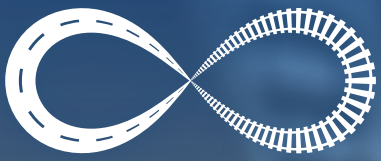

CETRA 2018

5th International Conference on Road and Rail Infrastructure
17–19 May 2018, Zadar, Croatia

Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR

IRF GLOBAL

FEHRL

Organizer
University of Zagreb
Faculty of Civil Engineering
Department of Transportation

CETRA 2018
5th International Conference on Road and Rail Infrastructure
17–19 May 2018, Zadar, Croatia

TITLE
Road and Rail Infrastructure V, Proceedings of the Conference CETRA 2018

EDITED BY
Stjepan Lakušić

ISSN
1848-9850

ISBN
978-953-8168-25-3

DOI
10.5592/CO/CETRA.2018

PUBLISHED BY
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Kačićeva 26, 10000 Zagreb, Croatia

DESIGN, LAYOUT & COVER PAGE
minimum d.o.o.
Marko Uremović · Matej Korlaet

PRINTED IN ZAGREB, CROATIA BY
"Tiskara Zelina", May 2018

COPIES
500

Zagreb, May 2018.

Proceedings of the
5th International Conference on Road and Rail Infrastructures – CETRA 2018
17–19 May 2018, Zadar, Croatia

Road and Rail Infrastructure V

EDITOR
Stjepan Lakušić
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Zagreb, Croatia

CETRA 2018
5th International Conference on Road and Rail Infrastructure
17–19 May 2018, Zadar, Croatia

ORGANISATION

CHAIRMEN

Prof. Stjepan Lakušić, University of Zagreb, Faculty of Civil Engineering
Prof. emer. Željko Korlaet, University of Zagreb, Faculty of Civil Engineering

ORGANIZING COMMITTEE

Prof. Stjepan Lakušić
Prof. emer. Željko Korlaet
Prof. Vesna Dragčević
Prof. Tatjana Rukavina
Assist. Prof. Ivica Stančerić
Assist. Prof. Maja Ahac
Assist. Prof. Saša Ahac
Assist. Prof. Ivo Haladin
Assist. Prof. Josipa Domitrović
Tamara Džambas
Viktorija Grgić
Šime Bezina
Katarina Vranešić
Željko Stepan
Prof. Rudolf Eger
Prof. Kenneth Gavin
Prof. Janusz Madejski
Prof. Nencho Nenov
Prof. Andrei Petriaev
Prof. Otto Plašek
Assist. Prof. Andreas Schoebel
Prof. Adam Szeląg
Brendan Halleman

INTERNATIONAL ACADEMIC SCIENTIFIC COMMITTEE

Stjepan Lakušić, University of Zagreb, president
Borna Abramović, University of Zagreb
Maja Ahac, University of Zagreb
Saša Ahac, University of Zagreb
Darko Babić, University of Zagreb
Danijela Barić, University of Zagreb
Davor Brčić, University of Zagreb
Domagoj Damjanović, University of Zagreb
Sanja Dimter, J. J. Strossmayer University of Osijek
Aleksandra Deluka Tibljaš, University of Rijeka
Josipa Domitrović, University of Zagreb
Vesna Dragčević, University of Zagreb
Rudolf Eger, RheinMain Univ. of App. Sciences, Wiesbaden
Adelino Ferreira, University of Coimbra
Makoto Fujiu, Kanazawa University
Laszlo Gaspar, Széchenyi István University in Győr
Kenneth Gavin, Delft University of Technology
Nenad Gucunski, Rutgers University
Ivo Haladin, University of Zagreb
Staša Jovanović, University of Novi Sad
Lajos Kisgyörgy, Budapest Univ. of Tech. and Economics
Anastasia Konon, St. Petersburg State Transport Univ.
Željko Korlaet, University of Zagreb
Meho Saša Kovačević, University of Zagreb
Zoran Krakutovski, Ss. Cyril and Methodius Univ. in Skopje
Dirk Lauwers, Ghent University
Janusz Madejski, Silesian University of Technology
Goran Mladenović, University of Belgrade
Tomislav Josip Mlinarić, University of Zagreb
Nencho Nenov, University of Transport in Sofia
Mladen Nikšić, University of Zagreb
Andrei Petriaev, St. Petersburg State Transport University
Otto Plašek, Brno University of Technology
Mauricio Pradena, University of Concepcion
Carmen Racanel, Tech. Univ. of Civil Eng. Bucharest
Tatjana Rukavina, University of Zagreb
Andreas Schoebel, Vienna University of Technology
Ivica Stančerić, University of Zagreb
Adam Szeląg, Warsaw University of Technology
Marjan Tušar, National Institute of Chemistry, Ljubljana
Audrius Vaitkus, Vilnius Gediminas Technical University
Andrei Zaitsev, Russian University of transport, Moscow

CETRA 2018 17–19 May 2018, Zadar, Croatia
5th International Conference on Road and Rail Infrastructure

ANALYSIS OF REASONS OF ACCIDENTS BETWEEN CYCLISTS AND PUBLIC TRANSPORT VEHICLES IN CITIES

Marek Bauer[1], Wiesław Dźwigoń[1], Romanika Okraszewska[2]
[1] *Cracow University of Technology, Poland*
[2] *Gdansk University of Technology, Poland*

Abstract

In European cities, a bicycle is now or is systematically becoming an equal means of transport. Unfortunately, the growth of bicycle traffic is associated with an increase in the number of accidents involving cyclists. Some of these accidents, are events with cyclists and public transport vehicles – and therefore means of transport, which together are to constitute a serious alternative to a car. Although the share of these kind of accidents is relatively small – each such event has a very negative impact on the perception of ecological forms of transport. The paper discusses types of events between cyclists and public transport vehicles, with the identification of dangerous behaviours of cyclists and drivers. The most frequent reasons of these events are discussed, taking into account the places of occurrence of accidents, type and condition of bicycle and public transport infrastructure and types of behaviours of traffic participants. The research part of the paper presents statistical analyses of the number of accidents between cyclists and public transport vehicles, as well as statistics describing the number of victims in accidents in the six largest Polish cities. Based on detailed descriptions of events – using statistical tools – accidents were analysed in terms of identifying the most important reasons of their occurrence and circumstances conducive to the occurrence of accidents. The article was crowned with the recommendations for the application of solutions reducing the risk of accidents.

Keywords: sustainable transport, cycling, public transport, safety, accident

1 Introduction

The high share of car trips is the cause of the occurrence of congestion states with an increasingly large spatial and temporal range. The larger the city – the global effects of car traffic are more pronounced, as the number of trips made by the entire population in cities still increases [1]. The problem concerns in particular inner-city areas and transportation corridors leading directly to the city centres, where there is a strong concentration of trip destinations, especially during morning and afternoon periods. The situation is not sustained by the further development of road systems, which, despite incurring considerable financial and social outlays – most often only brings short-term relief [2]. Since the extension of cross sections of streets is often not possible, it is necessary to change the transportation behaviours of at least some users of the transport system [3]. To make this possible, it is indispensable to provide the infrastructure that will encourage the exchange of the car into other means of transport, that use the available space in a more efficient way: urban public transport [4] and bicycle transport [5]. The result will be a positive change in modal split [6], especially in inner-city areas. This is also the case in Polish cities [7]. However, a greater number of cyclists and public transport vehicles on the streets will increase the probability of dangerous situations between

these two groups of users. Some of these situations – unfortunately, will result in accidents. Therefore, it is crucial to appreciate the causes of accidents and look for effective solutions that will be conducive to reducing the number of accidents, and if they will be – limiting the effects of such accidents. This issue has already been discussed – among others – in papers [8], [9] and [10]. In Poland, this subject was usually skipped, because by far the most accidents involving cyclists are related to the individual car traffic [11]. However, the problem is very important, because any such accident has a negative impact on the perception of cycling and public transport [12]. It is also a frequent argument against increasing the role of the bicycle in servicing the city. This article is an analysis of road accidents between cyclists and urban public transport vehicles: trams, trolleybuses and buses – in the largest Polish cities.

2 Methodology

An accident is usually the result of several causes, the most important of which are related to single decisions made by road users [13]. Additional, external causes including, e.g. the condition of the infrastructure – may be less important, provided that the public transport drivers and cyclists are fully aware of their behaviours. The paper uses the database of road accidents from the Police Accident and Collision Register System (SEWIK) from the period 2011-2015, made available by The Polish National Police for the organisation: Cities for the Bicycles [14]. The SEWIK database makes it possible to determine the following characteristics of accidents involving cyclists and urban public transport vehicles:

- general data of the accident (date, time of day in which the accident occurred),
- location of the accident (geographical coordinates, street name, type of infrastructure (street section, junction, separated cycling route, bicycle lane, sidewalk, tram crossing, bicycle and pedestrian crossing, etc.),
- speed limit,
- weather conditions (good conditions, cloudy, rainfall, snowfall, fog, blinding sun,
- human factors (age, gender, consumption of alcohol),
- the causes of the accident (kind of behaviours: failing to yield the right of way, entry at the red-light, failure to observe other signals, failure to secure distance between vehicles, non-adjustment of speed to traffic conditions, incorrect changing the lane, incorrect drive the pedestrian crossing or the bicycle crossing, improper overtaking, improper driving past, improper turn, violent braking)
- consequences of accident (death, serious injury, slight injury).

The analysis includes only the largest Polish cities in terms of the number of inhabitants. These are: Warsaw (1754K inhabitants), Krakow (765K), Lodz (697K), Wroclaw (638K), Poznan (540K) and Gdansk (464K) – however, in this last case, Gdynia and Sopot were also included, which together with Gdansk form a polycentric metropolitan area, officially referred to as the Tricity (748K inhabitants in total) [15]. In all six cities, besides the bus transport, there is tram transport, and additionally, in the Tri-City – also trolleybus transport. Unfortunately, in none of the analysed cities the share of the bicycle trips has exceeded the barrier of 10 %. The closest is Gdansk, which is considered a city with the best bicycle infrastructure in Poland. For now, this results in 6 % of bicycle trips on an average working day.

3 Results

In the years 2011-2015, in the analysed cities, a total of 272 accidents of cyclists with public transport vehicles were registered (Figure 1). One can see an increase in the total number of accidents in the analysed period, which also transfers into an increase in the number of slightly and seriously injured. However, the number of killed is so small, that it is difficult to notice the regularity – the year 2013 was particularly cruel (Figure 2).

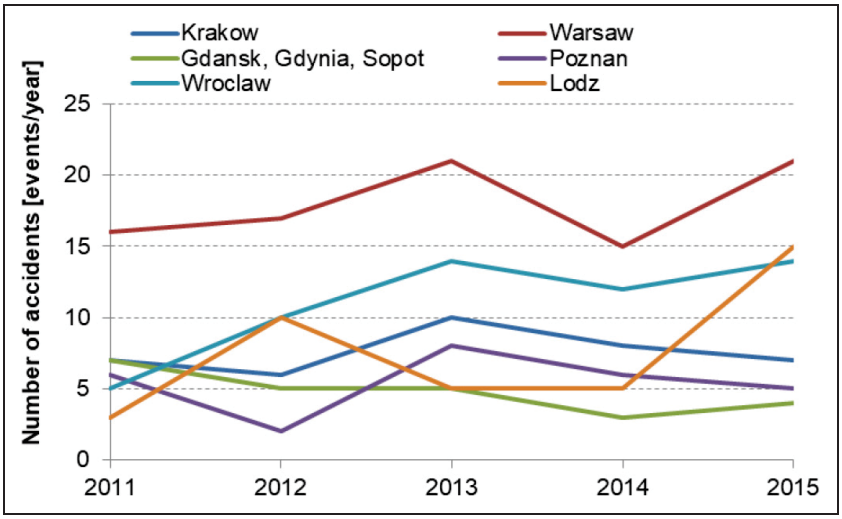

Figure 1 Number of accidents between cyclists and urban public transport vehicles in six Polish biggest cities (2011-2015)

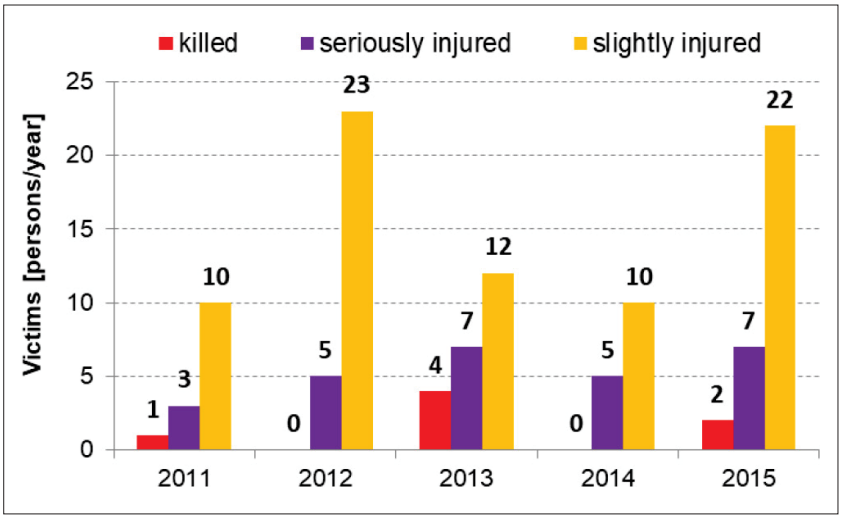

Figure 2 The structure of victims in road accidents between cyclists and public transport vehicles in six Polish biggest cities (2011-2015)

Because in all six analysed cities the number of buses in the network (as well as the number courses operated by buses) is higher than in the case of trams, it is not surprising, that more bicycle accidents concern buses. However, the situation in terms of victims is completely different. Mortality in accidents with trams is twice as high (over 4 %) than in case of buses. In addition, to as much as 14 % of such accidents results serious injuries (Table 1). In turn in cases with accidents with buses, one can notice a slightly higher percentage of slightly injured people.

Table 1 The effects of accidents between cyclists and vehicles of urban public transport, in the analysed cities (six biggest Polish cities, 2011-2015)

Measure	Total number of accidents and victims [-]			Mortality (killed, injured per accident) [%]		
	Bike vs Tram	Bike vs Bus	Bike vs Tram or Bus	Bike vs Tram	Bike vs Bus	Bike vs Tram or Bus
Accidents	96	176	272	-	-	-
Killed	4	3	7	4.2	1.7	2.6
Seriously injured	14	13	27	14.6	7.4	9.9
Slightly injured	24	53	77	25.0	30.1	28.3

The literature shows that most accidents take place in warm months, which is associated with more cyclists on city streets (e.g.: [16]). Similarly in the cities studied, however, only in February there was no accident recorded over 5 years (Figure 3).

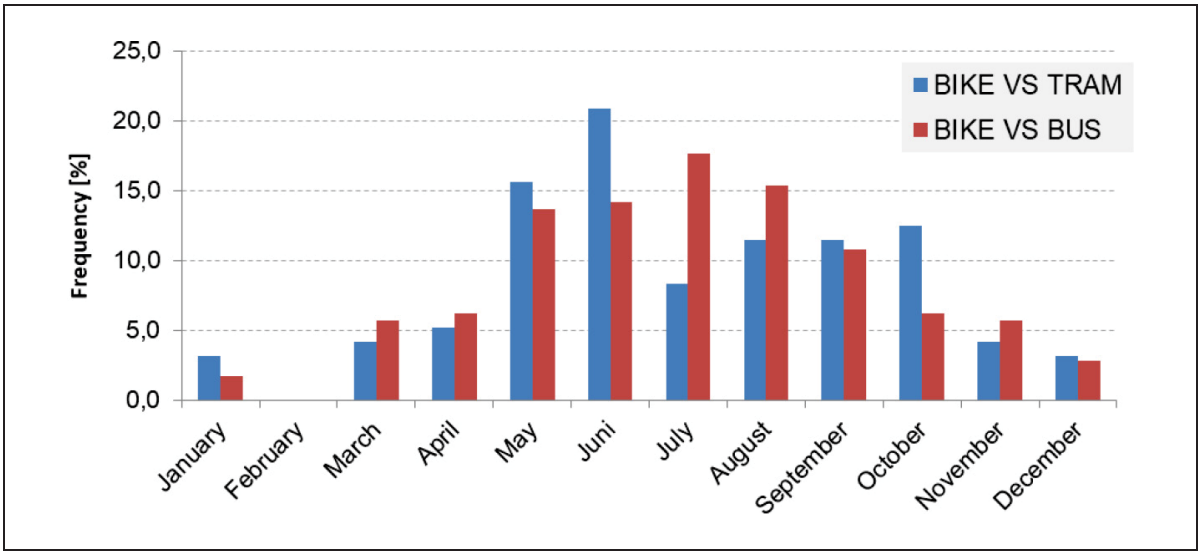

Figure 3 The yearly structure of accidents between cyclists and public transport vehicles in six Polish biggest cities (2011-2015)

It is also interesting, that 89 % of analysed accidents happened on weekdays, 85 % took place in a daylight, and additionally: 83 % happened in good weather conditions. This is confirming, that many accidents result from wrong decisions made by traffic participants. The cyclists made more mistakes. They were responsible for a total of 69 % of accidents with urban public transport vehicles. However, there is a very strong disproportion between accidents with trams and buses. Tram drivers were responsible for 15 % of accidents while bus drivers – for 40 %, which may be surprising, because they are professional drivers. The figures below present a comparison of reasons of accidents caused by cyclists (Figure 4) and public transport drivers (Figure 5).

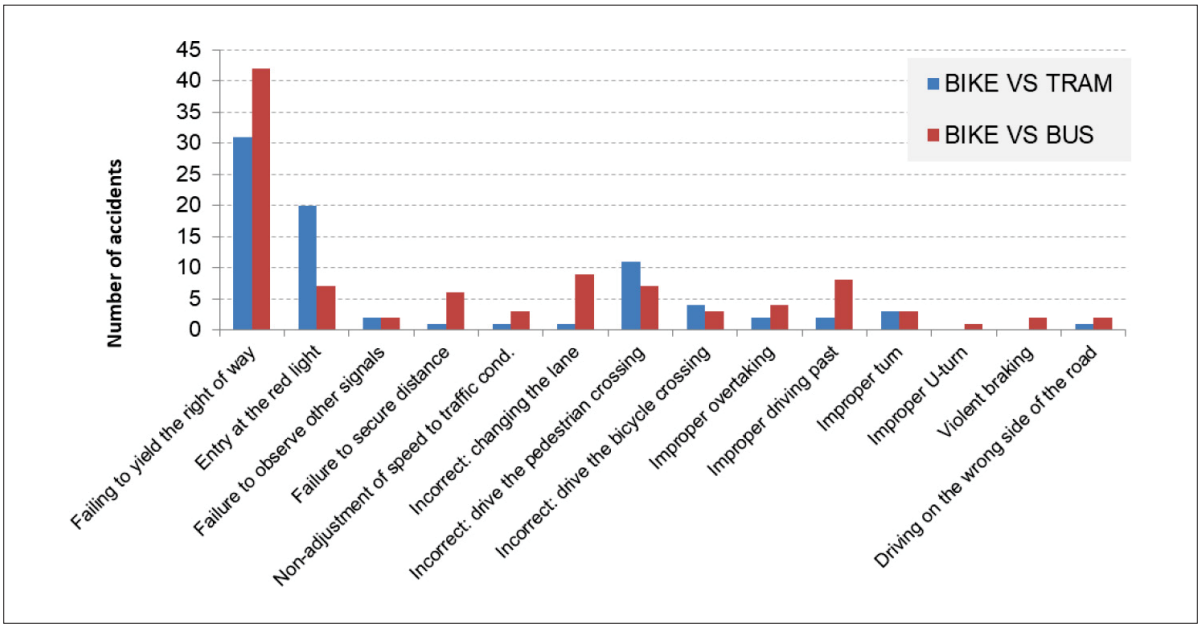

Figure 4 Reasons of accidents between cyclists and public transport vehicles caused by cyclists, in analysed cities (2011-2015)

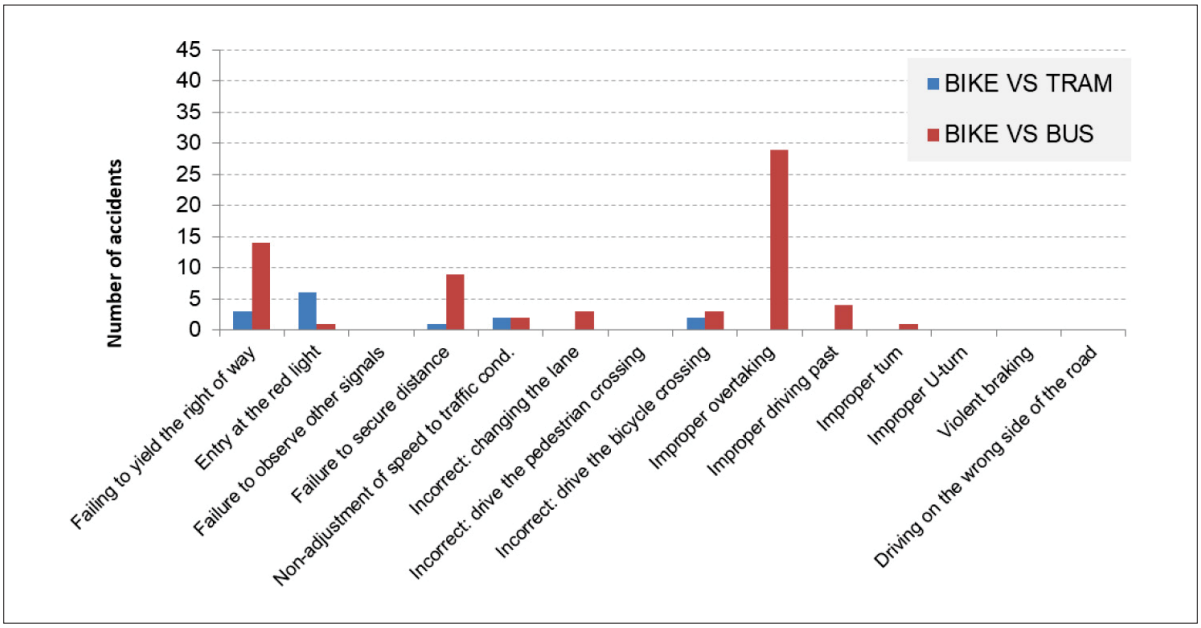

Figure 5 Reasons of accidents between cyclists and public transport vehicles caused by public transport drivers, in analysed cities (2011-2015 (2011-2015)

In the case of cyclists, there are two main reasons: failing to yield the right of way and entry at the red light – connected with poor assessment of the situation at the junctions. As much as 39 % of accidents with trams and 42 % of accidents with buses, result from failure to keep the right of way, another 25 % of accidents with trams take place during the entry of cyclists at a red-light. The trams drivers caused only 14 accidents, the most – 6 (43 %) through by entry at the red-light. In turn, the most common cause of accidents caused by bus drivers was incorrect overtaking of cyclists – 29 accidents (44 %). Unprotected participants of the traffic stand in a lost position in the clash with heavy public transport vehicles. However, the aspect of victims among public transport passengers is often underestimated. In table 2, the structure of the victims was presented.

Table 2 The structure of the victims of accidents (six Polish cities, 2011-2015)

Measure	Victims in the group of cyclists			Victims in the group of public transport passengers		
	Bike vs Tram	Bike vs Bus	Bike vs Tram or Bus	Bike vs Tram	Bike vs Bus	Bike vs Tram or Bus
Killed	4	3	7	0	0	0
Seriously injured	13	9	22	1	3	4
Slightly injured	21	27	48	2	24	26

The fatalities were only on the side of cyclists, in the case of seriously injured – it was 85 %, whereas among slightly injured – 65 %. Particularly, the last value shows, that there is a serious problem to be solved. So far, discussions have focused mainly on ways to reduce the number of victims in the group of unprotected road users. This is due to the fact that the most frequent accidents of cyclists concern private cars. In the case of urban public transport vehicles, there is a completely different kind of victims – these are mainly people suffering injuries as a result of sudden braking of the vehicle.

4 Solutions

Obtained results clearly indicate, that accidents of cyclists with trams occur mainly within junctions with traffic signals and tram crossings. It is therefore necessary to increase the attention when designing these places, especially in terms of geometry and visibility. The general education of cyclists is also of great importance, especially in the heyday of this mode of transport. Particular importance should be attached to the issue of compliance with yield the right of way and respecting traffic lights, especially since the effects of accidents with trams are characterized by high mortality.
A slightly more complex issue is the improvement of safety in the case of bike-bus accidents. As many as 80 % of these accidents take place on the roadway. The most effective solution is separation of bicycle routes, outside the roadway. A shared bus-bike lanes are also implemented, but they do not eliminate frequent cases of overtake the cyclists by buses – in practice they can be safely used only at relatively low public transport traffic volumes or in the areas with limited accessibility for private cars. In addition, the effects of the bus-bike lanes operation are not evident. On the one hand, they can help increase the safety of cyclists on multi-lane roadways, and on the other – they usually cause additional losses of time for public transport passengers. Another solution, is to lower the speed limit on streets of lower classes, so that cyclists can safely ride the roadway and at the same time they are not overtaken.

5 Conclusions

The problem of accidents involving cyclists and urban public transport vehicles is becoming more and more important, not only in Polish cities. General tendencies in European cities are aimed at reducing car traffic in inner-city areas. Travel by car is being replaced by public transport, and for smaller distances – by bike. The actions of municipal authorities must aim at providing high quality infrastructure for cyclists and urban public transport, ensuring on the one hand: a high level of safety, and on the other: a high level of functionality of the solutions used. However, the unnecessary bike competition with public transport should be avoided. One can not do this without identifying the causes of accidents between the analyzed groups of traffic participants.
Further research will lead to build a model of risk accident's between cyclists and urban public transport vehicles, that could support the planning and designing process of transport infrastructure.

References

[1] Stefanello, F., Buriol, L.S., Hirsch, M.J., et al.: On the minimization of traffic congestion in road networks with tolls, Annals of Operations Research, Vol. 249, Issue 1-2, 2017, pp. 119-139, doi: 10.1007/s10479-015-1800-1

[2] Pojani, D., Stead, D.: Sustainable Urban Transport in the Developing World: Beyond Megacities, Sustainability 7(6), 2015, pp. 7784-7805, doi:10.3390/su7067784

[3] Okraszewska, R., Romanowska, A., Wołek, M., Oskarbski, J., Birr, K., Jamroz, K.: Integration of a multilevel transport system model into sustainable Urban mobility planning, Sustainability, vol. 10, no. 2, 2018.

[4] Camargo Perez, J., Carrillo, M.H., Montoya-Torres, J.R.: Multi-criteria approaches for urban passenger transport systems: a literature review, Annals of Operations Research, Vol. 226, Issue 1, pp. 69–87, 2015.

[5] Urbanczyk, R.: PRESTO Cycling Police Guide, Promotion of Cycling. Ruprecht Consult GmbH, Germany, 2010.

[6] Heinen, E., Panter, J., Mackett, R., Ogilvie, D.: Changes in mode of travel to work: a natural experimental study of new transport infrastructure, International Journal of Behavioral Nutrition and Physical Activity, 2015.

[7] Okraszewska, R., Jamroz, K., Bauer, M., Birr, K., Gobis A.: Identification of Risk Factors for Collisions Involving Cyclists Based on Gdansk Example, Environmental Engineering 10th International Conference, Vilnius Gediminas Technical University, Lithuania, 27–28 April 2017, doi: 10.3846/enviro.2017.112

[8] OECD. 2016: The number of fatalities among cyclists in selected countries in years 1990 – 2015, www.stats.oecd.org, 25.02.2018.

[9] Cameron, I.C., Harris, N.J., Kehoe, N.J.S.: Tram-related injuries in Sheffield, Injury, Vol. 32, Issue 4, 2001, pp. 275–277, doi: 10.1016/S0020-1383(00)00196-0

[10] Marti, C.M., Kupferschmid, J., Schwertner, M., Nash, A., Weidmann, U.: Tram Safety in Mixed Traffic, Best Practices from Switzerland, Transportation Research Record, Vol. 2540, 2016, pp. 125-137, doi: 10.3141/2540-14

[11] Levulytė, L., Baranyai, D., Ádám Török, A., Sokolovskij, E.: Bicycles' Role in Road Accidents a Review of Literature, Transport and Telecommunication Journal, Vol. 17, Issue 2, 2016, pp. 122-127, doi: 10.1515/ttj-2016-0011

[12] Kaplan, S., Prato, C.G.: Them or Us: Perceptions, cognitions, emotions, and overt behavior associated with cyclists and motorists sharing the road, International Journal of Sustainable Transportation, Vol. 10, Issue 3, pp. 193-200, 2016.

[13] Levulytė, L., Baranyai, D., Török, A., Sokolovskij, E.: Bicycles' role in road accidents, a review of literature, Transport and Telecommunication, Vol. 17, no. 2, 2016, pp. 122–127, doi: 10.1515/ttj-2016-0011

[14] Police Accident and Collision Register System, www.sewik.pl, 20.12.2017.

[15] CSO, Methodology, Standards and Registers Department: Area and population in the territorial profile in 2017. Central Statistical Office, Statistical Information and Elaborations, Warsaw, 2017.

[16] Miranda-Moreno, L., Nosal, T.: Weather or Not to Cycle, Temporal Trends and Impact of Weather on Cycling in an Urban Environment, Transportation Research Record, Volume 2247, 2011, pp. 42-52, doi: 10.3141/2247-06