

ASSESSMENT OF POSSIBILITIES OF USING BIKE-SHARING SYSTEMS IN THE TOURIST ASPECT

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Abstract

In recent years, a high development of the length of bicycle paths in Polish cities can be observed. Along with their increase, there are also many elements of road infrastructure that improve the safety and comfort of traveling cyclists in cities. Parallel to improving traffic conditions, bike-sharing systems are developing. Operators and organizers of this form of transport in cities are introducing new offers consisting in lowering toll prices or introducing special tariffs for offered services. In Poland, bike-sharing systems are also being integrated between different cities. All this increases the share of bicycle users (including those with bike-sharing systems) in urban traffic. The article presents suggestions for using the bike-sharing systems as means of transport for carrying out tourist trips around the city and factors affecting the possibility of using city bikes in tourism. The study was conducted in Wrocław in October 2019. The article analyses the distance between bike-sharing systems stations and several key tourist points located in Wrocław. A total of 21 tourist points was selected for analysis. The collected information also presents the distance separating tourist points from each other and the travel times between them using bicycles.

The results of the conducted research indicate the potential to use bike-sharing systems in the aspect of urban tourism, presenting the strengths and weaknesses of this solution. The current location of bicycle stations around the analysed tourist attractions allows to travel the entire route in a cost-free option which, from the point of view of the possibility of incurring costs resulting from moving quickly around the city, can be very beneficial for tourists.

Keywords: Bike-sharing systems, tourist transport

1. INTRODUCTION

Tourist travels in cities can take place in various ways: on foot, by public transport, by car or by bicycle. The choice of mean of transport is usually preceded by a detailed analysis taking into account the needs and requirements of decision makers [6]. In the case of tourists, the dominant selection criteria are classic evaluation parameters depending on the tourist's preferences and their assessment regarding the costs, time and safety of transport [4,5,8,9]. It can also be stated that the availability of the required transport infrastructure is significant for the functioning of a tourist attraction [10]. This infrastructure includes both means of transport used and transport routes. It should also be noted that many means of transport constitute an attraction in itself and enrich the tourist offer of the area, e.g. rail tourist routes, yacht and ship cruises, helicopter and balloon flights [10]. Confirmation of the role of transport in the development of tourism are, among others Wodejko's research [12]. Author among 5 stages of tourist consumption, mentions transport twice. The author also points out that a properly developed transport base is a prerequisite for the development of transport services. Sawicki in its publication [10]. indicates that the experience to date confirms the high correlation between the quality of transport means and the price of services rendered, and the development of tourism.

Emphasizing the role of transport in tourism development, the importance of determining the capacity of tourist routes should be pointed out [7]. This aspect is particularly important for the most popular attractions in the city center. This area is characterized by the highest rate of urban traffic, which means that moving with individual

vehicles is associated with a longer movement time, due to congestion. At the same time, limited access to parking spaces extends the time of walking to and from a parking place and leaving the vehicle in this place.

However, the implementation of travel by bicycle: provides high mobility in travel, is faster than walking and can be competitive to travel by public transport or car (in particular during a traffic summit and within the city center), it can be completely free, it is ecological and improves physical condition. At the same time, it meets the requirements for a high quality service, which is rated by tourists on the basis of time comfort (speed of transport), travel convenience, transport costs, as well as the opportunity to admire the landscape [10]. For this reason, the purpose of the article is to assess the possibilities of using the bike-sharing system as a solution supporting the development of urban tourism on the example of the city of Wroclaw. To achieve this goal, the first step presents the development of cycling and the characteristics of the bike-sharing system in Wroclaw. Then, the results of research on the possibilities of using the bike-sharing system to visit selected tourist attractions in the city were presented. The final point presents the conclusions of the analysis.

2. DEVELOPMENT OF CYCLING TRAFFIC

In recent years, a clear increase in the share of cycling traffic in Polish cities can be observed. In the period from 2010 to 2018, in Wroclaw, an increase in the share of travels by bicycle from 3.8 % to 6.3 % was observed [2]. The three main factors affecting such changes include: 1 - quantitative and qualitative improvement of the bicycle infrastructure (constant upward trend in large Polish cities [1]); 2 - a growing automotive indicator contributing to the creation of traffic jams through which residents are looking for alternative means of transport in their daily travels; 3 - development of bike-sharing systems, including increasing the availability and number of bikes offered in systems.

Bike-sharing systems have undergone major changes in recent years due to the introduction of 4th generation bikes, which are characterized by the fact that the user does not have to use the docking station but can leave and take a bike from anywhere within the zone's accessibility. However, this option often involves additional fees. Currently, NextBike is the company that serves the largest part of the bike-sharing systems market in Poland. The presence of this company's services in many cities allows users to use bike-sharing systems in different cities without registering several times. The integration of systems within one operator allows traveling around the city by bicycle also by tourists. This fact initiated research on the possibilities of using a bike-sharing systems in the tourist aspect.

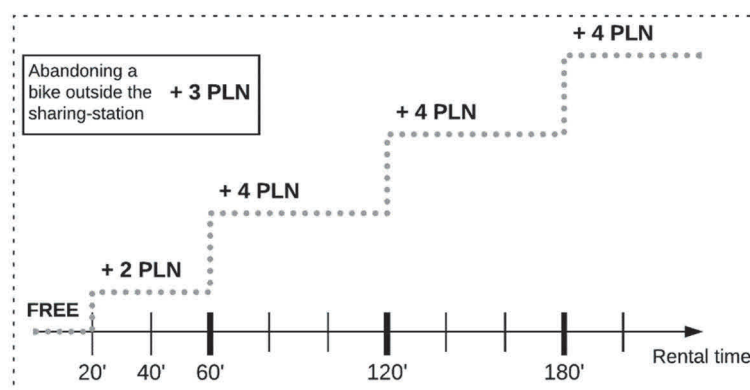


Figure 1 Fees for using city bikes in Wroclaw, source: own study based on [14]

In Wroclaw, the Wroclaw City Bike system has been operating continuously since 2010, the contract of which is concluded every 4 years. The currently operating system is the result of a third contract with NextBike, under which currently 2,000 bikes are available at 200 stations, located throughout the city [14]. Bicycles are available all year round and are all 4th generation bicycles. The location of the station is a result of experience from previously functioning systems in the city and research work carried out in this field [13]. The tariff in force in

the Wrocław bike-sharing system has not changed since the first system maintenance contract was in force. **Figure 1** presents the most important information regarding fees for using city bikes in Wrocław. A novelty, resulting from the introduction of 4th generation bicycles, is a fee for leaving a bike outside the docking station, which is 3 PLN. The operator has also introduced a system of rewarding users, under which termination of use of a bike within the station after taking it from outside the station, results in topping up the user's account by PLN 2.

3. USE OF BIKE-SHARING SYSTEMS IN TOURISM

Travels carried out via rented city bikes can be divided into two basic types:

- economic trip - the main assumption is to minimize costs by using the first 20 minutes of free bicycle ride and each time leaving the bike within the docking stations, which means that there is no need to pay any fees. Traveling over longer distances (thus extending the journey) takes place in stages where the bike can be returned at an intermediate station and after a while rented again to continue the journey. This option requires walking to and from the station to the destination or travel source;
- minimum-time trip - the main assumption is to minimize travel time and reduce walking to a minimum. Costs incurred as a result of traveling between objects are secondary. Depending on the length of the journey, in this case there may be costs for: riding time (exceeding 20 free minutes) and leaving the bike outside the station (in situations where the destination is significantly distant from the nearest station of the bike rental system). Information on the amount of costs incurred is presented in **Figure 1**.

A city bike may be the main mean of transport in the city or a mean of serving as one of elements of the combined transport carried out as a part of the journey. Its use can also grow among tourists, among others, by:

- integration of bike-sharing systems operated in different cities by the same operator,
- a quick and convenient way of registering in the system, possible to use via smartphone,
- two bikes for rent for one user,
- a large number of bikes and station locations available in the system,
- affordable tariff,
- availability of different types of bikes that can be rented (e.g. tandem, children's bike or electric bicycle),
- the ability to rent and leave bicycles outside of sharing stations (this involves an additional fee - **Figure 1**),
- a faster way of traveling between tourist points in relation to walking or by car, which gives the opportunity to spend more time on sightseeing.

A large number of rental stations is important from the point of view of effective operation of bike-sharing systems, however in the aspect of using the system in tourism, the key element is the distance in which the rental stations are from tourist points. This analysis was made on the basis of selected points recognized by the authors as key from the point of view of tourism in Wrocław. The tourist points selected for analysis are located in the center of Wrocław and on its eastern side. These points are as follows (for each of the points its name was given and in brackets the distance between this place and the nearest bike-sharing station was given [3]): 1. Aquapark (210 m), 2. Viewpoint Sky Tower (240 m), 3. Main Railway Station (80 m), 4. Wrocław Opera (230 m), 5. City Museum (400 m), 6. National Forum of Music (520 m), 7. Wrocław Old Town Garden (260 m), 8. Wzgórze Partyzantów (170 m), 9. The City Hall (110 m), 10. Galeria Dominikańska (30 m), 11. Mathematical Tower (University of Wrocław) (100 m), 12. Słodowa Island (370 m), 13. Panorama of the Battle of Racławice (290 m), 14. National Museum (90 m), 15. Cathedral (Ostrów Tumski) (370 m), 16. Botanical Garden (400 m), 17. Hydropolis (340 m), 18. Japanese Garden (620 m), 19. Multimedical Fountain (460 m), 20. Centennial Hall (260 m), 21. Zoo Wrocław (30 m).

The distance to bike-sharing stations from tourist points is from 30 meters to even 620 m. The average distance between selected points is about 270 m with a deviation of about 160 m. This indicates a large discrepancy in the distance between bike-sharing stations and key tourist points. Points such as Hala Stulecia and the adjacent multimedia fountain and Japanese garden, as well as the City Museum located in the city centre, are particularly well-located.

The key from the point of view of analysing the use of bike-sharing systems in tourism is to determine the distance that separates individual tourist facilities from each other. Tourist journeys within the city are usually characterized by numerous of short-distance journeys made between points on the route. This is dictated by the desire to visit as many places as possible with often limited time. **Table 1** shows the matrix of distance and cycling times that occur between selected tourist points within Wroclaw. As it can be seen, these distances range between 0.1 and 5.7 km and travel times in 98 % do not exceed 20 minutes, which indicates the possibility of carrying out a free ride by city bike between a very large number Wroclaw tourist points. The average distance between points is 2.2 km and the average journey time is less than 9 minutes with a standard deviation of 5 minutes. Due to the fact that most of the possible routes can be completed in less than 20 minutes, one of the key decisions when making a bicycle trip by a tourist is to specify the place where the bike will be left. In the case of tourist attractions for which the distance from the bike-sharing station is large and the person making the trip does not want to pay fees for leaving the bike outside the station, the means of transport selected for travel may be different than the bike.

Table 1 the matrix of distance and cycling times between selected tourist points within Wroclaw

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	Tourist point	time [min]																				
1	Aquapark		8	6	9	10	10	9	12	10	13	13	12	12	14	17	10	19	19	18	17	
2	Viewpoint Sky Tower	2		7	6	8	8	7	9	10	9	11	13	11	13	14	15	22	22	22	20	
3	Main Railway Station	1,4	1,7		4	6	5	3	3	6	4	7	7	5	5	8	9	9	16	16	16	15
4	Wroclaw Opera	2,2	1,5	1		2	2	2	4	4	6	5	8	6	7	9	9	11	17	16	16	15
5	City Museum	2,6	1,9	1,6	0,7		1	3	4	3	5	4	8	6	6	9	9	9	16	16	16	15
6	National Forum of Music	2,7	1,9	1,5	0,7	0,3		2	5	4	6	5	9	6	7	10	10	10	17	16	16	15
7	Wroclaw Old Town Garden	2,2	1,6	0,7	0,2	0,7	0,6		2	5	2	5	6	4	4	8	8	9	16	15	15	14
8	Wzgórze Partyzantów	2	1,9	0,6	0,8	1,1	1,2	0,4		5	2	5	6	4	4	8	8	7	14	14	13	12
9	The City Hall	3	2,1	1,6	0,5	0,6	0,8	1,3	1,1		4	2	4	5	5	6	7	11	17	16	16	15
10	Galeria Dominikańska	2,3	2,3	1	1,2	1,1	1,4	0,7	0,4	1,1		4	5	2	2	6	6	7	13	12	12	11
11	Mathematical Tower	3,2	2,6	1,8	1	1,1	1,3	1,5	1,4	0,7	1,2		3	4	4	5	5	9	15	14	14	13
12	Slodowa Island	3,2	3,2	1,8	2	1,8	2,1	1,6	1,4	1,4	1,5	1		3	3	3	3	8	14	13	13	12
13	Panorama of the Battle of Raclawice	3	3	1,6	1,4	1,5	1,7	1,4	1,1	1,2	0,7	1,2	1		1	3	5	6	12	11	11	10
14	National Museum	3	3	1,6	1,6	1,6	1,9	1,4	1,1	1,6	0,7	1,2	1	0,3		2	5	5	11	10	10	9
15	Cathedral (Ostrów Tumski)	3,7	3,7	2,3	2,4	2,3	2,5	2,2	1,8	1,9	1,4	1,3	0,8	1	0,7		2	8	11	10	10	9
16	Botanical Garden	4,7	4	2,6	2,4	2,3	2,6	2,3	2,5	1,9	2,1	1,3	0,9	1,4	1,5	0,8		9	12	11	11	10
17	Hydropolis	2,9	3,9	2,2	2,7	2,2	2,5	2	1,6	3,3	1,9	2,7	2,7	2	1,6	2,3	2,6		8	4	7	6
18	Japanese Garden	5,3	5,7	4	3,8	3,9	4,1	3,7	3,4	4,5	3,2	3,9	3,8	3	2,8	2,5	2,8	2,4		1	1	4
19	Multimedical Fountain	5,1	5,5	4,2	3,6	4,3	3,9	3,5	3,2	4,3	3	3,7	3,6	2,8	2,6	2,3	2,6	2,2	0,2		1	3
20	Centennial Hall	5	5,4	4,1	3,5	4,2	3,8	3,4	3,1	4,2	2,9	3,6	3,5	2,7	2,5	2,2	2,5	2,1	0,5	0,1		2
21	Zoo Wroclaw	5	5,7	4,3	3,5	4,2	3,8	3,4	3,1	4,2	2,9	3,6	3,5	2,7	2,5	2,2	2,5	2,1	1,1	0,7	0,6	

4. CONCLUSION

Research work presented in the article is a continuation of the analysis described in [11]. The study was aimed at determining the possibility of using the existing bike-sharing system as a solution providing a comfortable and economical means of transport in visiting tourist attractions in Wroclaw. The current location of bicycle stations around the analysed tourist attractions allows to travel the entire route in a cost-free option. However, this requires putting the bicycle back to the station and walking to the selected location on foot. If the distance between the station and the location is too great - the tourist will give up this transport system. Therefore, decision-makers should locate bicycle rental stations in a sharing system in close proximity to the most

important tourist attractions. This will increase the availability of important points on the tourist route of the city, and at the same time will positively affect the popularity of using the bike-sharing system.

Of course, using sharing bicycle, in addition to ensuring a comfortable and economical journey, must also be safe. In this connection, the technical condition of the vehicles used and the available infrastructure in the form of bicycle paths are of particular importance. This will be the subject of further research by the authors. The first stage of the research will focus on analysing the current availability of bicycle paths and preparing a forecast of the increase required for them in subsequent years. The second stage of the research will focus on determining the frequency of damage occurring in bicycles shared in the sharing system in Wrocław.

REFERENCES

- [1] GŁÓWNY URZĄD STATYSTYCZNY. Dane statystyczne dla długości ścieżek rowerowych w Polsce [online]. [viewed 2019-10-15]. Available from: <https://bdl.stat.gov.pl/BDL/metadane/cechy/3164>.
- [2] GMINA WROCŁAW. Kompleksowe Badania Ruchu we Wrocławiu i otoczeniu - KBR 2018 [online]. [viewed 2019-10-30]. Available from: <http://bip.um.wroc.pl/artykul/565/37499/kompleksowe-badania-ruchu-we-wroclawiu-i-otoczeniu-kbr-2018>.
- [3] GMINA WROCŁAW. System Informacji Przestrzennej - ortofotomapa 2018 [online]. [viewed 2019-10-30]. Available from: <https://geoportal.wroclaw.pl/sip/>.
- [4] KIERZKOWSKI, A. KISIEL, T. Modelling the Passenger Flow at an Airport Terminal to Increase the Safety Level. In: *ICMT 2015 5th International Conference on Military Technologies, Brno, Czech Republic*. 2015, pp. 107-113.
- [5] KIERZKOWSKI, A. KISIEL, T. Airport Security Screeners Reliability Analysis. In: *IEEE International Conference on Industrial Engineering and Engineering Management*. 2016, pp. 1158-1163.
- [6] MILEWSKI, R., SMAL, T. The use of Multidimensional Comparative Analysis in the Choice of Means of Transport for the Army. In: *ESREL 2015 Safety and Reliability of Complex Engineered Systems: proceedings of the 25th European Safety and Reliability Conference*, Leiden: CRC Press/Balkema, 2015.
- [7] PŁOCKIEJ, J. *Wybrane zagadnienia z zagospodarowania turystycznego cz.II*. Toruń: Biblioteka CKU, 2002
- [8] RESTEL, F., WOLNIEWICZ, L. Tramway reliability and safety influencing factors. *Procedia Engineering*. 2017, vol. 187, pp. 477-482.
- [9] RESTEL, F., WOLNIEWICZ, L. Factors affecting the efficiency indicator of the public transport system : case study. In: *RelStat 2018 Reliability and statistics in transportation and communication : selected papers from the 18th International Conference on Reliability and Statistics in Transportation and Communication*, Riga, Latvia. Springer, 2019, pp. 57-68.
- [10] SAWICKI, B. The role of transport in developing tourism. *Logistyka*. 2012, vol. 3, pp. 1957-1961.
- [11] TUBIS, A.A., RYDLEWSKI, M., SKUPIEŃ, E. Non-technical aspects of safety in scooter-sharing system in Wrocław. In: MACIOSZEK, E. SIERPIŃSKI, G. (eds.) *Modern traffic engineering in the system approach to the development of traffic networks: 16th scientific and technical conference. Transport System. Theory and Practice*. 2019. Springer 2020, pp. 163-173.
- [12] WODEJKO, S. *Ekonomiczne zagadnienia turystyki*. Warszawa: Wyższa Szkoła Handlu i Prawa, 1998.
- [13] <https://pwr.edu.pl/uczelnia/aktualnosci/modelowanie-pomoglo-wybrac-lokalizacje-stacji-roweru-miejskiego-11229.html>. [viewed 2019-10-30].
- [14] <https://www.wroclaw.pl/wroclawski-rower-miejski-2019-mapa-stacji>. [viewed 2019-10-30].