

The Development of Bike-Sharing Systems in Poland. The Study of Wavelo System in Kraków

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The interest in bike transport in Polish cities and towns has been growing systematically in the recent years. A great number of local authorities take various actions to support the development of cycling systems. They make an effort to develop a cycling infrastructure – bike lanes, Bike&Ride type of parking, bike stands and advanced stop lines. An increased interest in bike-sharing systems is visible as well. Apart from that, the authorities implement policies and take other actions which make cycling in a city more convenient.

The aim of the article is to characterize the experience of Polish cities in the area of bike transport support, with a special attention to bike-sharing systems. The article presents a comparison of 38 city bike systems. In addition, the Wavelo system in Kraków was studied in detail. Wavelo city bike system is very popular among citizens of Kraków. Despite relatively high prices and the lack of free minutes, the number of system users is growing. A large number of docking stations and their locations make bikes more accessible to citizens. Moreover, Kraków's authorities take action to develop a proper bike infrastructure which increases the interest in cycling as a transportation system. Selected methods of constructing special inserts in the transition zones between the embankment of the railway track and the engineering object (bridge, viaduct, or culvert) were discussed. The purpose of mounting the designed inserts is to eliminate the so-called threshold effect, i.e. continuously creating a mild change in the stiffness of the ground under the track. In addition to the solutions presented in practice, attention was also paid to projects developed by the authors of this article. The results of experimental research constituting the basis for the development of some solutions are also given.

Keywords: railway track, engineering facility, transition zone, reinforcing inserts.

1. INTRODUCTION

The increase of bicycle transport popularity is the result of the work of urban developers who look for effective transport solutions based on a sustainable transport development and pro-ecology actions. Numerous studies (Beim, Wiśniewski 2011; Brzeziński et al., 2014; Łastowska et al., 2015; Mroziak et al., 2016; Chalfen et al., 2016; Dębowska-Mróż et al., 2016) on cycling in the city show a significant change in trends – bikes frequently used on everyday basis rather than for recreational purposes only. The increasing popularity of cycling could result directly from the advantages that come with it. The biggest advantage is the possibility to reach a destination faster – going a short distance (5-6 km) by bike in the zones of increased car traffic is less time-consuming when compared to other means of transport (Ciesielski 2014; Mroziak et al., 2016). Apart from this fact, cycling enables people to travel door-to-door, which is a great advantage.

Other benefits resulting from everyday bike use are savings (lower travel and maintenance costs), convenience, health and ecology.

The possibility of using a bike on everyday basis is determined by 5 groups of factors, i.e. architectural environment, natural environment, socio-economic factors, psychological factors, and the effectiveness of the journey (Heinen et al., 2010). The specificity of architectural environment in the cities, such as dense housing and proper road infrastructure, makes daily travelling by bike more convenient. This results from short distances between one's home and their place of work, school, entertainment, as well as high level of safety during travel and the security of bike parking. The second determinant is the natural environment – the terrain and the climate is what influences everyday use of a bike. Citizens' behaviour can also be influenced by socio-economic and psychological factors. The socio-economic factors include individual characteristics, such as age, sex, economic or work status. The

psychological factors involve people's attitude towards cycling (cultural and historical conditions, habits etc.). The effectiveness of a journey is influenced by the level of safety, economic factors and the possibility of moving around the city by bike fast. The level of safety could be defined by the probability of an accident as well as subjective feeling of safety when going by bike through the city (Ciesielski 2014).

Currently, a great number of local authorities take various actions to support the development of cycling systems. They make an effort to develop a cycling infrastructure – bike lanes, Bike&Ride type of parking (B+R), bike stands and advanced stop lines. An increased interest in bike-sharing systems is visible as well. Apart from that, the authorities implement policies and take other actions which make cycling in a city more convenient.

The aim of the article is to characterize the experience of Polish cities in the area of bike transport support, with a special attention to bike-sharing systems. The article presents a comparison of 38 city bike systems, including such data as: the name of an operator, the year of system launch, the number of stations and bikes in the system, and the duration of the season. The data was obtained from the websites of operators and individual bike systems. In addition, the Wavelo system in Kraków was studied in detail. On the basis of data published by ZIKiT (The Kraków Board of Municipal Infrastructure and Transport) regarding the number of rentals, time of rental in hours and distance in kilometres, from 1st March 2017 to 30th June 2018. Kraków was chosen as it has the longest history of the bicycle system and the most developed cycling policy.

2. THE DEVELOPMENT OF CYCLING INFRASTRUCTURE IN POLAND

An adequate cycling infrastructure has a direct impact on the safety of bikers, which in turn makes cycling a more attractive daily means of transport. Among various solutions applied in cycling infrastructure, there are three that result the most popular: building a separate bike lane, designating a bike lane next to a car lane, and integrating bike and car systems in the areas of so-called slow traffic (up to 30 km/h). Separate bike lanes are the most common solution in Poland (Mrozik et al., 2016).

According to the study prepared by BDL GUS (Central Statistical Office) in the years 2011 –

2016, a dynamic increase in the length of bike routes was noted. During the 6 years, nearly 4 000 km were built and in 2016 the total length of bike routes for Polish cities reached over 8 500 km. The biggest increase took place in Warsaw, where since 2013 over 130 km of bike routes were built. In the group of middle-size towns, Augustów was the most significant one (44 km), and in the group of small-size towns it was Czersk (25 km).

The integration of bike lanes with car lanes in the areas of slow traffic is becoming an integral part of city-centres of big cities in Poland. Places like Poznań, Katowice, Gdańsk or Wrocław have followed the footsteps of Copenhagen. Limiting the speed to 30 km/h and creating a proper traffic organization helps to increase the safety of pedestrians and bikers, the quality of citizens' life (less noise pollution and exhaust emission) as well as it brings profits to the owners of local businesses (Beim 2011; Bohatkiewicz et al., 2014). Implementing various technical solutions such as speed bumps, elevated pedestrian crossings, but also reorganizing the traffic – designating one-way streets, brings back the old multi-functional character of a street. Moreover, there is a possibility to use the additional space for a parking or a green zone in the areas of “tempo 30.” It should be emphasized that traffic reorganization is often cheaper and more effective than building new bike paths. More and more frequent biker-friendly solution involves letting the cycling traffic onto one-way streets (Bohatkiewicz 2008; Mrozik et al., 2016).

Having the possibility to keep a bike safe when parked influences the decision to use it as a means of everyday transport. Currently, most of the cities in Poland are equipped with parking bike stands or canopies. Companies, schools, institutions and block of flats' administrators invest in private bike parking for employees, citizens and clients more and more frequently. What is important, the standards are also changing – apart from the most basic solutions, closed and roofed garages, multi-level stands or the highest security standards stands are built.

City authorities, of big agglomerations especially, encourage the citizens of neighbouring municipalities to leave their cars at the borders of the city and use a different means of transport. Warsaw has had bike stands with electronic locks operated by Warsaw City Card at the transportation hubs and B+R types of parking since 2015. This original solution lets the owner secure their bike without the need to carry their own lock

(<http://www.ztm.waw.pl>). In 2017 this idea was also introduced in a newly created B+R parking in the district of Bieżanów in Kraków (<http://kmr.org.pl/>).

3. CHARACTERISTICS OF BIKE SYSTEMS IN POLAND

One of the solutions in the area of cycling transport support is the development of a bike-sharing system. A city bike network involves the use of a bike as a means of transport mainly, and then in the second place the bike is rented for recreational purposes. The idea of a bike-sharing rental was born in 1965 in Amsterdam and with time it has reached many places in the world (Sołowij 2014). The pioneer of this solution in Poland was the city of Kraków, where the possibility to rent a bike appeared as early as 2008. In June 2018 bike-sharing systems were present in 38 cities and towns (Tab. 1, Fig. 1) and they were operated by the following three operators: Nextbike (32 systems), BikeU (5 systems) and Romet Rental Systems (1 system).

Mainly big cities (the capitals of regions) joined the bike-sharing project. However, smaller towns, such as Zgierz, Stalowa Wola or Pszczyna also support this type of transport (Fig. 1). In the Silesia region there are as many as 9 cities where bike systems were created. A very interesting solution was applied in Białystok, Bydgoszcz and Lublin, where the network includes not only the city area, but also municipalities which belong to the agglomeration. Growing popularity of bike rentals was also reflected by creating the system in a village municipality of Michałowice (Pruszków County). However, it was not present everywhere – in 4 regions (pomorskie, warmińsko-mazurskie, lubuskie and świętokrzyskie) there are no operating bike rentals at the moment. The Tri-City Bike (Rower Trójmiejski) system started in 2013 in Sopot and it was closed, due to financial reasons, in 2015. The opening of Mevo system, however, is planned for November 2018. The metropolitan bike will be operated by Nextbike and at the beginning it will include 1 200 bikes, and eventually the total number of 4 000 bikes. The Mevo system stations will be located in 14 municipalities – Gdańsk, Gdynia, Sopot, Tczew, Puck, Reda, Kartuzy, Sierakowice, Somonin, Stężyca, Władysławowo, Żuków, Pruszcz Gdański and Rumia (<http://nextbike.pl/>).

Newly created networks as well as the increasing number of users confirm the growing

popularity of the city bike system. In 2017 the total of 13 centres started their bike rentals (Tab. 1), by June 2018 another 6 systems appeared. There are also plans to open new ones – in Świętochłowice and Zabrze in summer 2018 a pioneer program will be realized. In total, in the Polish system there were over one million users and 14 000 bikes which were rented over 20 million times. The biggest system is Veturilo in Warsaw which has 360 stations, over 5,000 bikes and 600,000 users registered since 2012.

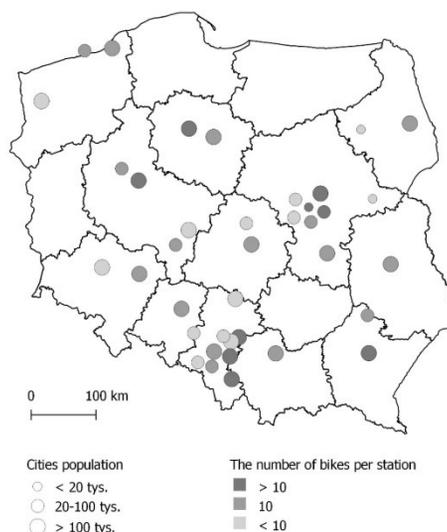


Fig.1. The number of bikes per station for particular bike systems.

Source: Own study based on Internet websites of bike system operators (<https://www.nextbike.de/en/>, <http://bikeu.pl/>, <http://www.rometrentalsystems.pl>) and Internet websites of particular bike systems.

On average, bike-sharing system in a city includes 440 bikes and 40 stations. Apart from previously mentioned Warsaw, the most active are also Łódź (154 stations, 1 540 bikes) and Kraków (150 stations, 1 500 bikes). The biggest density of docking stations is noted in Warsaw, Lublin, Białystok with over 60 stations per 100 km². In Piaseczno the density is the smallest – there are 2 stations per 100 km². Bike accessibility has been characterized by using two indices. The first one is the relation of the number of bikes available for rent to the number of docking stations (Fig. 1). On average, there are 11 bikes per station. Warsaw and Sosnowiec has 14 bikes per station. The lowest number of bikes (6) is at the station of Kędzierzyn-Koźle. The second index of accessibility expresses the number of inhabitants per one bike. In Warsaw, Kalisz, Kołobrzeg and Lublin there are less than 400 inhabitants per bike. The lowest accessibility

is visible in Tychy and Ostrów Wielkopolski, where the value of the index is more than 3 000 inhabitants.

Moreover, the number of rentals in relation to the number of bikes available was also measured from the start year (<https://www.nextbike.de/en/>, <http://bikeu.pl/>, <http://www.rometrentalsystems.pl>). The analysis included 21 systems operating in 2017. Wrocław, Białystok and Bydgoszcz had the highest value, however it can be interpreted in two ways. On the one hand, the high index could mean that the system is very popular. On the other hand, it could indicate that there are not enough bikes for rent in that system for. As the data is collected by city bike operators in different ways, it is not possible to count the number of active users per bike or the number of times they use the service.

The popularity of a system can be influenced by the duration of the season or the additional services that are offered to the users. Cities like Białystok or Łódź, apart from renting standard bikes, also offer tandems, bikes for kids or cargo bikes. Bikes equipped with baby chairs are available in Kolobrzeg. Moreover, the majority of bike rentals offer free minutes to its users. In Szamotuły and Ostrów Wielkopolski there are 3 hours free of charge. Only Wavelo system in Kraków does not offer the possibility to use the bike for free. However, to make up for this fact, the system is available all year round. For the majority of stations, the season starts on 1st March, and it finishes on 30th November (Tab. 1). In September 2017, a new service was introduced in Warsaw – a public dockless Cross Bike. The functioning of dockless bike-sharing system is based entirely on a smartphone app. The system is supposed to be a cheaper alternative to traditional bike rentals as there are no costs to maintain a docking station (<http://www.transport-publiczny.pl>).

4. CHARACTERISTICS OF FUNCTIONING AND THE USE OF WAVELO SYSTEM IN KRAKÓW

Kraków was the first city in Poland to introduce a city bike system. KMK Bike operated in the years 2008-2016 and it had nearly 50,000 of users (<http://rowery.zikit.pl>). The System of Unmanned Bike Rentals of the fourth generation called Wavelo started in October 2016. This system is one of the biggest in Poland and it offers 150 docking stations and 1,500 bikes. The docking stations are distributed quite evenly throughout the city, but they are more dense in the city-centre.

They are mainly located in places like universities, shopping malls, administration, culture and sport centres. Moreover, the stations are also available at interchanges and in residential areas (<https://www.wavelo.pl/>).

The operator (BikeU) offers 4 various price packages. The first two are the best solution for the city inhabitants mainly as the rental is on monthly or annual basis. The package prices differ depending on the daily duration of the bike use (60 or 90 minutes per day). The highest price per hour is definitely in the package which offers a charge per minute. The best solution for tourist would be the package which allows to rent a bike for 12 hours a day (<https://www.wavelo.pl/>).

The Wavelo system is the only one in Poland available all year round. From the beginning of March 2017 till the end of February 2018 the bikes were rented 770,000 times, which is on average 2,000 times per day. During that year the highest number of rentals was on Tuesday, July 18th 2017 and the number was 6,691. What is interesting, in May 2018 there were days where the number of rentals was bigger than 7,000. In the analysed period the highest number of rentals took place during the summer season – from June to August 2017 (Fig. 2).

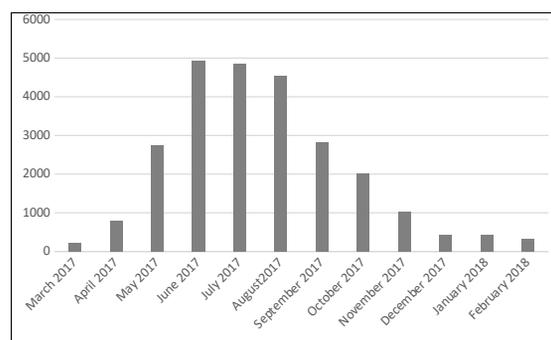


Fig. 2. Daily average number of city bike rentals in Wavelo system for every month.

Source: Own study based on the data from ZIKiT (<http://rowery.zikit.pl>)

The lowest activity could be observed during winter and early spring – from December till March. A. Brzeziński i K. Jesionkiewicz-Niedzińska (2014) emphasizes the fact that bike transport is seasonal and it is highly sensitive to weather, showing 75% less demand on rainy days. The study by K. Iwińska and her team (2018) shows that the biggest obstacle for bikers in using a bike the whole year is heavy rain and slippery surface as well as inappropriate maintenance of bike paths after it snows in winter.

A data set for spring 2017 and 2018 seems to be interesting (Fig.3). In 2018 the interest in the city bike was a few times higher than on average. It is especially visible for April – in 2017 the bikes were rented 806 times and in 2018 they were rented 4,701 times. Such a big demand for city bikes could indicate an increase in the popularity of the Wavelo system, better weather conditions in spring 2018 or a general interest in a bike as a means of transport. When it comes to analysing the bike or the system popularity, it is difficult to rely on a trustful source. When considering the climate, the IMGW (Institute of Meteorology and Water Management) presents better weather conditions from April to June 2018. In April 2018 the average temperature was nearly twice as high as in 2017. In addition the average monthly relative humidity was lower. The situation was similar in May 2018. The weather conditions in March and June 2017 and 2018 were comparable (Tab. 2).

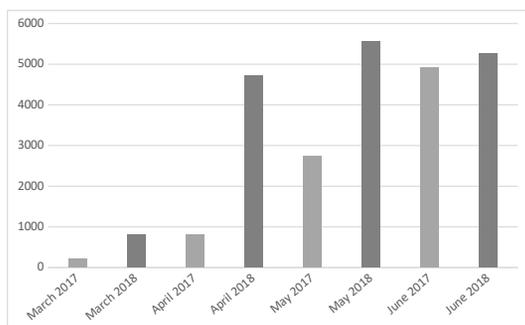


Fig.3. Daily average number of Wavelo city bike rentals for every month in 2017 and 2018.

Source: Own study based on ZIKiT data (<http://rowery.zikit.pl>)

Table 2. Monthly average temperatures and monthly average relative humidity for chosen months in 2017 and 2018.

Month	2017	2018
Monthly average temperatures [°C]		
- March	6.9	1.3
- April	8.4	14.5
- May	14.7	17.5
- June	19.9	19.6
Monthly average relative humidity [%]		
- March	72.4	73.1
- April	71.1	58.3
- May	72.1	63.4
- June	58.7	66.8

Source: Own study based on IMGW data (<https://danepubliczne.imgw.pl/>)

City bikes are recommended for citizens as a means of everyday transport mainly. This has been confirmed by the analysis of daily average number of rentals for particular days of the week (Fig.4). The average number of rentals is definitely higher for the working days than for the weekend. During weekends people use bikes mainly for recreational purposes, which is expressed in longer rental time and distance (Fig.5). On average, the bikes were rented for 21 minutes to cover a distance of 3.5 km.

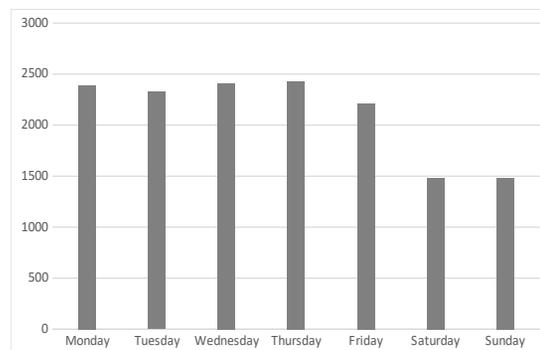


Fig. 4. Daily average number of rentals for particular days of the week.

Source: Own study based on ZIKiT data (<http://rowery.zikit.pl>)

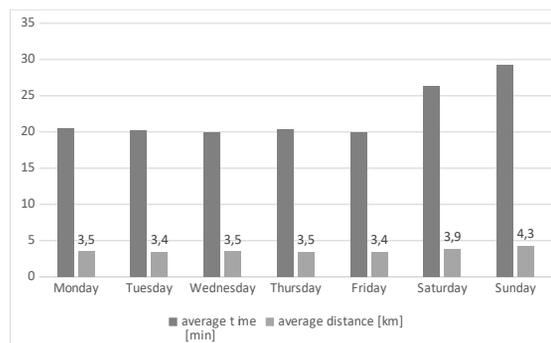


Fig. 5. Average rental time (in minutes) and distance (in kilometres) for particular days of the week.

Source: Own study based on ZIKiT data (<http://rowery.zikit.pl>)

5. CONCLUSIONS

The interest in bike transport in Polish cities and towns has been growing systematically in the recent years. This is the result of the actions taken by authorities as well as the trend for a healthy lifestyle. Solutions such as new cycling paths or bike-sharing systems are implemented every year. Undoubtedly, the presence of bikers on the streets is noted and along with it, their security increases. Moreover, there are various educational campaigns which help to increase the bikers' responsibility as well.

Wavelo city bike system is very popular among the citizens of Kraków. Despite relatively high prices and the lack of free minutes, the number of system users is growing. A large number of docking stations and their locations make bikes more accessible to the citizens. Moreover, Kraków's authorities take action to develop a proper bike infrastructure which increases the interest in cycling as a transportation system. Many times, however, the bike paths do not form a coherent system which makes cycling more difficult. In addition, a comprehensive approach to the implemented solutions is still missing – citizens not only need new paths, but also small cycling infrastructure (bike stands, advanced stop lines, etc.).

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