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ANALYSIS OF MOBILE APPLICATIONS SUPPORTING PUBLIC TRANSPORT PASSENGERS IN SELECTED CITIES

Analiza aplikacji mobilnych wspierających pasażerów komunikacji miejskiej w wybranych miastach

Joanna Górniak

Department of Logistics and Innovations, Faculty of Economics and Sociology, University of Lodz, Rewolucji 1905 37/39, 90-214 Lodz, Poland

e-mail: joanna.gorniak@uni.lodz.pl

https://orcid.org/0000-0003-0345-6428

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Abstract: Nowadays, technical and technological development is subject to many new concepts and challenges, such as sustainable development, smart city and electromobility. In order to improve the flow of people through cities, it is necessary to skillfully implement various types of solutions and tools. The article presents the essence and importance of information in urban transport. The considerations focus mainly on selected mobile applications, which are designed to provide travelers with information about traveling by public transport in Poland. Various classifications distinguishing information mobile applications in urban transport have been presented. The empirical part of the article presents the division into two groups of these tools, namely applications whose main functionality is the possibility of purchasing a ticket and planning the route. In the comparative analysis of mobile information applications in urban transport, parameters such as geographical coverage, payment, the need to log in and additional functionalities were taken into account.

Keywords: transport, urban transport, information, mobile application

Introduction

Contemporary cities contend with many problems (i.e. transport congestion, road accidents and collisions, or negative impact on the environment), while their efficient functioning affects both residents, entrepreneurs and tourists. There are many concepts affecting the development of cities, e.g. electromobility, smart city, sustainable development (Arvianto et al., 2021; Barton, Manning, 2017; Cichosz, 2015; Gassmann et al., 2019; Siedlecki, 2018; Taniguchi et al., 2001).

A significant progress in the context of the integration of means of transport is the concept of mobility as a service (or transport as a service, i.e. Mobility-as-a-Service, MaaS), which is one of the instruments in the area of providing transport services and shaping preferences and communication behaviors. The key variable for the planning and operation of transport within MaaS are users and their needs. Contemporary MaaS solutions usually take the form of digital platforms and applications (e.g. a travel planner). An important feature is also the booking and payment for the selected transport service integrated with the application (Zawieska, 2018).

In order to improve the functioning of cities, many solutions and tools are implemented which are consistent with the above concepts (it is worth adding that these solutions are complementary to each other), for example (Siedlecki, 2018 after: Cichosz, 2015):

- purchase and exploitation of a modern and environmentally-friendly public transport fleet,
- creating separate lanes for public transport vehicles (e.g. bus lanes),
- prioritization of urban transport vehicles at crossroads with traffic lights,
- development of the rail transport system and infrastructure,
- coordination and synchronization of timetables for various types of transport,
- implementation of modern solutions in urban transport infrastructure (e.g. stop platforms adapted to floor height, dynamic passenger information system),
- creating transfer nodes,
- providing connection search engines for effective planning of travel by means of public transport (e.g. mobile applications, which will be discussed in more detail later in the article),
- introduction of tariff and ticket integration together with a ticket in the form of an electronic city card.

The examples mentioned above have a slightly wider scope, although their functioning has an impact on the effective flow of information. The subject of analysis in this article is information, which is a very important aspect of the functioning of societies and economies. In addition, it is ubiquitous in every area of life, and the speed of its flow determines the quality of services or tasks performed.

In urban transport, information plays a special role, as it allows, among other things, to plan a trip, but also to verify any difficulties that may arise during the journey. The development of modern technologies contributes to the appear of new forms of information in urban transport (Modelewski, 2018). What's more, such innovative solutions are designed to encourage travelers to use group or collective forms of transport.

M. Batorski (2021) distinguishes a division into mobile applications: calendar and shift applications, monitoring bus routes, controlling the number of passengers in the vehicle, evaluating the work of drivers and alerting. Thus, an even wider range of functioning of mobile applications, which are the carrier of information in urban transport, was noticed. E. Berlińska and J. Choma (2018) point to the division distinguishing the following types of mobile applications in urban transport: improvement of moving around the city (e.g. Google Maps or Yanosik), improvement of public transport connections (e.g. Mobile MPK, My Bus), improvement of the payment process (e.g. SkyCash) and improvment of the use of city bikes (e.g. NextBike).

The research methodology in the article was based primarily on a literature review and use of deductive reasoning in order to draw conclusions regarding the functioning and use of information mobile applications for passengers in urban transport. A conceptual review of the literature was conducted in order to familiarize with the current scientific achievements regarding the importance of information in urban transport, with particular emphasis on the existence of mobile applications and to conduct a synthesis of knowledge on this research issue. The implementation of this task was based on the review of academic and scientific databases through a systematic search, selection and synthesis of existing literature. In addition, the analysis of the evaluation of mobile applications in passenger transport was made on the basis of a review of these tools. The search for mobile applications was made on the basis of a review of the application store in a smartphone with the Android operating system. The keywords used were: transport, public transport, public transport, mobile. The study was conducted from July 2022 to September 2022.

1. The specificity of urban transport

All forms of activity are associated with the need to move people, goods and information. In urbanized areas, people move by means of urban transport, also known as public transport (Wyszomirski, 2007). As part of transport, various means of transport are

used, as well as the road, which has been distinguished in Fig. 1. Urban transport can be distinguished in the diagram, which compared to transport in general, is characterized by its specific features, including:

- transport area – city and/or urban agglomeration,
- subject of transport – mainly passengers,
- ownership of the means of transport – public entity,
- impact range – close distance (short-distance transport),
- means of transport – bus, tram, trolleybus, urban railway.

According to the division criterion, the nature of urban transport, the means of transport can be distinguished:

- collective, e.g. bus, trolleybus, tram, urban railway,
- group, e.g. taxi, passenger car carrying more than one person,
- individual, e.g. private car, bicycle, motorcycle.
- concentration on a limited area (it results from the fact that demand is concentrated mainly in the city or agglomeration),
- universality (means that the need to move occurs throughout the inhabited area of an urbanized centre),
- unevenness in space (related to the uneven population density of the urbanized area and the location of destinations, e.g. workplaces, educational institutions, hospitals),
- unevenness in time (results from temporary emigration within one good or a week, and in the long term from demographic changes of the local community),
- mass (it is a consequence of the unevenness of demand in time and space and is revealed by the formation of passenger flows on specific routes in specific directions).

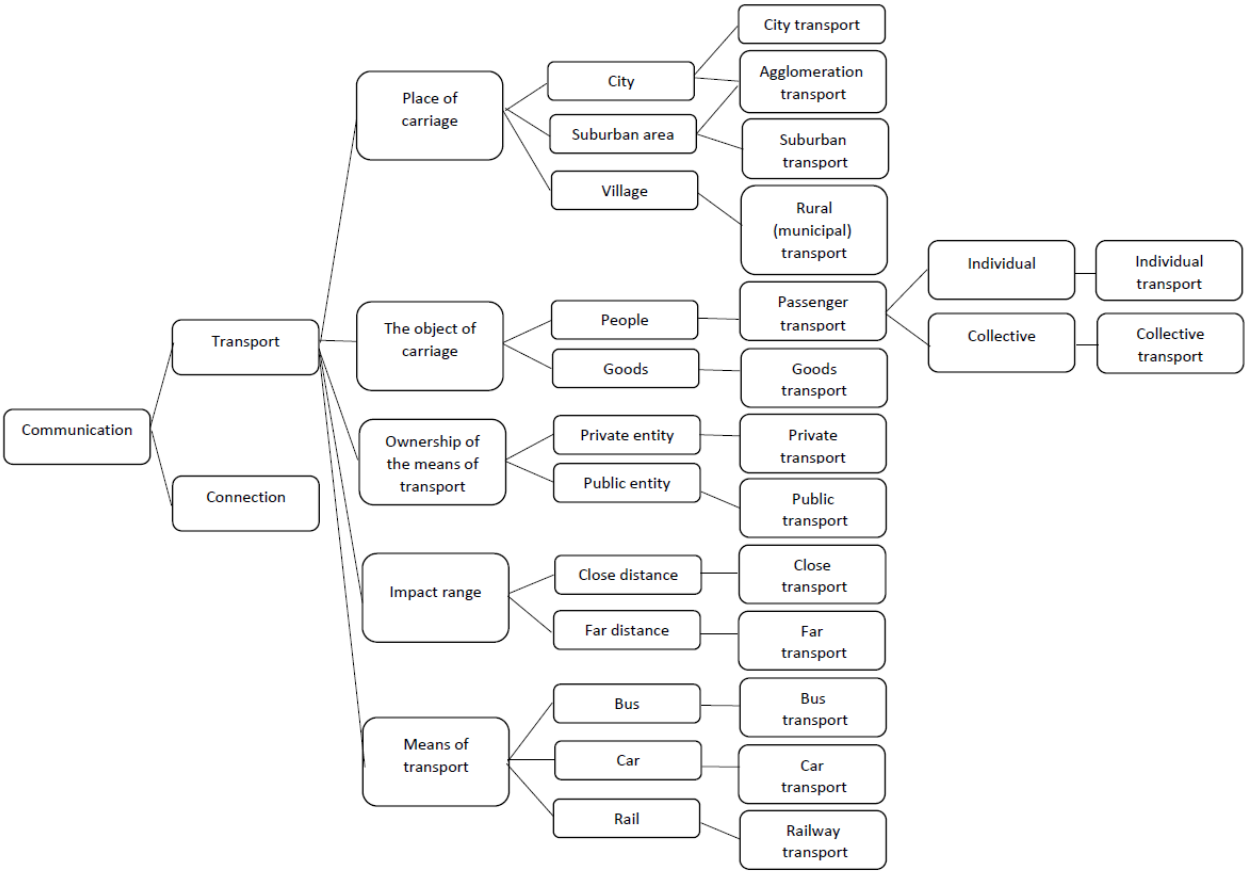

Fig. 1. Criteria and ways of dividing communication in the context of transport and communication

Source: own study based on Churski (2010, p. 19).

In the context of urban transport, we can talk about communication needs, i.e. the demand for public transport in the city. The following needs are most often mentioned (Wyszomirski, 2007, pp. 56-57):

Demand for urban transport services may fluctuate. There are many factors that determine its condition. Positive factors (increasing transport needs) and negative factors (reducing the demand for transport) can be distinguished – Tab. 1.

Tab. 1. Factors determining the demand for urban transport services.

Positive	Negative
Population growth in an area	High and growing travel costs (increase in ticket prices or additional fees)
Income changes	Extending the travel time
Locations of new services and workplaces within the range of transport connections	Worsening of travel comfort
Development of the existing transport network	Insecurity
Advertising campaigns promoting public transport	Worsening of condition of transport infrastructure

Source: own study based on Churski (2010, p. 21).

Many factors influence the choice of mode of transport. The traveler consciously or less consciously decides to choose the most convenient form of travel, taking into account the most important parameters, i.e. cost and time, as well as safety and comfort. These parameters together characterize the quality of transport. This quality can be considered in terms of the competitiveness of a given branch or means of transport. In Fig. 2 presents the factors of urban transport quality, with the information that is extremely valuable for the traveler and is the main interest of the author in this article (marked in red).

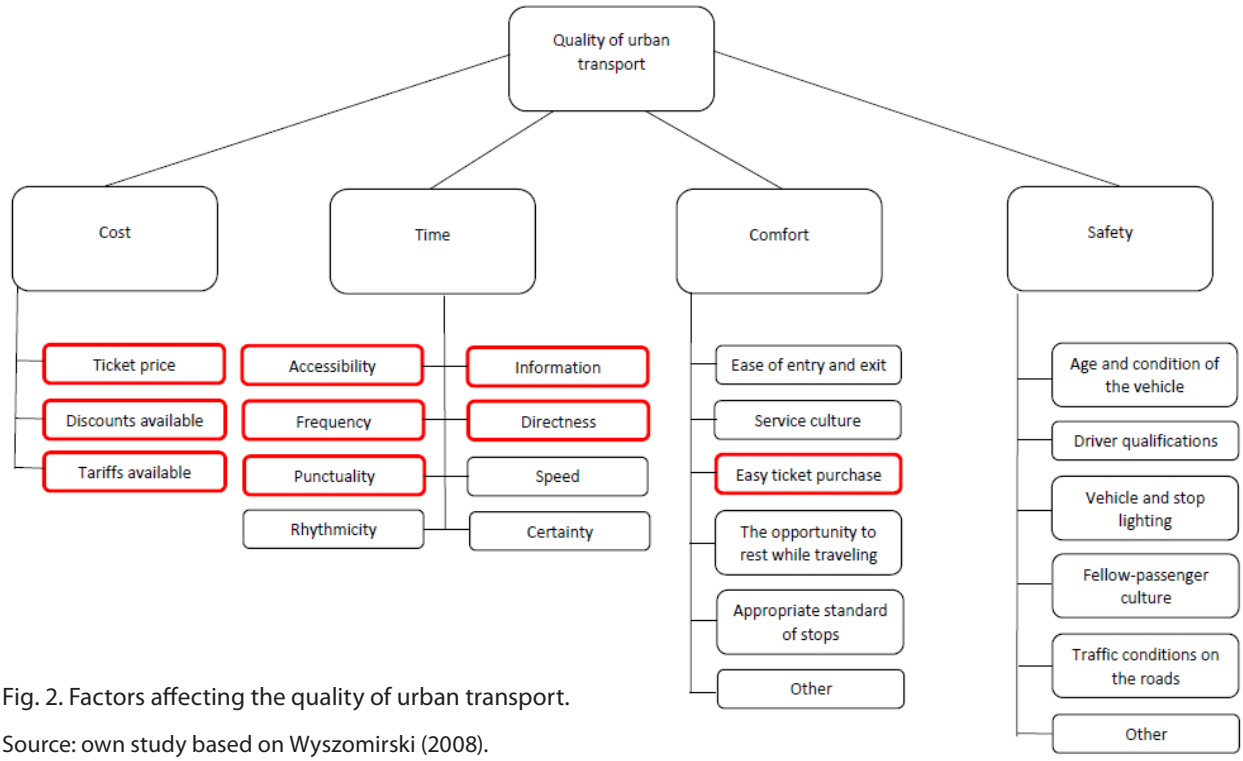

Fig. 2. Factors affecting the quality of urban transport.

Source: own study based on Wyszomirski (2008).

The above-mentioned characteristics of transport quality also play the role of the so-called transport demands in urban transport at various stages of transport, namely (Wyszomirski, 2007, pp. 70-72):

– travel cost – minimizing the fare,
– trip duration – speed, which determines the travel time; frequency, punctuality, rhythmicity and reliability, determining the waiting time; accessibility determining the time of arrival; the immediacy that determines the possibility of traveling without having to change trains,
– comfort of travel – simplicity of the tariff system; freedom to buy a ticket; comprehensible route and timetable information system; easy access to the stop (number of pedestrian crossings, tunnels, sidewalks); readability of timetables; aesthetics and lighting of bus shelters; protection against attacks at stops; legible marking of vehicles; ease of entry and exit; the smoothness of the ride; lighting and air conditioning; arrangement of doors and seats;

type of seats used; interior decoration; service culture; access to validators; luggage space; legible marking of stops,
– travel safety – technical condition of stops, which ensures safety on the way to the stop; time of day, which determines the safety of waiting for the vehicle; technical condition of the vehicle, weather and road conditions, which ensures the safety of travel by means of transport; behavior of fellow passengers, which is important for safety at every stage of the journey.

Taking into account the information in the context of the above-mentioned transport demands, it appears many times. This means that the efficient functioning and high quality of urban transport is determined by information. It is all the more justified to analyze this factor later in the article.

2. The role, functions and examples of passenger information in urban transport

As indicated earlier, information plays an extremely important role in urban transport. The main role of passenger information is to facilitate access to public transport services. This information should be adapted to the next stages of the journey. This is especially important for combined travel, where there is a need to change or the traveler does not know the city well. Therefore, three stages of the occurrence and use of information in urban transport are distinguished (Burzec-Burzyńska, Kłos, 2012, p. 10), as shown in Tab. 2.

One can also distinguish the division of information in transport according to K. Modelewski (2018) due to:
– recipient, i.e. individuals, business entities, target groups, mass recipient,
– type of information, i.e. traffic conditions, functioning of public transport, car parks, driver assistance, violations of the law, restrictions, property),
– location, i.e. in the right-of-way, outside the right-of-way,
– time, i.e. before the trip, during the trip.

In addition, information in urban transport should have the following characteristics:
– reliability,
– legibility,
– intelligibility,
– topicality,
– precision,
– taking into account changes in the timetable.

The elementary functions of information in urban transport include: management, monitoring and providing basic and detailed information on travel by means of urban transport (Burzec-Burzyńska, Kłos, 2012, p. 10).

The above information in urban transport is presented using various types of tools. Their examples are shown in Fig. 3, in order to approximate these forms. It is worth noting that the most tools are present at the trip planning stage, the fewest after the end of the trip (the transport service has been performed, so it is reasonable that the number of tools has run

Tab. 2. Information present in urban transport according to the stages of the journey.

Pre-trip information (for the planning phase)	Information available during the trip	Important information at the end of the trip, on the way back
Availability of public transport vehicles	Line and direction designation	Options to reach your final destination (directional signs with important places)
The fare	Entrance for the disabled	Way back options
Opportunity to take advantage of discounts	Location of the ticket machine	Surroundings of the stop (properly marked exit routes, map of the city)
The frequency of the vehicles of the selected connection	Line map with marked stops and possible transfers	
Departure time	Informing travelers about the next stop	
Travel time and arrival time at destination	Route diagram	
Transfer places (nodes)	Compliance with the timetable	
Adaptation of the vehicle to the transport of disabled people	Changes in traffic organization	
Possibility to carry luggage	Information about failures and delays	
Driving comfort		
Additional services		

Source: own study based on Kędzior, Bryniarska (2015) and Burzec-Burzyńska, Kłos (2012).

out) or on the way back (usually it is a return to the first stage, i.e. trip planning).

In addition, a lot of information in the context of urban transport appears in social media, concerning the entire spectrum of urban travel. This is certainly valuable information for both current and future public transport customers.

of the means of transport, delays and difficulties in urban traffic (Fig. 5).

Slightly more technologically advanced tools supporting travel planning in the city are the websites of urban transport operators (Fig. 6) and various types of mobile applications. In the context of websites, searching for information looks similar to

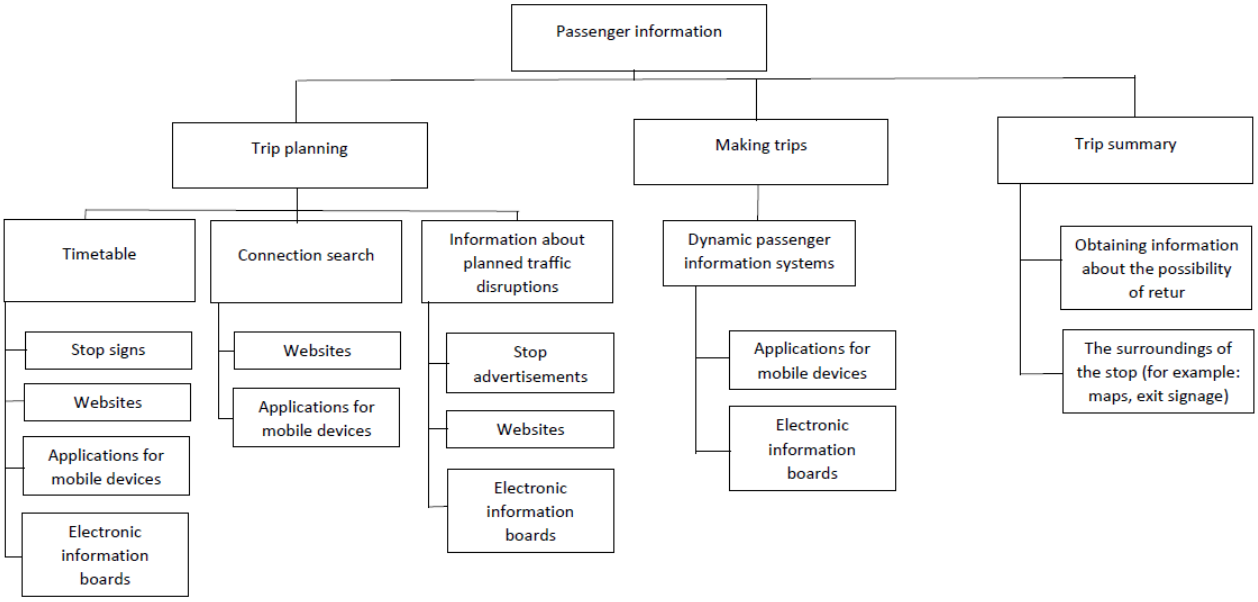

Fig. 3. The basic division of passenger information tools in urban transport.

Source: own study based on Burzec-Burzyńska, Kłos (2012) and Kosobucki (2011).

Taking into account the above tools, additional elements can also be indicated that could significantly improve the functioning of public transport (Kędzior, Bryniarska, 2015, p. 33):

- GPS in all vehicles: tracking the position of the vehicle online, the ability to check the current delay,
- dynamic boards at each stop,
- clock at each stop,
- collective information on the timetable and available lines from all stops in the node (collective tables),
- Wi-Fi in public transport vehicles.

2.1. Pre-trip information

The first phase of your journey is planning it. It is important for the traveler that this plan is as accurate as possible. For this purpose, the traveler can use many solutions supporting this planning. Starting from the elements that are located directly at stops, i.e. paper timetables of public transport along with designated routes (Fig. 4) and electronic boards displaying information about the arrival/departure time

the above-mentioned examples (Fig. 4 and 5), only the form of transferring this information is different. A model website should contain information such as (Miłaszewicz, 2017, p. 1246):

- timetable by line,
- timetable by stops,
- route search/planning tool,
- interactive map,
- a tool for determining actual arrival times, e.g. redirecting to a mobile application,
- information for people with disabilities with a list of facilities for these people,
- information on the possibility and method of purchasing a ticket using mobile applications, e.g. redirection to the website of the relevant applications,
- information on the electronic ticket (if such a system exists) along with the regulations of use,
- information on the ticket sales network,
- ticket control regulations,
- current ticket price list,
- passenger guide,
- a timetable in a print-ready form, which seems particularly convenient for the elderly.

Fig. 4. Stop board – example of MPK Łódź.

Source: own collections.

Fig. 5. Electronic information board – example of MPK Łódź.

Source: own collections.

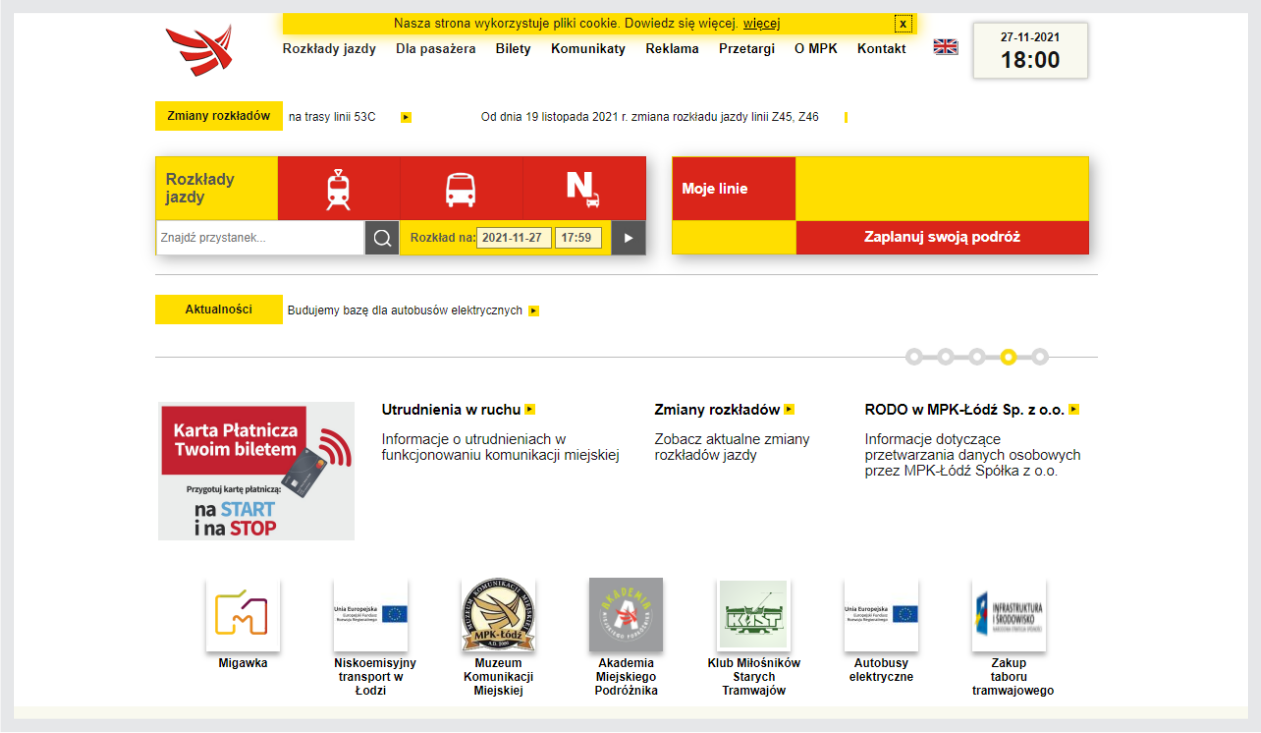

Fig. 6. An example website of the operator of public transport services – MPK Łódź.

Source: https://www.mpk.lodz.pl/ (access: 27.11.2021).

Mobile applications are similar in terms of functionality to websites, which allow travelers not only to check the arrival/departure time of a means of transport, but also to plan a route including transfers or purchase a ticket (more in point 3).

2.2. Information available during the trip

Due to the fact that the situation during the journey may change (this may be due to traffic difficulties, transport congestion), but also the traveler should have clear access to information about the journey when using the transport service, voice messages in the informing about the current stops, among other things. In addition, the vehicles are equipped with various types of boards showing the current passage: static (Fig. 7) and dynamic (Fig. 8). This information includes key elements for the traveller, i.e. line number, direction of travel or estimated time of public transport. It is also important to correctly and accurately mark the vehicle in which the traveler will be moving.

Fig. 7. Static information board in the vehicle – MPK Łódź.

Source: own collections.

Fig. 8. Dynamic information board in the vehicle – MPK Łódź.

Source: own collections.

2.3. Post-trip information

In the last phase, i.e. after the end of the journey, the traveler can also look for information. This may be information related to finding a destination. Thus, correct marking in space will be extremely valuable from the point of view of a traveler who, for example, is in a given place for the first time. Therefore, in the vicinity of stops, there are various types of information showing how to get to your destination, for example, directional signs with street names or directions to tourist places or key facilities located nearby. Signs located right next to the exit from the stop or train station play an important role.

3. Mobile applications in urban transport

The functioning of mobile applications as part of urban transport significantly facilitates travel. Adapting the capabilities of mobile applications also creates new opportunities for travelers. The applications enable access to public transport timetables in any mobile phone that supports such an application. Mobile timetables make it possible to search and define connections, as well as obtain information about connections between stops in the city, duration of the journey and details of transfers (Kos, 2016, p. 152; Zalewska, 2017, p. 12).

In addition, it is worth distinguishing the division of mobile applications in urban transport due to detailed parameters and functionalities:

- due to geographical scope: local, national, international,
- payment: paid, free of charge,
- due to functions (possibilities): purchase of a ticket, planning a trip, checking the timetable of a vehicle, etc.,
- due to the method of logging in: with logging in, without logging in.

On this basis, a thorough review of mobile applications in public transport in Poland was made. The study period covered the observations carried out from July 2022 to September 2022. In connection with the above, exemplary applications were distinguished, which are mainly used to purchase tickets (Tab. 3) and plan travel routes (Tab. 4). The tables present detailed conclusions from the conducted searches.

It is worth noting that most mobile applications that allow you to buy a ticket also have additional functions, i.e. payment for parking in the city (MoBILET, MPay, Skycash). Apart from the range of impact of selected applications, there are both local tools (e.g. mobiWAWA) and international tools (e.g. MPay). Probably the advantage of mobile applications operating on an international scale is their versatility and the possibility of using them in different places (in this case – Europe). All the analyzed applications for purchasing tickets in public transport require logging

Tab. 3. Mobile applications mainly used to buy tickets in public transport – examples.

Name	Operating range	Payment	Login	Additional functions
moBILET	Selected polish cities	– Free app – Payment for the ride service (various forms of payment)	Yes	– Vehicle parking fee – Purchase of a long-distance ticket
Mint Mobile	Bydgoszcz Łódź Warsaw	– Free app – Payment for the ride service (various forms of payment)	Yes	-
zBiletem.pl	Selected polish cities	– Free app – Payment for the ride service (various forms of payment)	Yes	-
Bilkom[1]	Nationwide application for rail travel (PKP, TLK, EIP trains)	– Free app – Payment for the ride service (various forms of payment)	Yes	– Timetable for train – Checking train delays
KOLEO[2]	Selected polish cities with railway stations	– Free app – Payment for the ride service (various forms of payment)	Yes	– Searching for train connections
MPay	Poland[3] Europe	– Free app – Payment for the ride service (various forms of payment)	Yes	– Vehicle parking fee – Public transport timetable – Purchase of other services (e.g. insurance, phone account top-up)
Skycash	Selected polish cities	– Free app – Payment for the ride service (various forms of payment)	Yes	– Vehicle parking fee – Purchase of other services (e.g. airline tickets, insurance, cinema tickets) – Possibility to plan the route
mobiWAWA	Warsaw	– Free app – Payment for the ride service (various forms of payment)	Yes	-

Source: own elaboration based on distributed data.

in. This is determined by the fact that the traveler bears the cost of purchasing the ticket for this service.

Mobile applications for planning routes in cities are definitely more interdisciplinary than the tools described in Tab. 3. They allow for comprehensive travel planning (including transfers) in real time. By far the most comprehensive application is: Jakdojade.pl, it gives the opportunity not only to plan the route in detail, but also to buy a ticket in public transport according to the rules. Some mobile applications allow to plan a route with transfers using other forms of transport, e.g. city bike (Bus Live, MobileMPK) or

[1] The Bilkom application was included due to the fact that sometimes rail travel takes place within the city, e.g. Łódź and Łódzka Kolej Aglomeracyjna, which have railway stations.

[2] The KOLEO application has been included due to the fact that sometimes rail journeys take place within the city, e.g. Łódź and Łódzka Kolej Aglomeracyjna.

[3] As part of the mPay application, it is possible to purchase tickets for public transport (approx. 100 locations), railway (cooperation with, among others: Koleje Mazowieckie, Łódzka Kolej Aglomeracyjna, Koleje Wielkopolskie, Koleje Śląskie, Koleje Małopolskie) and bus (including on international routes).

Tab. 4. Mobile applications mainly used to plan routes – examples.

Name	Operating range	Payment	Login	Additional functions
Bus Live	Selected british, spanish, polish and italian cities	Free	No	– Timetable of public transport vehicles in real time – Map of journeys and stops in public transport – Traffic – City bike stations
myBUS	Selected polish cities, but also Žilina (Slovakia) and Siauliai (Lithuania)	Free	No	– Timetable of public transport vehicles in real time – Map of lines, crossings and stops in public transport – Possibility to plan a trip with transfers
Google Maps	The whole world	Free	No	– Searching for connections by individual, group and collective means of transport – Information about tourist attractions, gas stations, hotels, restaurants – Traffic
Jakdojade.pl	Selected polish cities	– Free basic version – The paid version of the so-called premium (no ads, full navigation, etc.) – Payment for the ride service (various forms of payment)	No	– Timetable of public transport vehicles in real time – Searching for connections with transfers – Map of stops, routes, vehicles – Possibility to buy a ticket
mobileMPK	Selected larger polish cities	– Free basic version – The paid version of the so-called premium	No	– Route plan – Connection search – Route tracking – Possibility to check the availability of city bikes in Veturilo, Opolebike, Biker, CityBeBike systems
Moovit	Selected polish cities	Free	No	– Public transport route planning (including Uber)
Transportoid.pl	Selected polish cities	Free	No	– Connection search – List of stops, routes, lines – Notebook
Circuit	The whole world	Free	Yes	Travel planner
Time4Bus Autobusy i Tramwaje	Selected polish cities	Free	No	List of stops, routes, lines
WatchLine Lodz	Łódź	Free	No	– The application compatible with the MPK Łódź website contains information on line diagrams, maps of stops, vehicles on the route, stops, traffic obstructions or „snapshots"

Source: own elaboration based on distributed data.

Uber (Moovit). In addition, almost all (except Circuit) analyzed route planning applications do not require a login.

Conclusions

Progressing technical and technological development creates many opportunities for the efficient functioning of urban transport in modern cities. Among other things, it favors a faster information flow process, which may have a positive impact on travelers whose expectations are also growing.

Based on the review, it can be indicated that there are many tools that are carriers of information in urban transport. In recent years, their number has increased, new applications have appeared, but also existing ones began to cover new areas. The versatility of mobile applications in urban transport for the flow of information has been noticed. It is worth noting that mobile applications in urban transport complement each other, but at the same time they are carriers of both complementary and substitutive information for other tools in the context of information flow in urban transport. The development of information functionalities of mobile applications may also contribute to increasing the transport accessibility in cities to various destinations.

The development of information mobile applications in urban transport can also be used as a promotion for the cities where they are implemented. By the way, it is worth improving these applications on an ongoing basis, because the expectations of travelers may evolve over time, and new problems may arise that are or will be faced by travelers and those managing urban transport.

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