

The analysis of safety on Polish roads between 2000 - 2010

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Abstract This article provides an assessment of the security situation on Polish roads. Statistical data on road accidents that occurred in different provinces in late 2000 - 2010 were analysed and the attention was drawn to the differences in the number of road accidents recorded between them. The analysis of accident statistics and the effects they had on particular provinces was made. They were presented for Świętokrzyskie province and compared to other provinces.

Keywords safety, accident, accident statistics

JEL R41 - Transportation: Demand, Supply, and Congestion • Safety and Accidents • Transportation Noise

1. Introduction

Each year tens of thousands of car accidents are reported on Polish roads. In these accidents, several thousand people are killed, and tens of thousands go to hospitals with more or less serious injuries. As a result of these injuries, many of these people will never be able to regain full physical and mental fitness.

Many authors take in their articles subject causes of road accidents in other countries [1, 2, 3].

In many publications [4, 5, 6], the authors try to make the analysis of the current state of road safety in order to find a way for Polish roads to be safer and in the near perspective to achieve European standards in this field. The authors of this article evaluated the statistical data covering some selected statistical elements, with particular emphasis on their occurrence in different provinces.

2. Accident indicators in Poland

Number of motor vehicles in Poland in recent years has significantly changed. In the past decade it increased from about 14 million to more than 23m, an increase of over 65% compared to 2000.

At the same time, the number of cars has increased from almost 9m to over 17 million. These figures may give some idea of the great development of the automotive industry which had and still has a place in Poland – Fig. 1. Motorization rate of population indicating the number of cars per 1000 citizens in 2010 exceeded the value of 450. This moved Poland to European averages in this area. With the increasing number of cars on Polish roads, the number of road accidents also changed.

Fig. 2 shows the number of road accidents and injured people. Number of road accidents recorded in 2000 decreased compared to 2010 by 48%, the number of people killed fell by as much as 61%, while the number of people injured by 46%. Presented data clearly show a considerable progress in improving road safety.

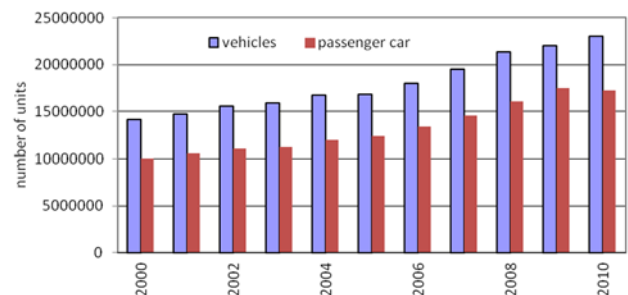


Figure 1. The number of cars in Poland between 2000 - 2010.

A question should, however, be asked whether this improvement in road safety is noticeable? Analysing statistical data, it could be said that in this respect there has been a significant quantitative change.

Unfortunately, data concerning accidents continue to be alarming in comparison with other European countries and we can conclude that there is a long way in order to get close to them as for accident rates.

Poland has been placed on the first position in EU regarding fatalities in comparison to other European countries.

Indicator of the number of deaths per 100 accidents in Poland is one of the highest in Europe, and in 2010 was just over 10, while, for example, in Germany, Great Britain, Italy, Austria and Sweden the figure is less than 2. In Slovakia, in 2009 the ratio was approximately 4.4.

In Germany, where the number of accidents recorded (over 300K) is 5 times higher than in Poland, the number of people killed in them estimates at 4 – 4.5K, which is "only"

about ten percent higher than in Poland. The death rate in road accidents in Poland is several times higher than in other EU countries [6]. Fig. 3 shows a decrease in the number of accidents per vehicle.

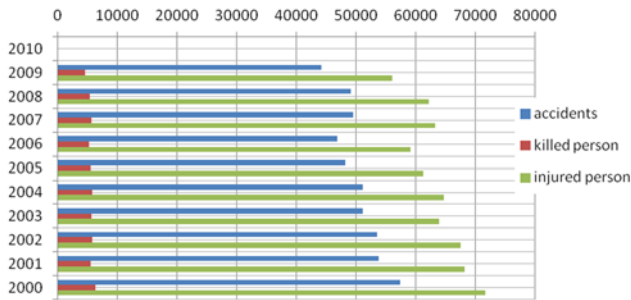


Figure 2. The number of road accidents and people injured in accidents in Poland in 2000-2010.



Figure 3. Decrease in the number of accidents per vehicle.

Interesting observations on road accidents in Poland can be drawn by analysing their presence in each province – Fig. 4, including Świętokrzyskie province.

Important is the fact that the number of accident values gradually decreases in most provinces. Particularly noticeable is the decline, in recent years, of the number of accidents in the provinces: Wielkopolskie, Mazowieckie and Małopolskie.

As shown in Fig. 4 in Poland during the last 10 years, most accidents occurred on the roads of five provinces: Łódzkie, Małopolskie, Mazowieckie, Śląskie and Wielkopolskie. Their area covers more than 35% of the territory of Poland with nearly 55% of Polish citizens living there.

On the roads of the above-mentioned provinces, a total of more than 50% of all accidents in Poland was recorded – Fig. 5. In contrast, however, to the number of road accidents (Fig. 3), where in recent years lower and lower values are recorded, it appears that the share of these events in overall numbers changed slightly (remain almost unchanged). It is worth mentioning that in many provinces such as Śląskie and Łódzkie in 2009-2010, they reached the highest values in the last 10 years, and Wielkopolskie province by far the lowest one.

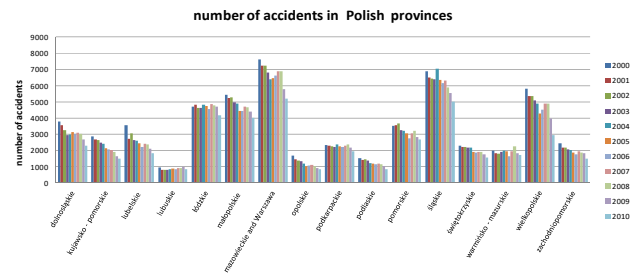


Figure 4. The number of accidents in Polish provinces.

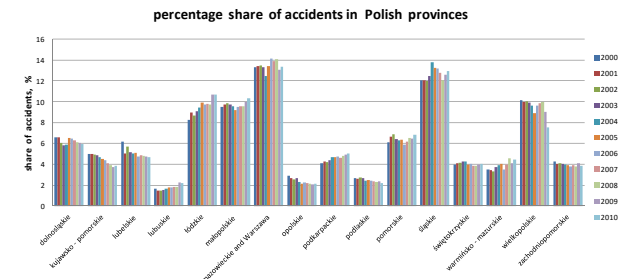


Figure 5. Percentage share of accidents in Polish provinces.

Several thousand people get killed on Polish roads every year. By analysing their number – Fig. 6, it can be said that in terms of the number of most tragic accidents, Mazowieckie province takes a disgraceful first place (along with Warsaw, the region of the Metropolitan Police command). A significant reduction in the number of deaths in all provinces in the period from 2009 to 2010 is worth noting here. Perhaps this is a lasting trend, but in a next few years it will be confirmed.

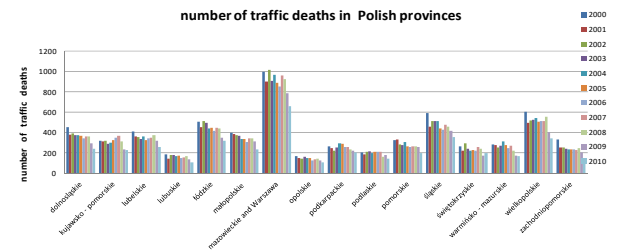


Figure 6. Number of traffic deaths.

Analysing the share of people killed in accidents in relation to the total number of victims in Poland – Fig. 7, it can be concluded that for Mazowieckie province in the years 2000-2010 registered a share of people killed in the amount of 15 - 17%. Other provinces such as Łódzkie, Śląskie or Wielkopolskie record significantly lower results in this respect and their share is 8 - 10%.

Equally important is the fact that the share of the number of people killed in road accidents (Fig. 7) (as well as accidents themselves – Fig. 5) at the end of the period of 10 years does not change significantly, which could mean that each province has its own characteristics including road infrastructure, specific habits of drivers and other features that may determine the analysed data, and which, at the

same time, do not change dramatically at the end of the period concerned.

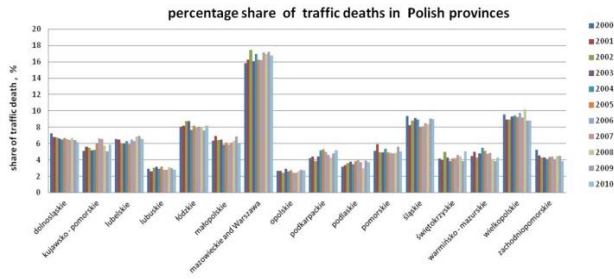


Figure 7. Percentage share of traffic deaths in provinces in 2000-2010.

A similar trend as in the case of accidents and fatalities can be observed by the number of people injured in each province – Fig. 8, and the percentage of their share – Fig. 9. It may be noted that the decline in the number of injured is noticeable especially in 2009-2010, while in most provinces minimum values during the period were reached. In contrast to earlier comparisons, however, we can see a large increase in the number of people injured in accidents in Śląskie and Wielkopolskie provinces.

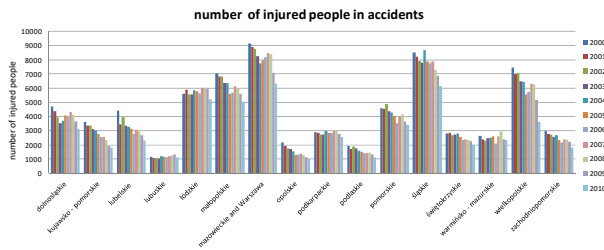


Figure 8. Comparison of the numbers of injured people in accidents.

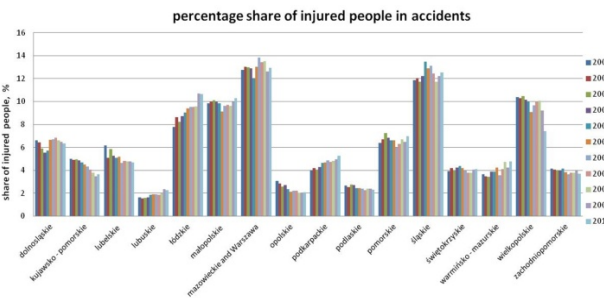


Figure 9. Percentage share of injured people in accidents.

Analysing accident statistics, one can often meet with various relative indicators, thanks to which deeper assessments can be made. One of such indicators is the number of people who died in accidents per 100 accidents - Fig. 10.

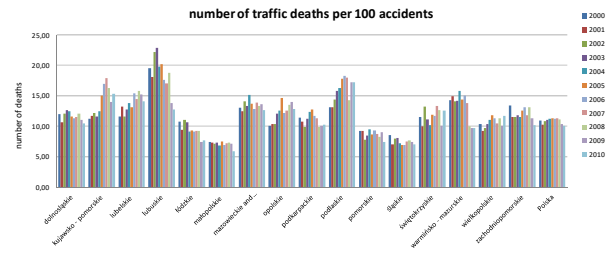


Figure 10. The number of people killed in 100 accidents.

Analysing the graph of Fig. 10, it can be seen that in terms of the number of deaths in accidents in relation to the number of accidents in previously-mentioned provinces, which had the highest numerical values here, relatively "good" results were reached. In the case of Lubuskie, Podlaskie, and Warmińsko-Mazurskie provinces, it can be said that the events that took place on their territories, carried a higher risk of death. A record-holder in this regard is Lubuskie with "top" results in the last 10 years. It should be noted that in recent years the value of the index for this province significantly decreased, while only for the Warmińsko-Mazurski increased. The average value of the number of traffic deaths per 100 accidents in Poland amounts to few more than 10, and only a few provinces like Łódzkie, Małopolskie, Pomorskie and Śląskie have a value below this average.

It should be noted that the rates achieved in Poland are several times higher than the same rates recorded in Germany and Austria.

Table 1 shows examples of indicators for selected provinces. The shaded cells indicate the highest rates of the year, marked in bold suggest smallest values. What is worth emphasizing is the fact that Małopolskie province achieved the best results over 10 years.

Table 1. Indicators of severity of accidents (deaths per 100 accidents)

Province/year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Dolnośląskie	11.99	10.61	12.12	12.64	12.42	11.56	11.35	11.52	12.09	11.02	10.51
Kujawsko - pomorskie	11.22	11.67	12.19	11.62	12.48	15.07	16.92	17.86	16.30	14.03	15.30
Lubelskie	11.62	13.23	11.63	12.71	13.84	13.16	15.42	14.51	15.78	15.19	14.07
lubuskie	19.47	18.10	22.15	22.84	19.83	20.23	17.60	17.07	18.76	13.81	12.78
łódzkie	10.72	9.39	10.99	10.65	9.12	9.34	9.11	9.22	9.20	7.37	7.70
małopolskie	7.37	7.33	7.09	7.34	6.86	7.53	6.94	7.22	7.36	7.11	5.87
Mazowieckie i Warszawa	13.03	12.46	14.05	13.30	15.17	13.72	12.83	13.89	13.31	13.64	12.62
opolskie	10.05	10.35	10.32	12.09	12.59	14.61	12.21	12.51	13.52	14.04	12.80
Podkarpackie	11.43	10.72	9.91	11.22	12.39	12.79	11.70	11.28	9.93	10.12	10.30
Podlaskie	13.09	13.15	14.39	15.80	16.31	17.81	18.33	17.99	14.26	17.20	17.24
pomorskie	9.18	9.19	7.74	8.46	9.55	8.68	9.31	8.70	8.28	9.02	7.44
śląskie	8.52	7.04	7.99	8.04	7.25	6.91	6.91	7.52	7.71	7.44	7.02
Świętokrzyskie	11.51	9.96	13.22	11.15	10.17	11.91	11.72	13.34	12.64	10.09	12.52
Warmińsko- Mazurskie	14.29	14.98	14.05	14.16	15.77	14.41	15.08	13.81	10.00	9.69	9.74
Wielkopolskie	10.39	9.23	9.70	10.35	11.00	11.79	11.36	10.46	11.33	10.10	11.71
Zachodniopomorskie	13.46	11.50	11.47	11.81	11.55	12.59	13.16	11.82	13.12	11.33	10.17
Poland	10.98	10.29	10.88	11.04	11.18	11.31	11.18	11.27	11.08	10.34	10.06

However, analysing how the value of the index decreases Fig. 11, it can be said that by 10 years, this indicator decreased most in Lubuskie and Warmińsko-Mazurskie, and least in Kujawsko-Pomorski and Podlaski provinces.

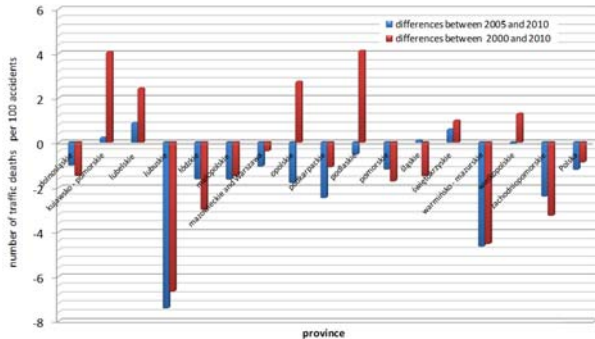


Figure 11. The decrease in traffic deaths per 100 accidents in 2000-2010 and 2005-2010.

Similar analysis can be carried out by estimating the number of injuries per 100 accidents – Fig. 12. In contrast to Fig. 10, where significant differences were noted, all of the provinces reach relatively similar results. High indicators are recorded by Lubuskie province, but in recent years Dolnośląskie takes the first place - Table 2. Table 2 highlights the highest indicator values in a given year. It should however be noted that this figure places Poland in the middle of European countries. For instance, Luxembourg in 2009 recorded a rate of 145.2 injuries and Slovakia 135.3 respectively. In Poland, the relatively highest values are obtained by Dolnośląskie and Lubuskie with Łódzkie recording the smallest values in recent years. Fig. 13 shows the percentage decrease of the injured per 100 accidents in 2000-2010 and 2005-2010.

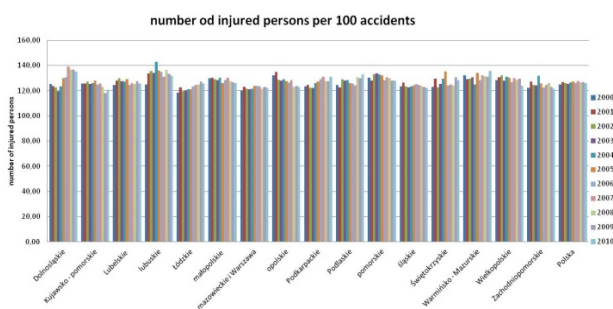


Figure 12. Number of injured people in 100 accidents.

By analysing the statistical data, it can be concluded that the presented results may depend on many factors such as specific features of a province, terrain, particular weather conditions, population, density of road network and many others. It is difficult to assess which of them have a decisive impact.

Table 2. Number of injured people per 100 accidents

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
dolnośląskie	125	123	122	119	123	129	130	139	136	136	135
kujawsko - pomorskie	125	125	127	125	125	127	124	125	122	118	120
lubelskie	124	127	129	127	127	129	124	126	125	127	125
lubuskie	124	133	135	133	142	135	134	131	136	133	131
łódzkie	118	122	119	120	121	121	123	124	124	127	125
małopolskie	129	130	129	128	130	126	128	130	127	126	126
mazowieckie, Warszawa	119	123	121	121	121	123	123	123	121	122	122
opolskie	132	135	128	127	128	127	126	128	122	123	122
podkarpackie	123	124	122	122	126	127	129	131	127	127	131
podlaskie	124	122	129	127	128	126	125	124	130	129	132
pomorskie	130	127	132	133	132	131	128	130	130	127	128
śląskie	123	126	123	122	123	124	125	124	123	123	122
świętokrzyskie	122	129	122	125	129	135	124	124	124	130	128
warmińsko-mazurskie	132	128	129	130	125	134	128	132	131	131	135
wielkopolskie	128	130	132	128	131	130	126	129	128	129	123
zachodniopomorskie	122	127	124	124	131	125	122	124	125	123	121
Poland	124	126	126	125	126	127	126	127	126	126	126

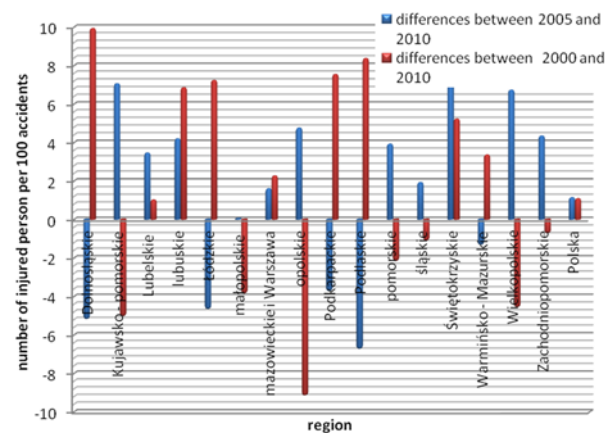


Figure 13. The percentage decrease of the injured persons per 100 accidents in 2000-2010 and 2005-2010.

Fig. 14 shows the number of accidents per number of people living in a particular province [4, 5]. In this respect, Łódzkie (164-185) and Świętokrzyskie (164-185) noted the highest rates in 2000 - 2010.

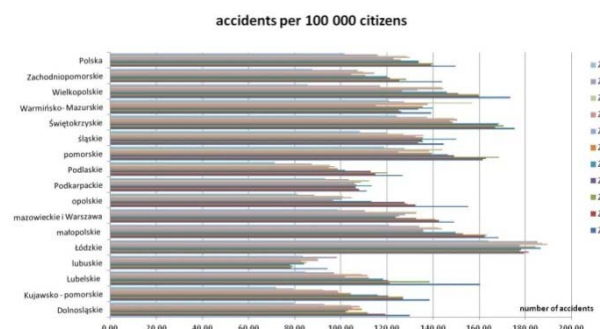


Figure 14. The number of accidents per 100 000 citizens.

In 2010, only 10 provinces had a rate less than the average for the whole Poland amounting to 101.6 (in 2000 it amounted to as much as 150), and this year the best result of 71.3 has been recorded by Podlaskie province.

Similar analysis was carried out for the traffic deaths in relation to the 100 000 citizens of the province – Fig. 15.

The worst results in this area were reached by Świętokrzyskie and Warmińsko-Mazurskie. The average value for Poland in 2010 estimated to 10.22, while in the year 2000 amounted to as much as 16.45. In 2010, the worst result was achieved by Świętokrzyskie - 15.56 where Małopolskie had the best results - the value of 7.1.

For the analysis of the number of people injured in comparison to the number of citizens in the province – Fig. 16, Łódzkie province notes the highest indicators. While the average value estimated for the year 2010 amounted to 128.1, Łódzkie province registered the value of 204.2. Łódzkie and Lubuskie provinces, in any case, record the smallest changes of values obtained at the end of 10 years, while most of the provinces recorded a significant improvement in this indicator at that time. Fig. 17 shows an annual decline in the relative rate of injuries per 100 000 citizens.

While studying the number of accidents on Polish roads, we may also consider a very important aspect related to road infrastructure - the quality and type of roads [7].

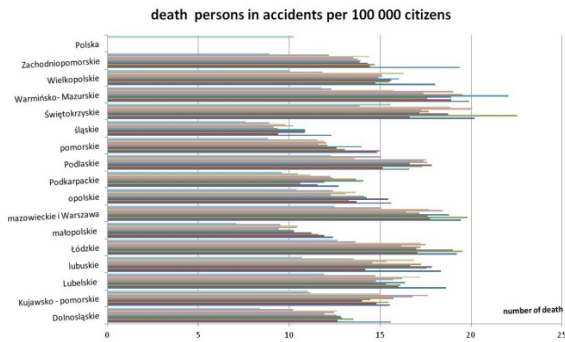


Figure 15. The traffic deaths in accidents per 100 000 citizens.

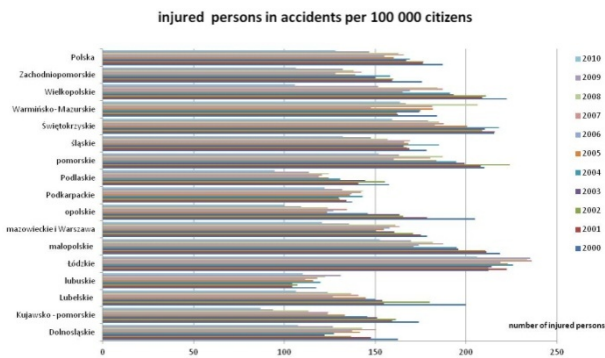


Figure 16. The injured in accidents per 100 000 citizens.

Analysing the percentage of accidents that have occurred at different types of roads, it can be stated that, despite ongoing and constant road investments for several years in this area, relatively few changes have taken place. A very important aspect of the studies carried out for many years, is the fact that accidents often occur in Poland on two specific types of roads (Fig. 18). These are single-lane two-way roads (without separated lanes, which in the case of a head-on collision the most tragic consequences). These roads, unfortunately, are mostly common in Poland and roads of

two one-way lanes (like expressways with a much lower standard of safety).

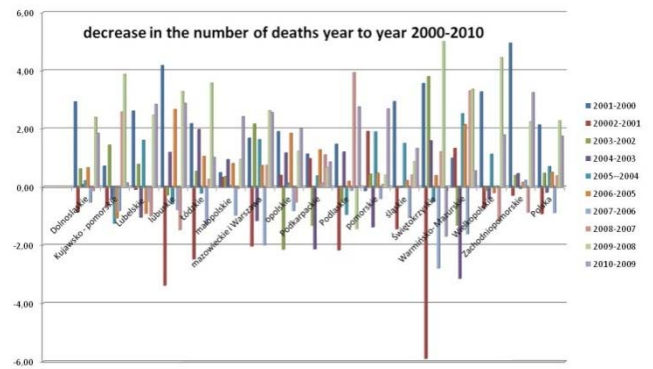


Figure 17. The annual decline in the relative rate of injuries on 100 000 citizens.

The results shown in Fig. 12 confirm that most accidents happen on single-lane two-way roads - Table 3 and on the roads with two single-way roads - Table 4.

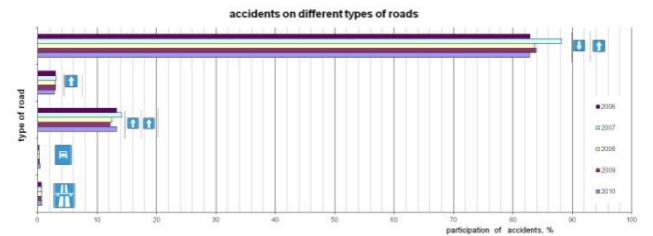


Figure 18. The percentage of accidents depending on road type.

The important fact is that 95% of all accidents occur on these two types of roads [8]. On other roads, drivers cause significantly fewer road accidents: motorways and expressways - a total of about 1% - Tab. 5, one-way roads around 3%.

Table 3. Accidents and their consequences on two-way single-lane roads

	2010	2009	2008	2007	2006
Accidents, %	82.8	83.9	83.7	88.2	82.9
The killed, %	88.6	88.8	89.2	88.7	88
The injured, %	83.2	84.2	84.1	83	83.2

Table 4. Accidents and their consequences on the road of two one-way lanes

	2010	2009	2008	2007	2006
Accidents, %	13.3	12.2	12.5	14.1	13.3
The killed, %	8.9	8.4	8.8	9	9.3
The injured, %	13	12	12.3	13.1	13

Table 5. Accidents and their effects on motorways and expressways

	2010	2009	2008	2007	2006
Accidents, %	13.3	12.2	12.5	14.1	13.3
The killed, %	8.9	8.4	8.8	9	9.3
The injured, %	13	12	12.3	13.1	13

Which is equally important to emphasize is that on the roads without separated lanes (majority in Poland), significantly more people died in accidents – Fig. 19. In cases of accidents on single-lane two-way roads almost 88% of people die, on the roads with two lanes close to 10%. The remaining 2% of people die in accidents on other types of roads [8].

After analysing the above-mentioned data, we may hopefully accept efforts aiming to modernize Polish roads, construction of expressways and motorways, which according to data forwarded before, carry the smallest risk of traffic accidents. So far, despite the attempts made in this regard, a significant change in the percentage shares of accidents on various types of roads cannot be observed.

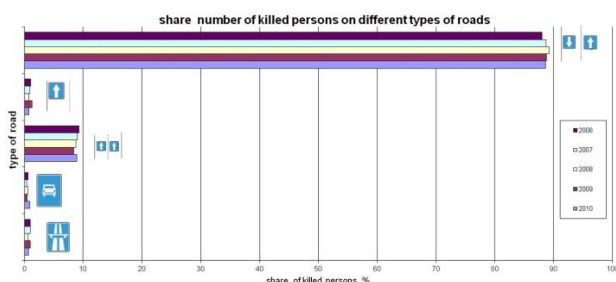


Figure 19. The percentage of traffic fatalities depending on road type.

A similar analysis of the number of people injured also confirms the danger to which drivers are exposed while driving vehicles on these two most dangerous types of roads. For these types of roads, the sum of the share of people injured is over 90%.

Fig. 20 indicates the length of the safest types of roads in particular provinces in terms of the number of accidents and traffic deaths, that is expressways and motorways. By analysing this data, it can be seen that the length of such roads in most provinces is growing, but these are the provinces where, at the end of 2009, such roads did not exist at all (Podkarpackie, Podlaskie). The location of these roads is also uneven. Most of expressways and motorways are located in the Wielkopolskie, Śląskie and Dolnośląskie provinces.

It should also be noted that the number of roads since 2005 has increased from 785 km to over 1370 [9].

Based on accident data presented, there is any significant impact of infrastructure projects on road safety visible yet, as expressways and motorways in Poland constitute only about 0.6% of all roads with improved surface. Another problem is the accessibility of these roads. Many road users usually select alternative routes to reduce travel costs. Drivers of vehicles over 3.5 tons, try not to use the roads on which fees are collected.

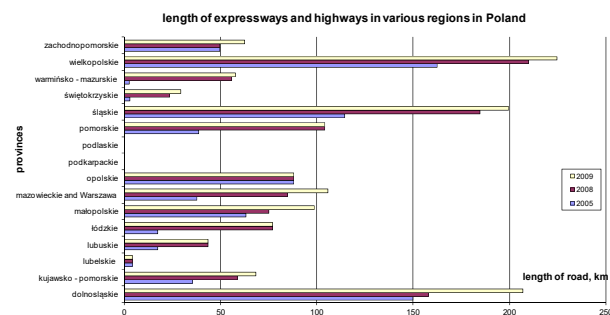


Figure 20. Length of expressways and motorways in each province.

3. Conclusions

Polish roads for many years have been one of the most dangerous in Europe. Backlog inherited from the previous system, makes Polish roads transport inefficient. The number of cars increasing from year to year increases traffic congestion. Single-lane two-way roads are dominant in Poland. Head-on collisions are most common on such roads. As it is well known, a head-on collision is one of the most dangerous one. At the moment of impact, a human body is exposed to great inertial forces caused by a sudden change in speed. For instance, a head-on collision of vehicles moving at speeds of 50 km/h causes the head of a driver or a passenger accept the delay from 60 to 500g depending on the place of impact of the head [10, 11, 12,13]. Thus, the presence of such large delays in a very short period of time brings with it consequences which are visible in statistics. In spite of such data, it can be stated with satisfaction that the number of accidents and traffic deaths still decrease. But is the trend constant? Using the patterns of other European countries, especially after Poland's accession to the European Union, significant improvement (using EU funds) of road infrastructure has been performed. Unfortunately, in many provinces no investment in expressways not to mention the motorways has been realised, and these roads are the safest as it has been shown in this paper.

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