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## **ANALYSIS OF ROAD SAFETY IN THE CITY OF SOSNOWIEC IN THE PERIOD 2006-2016**

**Summary.** The article discusses the level of road safety in the case of the city of Sosnowiec. Traffic safety was compared over a 11-year period from 2006 to 2016. The data were obtained from the municipal police headquarters in Sosnowiec. The authors of this publication created a graphical presentation of traffic incidents with their participants and causes. Numerical data have been presented, and separated into road accidents and collisions as well as injured and fatalities. The age and sex characteristics of the perpetrators of road accidents were presented. The QGIS program was also used for the analysis, which allowed us to map the most dangerous intersections in Sosnowiec.

**Keywords:** road safety; road accidents; person injured; person killed.

### **1. INTRODUCTION**

Road accidents involving humans have occurred since the beginning of motorization. Some of the earliest victims were participants in car rallies at the end of the 19th century, with the main issue is recklessness, as well as low speeds achieved by the vehicles, improper road surfaces and the non-observance of the spectators and pedestrians [13,14,16,17]. The first

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road incident occurred just after the construction of a stream-driven vehicle in 1769. The designer and constructor Nicolas-Joseph Cugnot, while driving the car, hit a wall. The first event involving two vehicles took place in 1893, while, in Europe, in 1896, the first pedestrian fatality in a road incident was recorded [3].

The mobility indicator in Poland has been growing continuously for several decades, including in the city of Sosnowiec. In 2016, it amounted to 611 vehicles per 1,000 inhabitants [7]. More and more vehicles on the road have a negative impact on road safety, because road infrastructure is not adapted to such large numbers of vehicles. Additionally, there is a problem with the interlacing of streams with different structures. Transit traffic and external traffic are mixed with local and access traffic [4,15].

The analysis of road safety in the city is carried out to determine the critical points in the road network, which elements affect the occurrence of road events and how these factors change over time. You can also specify the most dangerous points on the streets of a city [4]. In this paper, it was decided to carry out such an analysis for the city of Sosnowiec in the period 2006-2016.

## 2. THE CONDITION OF SAFETY ON ROADS IN POLAND AND SILESIAN PROVINCE

According to [2], traffic safety it is a feature of the road transportation system, characterized as a condition in which there is no danger. A traffic accident is an incident that takes place in the area of a road, in which people are injured or killed. Meanwhile, a collision is an incident in which there are only financial losses [1,17].

Poland is poorly positioned in rankings comparing traffic safety in all EU countries [8]. From 2007 (excluding 2011), a decrease the number of traffic accidents can be observed. However, in 2016, this number rose again (Figure 1). A similar situation can be observed in the case of injured people [7]. The number of traffic incidents remains at a high level.

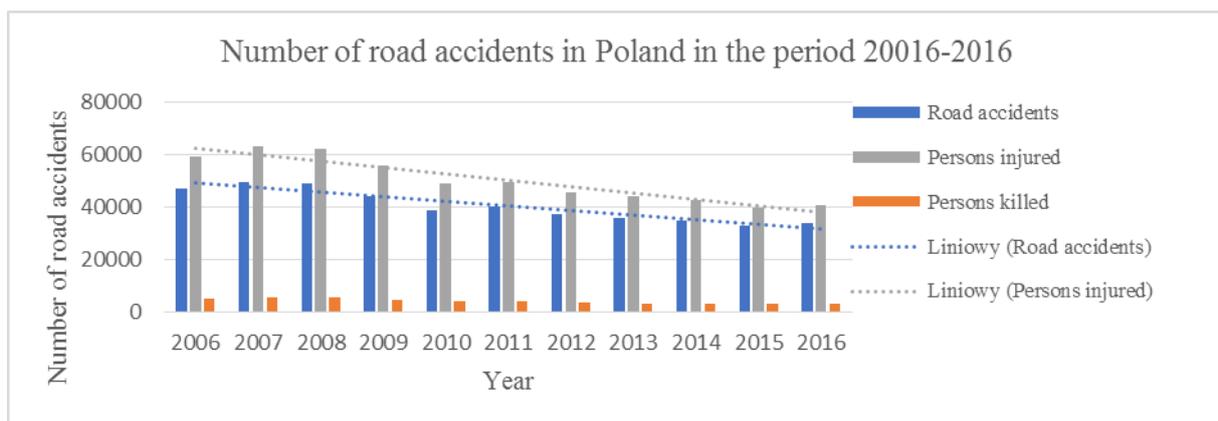


Fig. 1. Traffic accidents, injuries and fatalities in the period 2006-2016 in Poland [7]

In the Silesian Province, a decrease in the number of traffic incidents took place from 2007 (Figure 2); however, the number of incidents in 2011 was the same as in 2010. The number of people killed fell from 2007 to 2014, but, from 2014 to 2016, no further decline took place. The number of people injured, however, decreased consistently between 2007 and 2016 [7].

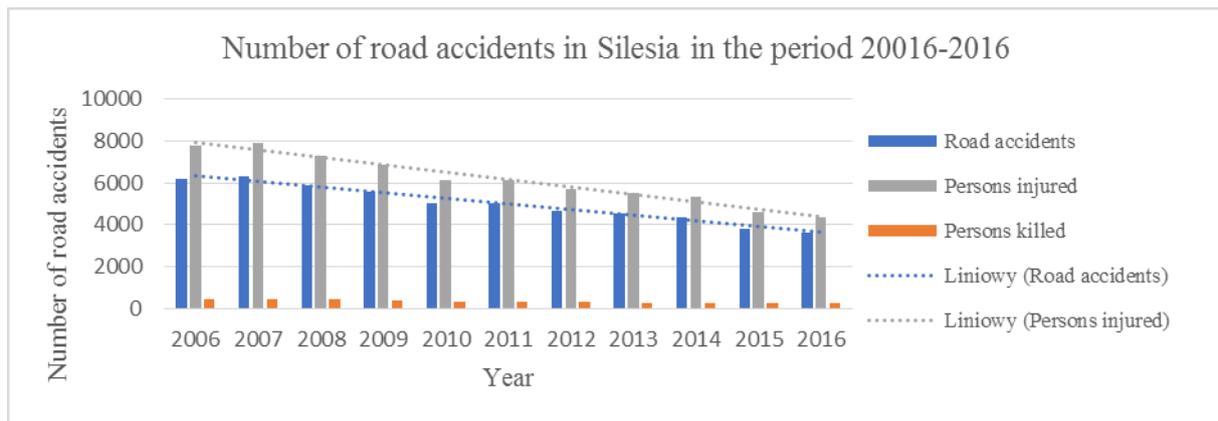


Fig. 2. Traffic accidents, injuries and fatalities in the period 2006-2016 in Silesia [7]

### 3. ROAD SAFETY SITUATION IN SOSNOWIEC FROM 2006 TO 2016

Every year between 2006 and 2016, in the city of Sosnowiec, 2,000 to 2,500 traffic accidents were recorded. A downward trend can be observed in the early years of this period (Figure 3). Since 2014, the number of road accidents has been increasing, and, in 2016, it was the highest in relation to the analysed period of time.

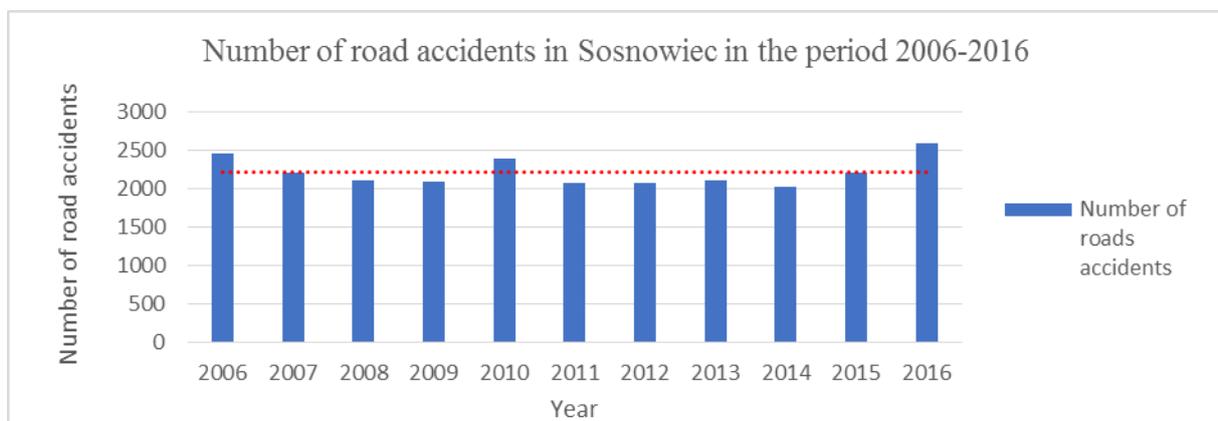


Fig. 3. Traffic incidents in the city of Sosnowiec in the period 2006-2016

In 2016, there were 199 road accidents on the streets of Sosnowiec, in which eight people died and 225 were injured (Table 1). Analysing data from 2015, the number of injuries has not changed, although the safety situation has deteriorated. The number of road traffic accidents and their participants was at a similar level to that in 2006.

In 2016, the number of accidents increased by 14 (an increase of 7%) compared to 2015. There was also, in the case of fatalities, an increase of 50%. However, the number of collisions increased by 383 (an increase of 16% compared to 2015).

Between 2006 and 2016, the average annual number of fatalities was more than 10, with eight victims below this average in 2016. The highest number of deaths occurred in 2007. In the same year, there were also the highest number of accidents and of injuries. The lowest number of road accidents and collisions was in 2013, while the lowest number of accidents

and fatalities occurred in 2015. 2009 was characterized by the lowest number of injured persons.

Table 1

Traffic incidents in the period 2006-2016 in Sosnowiec

Year	Number of incidents	Number of accidents	Number of deaths	Number of injured	Number of collisions
2006	2457	199	15	224	2,258
2007	2205	236	23	314	1,969
2008	2096	197	17	239	1,899
2009	2082	187	13	207	1,895
2010	2390	195	13	222	2,195
2011	2071	197	9	229	1,874
2012	2076	186	5	213	1,890
2013	2102	202	6	245	1,900
2014	2017	201	5	246	1,816
2015	2196	185	4	225	2,011
2016	2593	199	8	225	2,394

#### 4. ANALYSIS OF TRAFFIC INCIDENT CAUSES IN THE PERIOD 2006-2016 IN SOSNOWIEC

To counteract threats concerning road traffic, it is necessary to analyse the causes and culprits of traffic incidents. Therefore, it is essential to assemble data. In Poland, such analyses are based on traffic incident reports. However, data from these reports are not always comprehensive, so specific analyses are impossible. The problem also affect this research. Data received from the main police headquarters contain a large number of incidents, without information on which intersections they took place; this means there are no data about which streets are more prone to road accidents.

Figure 4 presents the number of traffic incidents and the main causes for the period 2006-2016 in the Sosnowiec area. The main reasons behind those incidents are speed non-adjustment due to traffic conditions (6,029 incidents) and not keeping a safe distance between vehicles (5,073 incidents). The least number of incidents (93) were caused by incorrect changes between road lanes. In the examined period, there were other factors not related to incorrect driver behaviours, with the most frequent cause being the poor condition of the roadway.

The main reason for traffic incidents between 2006 and 2016, in which 118 people were killed, was speed non-adjustment due to traffic conditions. Therefore, vehicle speed has a significant impact on the extent of participants' injuries during traffic accidents. This factor affects different traffic participants. For example, a pedestrian hit by a car at a speed of 50 km/h has less chance of survival than a pedestrian hit by a car at a speed of 30 km/h (Table 2).

Figure 5 presents the causes of traffic incidents in which no less than 10 people were killed. It can be observed that between three and five causes are related to pedestrians. This means that, during any traffic incident, unprotected traffic participants have the least chance of survival.

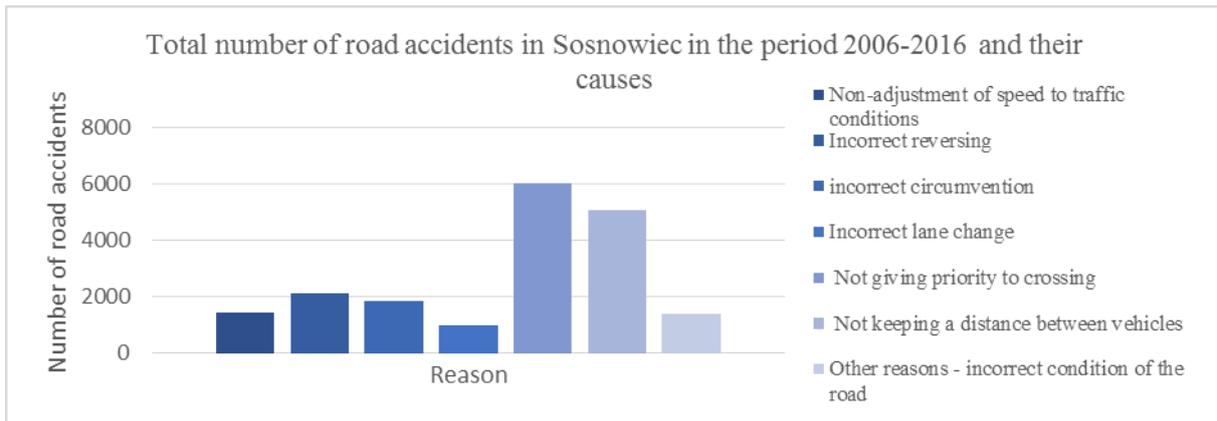


Fig. 4. Traffic incidents by cause in the period 2006-2016 in Sosnowiec

Table 2  
Probability of occurrence of the effects of an accident when the vehicle has been approached by a pedestrian

Velocity	Slightly injured	Heavily injured	A death victim
30 km/h	63%	29%	8%
40 km/h	40%	36%	24%
50 km/h	22%	39%	39%
70 km/h	-	14%	86%

Source: [1]

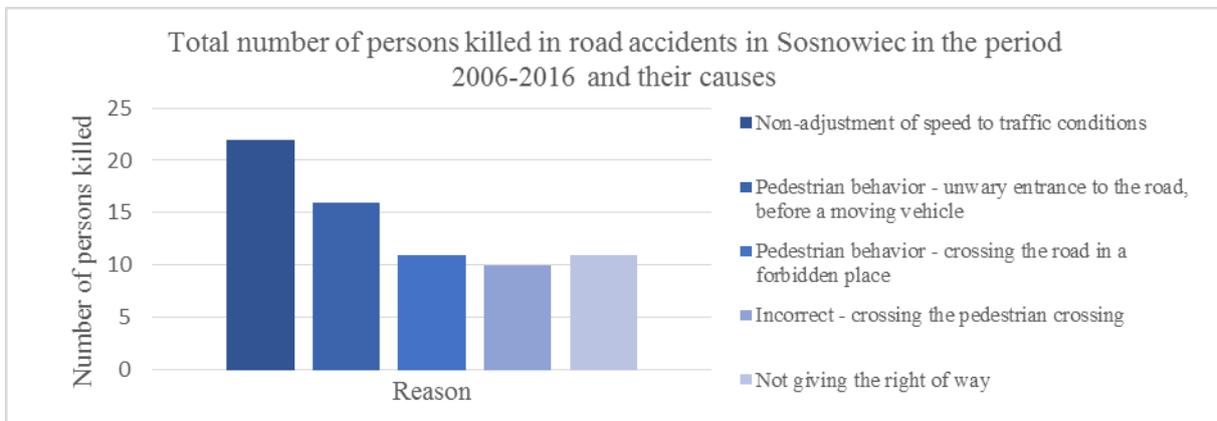


Fig. 5. Deaths by cause in the period 2006-2016 on the roads in Sosnowiec

Figure 6 presents the most frequently occurring causes of traffic incidents involving pedestrians. In 324 incidents, the main reason was carelessly running by a pedestrian onto the road in front of a moving vehicle, while the least amount of incidents was caused by crossing a road when the lights were on red for pedestrians.

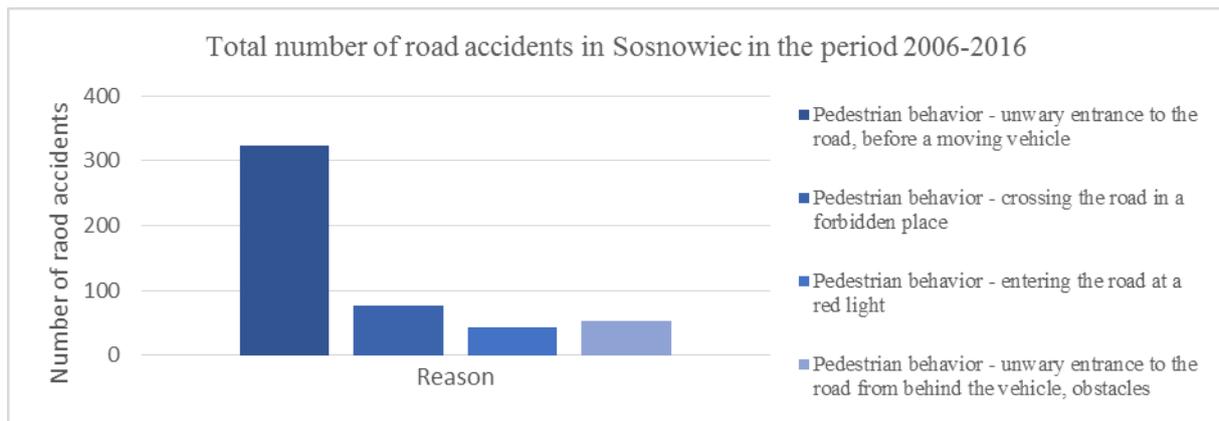


Fig. 6. Road incidents where pedestrians were at fault in the period 2006-2016 in Sosnowiec

## 5. ANALYSIS OF THE ROAD TRAFFIC PERPETRATORS IN THE PERIOD 2006 - 2016 IN SOSNOWIEC

On analysing the graph in Figure 7, it can be observed that, in the analysed period, the largest group of road traffic perpetrators comprised adults aged 25-39 years and 40-59 years. For all perpetrators, they accounted for 70% of the total. On the other hand, people aged 60 or over were responsible for 2,423 road accidents. Children and young people did not cause any traffic incidents.

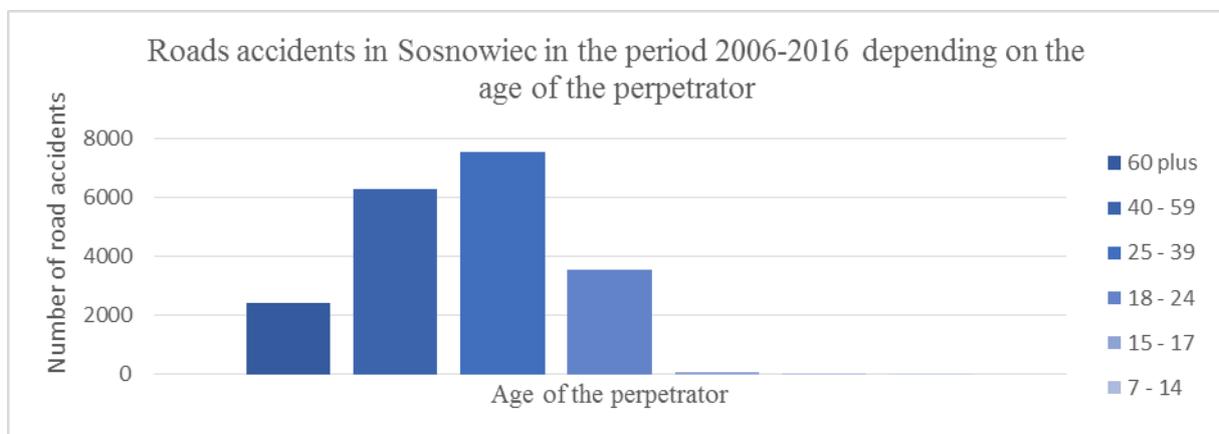


Fig. 7. Share of individual age groups in the occurrence of road incidents in the period 2006-2016 in Sosnowiec

The graph in Figure 8 shows the number of pedestrian perpetrators of road accidents in relation to their age. Analysing the situation, we can observe that the highest share (66% of road incidents) are caused by those in the 25 years and older range. It is surprising that, among children and young people up to 18 years of age, we can distinguish the seven to 14 years age group, which is characterized by the highest share of perpetrators of road accidents.

According to Figure 8, it can also be concluded that, during road accidents, more people were slightly or severely injured and a small number of people died. The most frequent fatalities in road accidents, where the perpetrator was a pedestrian, were people aged 60 or

over (14 people) and 40-59 (13 people). In the case of injured people, the largest number of participants was aged 40-59 (78 persons) and 25-39 (67 persons). The seven to 14 years age group also stands out, with 58 injuries.



Fig. 8. Number of traffic incidents and people injured or killed in road accidents where pedestrians were at fault in the period 2006-2016 in Sosnowiec

According to [7], in 2006, there were 117,588 women and 106,656 men in Sosnowiec, while, in 2016, there were 108,421 women and 97,452 men. In the period 2006-2016, there were 486 traffic incidents in Sosnowiec in which pedestrians were perpetrators. The analysis was based on gender (Figure 9) and shows that men have the largest share in terms of the occurrence of road accidents (333 cases). In the case of women, they are more likely to be victims (injured or fatalities) of road accidents.

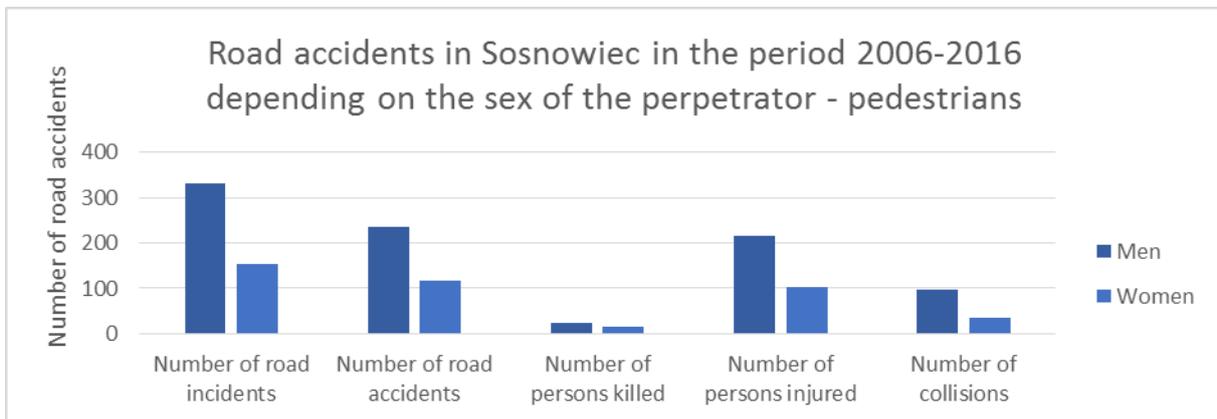


Fig. 9. Division of pedestrians - perpetrators of road accidents by sex in the period 2006-2016 in Sosnowiec

The division of road accidents by the sex of the perpetrator is presented in Figure 10. Men represent the largest group of the analysed case. Their share is four times higher than the share for women in road accidents. They dominate the group of those injured and killed in road accidents. In Sosnowiec, the number of men holding a driving licence is almost four times higher than that for women [7].



Fig. 10. Distribution of the perpetrators of road traffic incidents by sex in the period 2006-2016 in Sosnowiec

One of the macro indicators used to analyse road safety is the number of accidents per one million inhabitants  $W_m$  [1]:

$$W_m = \frac{W \cdot 10^6}{M} \left[ \frac{\text{accidents}}{\text{mln residents}} \right]$$

where:

M - the number of residents

According to the trend line, this indicator is slowly declining from year to year. This means that, despite the decreasing number of accidents (Figure 11), the demographic indicator is decreasing [7] and the probability that a resident of Sosnowiec will be a participant in road accident is increasing.

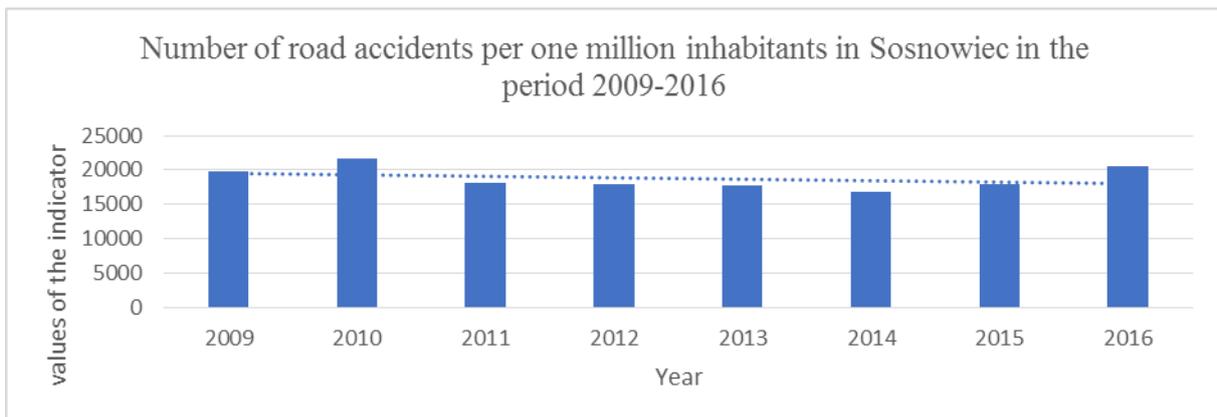


Fig. 11. Value of the  $W_m$  index for the residents of Sosnowiec in the period 2006-2016

The map in Figure 12 illustrates the locations of fatal accidents in the period 2006-2014, because, for 2015 and 2016, there are no data regarding the streets where deadly road incidents occurred. The highest number of accidents took place on National Road No. 94, near the border with the city of Dąbrowa Górnicza. At the intersection of General Mariusz Zaruski Street, 11 November Street, Mieroszewscy Brothers Street and Marshal Edward

Rydz-Śmigły Street, there were three fatal accidents. In the analysed period, an equal number of fatal accidents occurred on the S86 Expressway, which is one of the main access roads into Sosnowiec. Most individual accidents took place on 3 May Street (purple on the map in Figure 14) and near the city centre, which is coloured red on the map.

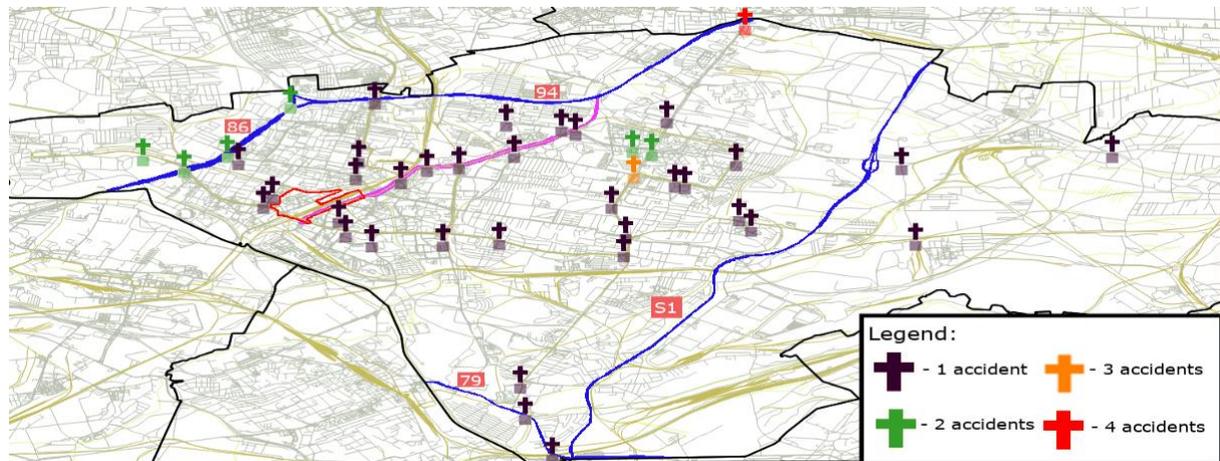


Fig. 12. Locations of fatal road accidents in the period 2006-2016 in Sosnowiec  
Source: Own elaboration with the help of the QGIS program

## 6. SUMMARY

Road safety in Sosnowiec can be assessed as unsatisfactory. The increase in the number of road accidents in 2016 is the highest in 10 years, during which there were 2,184 accidents, where 118 people were killed and 2,589 were injured. The reason for these road accidents is not so much the increase in the number of vehicles on the road as the human factor. In order to increase traffic safety, it is necessary to carry out comprehensive activities. The awareness of road users about the effects of careless driving and causing road accidents should be enhanced. The modernization of road infrastructure may also contribute to the elimination of dangerous places in road traffic [5]. These and other activities may have a positive impact on the reduction of road accidents and fatalities.

Based on the analysis of the state of road safety in Sosnowiec, we can distinguish pedestrian participants in road incidents in the age range of 40 to 59 years. These people, despite the fact that they have a high awareness of traffic regulations resulting from knowledge obtained in the course of education and life experience, are the main perpetrators of traffic accidents. The second main group of pedestrians, i.e., perpetrators and victims of road incidents, are children in the age range of seven to 14 years. According to [6], children over seven years of age may already be entering onto the road without being in the care of an adult. It is the responsibility of the parent or guardian to provide knowledge about the safe crossing of roads. Schools also have a large role to play here. However, children in this age range may be too carefree to learn the rules of road traffic.

Conducting similar analyses allows us to link causes with the number of accidents, and thus allows us to take actions aimed at preventing the occurrence of dangerous road accidents [1]. Furthermore, in further research, some important factors should be considered based on new solutions such as 3D navigation [9], autonomous vehicles [10] or new approaches to driver education [11,18].

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