Organization of Urban Transport Organization – Presentation of Bicycle System and Bicycle Infrastructure in Lublin

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Abstract: The introduction of a city bike system, which has become a complement to the public transport system in large cities and mainly in the most crowded city centers, seems to be a very good solution, which may contribute to reducing urban congestion, air pollution, and noise level. In many situations, bicycle transport can solve the deficiencies in public transport, e.g. at nights, during holidays and on days when bus services are operated to a limited extent. The article presents the functioning of the city bike system in Lublin implemented at the end of 2014, including basic information on the system, its advantages and disadvantages, as well as the existing infrastructure and development prospects.

Keywords: City logistics, public transport, bicycle rental

1. Introduction

The highest concentration of traffic is in large cities and whole agglomerations [1]. Public transport is operated to satisfy the transport needs of persons, especially vulnerable groups of people, pupils, students, and pensioners as well as workers [2]. However, urban transport is not the only form of mobility. It should be emphasized that the ecological awareness of city dwellers is constantly growing, which leads them to decide for alternative forms of travelling. The most popular ones include, for example, bicycle, car sharing, or walking. One of sustainable transport options consists in using non-motorized transportation – cycling, or including cycling in urban transport [3,4]. New regulations of the European Union enforce the limitation of the impact on the environment, which is reflected in restrictions imposed on car traffic in city centers and the renaissance of trolleybuses [5]. Importantly, the inflow of EU funds contributed to the development of transport infrastructure

throughout Poland. New sources of financing also forced new forms of management and innovative infrastructure solutions. One of the manifestations of this situation is the construction of numerous bicycle paths which, apart from recreational, are used as a form of alternative urban mode of transport. The introduction of the city bike system as a complement to the public transport system in large agglomerations and mainly in the most crowded city centers, appears to be a very good solution, which may contribute to reducing air pollution [6-13], noise levels [14,15], the occurrence of transport congestion [16-21]. Poliak et al. [22] present the issues of social legislation in road transport as a means to ensure safe road transport. In turn, Kampf et al. [23] studied the macroeconomic evaluation of projects concerning transportation structures and facilities. Cycle transport represents a mode of transport that has efficient transport requirements especially for short as well as long distances [4]. Research into bicycle level-of-service (BLOS) has been extensively conducted in recent years [24,25]. This research is mostly focused on user perceptions of comfort [26-28] to provide guidance for decision-makers and planners [17,29-33] and city databases [34]. Recently, there has been an increase in interest in electric mobility, including both bicycles [35] and cars [5,12,36]. Electric drivetrain is particularly suitable in vehicles with high annual mileage, such as city buses operating in public transport [37].

This objective of this paper is to present the functioning of the city bike system in the city of Lublin, located in south-eastern Poland, including basic information on this system as well as the existing infrastructure and development prospects. An additional aspect discussed in this study is the epidemic situation in the country, which has demonstrably affected many areas of life, including the operation of the Lublin City Bike system.

2. Ways of Traveling in an Urban Agglomeration

A typical feature of current urban development is immense growth of towns caused by the creation of industrial zones, shopping and amusement parks, and residential zones [38]. The main purpose of transport is to meet this growth by appropriate means. A specific form of transport is urban transport, which, according to horizontal classification, can be divided based on the criteria of range and distance into territorial units within which individual transport operations are performed [39]. It consists mainly in the provision of transport services within cities and suburban areas. In addition, it has a direct impact on urban development of cities. One of its forms is the so-called public transport ensured mainly by buses, trolleybuses, trams, and metro. The choice of a specific means of transport is influenced by many factors, such as its availability, safety, travel comfort, personal preferences of travelers [38,40]. The final choice is always made subjectively. Changing habits is possible but requires a long time and consistent actions [28]. The creation of an efficient public transport system that would meet the expectations of inhabitants is one of the key tasks for the boards of territorial

units [41]. Currently, the main goal of such a system is to reduce congestion and the negative effects it causes, and to minimize the number of road accidents. Drivers and their personality traits play a significant role in the occurrence of risk situations and problems while driving on public roads [42]. As already mentioned, the ecological awareness of city dwellers is increasing, which results in using alternative forms of transport, e.g. bicycle, scooter, car sharing, or walking.

3. Data and Methods

The aim of the paper is to describe the functioning of the city bike system in Lublin implemented at the end of 2014, and the prospects for its further development. The paper includes a short analysis of data from bicycle rentals in the years 2014-2020 provided by the operator of this system. In addition, the paper presents the basic information about this system, its advantages and disadvantages as well as the existing infrastructure.

4. Lublin's Communication Infrastructure

Lublin is an example of a city whose road network in many places is difficult to solve, e.g. due to past urban planning errors, location on hills, or unfavorable soil and water conditions which require high investments in the road network [43]. As in most Polish cities, the road network has a radial-ring character. Such an arrangement developed naturally along with the development of the city around the center.

The weaknesses of the current road system include:

- inefficiency of basic routes (their standard and technical parameters do not correspond to the existing traffic volume),
- insufficient capacity of some streets,
- insufficiently developed system of ring roads and their non-uniform standard,
- ambiguity of the road system (duplication of ring roads by lower class roads in the downtown area),
- poor technical condition of streets and road facilities, which causes low travel comfort,
- missing modern, intelligent traffic management system,
- no P + R (park & ride), B&R (bike & ride) parking system for people commuting to Lublin by car or bicycle.

The strengths include:

- Lublin's location in an important communication node,
- a developed long-distance road network,
- a developed and modern/sophisticated? urban public transport system,
- introduction of paid parking zones in the centre,

- progress in adapting the public transport system and road infrastructure to the needs of disabled people,
- construction of the traffic management system has been started [43].

In recent years, the city of Lublin has made many investments. They include the construction of new roads and the renovation and reconstruction of existing urban roads. The common feature of the works carried out is the investment not only in improving the possibility for drivers of passenger cars but also for public transport and cyclists. New cycle paths, bus lanes and locks for buses departing from bus stops are being built. The city also makes significant investments in the modernization and expansion of trolleybus traction. These investments are in line with the Low Emission Economy Plan for the city of Lublin (trolleybuses are zero-emission vehicles, reconstruction of key intersections such as national roads 12, 17, 19 (Sikorskiego Av., Solidarności Av.) and Voivodeship road 809 (Poligonowa and Ducha Street) or the extension of Bohaterów Monte Cassino Street to the Sławin junction along the Lublin-Warsaw national road should contribute to the reduction of congestion in the city. Implementation of traffic management system is expected to increase the capacity of the road network, reduce the time loss in the road network, improve road safety, and positive effect on the environment by reducing emissions [43].

5. Bicycle Infrastructure

The development of the bicycle path network in the city is based on the Cycling Policy and the related documents including:

- Technical standards for the bicycle infrastructure of the city of Lublin valid from 2010 [44],
- Bicycle Policy of the city of Lublin valid from 2011 [45],
- Concept for the development of bicycle transport in the city of Lublin valid from 2011 [46],
- Strategy for the implementation of the bicycle road system in the city of Lublin valid from 2014 [47],
- Sustainable Mobility Plan for Lublin valid from 2015 [48].

This policy is implemented within the framework and respecting the principles of Lublin's Transport Policy and the city's spatial policy, and has a strategic goal of achieving a 15% share of bicycle traffic in the total number of roads in the city in 2025 [45]. Moreover, other partial goals are to be implemented, such as improving traffic safety, increasing the speed of movement within the city, promoting environmentally friendly transport behavior of the residents. It is recognized that the boom of cycling is associated with many environmental, economic, and social benefits (reduction of congestions, improve health, improved quality of living in the city due to reduced pollution and noise levels). The analysis of the differences in the popularity and importance of cycling in Lublin and in similar European cities shows a large development potential of this type of transport. Significant

development of this mode of transport has been recorded especially in recent years. In 2013, there were approx. 70 km of pedestrian and bicycle routes in Lublin. According to the official website of the city of Lublin [49], in January 2017, it was approx. 140 km. In 2020, the overall length of the cycle paths exceeded 170 km.

In September 2014, a city bike rental system was launched. Initially, it included 40 stations with a total of 400 bicycles, which has currently expanded to 91 stations and 891 two-wheelers - including 5 stations and 41 bicycles in Świdnik (a nearby town) and 2 stations with 20 bicycles for children. Table 1 presents data on the operation of the Lublin City Bike system. The data for 2019 shows that the most common time for renting a bike (17 %) is between 3 p.m. and 5 p.m., i.e. when people return from work. The most numerous group – 45 % of all registered users - are users aged 18-25 (i.e. approx. 50.8 thousand people) [50]. The second largest group of cyclists, the inhabitants of Lublin and Świdnik, are people aged 30 - 39 (almost 20 % of approx. 22.1 thousand inhabitants). Seniors make up nearly 1.2 % (about 1,350) of active city cyclists. .

Table 1 Statistics of Lublin City Bike. Source: author based on [51].

Season	Rental
2014 (19//09//2014 – 30/11/2014)	128,644
2015 (21/03/2015 – 30/11/2015)	436,965
2016 (21/03/2016 – 30/11/2016)	784,737
2017 (21/03/2017 – 30/10/2017)	502,337
2018 (21/03/2018 – 30/11/2018)	637,953
2019 (21/03/2019 – 30/09/2019)	457,896
2020 (21/03/2020 – 31/10/2020)	8,611

As seen from the table above, there was a continuous increase in the number of users interested in car rentals until 2016, reaching its maximum of almost 800,000 rentals. This applies to both the number of new system users and the number of rentals in the season. The following years show alternating increase and decrease in the interest in bike rental. The worst situation was in 2020 due to restrictions related to the SARS-Cov2 coronavirus, when the bike rental did not exceed the value of 10,000.

6. Advantages and Disadvantages of Bicycle Infrastructure

The main advantages of Lublin's bicycle route network include:

- use of attractive areas in the city (parks, green areas, riverside boulevards or the vicinity of the Zemborzycki Lake),
- good access to recreational areas around the city,
- allowing the so-called versus traffic on one-way roads in the centre.

The main disadvantages of the network include:

- insufficient continuity and consistency of the network,
- poor quality and technical condition of the pavement in older sections,
- poorly developed system of bicycle routes in the city centre,
- a small number of bicycle parking lots,
- lack of quality corridors between the most popular destinations and starting points to ensure the possibility of traveling between districts [47].

7. Conclusion

Cycling is a sustainable mode of transport; moreover, health benefits of cycling as an intensive physical activity are well known [52]. According to own research, the most common means of transport in Lublin is a passenger car. This may be due to a lack of infrastructure and some limitations of public transport (too small coverage in neighboring municipalities).

Almost one million Poles already use the city bike system, and rentals are counted in millions. To be fully efficient, the system needs an appropriate infrastructure, i.e. the optimal number of stations and bikes, as well as the appropriate logistics system. The lack of this type of facilities or solutions may decrease the attractiveness of cycling and limit the use of this mode of transport. A city bike is an ideal means of transport that significantly reduces travel time, partially relieving public transport and reducing the number of passenger cars on the road. The system's popularity is also influenced by its operating costs. Considering the experience of not only Polish but also European cities, each of them had different reasons for the implementation of the system. Some cities introduce this solution as a supplement to public transport, others because of the desire to maintain their status as a place for recreation and to reduce car traffic. In Lublin, the system was implemented as a part of the project "Lublin - the capital of cycling tourism", emphasizing the tourism potential of the region.

From the beginning of the Lublin city bike system operation, i.e. from 2014, until 2020, a total of over 3 million bikes were rented. The year 2016 was record-breaking in terms of the number of rentals, with 784,737 rentals. In the following years, the popularity of the city bike system in Lublin increased and decreased. A special year was the year 2020, which, due to the epidemic situation in the country, forced the reduction of bicycle stations services. Despite these difficulties, the system operated during the selected period of the year, but the level of bike rentals was only 8611. However, based on the data analysis, it seems that reaching the value of 500,000 rentals in Lublin will be depend

on the system stability and will be achieved in the coming years, provided that the epidemic situation is normalized. The city of Lublin still makes the road system more attractive by introducing a system of electric scooter rentals, but it is too early to estimate the impact of this means of transport on the Lublin city bike system. The presented article can be seen as an introduction to further detailed analyses.

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