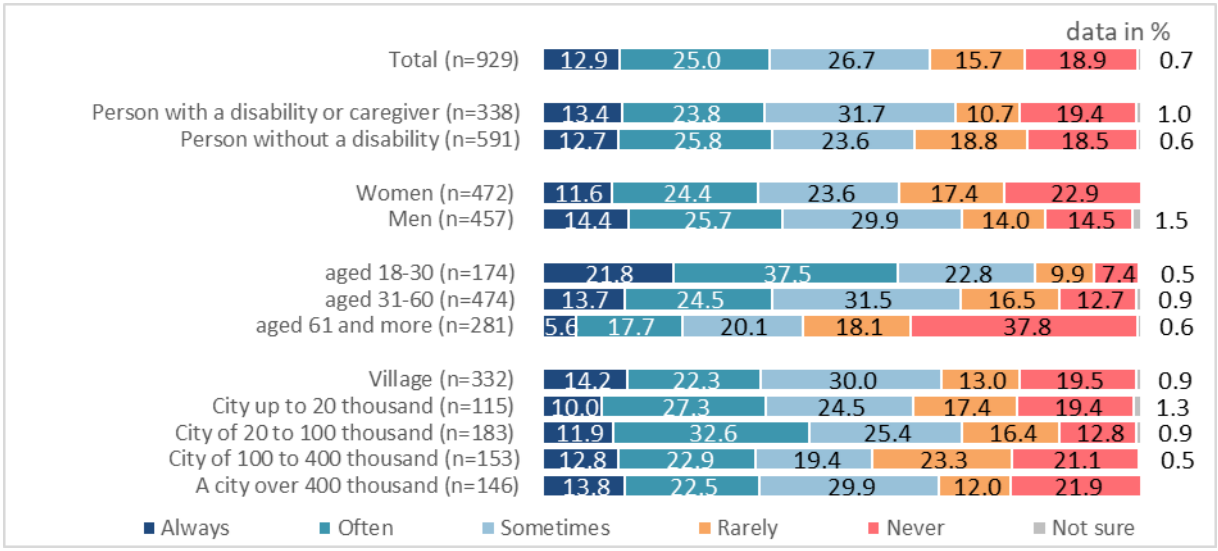
Figure 1. Use of Ticket Purchasing Applications During Travel Planning in 2023
Source: own elaboration.

Approximately 80% of respondents indicated that they use maps and navigation apps during travel planning or while traveling – 26.7% use them sometimes, 25% use them frequently, and 12.9% always use them (Fig. 2).

Individuals with disabilities statistically significantly more often than those without disabilities indicated that they sometimes use such apps (31.7% of responses in the disabled group versus 23.6% in the non-disabled group, $p < 0.05$).

Women statistically significantly more often than men indicated that they never use maps or navigation apps (22.9% of women selected this answer, compared to 14.5% of men, $p < 0.05$).

This response was also more frequently chosen by individuals older than 60 years (37.8% of responses in this group) compared to younger respondents. Among those aged 18-30, the percentage was 7.4%, and among those aged 31-60, it was 12.7%.



Percentage basis: respondents who have ever traveled by public transport (bus, minibus, trolleybus, tram, or train).

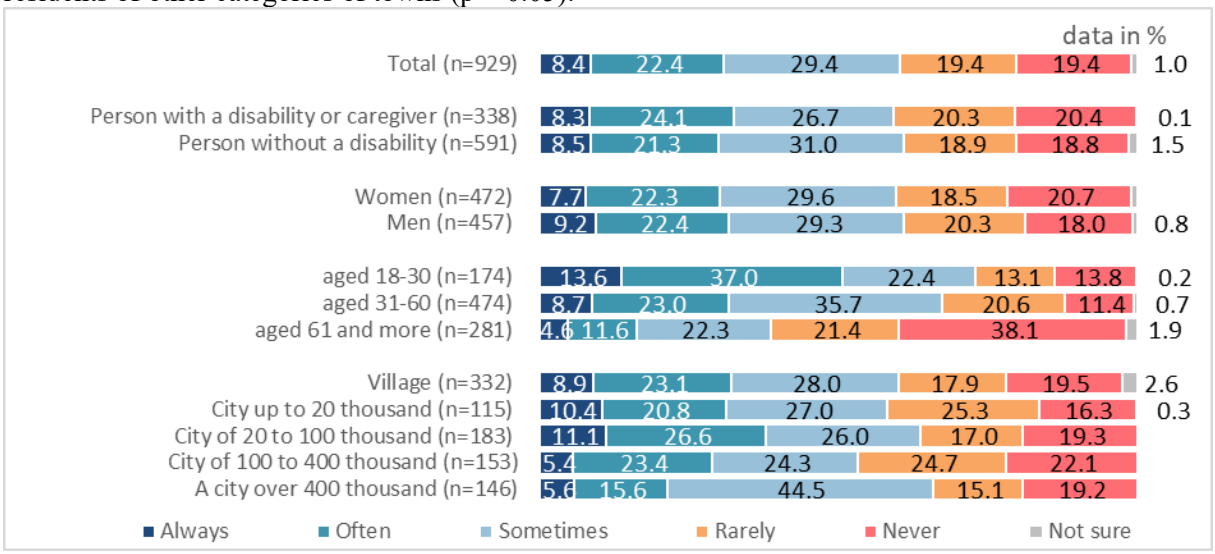
Figure 2. Use of Maps and Navigation Applications During Travel Planning or While Traveling in 2023

Source: own elaboration.

Nearly 80% of respondents indicated that they use location services during travel planning or while traveling – 29.4% use them sometimes, 22.4% use them frequently, and 8.4% always use them (Fig. 3).

Age and the size of the respondents' place of residence are variables that differentiate the distribution of responses to this question. Statistically significantly more individuals over the age of 60 (38.1% of responses in this group) indicated that they never use such applications compared to younger respondents. Among respondents aged 18-30, the percentage was 13.8%, and among those aged 31-60, it was 11.4% ($p < 0.05$).

Residents of cities with populations exceeding 400,000 were statistically significantly more likely to indicate that they rarely use such applications (44.5% of responses in this group) compared to residents of other categories of towns ($p < 0.05$).



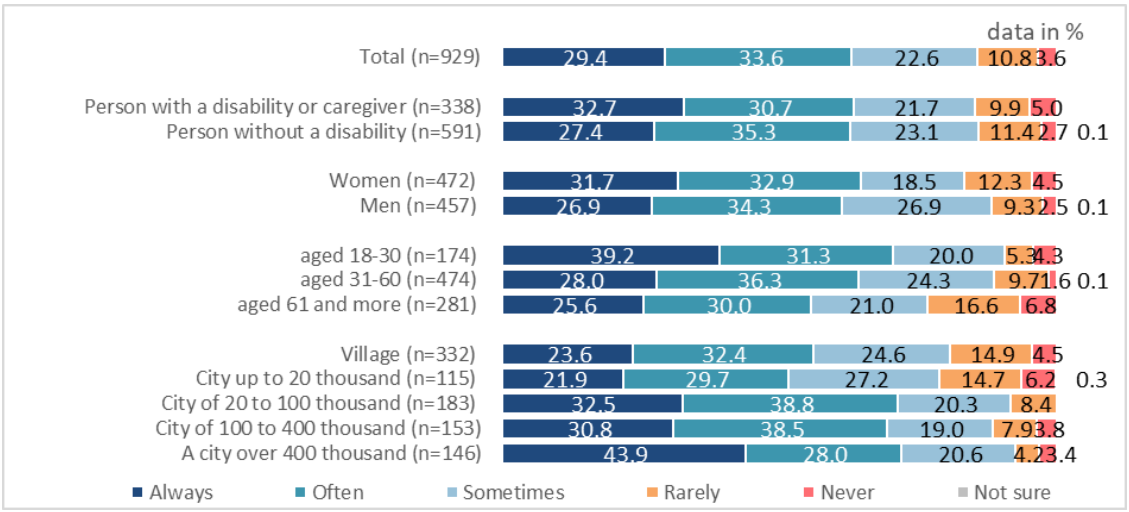
Percentage basis: respondents who have ever traveled by public transport (bus, minibus, trolleybus, tram, or train).

Figure 3. Use of Location or Position Services During Travel in 2023

Source: own elaboration.

Almost all respondents check the timetable online before their planned public transport journey (96.4%). One in five respondents checks it sometimes, one in three does so frequently, and nearly 30% always do so (Fig. 4).

Gender and age are variables that differentiate the distribution of responses to this question. Men statistically significantly more often than women indicated that they sometimes check the timetable in this way (26.9% of men selected this answer, compared to 18.5% of women, $p < 0.05$). Statistically significantly more individuals aged up to 30 years (39.2% of responses in this group) indicated that they always check the timetable online compared to older respondents. Among respondents aged 31-60, the percentage was 28%, and among those over 60, it was 25.6% ($p < 0.05$).



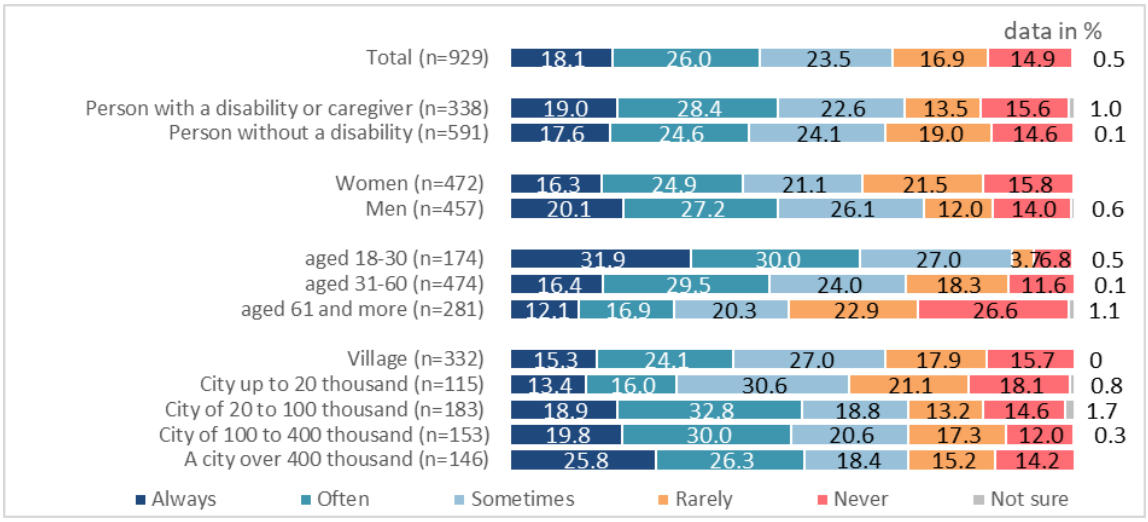
Percentage basis: respondents who have ever traveled by public transport (bus, minibus, trolleybus, tram, or train).

Figure 4. Checking Timetables Online During Travel Planning in 2023

Source: own elaboration.

Over 80% of respondents declared that they check the waiting time for their chosen mode of transport online during their public transport journey (84.6%). Of these, 23.5% do so sometimes, 26% do so frequently, and 18.1% always check the waiting time (Fig. 5).

Gender is a variable that differentiates the distribution of responses to this question. Women statistically significantly more often than men indicated that they rarely check the waiting time (21.1% of women selected this answer, compared to 26.1% of men, $p < 0.05$).



Percentage basis: respondents who have ever traveled by public transport (bus, minibus, trolleybus, tram, or train).

Figure 5. Checking the Waiting Time for the Chosen Mode of Transport Online During Travel Planning in 2023

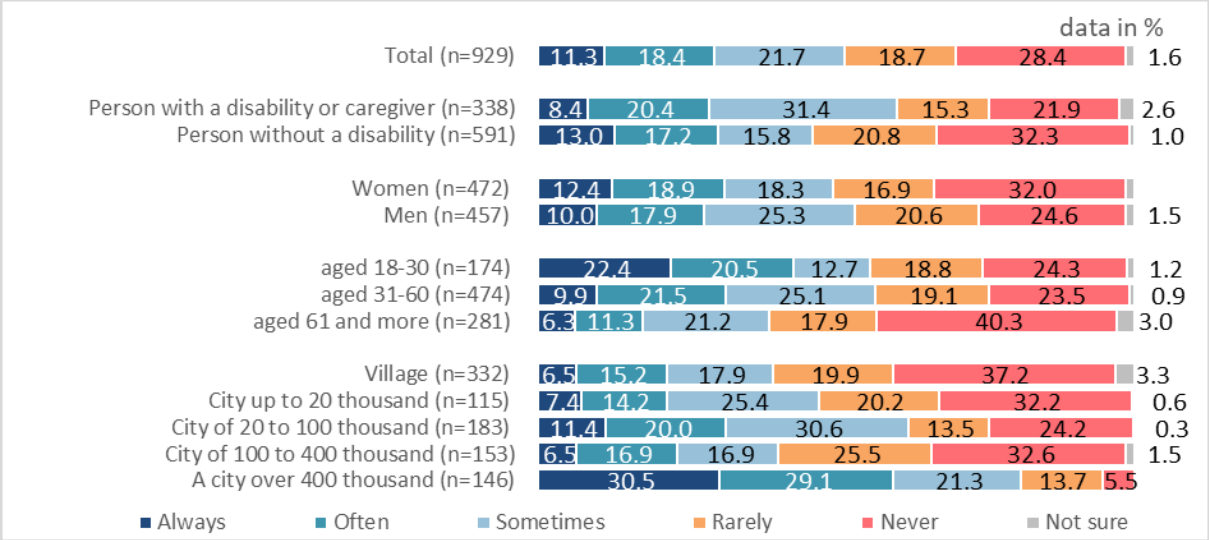
Source: own elaboration.

Nearly 30% of respondents have never used the "Jak dojadę?" app during their public transport journeys, 21% indicated that they use it sometimes, 18.4% use it frequently, and 11.3% always use it (Fig. 6).

Individuals with disabilities statistically significantly more often than those without disabilities indicated that they sometimes use this type of application (31.4% of responses in the disabled group versus 15.8% in the non-disabled group, $p < 0.05$).

Women statistically significantly more often than men indicated that they never use the "Jak dojadę?" app (32% of women selected this answer, compared to 24.6% of men, $p < 0.05$). This response was also significantly more frequent among individuals older than 60 years (40.3% of responses in this group) compared to younger respondents. Among respondents aged 18-30, the percentage was 24.3%, and among those aged 31-60, it was 23.5%.

The size of the place of residence is also a factor influencing differences between groups. Residents of cities with populations over 400,000 (30.5% of responses in this group) significantly more often indicated that they always use this app compared to residents of other town categories.



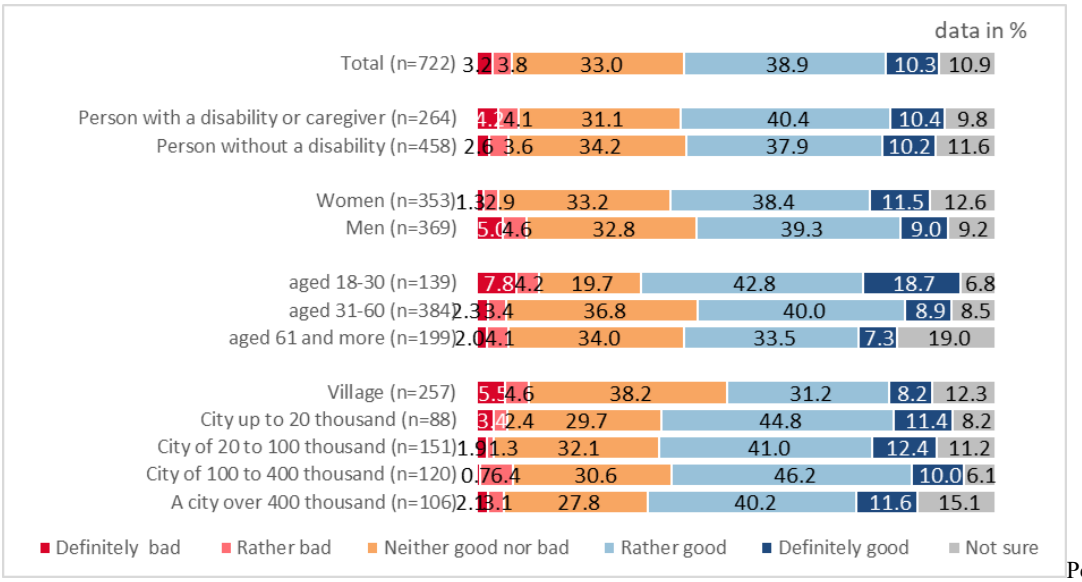
Percentage basis: respondents who have ever traveled by public transport (bus, minibus, trolleybus, tram, or train).

Figure 6. Use of the "Jak dojadę?" App During Travel Planning or While Traveling in 2023
Source: own elaboration.

4.2. Evaluation of the Website and Applications for Ticket Purchasing, Passenger Information, and Ticket Distribution

The evaluation results refer to passengers of rail transport (N = 722, Fig. 7-8) and bus transport (N = 583, Fig. 9-10). The evaluation of the website and applications for ticket purchasing and passenger information in rail transport is presented in Fig. 7. Half of the respondents rated this aspect positively, while 6.9% disagreed. Men statistically significantly more often than women rated the websites and ticket purchasing apps for trains very poorly (1.3% of women and 5% of men selected this answer, $p < 0.05$).

The results also vary based on the age of the respondents. Statistically significantly more individuals over 30 years old rated this aspect as neither good nor bad (36.8% in the 31-60 age group, 34% in the group over 60) compared to younger respondents (19.7% in this group, $p < 0.05$).



Percentage basis: respondents who traveled by train n=722

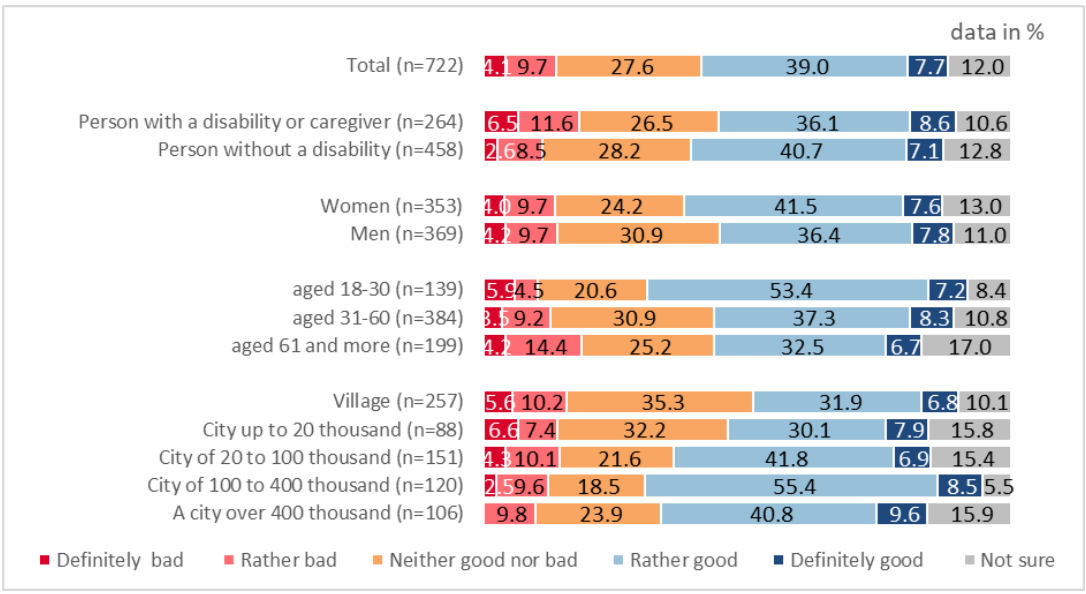
Figure 7. Evaluation of website/ticketing and passenger information applications in 2023
Source: own elaboration.

The respondents rated ticket machines in rail transport slightly worse – half of the respondents gave this aspect a positive evaluation, while only 13.8% disagreed (Fig. 8).

Individuals with disabilities statistically significantly more often than those without disabilities rated this aspect very poorly (2.6% of responses in the non-disabled group and 6.5% in the disabled group, $p < 0.05$).

The results also vary based on the age of the respondents. Statistically significantly more individuals aged up to 30 years rated this aspect rather positively (53.4% of responses in this group) compared to older respondents (37.3% in the 31-60 age group, 32.5% in the over 60 age group, $p < 0.05$).

The size of the place of residence is also a factor influencing differences between groups. Rural residents significantly more often selected the response "Neither good nor bad" (35.3% of responses in this group) compared to residents of towns with populations ranging from 20,000 to 400,000 (21.6% and 18.5% of responses in these groups, $p < 0.05$).



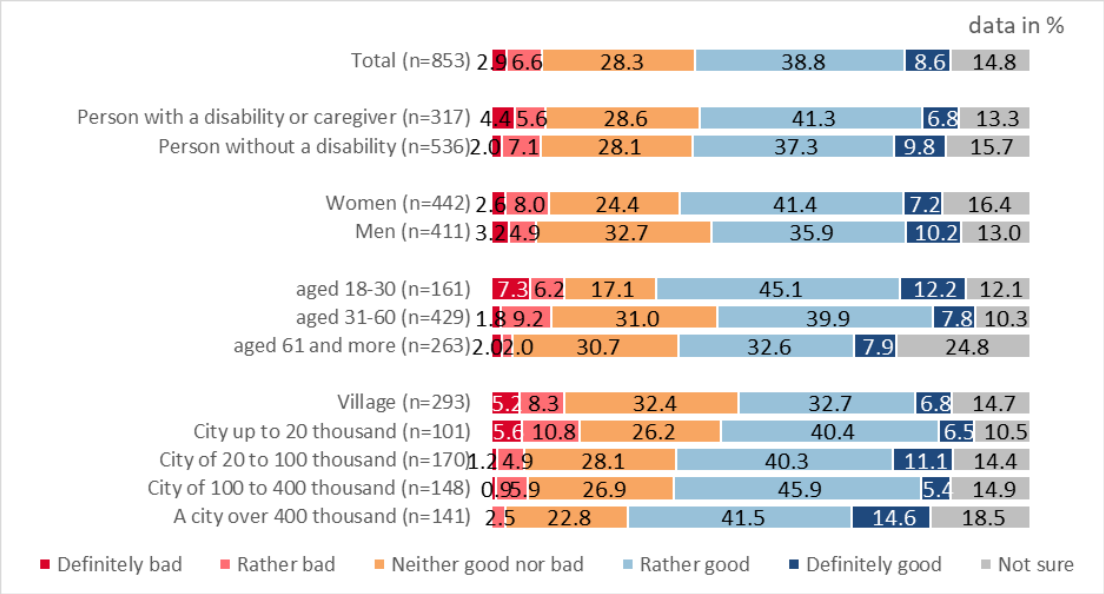
Percentage basis: respondents who traveled by train n=722

Figure 8. Evaluation of ticket machines in 2023
Source: own elaboration.

In bus transport, half of the respondents gave a positive evaluation to websites and applications for ticket purchasing and passenger information (47.4%), while one in ten disagreed (9.5%), as shown in Fig. 9.

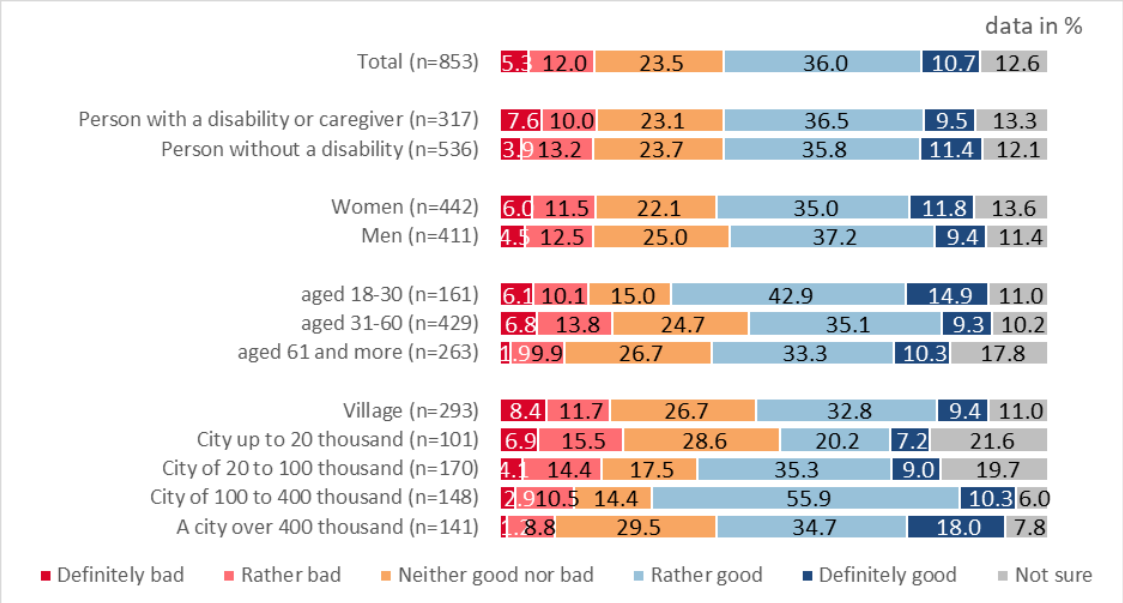
Men statistically significantly more often than women rated the websites and ticket purchasing apps for buses as neither good nor bad (24.4% of women and 32.7% of men selected this response, $p < 0.05$).

The results also vary based on the age of the respondents. Statistically significantly more individuals aged up to 30 years rated this aspect very poorly (7.3% of responses in this group) compared to older respondents (1.8% in the 31-60 age group, 2% in the over 60 age group, $p < 0.05$).



Percentage basis: respondents who have traveled by bus (N = 853).

Figure 9. Evaluation of website/ticketing and passenger information applications in 2023
Source: own elaboration.



Percentage basis: respondents who have traveled by bus (N = 853).

Figure 10. *Evaluation of ticket machines in 2023*
Source: own elaboration.

Similarly, respondents rated ticket machines in bus transport (Fig. 10) – half of the respondents gave a positive evaluation of this aspect (46.7%), while only 17.3% disagreed. Statistically significantly more individuals over 30 years old rated this aspect as neither good nor bad (24.7% in the 31-60 age group, 26.7% in the over 60 age group) compared to younger respondents (15% in this group, $p < 0.05$).

The size of the place of residence is also a factor influencing differences between groups. Residents of cities with populations ranging from 100,000 to 400,000 were statistically significantly more likely

to rate this aspect as "Rather good" (55.9% of responses in this group) compared to respondents from other categories of towns (with a maximum of 36% of responses in the other groups, $p < 0.05$).

5. DISCUSSION

In 2023, after the COVID-19 pandemic subsided, there was an observed increase in both transport services and the use of modern technologies by passengers: as many as 85% checked the waiting time for their chosen mode of transport online, 70% used mobile applications, and 96% checked timetables before their journey. However, relatively fewer passengers purchased tickets online (almost 50%), with the remaining individuals buying tickets in the traditional manner (Rosa 2024; Kos et al. 2020; Anuar 2024).

The results presented in this article from the conducted research are similar to those provided by transport operators based on their own calculations. They clearly indicate a steady increase in the use of mobile applications in planning and executing public transport journeys in Poland (Badanie satysfakcji pasażerów - edycja I; edycja II – 2019, 2022; Jakość usług w sektorze pasażerskich przewozów kolejowych – badanie opinii pasażerów, UTK, 2025).

The survey conducted in December 2019 showed that passengers were eager to use the new technological solutions offered to them (Badanie satysfakcji pasażerów – edycja I, UTK, 2020). This was indicated by the large number of individuals declaring the purchase of tickets using mobile applications and online sales systems (websites). Contributing factors include the ability to use sales services at any time and place, the increasing availability of internet access, ease, speed, and the growing security of online payments. Furthermore, the increasing number of purchases made online indicates that the trend of using mobile applications and websites to purchase tickets will continue to rise. The sample in the 2019 study consisted of 5,646 people. These results correlate with the statistics published by the Office of Rail Transport (UTK) based on annual data reports from railway operators. According to this data, the share of online channels (websites and mobile applications) in railway ticket sales has been increasing significantly year by year. A comparison of the data from 2017 and 2018 showed an annual increase in the internet share of total sales by nearly 40%. Passengers rated ticket vending machines the highest (with a combined 52.9% good and very good ratings) and online sales systems (53.7% of responses indicating a high level of satisfaction). However, the large number of respondents who expressed no opinion regarding their satisfaction with the use of mobile applications for this purpose – 38.8% of respondents – may indicate less frequent use of this ticket purchase method and also point to opportunities for development and improvement. Respondents positively evaluated the availability of passenger information from the most popular sources, particularly from the internet services of transport operators (58.6% of ratings were good or very good) (Badanie satysfakcji pasażerów – edycja I, UTK, 2020).

The Passenger Satisfaction Survey conducted in December 2021 was held in the form of an interactive questionnaire available on the website of the Office of Rail Transport (Badanie satysfakcji pasażerów – edycja II, 2022). A total of 1,516 individuals completed the survey. The results indicated that respondents most often purchased railway tickets using online sales systems (websites) – 70.2%, via mobile applications – 43.3%, or through ticket vending machines (43.1%). The largest number of respondents rated the quality of passenger information regarding available connections, train departure times, platforms, transfer opportunities, and the information provided on transport operators' websites and mobile applications as good or very good (76.3%), as well as the clarity and readability of timetables in search engines (87.4% rated this as good or very good). The most commonly used methods for checking timetables, ticket prices, or purchasing tickets included: connection search engines (75.9%), transport operators' websites (64.1%), and mobile applications (54.6%). The majority of respondents

rated the accessibility of passenger information on the most popular sources, particularly on transport operators' websites (58.6% rated it as good or very good) (Badanie satysfakcji pasażerów – edycja II, 2020).

The results of the next passenger satisfaction survey conducted by the Office of Rail Transport in December 2024 (Jakość usług w sektorze pasażerskich przewozów kolejowych – badanie opinii pasażerów, UTK, 2025) clearly show that passengers enjoy traveling by train, but they are not without criticism. With technological progress, their justified expectations are growing. Travelers expect intuitive ticket purchasing channels, fare integration, useful applications, and fast, but most importantly, reliable information – both traditional, provided by humans, and automated. The railway passenger satisfaction survey took the form of an interactive questionnaire posted on the UTK website. It was completed by a total of 2,208 people. Respondents rated the quality of passenger information about train schedules/movements on websites and in mobile applications the highest (65.4%). They rated train information provided through station megaphone announcements the lowest (43.6%). The majority of respondents rated the transparency and readability of timetables in online connection search engines as the best (87.4%), while the lowest ratings were for station posters (30.9%). The most commonly used methods for checking timetables, ticket prices, or purchasing tickets included: connection search engines (69.2%), transport operators' websites (61.2%), mobile applications (56.1%), and others (1.2%). Other sources mentioned by respondents included interactive trip planners, such as Google Maps, station displays, Network Timetable Tables (SRJP), friends, and ticket vending machines (which usually have a built-in connection search engine with timetables). The best ratings for accessibility for people with special needs were given to the websites and mobile applications of railway operators (55%) (Jakość usług w sektorze pasażerskich przewozów kolejowych – badanie opinii pasażerów, UTK, 2025).

A specific group included in the available studies consists of individuals with disabilities or limited mobility, including seniors. Many publications address similar approaches to the access and use of modern technologies, including mobile applications (Bokolo, 2023; Kos et al., 2020; Kos et al., 2022). Their importance is steadily growing among various passenger segments. A significant group that continues to grow is seniors, a segment related to the "aging societies" of many countries, who are increasingly proficient with modern technologies, particularly the use of mobile applications. This group is specifically analyzed in various studies (Jakość usług w sektorze pasażerskich przewozów kolejowych – badanie opinii pasażerów, UTK, 2025).

The main limitation of the studies conducted is the unstable period in which they were carried out, immediately following the COVID-19 pandemic. On one hand, there were growing passenger prejudices against public transport, while on the other, there was a very rapid development of societal digitalization. The access to mobile applications could be seen as a novelty, not resulting from passengers' previous experiences, thus not yet widespread. Additionally, the evaluations of the applications are based on a short period of use and do not result from long-term experiences. The period of implementation of modern technologies across various segments may vary, and their evaluation may change as users' experiences evolve.

6. CONCLUSION

In summary, the results of the presented studies, both those conducted by the author and those from organizations managing public transport, indicate that since the COVID-19 pandemic, there has been a rapid development of digitalization in society, including the use of mobile applications in public transport. Passengers in Poland generally use the available applications. The research results showed that:

- Approximately 60% of respondents use applications for ticket purchasing,
- 80% indicated that they use maps and navigation apps during travel planning or while traveling,
- Nearly 80% indicated that they use location services during travel planning or while traveling,
- 96.4%, or almost all respondents, check the timetable online before their planned public transport journey,
- Over 80% of respondents declared that they check the waiting time for their chosen mode of transport online during their public transport journey (84.6%),

- Nearly 70% use the "Jak dojadę" app, while just over 30% have never used it during their public transport journey.

Age differentiates the distribution of responses regarding the use of all the studied applications, particularly in relation to non-use. Seniors are not digitally excluded, but they use mobile applications in public transport to a lesser extent and less frequently.

Passengers with disabilities or limited mobility use mobile applications in public transport to a similar extent as those without disabilities and are not digitally excluded. Only in relation to the use of two applications can population differentiation be observed:

- Statistically significantly more individuals with disabilities than those without disabilities indicated that they sometimes use map and navigation applications (31.7% of responses from individuals with disabilities compared to 23.6% from those without disabilities, $p < 0.05$).
- Statistically significantly more individuals with disabilities than those without disabilities indicated that they sometimes use the "Jak dojadę?" app (31.4% of responses from individuals with disabilities compared to 15.8% from those without disabilities, $p < 0.05$).

Gender differentiates the population using mobile applications in travel planning. Women statistically significantly more often than men indicated that they never use mobile ticket purchasing applications (45.6% of responses from women compared to 34.9% from men, $p < 0.05$), never use maps or navigation apps (22.9% of responses from women compared to 14.5% from men, $p < 0.05$), and never use the "Jak dojadę?" app (32% of responses from women compared to 24.6% from men, $p < 0.05$).

Place of residence is a variable that differentiates the population using mobile applications in travel planning. Rural residents (19.6% of responses in this group) and residents of towns with populations up to 20,000 (21.8% of responses in this group) statistically significantly more often indicated that they rarely use ticket purchasing applications compared to residents of cities with populations ranging from 100,000 to 400,000 (5.9% of responses in this group, $p < 0.05$). Residents of cities with populations over 400,000 (30.5% of responses in this group) statistically significantly more often indicated that they always use the "Jak dojadę?" app compared to residents of other town categories.

The obtained information is a source of knowledge that transport operators need to encourage passengers who do not use modern technologies to start using them or to increase the activity of those who use them very rarely or rarely. The research results may also be useful for transport operators in improving individual applications, sales channels, and passenger information systems, including those for passengers with disabilities or limited mobility (including seniors). In the context of intelligent public transport management, the results of the presented studies indicate the significant role of digital technologies in improving the functioning of transport systems, particularly in the domain of mobile applications supporting passengers. The integration of such solutions with intelligent transport management systems has the potential to significantly enhance the efficiency and accessibility of transport services.

Intelligent public transport management relies on advanced information systems that allow for the monitoring and real-time optimization of urban transport flows. Mobile applications play a key role in this system by providing passengers with access to information on routes, delays, waiting times, as well as enabling easier travel planning and ticket purchasing. The use of such tools makes public transport more flexible, adapting to the changing needs of passengers.

The research results demonstrate that after the COVID-19 pandemic, there has been a dynamic development of digitalization, and the use of mobile applications has become more widespread, although usage varies depending on age, gender, and place of residence. The observed differences in user behavior suggest that intelligent transport management should take these variations into account in order to deliver appropriate services and information to each passenger group. For older adults and individuals with limited mobility, who use applications less frequently, it is necessary to adapt interfaces and functionalities to ensure easier access to information and services.

Furthermore, considering the research findings related to the differences in application usage depending on the place of residence, intelligent transport management should consider the development of solutions that will enable more effective outreach to passengers in rural areas or small towns who may have limited access to modern technologies.

From the perspective of public transport operators, intelligent system management should also include digital education for passengers, encouraging them to use mobile applications. This could

include informational campaigns, training programs, as well as further customization of applications to ensure they are accessible to the broadest possible group of users, including older adults and people with disabilities.

In conclusion, the application of intelligent solutions in public transport management, taking into account the diverse needs of passengers, is crucial for the future of urban mobility, enhancing both the accessibility and comfort of public transport.

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