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Park&Ride Car Parks as an Element of Improving the Quality of the Transport System in Wrocław

Parkingi *park&ride* jako element poprawy jakości systemu transportowego we Wrocławiu

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Abstract: The traffic problems of modern cities are mainly caused by increased intensity of car traffic. The key to encouraging city users to use public transport services is to increase the level of quality and accessibility. Park&ride car parks (P+R) are one element of a strategy to increase the quality of public transport systems, in this case the public transport system in Wrocław. The aim of the study was to indicate the importance of park&ride facilities in building and improving the quality of the public transport system in Wrocław. The study used the desk research method, the descriptive method and the results of document analysis. The research procedure established that the process of constructing park&ride facilities (which are an element of the public transport system in Wrocław) is being implemented continuously; at the same time it has a positive impact on reducing the level of car traffic. The current implementation period and the availability of P+R car parks in Wrocław are insufficient in comparison with the needs of such a large urban centre, which is constantly developing.

Keywords: car parks, park&ride, quality improvement, accessibility, transport system, Wrocław.

Streszczenie: Problemy komunikacyjne współczesnych miast spowodowane są głównie zwiększonym natężeniem ruchu samochodowego. Kluczowe w zachęcaniu użytkowników miasta do korzystania z usług komunikacji miejskiej jest zwiększenie poziomu jakości i dostępności jej środków. Parkingi *park&ride* (P+R) są jednym z elementów strategii zwiększenia jakości systemów transportu publicznego, w tym przypadku systemu transportu publicznego we Wrocławiu. Celem pracy było wskazanie znaczenia parkingów *park&ride* w budowie i podnoszeniu jakości systemu transportu publicznego we Wrocławiu. W opracowaniu wykorzystano metodę desk research, metodę opisową oraz wyniki analizy dokumentów. W postępowaniu badawczym ustalono, że proces budowy parkingów *park&ride* (będących elementem systemu transportu publicznego we Wrocławiu) jest realizowany w sposób ciągły; jednocześnie wpływa on pozytywnie na zmniejszenie poziomu natężenia ruchu samochodowego. Dotychczasowy zakres realizacji oraz dostępność parkingów P+R we Wrocławiu są niewystarczające w porównaniu z potrzebami tak dużego ośrodka miejskiego, który stale się rozwija.

Słowa kluczowe: parkingi, *park&ride*, podnoszenie jakości, dostępność, system transportowy, Wrocław.

1. Introduction

Today's cities face many traffic-related problems on a daily basis, such as increasing traffic volume and intensity, congested streets, shortage of parking spaces and air pollution (Rześny-Cieplińska & Wach-Kloskowska, 2018). This results in the need for a new perspective on the problems of urban centres and their citizens and requires the application of wide-ranging and highly technical and technological measures, such as initiatives promoting alternative forms of transport, car-sharing and commuter sharing (Rześny-Cieplińska & Wach-Kloskowska, 2018).

One example of a modern approach is the construction of park&ride (P+R) car parks, i.e. places where one can leave the car and use public transport. The aim of this study was to show the importance of park&ride facilities in building and improving the quality of the public transport system in Wrocław. The study used the desk research method, the descriptive method and the results of document analysis.

The following research questions were posed:

- what is the current state of the public transport system in Wrocław?
- what are the parts of the public transport system in Wrocław?
- what is the current quality of the public transport system in Wrocław and what measures are being taken to improve it?
- what place in the Wrocław public transport system do park-and-ride facilities have and what role do they play in improving its development?

The study analysed data and documents for the period 2014-2022 with a focus on 2020-2022, while spatially, the focus was on the area of the city of Wrocław.

2. Public transport system management from a theoretical perspective

The problem of public transport is widely described in the literature (Ciupa, 2017; Krysiński, 2020). This issue is particularly relevant in the case of large cities, where, according to new concepts of urban development, public transport is one of the determinants of the sustainable development of these centres (Szczech-Pietkiewicz, 2015). Transport, especially public transport, is a specific activity in which modern solutions are often applied first (Rześny-Cieplińska & Wach-Kloskowska, 2018). These solutions offer benefits that can be enjoyed by all users of the city: residents, tourists, and businesses. Thanks to them, traffic flow improves, thus increasing the comfort of movement and, consequently, the quality of life and living in the city (Rześny-Cieplińska & Wach-Kloskowska, 2018). This refers to both technological (ICT technologies) and infrastructural solutions, such as P+R car parks.

3. Characteristics of the public transport system in Wrocław

The trams and buses in Wrocław are operated by Miejskie Przedsiębiorstwo Komunikacyjne sp. z o. o, which is owned by the city. It is a monopolist in the case of the organisation of lines and rolling stock, whilst in terms of vehicular transport, it cooperates with private and local authority carriers. This is achieved by means of tenders for the operation of a particular route/network (for public-private partnerships) or by means of an agreement between the city and neighbouring municipalities (for municipal partnerships). The company, in cooperation with its subcontractors, operates a total of 142 daily bus lines (48 regular, 5 express, 2 peak, 4 suburban, 22 commercial), 13 night bus lines and 23 zone bus lines (crossing the city border), which are a joint venture of the City of Wrocław and the communes of Kobierzyce, Czernica and Siechnice. There 21 daily tram lines, running approximately from 4:30 am to 0:20 am (Wrocławska Komunikacja, 2022).

Wrocław's bus system is based on the fleet of MPK and its sub-companies. There is a wide range of models in the rolling stock due to the wide range of bus-manufacturing companies and the existence of a secondary market. The following table shows the composition of the fleet (excluding technical, special and historic vehicles).

Table 1. Bus stock of MPK Wrocław and partners as at 30.05.2022

Model	Owner	Number
Solaris Urbino 12 III	MPK Wrocław	45
Solaris Urbino 18 III	MPK Wrocław	12
Mercedes-Benz Citaro O530	MPK Wrocław	58
Mercedes-Benz Citaro O530 C2	MPK Wrocław	51
Mercedes-Benz Citaro O530G	MPK Wrocław	42

Mercedes-Benz Citaro O530G C2	MPK Wrocław	120
Mercedes-Benz Conecto LF II G	MPK Wrocław	12
Volvo 7700	MPK Wrocław	1
Volvo 7700A	MPK Wrocław	1
Isuzu Citiport	Mobilis	18
MAN NG323 Lion's City G	Michalczewski Wrocław	43
Solaris Urbino 8,6	Michalczewski Wrocław	7
MAN NL293 Lion's City	Michalczewski Wrocław	20
	DLA Wrocław	3
Autosan M12LF „SanCity”	Sevibus	3
	Marco Polo	3
Jelcz M181MB/3	Marco Polo	2
Autosan H7-20.07 „Solina”	DLA Wrocław	1
Jelcz M081MB	DLA Wrocław	1
Mercedes-Benz Conecto LF A30	DLA Wrocław	3
ZAZ A10C3A	DLA Wrocław	9

Source: (Sokołowski, 2022).

Wrocław's tram system is managed entirely by MPK (there are no private partners). All the tram lines are located within the city (no suburban connections). Peak times are from 6:00 am to 8:00 am/9:00 am, and from 2:00 pm to 6:00 pm/9:00 pm. With the exception of line 33, which runs every 6 minutes in the peak times, all lines run every 12 minutes in the peak hours, every 15 minutes in the off-peak hours and every 20 minutes in the mornings and evenings on weekdays and at all times on holidays. The trams are supplied with electricity from the 600 V overhead catenary. The total length of Wrocław's tram tracks is 84 km (Wrocławska Komunikacja, 2022).

Table 2. MPK Wrocław tram fleet as of 30.05.2022

Model	Number
Konstal 105Na	15
Konstal 105NaWr	168
Protram 204WrAs	12
Protram 205WrAs/Moderus Beta MF 17 AC	26
Škoda 16T	17
Škoda 19T	31
Moderus Beta MF 19 AC	22
Moderus Beta MF 24 AC	40
Moderus Gamma LF 07 AC	2
Pesa 2010NW Twist	8

Source: (Sokołowski, 2022).

In the case of Wrocław's trams, extensive efforts are being made to purchase modern rolling stock and to upgrade the already existing fleet to contemporary standards. This is happening in particular in conjunction with Modertrans Poznań. This company has supplied (Moderus Beta MF 19 AC, Moderus Beta MF 24 AC) and is supplying (Moderus Gamma LF 07 AC – two of which are already present in the city, forty-six in total) modern rolling stock and modernising older carriages (modernisation of Protram 205WrAs to the Moderus Beta MF 17 AC standard, resulting in the replacement of everything except the bogies of the vehicle). This is not the only example of MPK's action – in agreement with SAATZ, Škoda 19Ts were modernised, installing, among other things, air conditioning facilities (Wrocławska Komunikacja, 2022), thus increasing the level of passenger satisfaction with their use, especially on warm days. Together with the purchase of rolling stock from other sources (the tender for the purchase of 24 trams from PESA Bydgoszcz, awarded in December 2021), this has resulted in a steady increase in the quality level of the Wrocław tram system (MPK Wrocław, 2022).

The public transport system in Wrocław is one of the largest of its kind in the country. Recently, extensive changes have been taking place both in its shape and ways of functioning. Actions taken by the city authorities in cooperation with MPK Wrocław are aimed at improving the quality of its operation in three basic areas: accessibility, innovation and reliability (MPK Wrocław, 2022).

The public transport system in the capital of Lower Silesia faces many challenges. In order to overcome them, corrective measures have been taken, both in terms of infrastructure (renovation of tracks, reconstruction of tram and bus routes, e.g. TAT) and rolling stock (especially the purchase of new trams). Issues of delays or a poor network of connections, resulting from infrastructure problems, affect the public's opinion of the urban operator and, with it, the public's continued willingness to use its services. Consequently, steps should be taken to show the public in which direction and to what extent the quality of urban transport is improving. In the long term, investment activities, building a positive image and the reliability of the transport system are important for maintaining effective urban transport in Wrocław.

4. The role of park & ride car parks in Wrocław's public transport system

An example of the challenges in implementing projects to increase the quality of the public transport system in Wrocław in the spirit of innovation and the use of modern ICT technologies, is the issue of park&ride (P+R) car parks. They are being built as part of the municipal programme of the construction of a park-and-ride system in Wrocław, co-financed by the European Union under the Regional Operational Programme for the Lower Silesian Voivodeship 2014-2020. Its second phase is currently underway. A total of 27 car parks, offering 2,566 parking spaces, will have been built by June 2022 (Wrocław.pl, 2022).

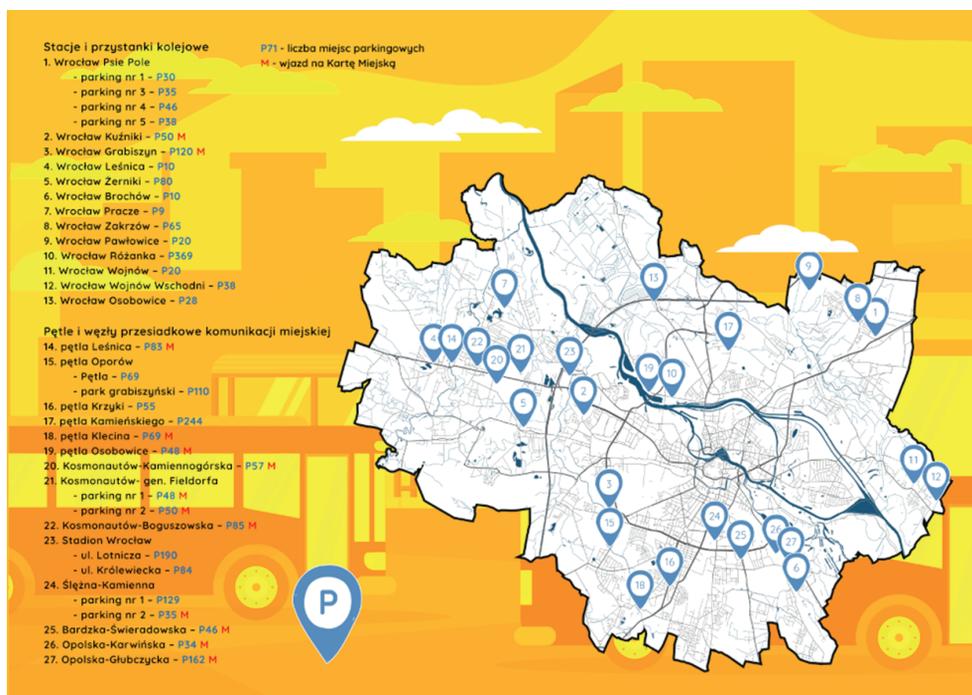


Fig. 1. Map of P+R car parks in Wrocław

Source: (Internet 1).

In total, the parking resource is 2566 spaces (data as of 26.10.2022). The distribution of car parks remains an important issue (Figure 1). As a rule, they are located at railway stations and train stops (car parks 1-13) and at public transport loops and interchanges (car parks 14-27).

In addition, due to the spatial conditions of the system, resulting from the spatial layout of the city (the so-called 'spoke layout'), most of the car parks are thus located close (one-kilometre radius) to the main traffic arteries, namely:

- Wrocław Motorway Bypass (Autostradowa Obwodnica Wrocławia) (car parks nos. 2, 5, 13, 25),
- Wrocław Downtown Bypass (Śródmiejska Obwodnica Wrocławia) (car parks nos. 3, 10, 15, 19, 24, 25, 26, 27),
- Kosmonautów/Legnicka Streets (car parks nos. 2, 4, 14, 20, 21, 22),
- Krakowska/Opolska Streets (car parks nos. 6, 26, 27),
- Ślężna/Powstańców Śląskich Streets/Karkonoska Avenue (car parks nos. 16, 18, 24).

All of these create synergies between the different modes of public transport by enabling a rapid exchange of passengers between them. The creation of new P+R

car parks is an ongoing process. The most recent addition put into use is the car park in Idzikowskiego Street, created on the initiative of residents as part of the WBO project. At the point of writing (November 2022), proceedings were underway for the extension of two facilities near railway stations (Wrocław Pracze and Wrocław Leśnica), and the construction of a new one in the area of the junction of Żmigrodzka and Wołowska was also planned (Wrocław.pl, 2022).

The appropriate use of P+R car parks makes it possible to create synergies between the various modes of transport offering their services within Wrocław. An example of this is the bus and tram terminal on Rogowska Street, situated at the end points of the Bus and Tram Route (Trasa Autobusowo-Tramwajowa, TAT). It represents a modern approach to the cooperation of various elements of the transport system – in addition to the above-mentioned components (car park, bus and tram stops), it also offers the possibility of changing trains (Wrocław Nowy Dwór station) or bicycles (cycle paths); in addition, a green area (small park) has been created locally.



Fig. 2. Layout of the Nowy Dwór loop in Rogowska Street

Source: (Internet 4).

The management of the city's infrastructure stock (Figure 2) takes into account the possibility of expansion, making it easy to bring about an increase in the parking stock. This way of thinking forms the basis for strategic planning in the long term.



Fig. 3. Scheme of the Nowy Dwór loop in Rogowska Street

Source: (Internet 4).

The P+R car park at the Nowy Dwór loop is to be accessible to the general public (and therefore without the need to present at least a 24-hour ticket or Urbancard). This will significantly facilitate its use by the interested drivers, and fits in with the general principle of unrestricted, universal and free access to car parks. However, there are exceptions to this – namely thirteen of those, located in areas “where there is a deficit of parking spaces in the area of neighbouring streets” (Wrocław.pl, 2022), are subject to controlled access, based on the necessity of having a valid season ticket: temporary (at least 24-hour), registered or bearer, encoded on the Urbancard (City Card), Urbancard EP or in the iMPK mobile application, or a valid park-and-ride card. The selected document must be presented at the entrance to the QR code reader at the barrier. Once a match has been checked, the automatic entry surveillance system opens the barrier, allowing access to the car park (Wrocław.pl, 2022). All car parks are closed from 02:00 am-04:00 am due to maintenance activities (Wrocław.pl, 2022). This raises the following problems:

- restricting access to the car park, although justified by the desire to maintain a reserve of free spaces in critical locations, makes it difficult to put the idea of P+R into practice. At the extreme, it forces the need for an Urbancard/Urbancard EP card or the purchase of a season ticket by a person interested only in using the car park; this calls into question the principle of unlimited, universal and free access and digitally excludes some users of the city;

- closing the facilities for maintenance purposes prevents 24-hour use. Although this prevents parking spaces from being used as de facto permanent car parking spaces, it causes difficulties for people interested in using the car park at night (i.e. those working at night, for example).

The importance of introducing P+R car parks into the public transport system in Wrocław is significant because of their effects. The presence of almost 2,500 universally accessible parking spaces has a significant impact on reducing traffic congestion, especially during peak travel periods (morning and afternoon hours – commuting to and from work/study) and on key entry/exit arterial roads. The introduction of car parks has the advantage of being located next to major transport hubs – railway stations and stops and MPK transfer points. This increases the level of integration of the transport system, in particular taking into account the provision of cycle lanes to the car parks and the presence of parking infrastructure for bicycles. An important element in the location, construction and realisation of the public transport system in Wrocław is the active participation of the inhabitants in this process. A disadvantage of the existing condition and location of car parks is the too low number of available spaces (with an optimistic assumption of four persons in one vehicle, only 10,000 persons can use their services at the same time). In addition, the controlled-access rule for some of them (44.4% of the car parks are subject to this, covering 34.5% of the spaces) and the scheduled maintenance of the car parks between 02:00 am and 04:00 am hinders the use of the available parking spaces.

5. Conclusion

The qualitative transformation of Wrocław's public transport system is progressing towards a sustainable and integrated organism using intelligent ICT solutions to the greatest possible extent. However, in addition to the use of the most modern technologies available, the transformation is also taking place in the area of the view of transport as a whole, mainly in terms of the synergy of individual means of transport fulfilling complementary roles. The issue of infrastructure solutions is also important, involving the construction of new infrastructure or the redevelopment of old infrastructure to adapt it to the requirements placed upon it. Park&ride car parks fit into both of these dimensions.

The study highlighted the important role of park&ride car parks in creating the quality of the transport system in urban centres, especially in large cities such as Wrocław. Park&ride car parks, according to the research findings, constitute a tool offering many possibilities, namely:

- allows for a sharp increase in the number of parking spaces (parking resource), especially at junction points, which are the place of intersection of routes of different types of public transport,

- can be applied through the reconstruction/extension of existing car parks (lower construction/modernisation costs),
- allows cars to be ‘pulled out’ of the city (especially from the centre), which increases fluidity of movement (less traffic),
- positively influences the creation of synergies between the different modes of public transport,
- earmarks some seats exclusively for season ticket holders, encouraging people to incur the cost of changing to public transport;
- exercising electronic control over these spaces allows them to be managed efficiently by the infrastructure operator (possibility to collect reports on parking usage in a simple way),
- contributes to a reduction in the amount of exhaust fumes emitted (especially per passenger-kilometre) and thus of particulates and greenhouse gases.

Further conclusions of the study are as follows:

- the process of locating, building, extending and commissioning park&ride car parks is and should remain continuous in order to meet the transport needs of the city’s users,
- park&ride facilities are an efficient method of creating synergies between modes of individual transport (cars, scooters, bicycles) and mass transport (buses, trams, trains), as they allow a smooth and efficient exchange of passengers between them,
- the construction of more car parks should be considered not only from an infrastructural point of view, but also from a social viewpoint (increasing the mobility of the city’s residents and visitors), as well as from the environmental one (beneficial impact on the environment by reducing the number of exhaust fumes’ emitters),
- the use of ICT (scanning of QR codes to access the car park), combined with the need to have an electronic season ticket to use some of the spaces, is both a convenience (allowing quick access to these spaces) and a hindrance (reducing the availability of part of the parking resource).

The set aim of the study was achieved by demonstrating the significant impact of park&ride facilities on improving the quality of the public transport system in Wrocław. It should be noted that it is debatable whether access to the car parks is actually restricted to those without a public transport season ticket. An important feature of this system is that it rewards socially responsible behaviour (using public transport more often than occasionally), however it may result in some city users being discouraged from using the car parks; this will be particularly the case when the need to use the car park is combined with the lack of availability of free ‘ticketless’ spaces. The basic research finding is therefore that the option of parking with ‘ticketed’ spaces should only be used if there is a fully ‘ticketless’ car park in the area.

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