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Analysis of the development and safety of cycling in Szczecin

Abstract: The article presents the problem of cycling, which, in spite of positive aspects, is consistent with the development and harmonious functioning of modern urban agglomerations, constitutes a transport subsystem characterized by high number of traffic incidents. The rising trend of accidents and collisions is in the case of highly urbanized areas, where two-wheelers are increasingly popular due to their high mobility, but also relatively low travel and maintenance costs. The analysis takes into consideration the role of maintenance-free rental systems, which contribute to the promotion of comfortable and environmentally friendly means of transport. The example of the Szczecin City Bike "Bike S" was used, which is a civic project gaining increasing support from various social groups and treated as a substitute for public transport.

Keywords: Two-wheel vehicle; Road accidents and collisions; "Bike S" system

Introduction

For many years, shaping the space of cities and metropolitan areas is one of the most important problems of contemporary urban planning. They are characterized by a complex structure resulting from historical conditions, but also by current socio-economic changes. It is accompanied by an intense expansion of the so-called Western civilization, which is translated into progressive uniformity and regression of local cultures. This process leads to simplification and, as a result, impoverishment of public areas, which are formed on the basis of ready, often duplicated patterns [10]. However, regardless of the degree and advancement of the transformations taking place, the element connecting the components of the spatial structure is the transport system, operating in conditions of increased demand for the flow of people and goods. The intensity of road traffic adversely affects the development of cities, because communication problems contribute to a significant decrease in their attractiveness, which can be considered on many levels. Overloading the road and street network affects even the costs related to transport, the amount of energy consumed and the negative impact on the natural environment, mainly in the aspect of noise emission and pollution of toxic exhaust components. These problems are particularly felt in the central districts, which are dominant, but also increasingly difficult to access, the purpose of the trip due to the administrative and cultural role, as well as the concentrating service facilities and public utilities.

The above considerations and conditions have caused that more cities have started to implement the concept of sustainable development, that is, the doctrine that assumes a balance between individual aspirations. According to its guidelines, the capacity of the road system (supply of roads and parking lots) should not be adapted to the requirements of motorized users. It is also necessary to effectively influence the demand and the method of satisfying it, popularizing completely different ways of traveling and limiting transport intensity and the number of motor vehicles in built-up areas [3]. From this point of view, collective and cycling communication seems to be the most effective alternative for private cars, which should be harmonized with each other and complement each other. At the moment, the second of these

transport modes is particularly promoted, as the creation of the required road and bus infrastructure, the costs of its use and maintenance in a good technical condition are relatively low [11]. Nevertheless, the smooth functioning of the entire system must be based on basic organizational principles, the most important of which are [1],[15]

a) cohesion - connecting all sources and destinations with each other;

b) directness - offering the optimal route in terms of route length and travel time;

c) safety - guaranteed for all road users (limiting the number of collision points and interleaving tracks, ensuring mutual eye contact);

d) attractiveness - greater in comparison to collective and private transport and meeting the needs of users;

e) convenience - ensuring fast and comfortable passage to the destination point (high design speed, minimization of inclinations and level difference)).

Despite a number of advantages, the widespread use of bicycles in urban traffic creates risks, which translates into a high percentage of road accidents in which the most serious injuries are suffered by their users [2],[12]. This is due to the technical and operational specification of two-wheeled vehicles, which are characterized by low stability, high impact of unevenness of the surface and lack of resistance to wind gusts, including lateral ones caused by passing motor vehicles [12]. Even a small collision or fall can cause serious injury to the cyclist, because the only protection is a helmet that protects the head. Unfortunately, these are usually simple "soft-shell" constructions that do not prevent face or jaw bone injuries. It should also be emphasized that the increased accident rate of the transport mode is affected by a number of often diverse factors, including: poor infrastructure, difficult weather conditions, ignorance or intentional violation of traffic rules, incorrect marking (lack of lighting, reflective elements)), using electronic devices while driving (music players, mobile phones, navigation, training counters). In addition, the data presented in the literature on the subject shows that car drivers are most of the collisions that are not aware of the presence of cyclists traveling alongside or behind them [1],[4],[10],[16],[20].

Conditions for the development of bicycle communication in Szczecin

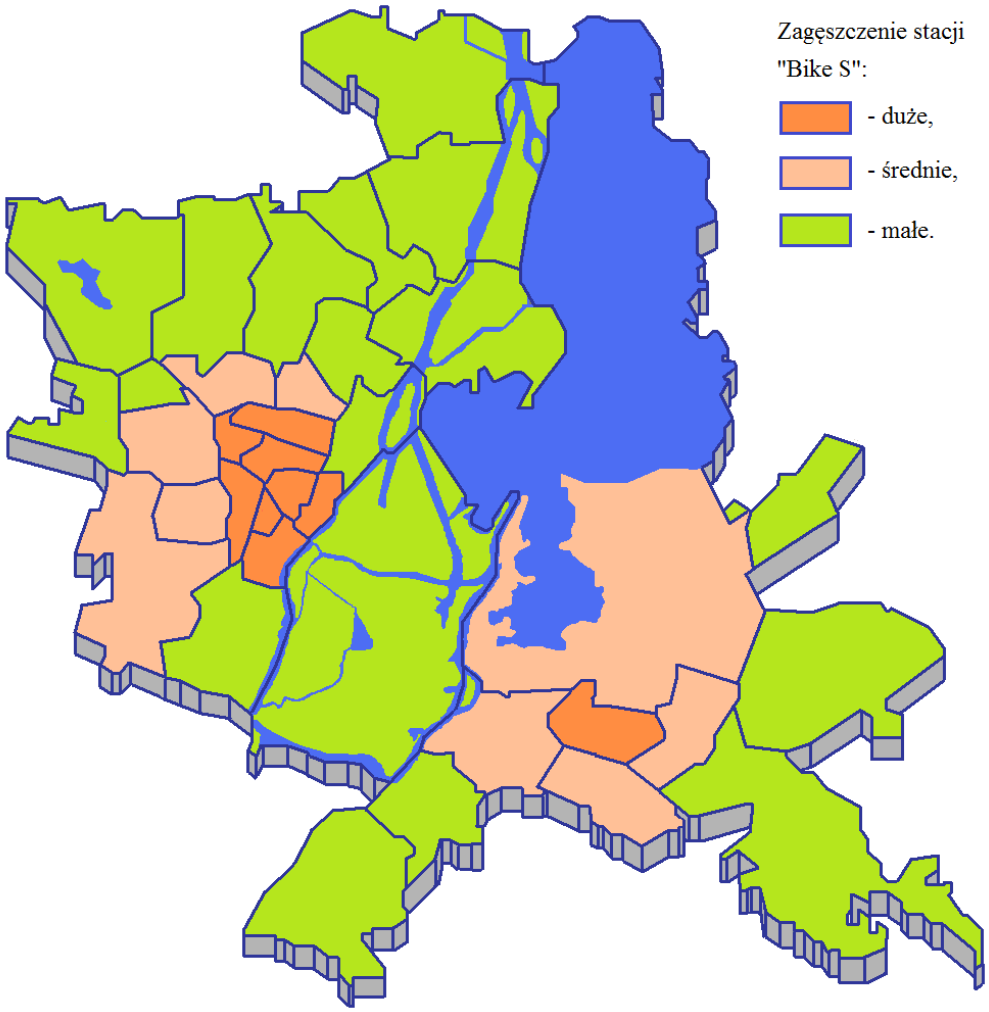
The urban structure of Szczecin is characterized by a bipolar system, because on both sides of the Odra strong urban centers were formed. Their development determines the quality of transport connections, which has been an unresolved problem for many years. While in terms of external communication, conditioned by an extremely attractive geographical location, the agglomeration has a competitive advantage in the form of access to almost any means of transport, so its internal structure limits the territorial extent and a small number of bridge crossings. This requires an individual approach also in terms of the development of bicycle traffic, which operates independently of each other within the right and left-bank districts. The situation has not been improved by the completion of the bicycle path linking both parts of the city (section from Panieńska Street to Cłowe bridge), because a lot of design and implementation errors were made during the planning and construction of this investment [14]. As a result, the route does not guarantee safe passage, which is undoubtedly influenced by such factors as: poor condition of the surface, numerous breakthroughs, passage through tracks and departures from the property, local sand, improper marking (Figures 1, 2). Its course is burdensome for users, as it requires overcoming very steep climbs, bypassing illegally parked cars and using sections adjacent to a noisy, multi-lane communication artery. In addition, a ride through Międzyodrze / Wyspa Pucka, which is a typical port and industrial estate, is basically devoid of any landscape values and tourist attractions. The above considerations make the bicycle is not a viable alternative to other transport means, the more so because fast and convenient connections with the right bank are provided by Szczecin Rapid Tram (SST).

1. Silting of bike lane (Międzyodrze / Wyspa Pucka)
Source: own study

2. Exposed sewer manholes and asphalt defects (Międzyodrze / Wyspa Pucka)
Source: own study

The development of two autonomous centers became even more noticeable after 2014, when the "Bike-S" Szczecin City Bike (SRM) project was launched. The system is operated by the Real Estate Company and Local Fees in cooperation with a specialized external company. To date, 83 stations have been commissioned, the vast majority located in the city center and its immediate vicinity (Figure 3) [5]. This does not mean, however, that the right-bank points are less popular, as some of them are in the lead in terms of the number of loans,

eg Iwaszkiewicz - Andrzejewski, Pętla Słoneczne - Łubinowa, CH Słoneczne, Jasna Osiedle, Dąbska - Gwarna [7]. The SRM interest is so high that at certain times of the day the demand is much higher than the supply (figure 4). This is in the opinion expressed in the study [14] that this part of Szczecin had much less potential to use the bicycle as a means of transport. For several years, apart from housing, it has fulfilled all the basic functions: administrative, commercial, service, healthcare, and recreation and tourism. In addition, the growing number of factories and manufacturing companies means that for many people the left-bank center has ceased to be an essential destination.



3. Concentration of the "Bike-S" Szczecin City Bike Station
Source: own study based on [5]

4. The unmanned loan station SRM "Dąbska - Gwarna" (Right Bank)
Source: own study

The popularity of SMR "Bike-S" consists of many aspects. Szczecin has a very good situation in terms of climatic conditions, as the average annual temperature is higher than in other Polish cities [15]. The location of the area, surrounded by large forest complexes and water reservoirs, manifests itself in the form of a relatively mild winter and moderately hot, humid summer [13]. The agglomeration is effectively sheltered from the winds, because from the north-west it is protected by the Uplands of Szczecin, and to the south by the Bukowe Hills. At the same time, the elevation of some settlements is a natural barrier to the promotion of two-wheeled vehicles (Warszewo, Bukowo, Osów, Książąt Pomorskich, and Żelechów) [14]. It is also worth emphasizing that due to the area occupied, and thus long distances to overcome, the bicycle cannot be treated as a substitute for other means of transport, but rather to supplement them. For this reason, many stations are located directly next to car parks and public transport terminal loops (Figure 5). Depending on the location, access to them provides various forms of traffic organization: integrated with the car, road strips, and bicycle counter strips in the roadway as well as separate paths and roads outside it [11]. From the point of view of security, the most favorable solution seems to be the last one, but their construction is not always possible. Therefore, an indirect solution was used in the strict city center, assuming that the reliable speed of motor vehicles will be within 30-50 km/h. Unfortunately, the problem remains high traffic, especially along national and provincial roads, related to the transit of heavy goods vehicles to the state border and one of the largest employers in the region, namely Grupa Azoty Zakłady Chemiczne in Police. An example can be the belts separated in Piłsudzkiego avenue (DW 115) and in Piastów avenue (DK 10 and 13) (Figure 6).

5. SRM station near the bus terminus "Zwierzyniecka" (Right Bank)
Source: own study

6. Bike lane in the roadway (Piastów avenue, Śródmieście-Zachód)
Source: own study

The data presented in Table 1 shows that the total length of bicycle routes in Szczecin is 126.6 km [6]. Attention is drawn to the marginal role of quiet traffic zones, which occur very rarely and do not play any role in the promotion of the discussed mode of transport. However, the most troublesome issue for users is the lack of network integrity, as its course does not create a single, continuous communication system. This restricts access to many destinations, as there is also a lack of improvements for cyclists in regular traffic, and the saturation of the surroundings with elements of cycling infrastructure is insufficient. In addition, its condition

is not of the best quality both in terms of design (Figure 7) and maintenance in good condition. This applies not only to peripheral and access routes, but also located within central districts [1],[14]. It should be noted that after a few years even the most-visited paths become non-functional and, in principle, useless, which results from their natural wear, acts of vandalism and the destructive action of nature.

Tab. 1. The length of bicycle routes in Szczecin at the end of 2016

No.	Description	Lenght [km]
1	Roads for bicycles	96,1
2	Walking and cycling routes	10,8
3	Bike lanes	13,1
4	Sidewalks with authorized bicycle movement	4,2
5	Streets of calmed traffic (speed below 30 km/h)	2,4

Source: own study based on [6]

7. Sewer manholes on the cycle path (Struga Andrzeja Street, Right bank)
Source: own study

Bicycle traffic safety

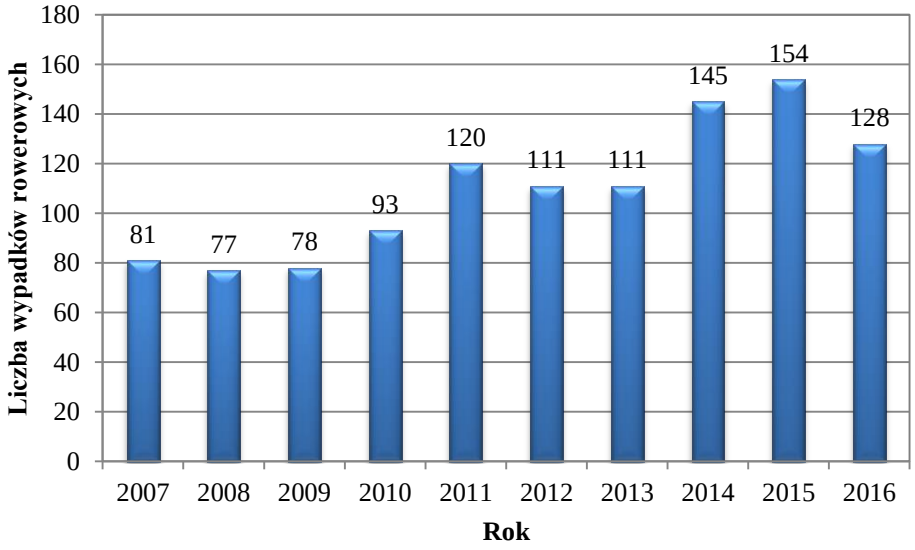
In 2007-2016, 1098 road accidents involving cyclists were registered within the administrative borders of Szczecin [8]. Analyzing the data presented in Figure 8, it can be seen that the number of accidents and collisions is characterized by an upward trend. This is undoubtedly related to the increasing popularity of this mode of transport, as well as the growing ecological awareness of residents who are gradually changing their communication preferences. However, linking this unfavorable statistic with the launch of the "Bike S" SMR system is very difficult, as in the third season of its operation a result similar to 2011 was recorded. However, from a safety point of view, the imperfections and shortages in the bicycle infrastructure that force vehicle users two-track to use the road and street network. As a result, the vast majority of incidents occurred directly on the road (table 2). In turn, marginal ones should be those that have occurred, among others at: public transport stops, rail and tram crossings, tracks, roadsides, engineering structures (bridges, viaducts, trestles, tunnels, etc.).

Tab. 2. Specification of road occurrence

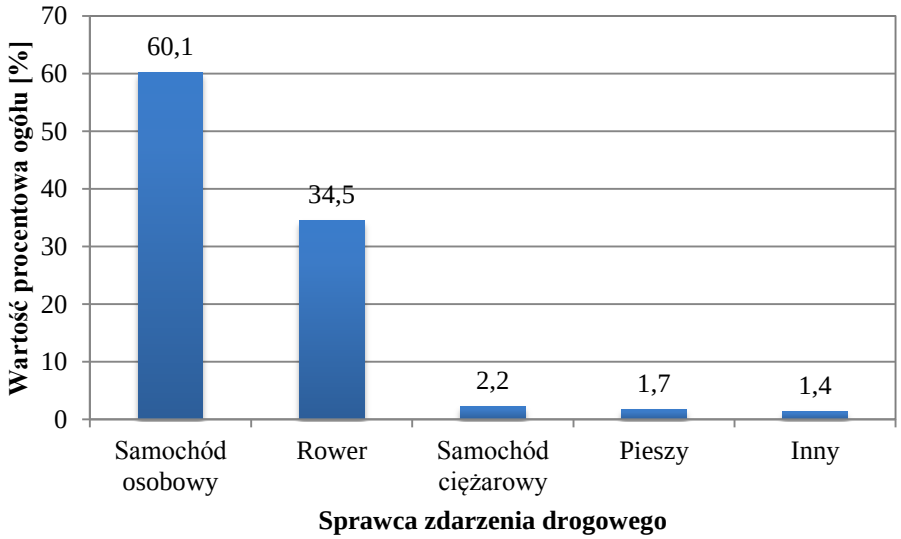
No.	Description of the place	Number	Percentage of total [%]
1	Road	653	59,5
2	Road for cyclists	174	15,8
3	Pedestrian crossing	101	9,2
4	Pedestrian road, sidewalk	88	8,0
5	Entry / exit from the property	38	3,5
6	Road, lane, sluice for bicycles	16	1,5
7	Parking, maneuvering area	11	1,0
8	Passage for cyclists	6	0,5
9	Other (altogether)	11	1,0

Source: own study [8]

The most common perpetrators of accidents were drivers of passenger cars (Figure 9). Because in almost two thirds cases no priority was given to traffic, it should be concluded that they probably did not expect cyclists on the road. Subsequently, the most frequently committed road offenses included incorrect maneuvers: crossing over pedestrian and bicycle crossings, turning, overtaking, reversing, changing lanes. These reasons may also indicate a disrespectful attitude towards users of two-wheelers who are not always treated as full-fledged participants in the traffic. Usually, however, the collision occurs due to lack of knowledge of regulations, inattention and / or insufficient visibility. An example can be a particularly dangerous right turn because a motorized driver has to give way to an oncoming cyclist, and at the same time has a very limited field of view. It is also worth emphasizing that the vast majority of incidents occurred in the city center, i.e. space characterized by the largest transport load (streets: Ku Słońcu, Wojska Polskiego, Aleja Poprze Jana Pawła II, Jagiellońska, Mieszka I, and Mickiewicza). This indicates not only the number of separate bicycle paths and routes in the area of Śródmieście and nearby administrative districts (Turzyn, Gumieńce, Niebuszewo Bolinko, Łękno, and Pomorzany) but also insufficient improvements for cyclists in street traffic. An additional issue is a congestion, contributing to increasing the pressure and frustration, and even aggressive behavior of car drivers in relation to those users who are not affected by these problems [17],[18].



8. Number of bicycle accidents in Szczecin in 2007-2016
Source: own study based on[8]



9. Perpetrators of road accidents involving cyclists
Source: own study [8]

Summary
In accordance with the assumptions presented in the Study of conditions and directions for spatial development of the city of Szczecin [19], bicycle routes are to have a coherent system, which will consist of strings connecting the place of residence with public buildings, as well as those of a recreational and tourist nature. In the central areas, for each newly built or modernized road, the required infrastructure is expected, unidirectional streets are opened for the movement of two-wheeled vehicles in both directions, the introduction of traffic calming zones or the use of friendly traffic lights. The construction of pavement made of bituminous masses instead of concrete blocks was also taken into account, as well as elimination of architectural barriers, e.g. dangerous downhills and watercourses, high curbs, power poles [15],[19]. However, the plans described are implemented in stages, in long-term periods and do not take into account all the needs of residents. This also applies to recently completed investments, which have been allocated significant financial resources and have significant

deficiencies in this regard. An example is the first "Park&Ride" type parking at the Hangar stop, allowing you to leave the vehicle and access the left-bank center thanks to SST. Unfortunately, it is completely inaccessible to cyclists, because no stand is available. They were installed only on the Turkusowa loop, but they are not used due to lack of monitoring. These dysfunctions in the technical infrastructure and the backwardness in the implementation of new projects negatively affect the security and popularization of this mode of transport, which could eventually fill the gap in the organization of travel modes. This is undoubtedly demonstrated by the unmatched success of the SRM "Bike-S" system, a socially acceptable project that enjoys an avalanche increase in users. It is also worth noting that in urban conditions the bike is the fastest means of moving on sections up to 6 km, which for many users is one of its greatest advantages [21].

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