

Comparison of Certain Road Accident Indicators in Poland and Selected European Countries

Jerzy Kisilowski¹, Jaroslaw Zalewski^{2,*}

¹Kazimierz Pulski University of technology and Humanities, Faculty of Transport and Electrical Engineering, Malczewskiego 29, 26-600 Radom, Poland

²Warsaw University of Technology, Faculty of Administration and Social Sciences, Pl. Politechniki 1, 00-661 Warsaw, Poland

*Corresponding Author: jarek.zalew@gmail.com

Copyright © 2014 Horizon Research Publishing All rights reserved.

Abstract The article discusses selected aspects of the analysis on road accidents data and the possibility of their use in order to create a background for further, more exhaustive study of specific problems of road safety. These problems may result from such analyzes by their breakdown through specific comparisons and drawing appropriate conclusions. Attention was paid to the manner of data presentation and important problem of their systematic collection. In this paper the results of particular analyses as well as selected aspects concerning the causes of road accidents are discussed. Attention was paid to the possibilities of conducting detailed analysis on this research area. Occurrence of road accidents does not have to be connected with relationships directly between motor vehicles, and it seems obvious that the influence of environment should be included. Also an important issue of systematic and consistent data collection about accidents is mentioned.

Keywords Road Accidents, Road Traffic Safety, Fatalities, Injuries, Infrastructure

1. Introduction

In the paper selected problems are undertaken concerning the way of presentation and analysis of data on road traffic accidents as a comparison between Poland and selected European countries. Such an approach is presented, which, except for pure data, allows developing information (indicators) on selected issues of road traffic accidents, draw conclusions and run analysis on the basis of trends, particularly when presented data are incomplete.

For the comparison of accident indicators data from Czech Republic, France, Germany, Poland and the United Kingdom were selected for the period 2002 to 2012. Data sets were derived from the accountancy system of incidents and accidents (SEWiK) in Poland [1] as well as the UN

database [2]. Some parts of the United Nations database are incomplete; hence not all indicators are presented for the full period of the given 11 years. Data in the United Nations are sometimes little corrected, in particular at the beginning of each year. Data sets presented for purposes of this paper are up to date for January 2013.

In order to complete some deficiencies, certain statistical yearbooks of the German statistical office DESTATIS-Statistisches Bundesamt [3], the World Development Indicators (WDI) by the World Bank [4] and data from Czech Statistical Office (5) were used. Lack of data are marked with “-“ in every table.

It should be highlighted that the approach to analysing road traffic accidents proposed by the author is only a part of a wider analysis [9], [10] and may complement or compose a background for broader considerations.

In order to ensure data representativeness the indicators were used, through which not only selected data can be compared in relative values ([6], [7], [8]), but above all the trends resulting from changes in these values can be analysed. In addition, the aim of the paper is to present the analysis results based on assessment of these trends, when not all data are complete. The completeness of data is determined by their availability and complexity of the analysed issues. Unfortunately, using publicly available databases mentioned above it was not possible to complete the full data, thus the interpretation of the obtained resources results mainly from the trends in changes of the observed indicators.

Final conclusions are not arbitrarily imposed points of reference as directions for further research to improve road safety, but only a desire to focus on certain essential aspects which may be used in any further action or bear evidence of the amendments made.

2. Comparison of the Selected Indicators

Statistical data are often used as a factor or background justifying undertaking certain research. They may be presented in two ways. The first one is presentation of data in an unprocessed form. This method enables nothing more but only displaying incomplete information, for which no comparisons can be made, especially between different countries. In table 1 and 2 data concerning the number of fatalities and injuries in road accidents in selected European countries are presented. The period from 2002 to 2012 is included and data are presented in absolute values. Such attempt was presented before in [6], [7] and [8].

Table 1. The number of fatalities in the selected countries between 2002 and 2012.

Year	Fatalities				
	Czech Republic	France	Germany	Poland	Great Britain
2002	1430	7655	6842	5827	3581
2003	1447	6058	6613	5640	3658
2004	1382	5530	5842	5712	3368
2005	1286	5318	5361	5444	3336
2006	1063	4709	5091	5243	3298
2007	1221	4620	4949	5583	3059
2008	1076	4275	4477	5437	2645
2009	901	4273	4152	4572	2337
2010	802	3992	3648	3907	1905
2011	773	3963	4009	4189	-
2012	-	-	-	3557	-

Table 2. The number of injuries in the selected countries between 2002 and 2012.

Year	Injuries				
	Czech Republic	France	Germany	Poland	Great Britain
2002	34389	137427	476404	67502	310938
2003	35438	115602	462170	63905	297274
2004	34254	108429	440109	64667	286979
2005	32211	108429	433430	61196	275840
2006	28114	108076	422322	59121	264288
2007	29191	102125	431419	63224	254157
2008	28501	103201	409047	62097	237811
2009	27244	95207	397671	56045	229576
2010	24384	84461	371170	48952	217605
2011	25611	-	-	49501	-
2012	-	-	-	45637	-

In order to prepare an overall assessment of road traffic safety in the compared countries on the basis of so presented statements, a conclusion can be made that both in terms of fatalities and injuries, Czech Republic is characterised by the highest level of safety, whereas Poland performs better in these comparisons than Germany and France. However, such information is incomplete, and in addition cannot be verified without additional data.

Another approach is the analysis of trends in changes of the number of fatalities and injuries in road accidents in all

five countries. Results show that in each compared country there is a declining trend, while in such approach values for separate years are not as important as the difference between the initial and the final one. Therefore the greatest decrease in the number of fatalities was reported in France, because there were about 3700 fatalities less in 2011 than in 2002. In terms of the number of injured in road accidents it can be ascertained that in the given decade the main decrease occurred in Germany and the United Kingdom.

The question that rises is whether data presented in such a way are representative, i.e. whether on the basis of them certain comparative analyses can be made. No reply seems to be unambiguous, particularly when taking into account the additional factors such as the number of road vehicles in each country, overall length of the road network, nature of the accidents (type and location of the collision), number of inhabitants, etc. In order to run such analysis more complete, certain factors should be taken into account, which can on one hand enable the comparisons and, on the other, explain the occurred juncture.

Table 3. The number of road accidents in the selected countries between 2002 and 2012.

Year	Number of accidents				
	Czech Republic	France	Germany	Poland	Great Britain
2002	26586	105470	362054	53558	228535
2003	27320	90220	354534	51076	220079
2004	26516	85390	339308	51068	213043
2005	25239	84525	336618	48100	203682
2006	22115	80309	327984	46875	194789
2007	23060	81272	335845	49536	188105
2008	22481	74487	320614	49054	176814
2009	21706	72315	310806	44195	169805
2010	19676	67288	288297	38832	154414
2011	-	65024	306266	40065	-
2012	-	-	-	36927	-

In table 3 the number of road accidents in Czech Republic, France, Germany, Poland and the United Kingdom in the years 2002 to 2012 is presented. It is discernible that the greatest decrease in the number of road accidents took place in Germany (about 90000) and in Great Britain (by around 80000).

After analysis of data from the tables 1 to 3, first and foremost trends in their changes, it appears that the first impression concerning road traffic safety in Czech Republic was not appropriate, as evidenced by a large number of injuries in the relatively small number of accidents as compared to four other countries. But because it is insufficient to compare separate data for each year and between different countries in absolute values, more detailed analysis was prepared.

Using additional data which form the background of changes and comparative plane two additional tables were prepared. In table 4 the number of road vehicles in the

selected countries from 2002 to 2012 is shown. It should be noted that only in Czech Republic in the given period there were around 3 times less vehicles than in Poland. However in France and the United Kingdom there were more than two, while in Germany over three times more vehicles than in Poland. In relation to this fact the comparison of the absolute values between the given countries and for concrete years raises wrong conclusions concerning the actual juncture. Such information cannot therefore be the basis of comparative analyses, because it contains the data not related to the common datum plane (e.g. the number of vehicles).

Table 4. The number of road vehicles in the selected countries between 2002 and 2012.

Year	Number of vehicles				
	Czech Republic	France	Germany	Poland	Great Britain
2002	3998696	34808708	47463269	15525733	29976693
2003	4092385	35228622	47797096	15899195	30504851
2004	4231701	35393620	48219014	16701072	31607029
2005	4396641	35631525	48939105	16815923	32170344
2006	4620235	36164754	49457882	18035047	31344793
2007	4855247	36619045	43762067	19472000	31961051
2008	5050787	36517187	43852088	21336913	32324715
2009	5056710	37101560	44370443	22024697	32087899
2010	5368068	37625443	44997890	23037149	32270122
2011	6414559	-	45716613	24189370	-
2012	-	-	-	-	-

When possessing the additional data, the question can be answered of how the increase in density of road vehicles contributed to occurrence of road traffic accidents as well as the number of fatalities and injuries.

One of the indicators enabling comparisons can be the number of accidents, fatalities or injuries in relation to 100 000 vehicles (2.1) depending on the purpose of comparison.

$$A_i = A_t \cdot \frac{100000}{V}, D_i = D_t \cdot \frac{100000}{V}, I_i = I_t \cdot \frac{100000}{V} \tag{2.1}$$

where:

- V - the number of road vehicles in every selected country in the given year,
- A_i - the number of accidents per 100000 vehicles in the given year,
- A_t - the total number of accidents in every selected country in the given year,
- D_i - the number of fatalities per 100000 vehicles in the given year,
- D_t - the total number of fatalities in every selected country in the given year,
- I_i - the number of injuries per 100000 vehicles in the given year,

- I_t - the total number of injuries in every selected country in the given year.

In the tables 5 – 7 the number of accidents, fatalities and injuries in relation to 100000 vehicles in the years from 2002 to 2012 is shown, on the basis of formulas (2.1). From the comparison it can be seen that with much more accidents in Czech Republic, Germany and Great Britain (table 5), and comparable number of accidents in France in relation to 100000 vehicles, the largest number of fatalities for the concerned period occurred in Poland. Moreover, in Germany and Great Britain, despite the large amount of vehicles, the number of fatalities per 100000 vehicles had been smallest every year (table 6).

When examining the trends of these changes it can be seen that, in terms of both accidents and fatalities per 100000 vehicles, the largest decrease of these indicators occurred in Czech Republic, Poland and the United Kingdom.

In a matter of injured per 100000 vehicles the most beneficial situation had year by year been in France and Poland (table 7), while the greatest absolute number of injured had been in Germany and the United Kingdom. When analysing the trends it can be seen that the greatest decrease in the number of the injured throughout 10 years occurred in Czech Republic and the United Kingdom.

Two different approaches give different results. However, when comparing data in relative values it is necessary to relate them to the conditions for which these data were collected. For example, the high number of injuries in Germany can not be an evidence of the poor road safety condition, because, year by year, the number of vehicles had been the highest among the five countries compared. In addition, taking into account the area of Germany equal to approximately 357000 km² and comparing it, e.g. with France (more than 640000 km²) the greatest car density may be assumed to had been in Germany (from among five selected countries).

Table 5. The number of accidents per 100000 vehicles in the selected countries between 2002 and 2012.

Year	Accidents per 100000 vehicles				
	Czech Republic	France	Germany	Poland	Great Britain
2002	664,87	303,00	762,81	344,97	762,38
2003	667,58	256,10	741,75	321,26	721,46
2004	626,60	241,26	703,68	305,78	674,04
2005	574,05	237,22	687,83	286,04	633,14
2006	478,66	222,06	663,16	259,92	621,44
2007	474,95	223,34	767,43	254,40	588,54
2008	445,10	204,69	731,13	229,90	546,99
2009	429,25	198,62	700,47	200,67	529,18
2010	366,53	178,83	640,69	168,56	496,06
2011	-	-	669,92	165,63	-
2012	-	-	-	-	-

Table 6. The number of fatalities per 100000 vehicles in the selected countries between 2002 and 2012.

Year	Fatalities per 100000 vehicles				
	Czech Republic	France	Germany	Poland	Great Britain
2002	35,76	21,99	14,42	37,53	11,95
2003	35,36	17,20	13,84	35,47	11,99
2004	32,66	15,62	12,12	34,20	10,66
2005	29,25	14,92	10,95	32,37	10,37
2006	23,01	13,02	10,29	29,07	10,52
2007	25,15	12,70	11,31	28,67	9,57
2008	21,30	11,75	10,21	25,48	8,18
2009	17,82	11,73	9,35	20,76	7,28
2010	14,94	10,6	8,10	16,96	5,90
2011	12,05	-	8,76	17,31	-
2012	-	-	-	-	-

Table 7. The number of injuries per 100000 vehicles in the selected countries between 2002 and 2012.

Year	Injuries per 100000 vehicles				
	Czech Republic	France	Germany	Poland	Great Britain
2002	860,01	394,81	1003,73	434,75	1037,27
2003	865,95	328,15	96,69	401,91	974,51
2004	809,46	306,35	912,73	387,17	907,96
2005	732,63	304,31	885,65	363,89	857,44
2006	608,50	298,84	853,90	327,82	843,16
2007	601,23	280,64	985,83	324,69	795,21
2008	564,29	283,60	932,79	291,03	735,69
2009	556,58	261,50	905,60	254,47	722,74
2010	454,24	224,47	824,86	212,49	674,32
2011	399,26	-	-	204,64	-
2012	-	-	-	-	-

When analysing the trends of changes in the accident indicators rates (relative values) it is possible, without a complete data set, to notice the differences in their values over the years and thus draw conclusions regarding the changes in a specified period of time. Taking into account e.g. the number of fatalities per 100000 vehicles (table 6) it can be assessed, that the greatest progress in eliminating fatal accidents took place in Poland and Czech Republic (the decrease of more than twice). It is important that at the same period the number of road vehicles had been constantly increasing year by year (table 4) and had nearly doubled for both countries.

Analysis presented above allows conclusion that in order to achieve a low number of fatalities in road accidents certain activities, at least partially, can be directed towards improving the number of injuries. Of course such status is not achieved deliberately, and may result rather from the nature of the carried out activities. On one hand increasingly better and safer structures of road vehicles, on the other appropriate traffic control might enable optimisation of its fluency aimed at reducing the number of fatalities. Road network modernisations and development of

infrastructure (e.g. motorways with roads separated by barriers) might increase the number of injured, because it may lead to reduction of front and side impact collisions, however the number of rear collisions may increase (e.g. multiple collisions).

An important aspect of infrastructure modernisation as well is the elimination of using the same roads by different groups of users, as referred to in the further part of the paper.

In table 8 the number of inhabitants for each compared country from 2002 to 2012 is shown, which gave the opportunity to present an indicator – the number road vehicles per 1 million inhabitants (table 9). This dataset shows that over the considered years the number of vehicles along with the low demographic increment in Germany, France and the United Kingdom the density of vehicles remained at the same level. Demographic growth in Czech Republic was also low, while the density of vehicles had increased significantly, whereas in Poland along with the low decrease, significant growth in density of vehicles can be noticed.

Table 8. The number of inhabitants in the selected countries between 2002 and 2012.

Year	Number of inhabitants				
	Czech Republic	France	Germany	Poland	Great Britain
2002	10204852	61644062	82488494	38230364	59325809
2003	10207362	62078164	82534176	38204570	59566258
2004	10216016	62532556	82516260	38182222	59867866
2005	10235828	63001252	82469422	38165445	60224306
2006	10269134	63437350	82376450	38141267	60595632
2007	10334160	63826129	82266372	38120560	60986648
2008	10424336	64178710	82110096	38125758	61393521
2009	10487177	64522361	81902306	38151602	61811026
2010	10496772	64871454	81776929	38348597	62262787
2011	10496088	65223162	81797672	38534156	62744081
2012	-	-	-	-	-

Table 9. The number of vehicles per 1 million inhabitants in the selected countries between 2002 and 2012.

Year	Road vehicles per 1 million inhabitants				
	Czech Republic	France	Germany	Poland	Great Britain
2002	391842,6	564672,5	575392,6	406110,0	505289,2
2003	400924,8	567488,1	579118,8	416159,5	512116,3
2004	414222,2	566003,1	584357,7	437404,4	527946,5
2005	429534,5	565568,5	593421,2	440606,0	534175,4
2006	449914,8	570086,1	600388,6	472848,7	517278,1
2007	469825,0	573731,3	531955,7	510800,5	524066,4
2008	484518,8	568992,2	534064,5	559645,6	526516,7
2009	482180,3	575018,6	541748,4	577294,2	519129,0
2010	511401,8	580000,0	550251,6	600729,9	518289,1
2011	611138,1	-	558898,7	627738,4	-
2012	-	-	-	-	-

Information about fatalities or injuries in road accidents

can also be analysed in relation to the number of accidents. In connection with this the number of fatalities and injuries in relation to 1000 accidents for each of the selected years are presented. Indicator describing this dataset was calculated with the use of formulas (2.2).

$$D_i = D_t \cdot \frac{1000}{A_i}, \quad I_i = I_t \cdot \frac{1000}{A_i} \quad (2.2)$$

where:

- A_i - the number of accidents in the selected country for each of the analysed years,
- D_i - the number of fatalities per 1000 accidents in the selected country for each of the analysed years,
- D_t - the total number of fatalities in the selected country for each of the analysed years,
- I_i - the number of injuries per 1000 accidents in the selected country for each of the analysed years,
- I_t - the total number of injuries in the selected country for each of the analysed years.

Table 10. The number of fatalities per 1000 road accidents between 2002 and 2012 in the selected countries.

Year	Fatalities per 1000 accidents				
	Czech Republic	France	Germany	Poland	Great Britain
2002	53,8	72,6	18,9	108,8	15,7
2003	53,0	67,1	18,7	110,4	16,6
2004	52,1	64,8	17,2	111,9	15,8
2005	51,0	62,9	15,9	113,2	16,4
2006	48,1	58,6	15,5	111,9	16,9
2007	52,9	56,8	14,7	112,7	16,3
2008	47,9	57,4	14,0	110,8	15,0
2009	41,5	59,1	13,4	103,5	13,8
2010	40,8	59,3	12,7	100,6	12,3
2011	-	60,9	13,1	104,6	-
2012	-	-	-	96,3	-

In table 10 the number of fatalities, whereas in table 11 – the number of injuries in relation to 1000 accidents is presented for the considered period. Supposing every year only in Czech Republic there were less accidents than in Poland (see table 3), that at the beginning of the period the number of fatalities in 1000 accidents was the highest in Poland (over two times more than in Czech Republic, almost twice as much as in France and almost six times more than in Germany and Great Britain). However, when examining the trend of this indicator, the largest decline of its value can be observed in Poland, where the difference between the beginning and the end of the period is more than 20 fatalities less per 1000 accidents. In any other compared countries so significant decrease had not taken place. Noticeable differences are in France (about 9 fatalities less) and in Czech Republic (14).

The number of injuries per 1000 accidents at the beginning of the selected period was in all countries similar and oscillated around 1300. It is important that a similar

number of injuries had been noticed in the countries with different number of road accidents. The trend, however, shows that the greatest decrease in the values of this indicator until the year 2010 took place in Czech Republic and Germany. In France weak fluctuations can be noted with a small tendency of decrease, in Poland the trend had shown stability with the average value around 1265 injured in 1000 accidents, while the UK little growth occurred. But the figures in the years 2011 – 2012 show that in Poland the number of injuries per 1000 accidents had been reduced by 25 people in relation to the year 2010. Incomplete data have prevented broader analysis, but despite that the annual decrease in the number of road accidents in the rest of the selected countries can be expected, as well as the fact that it had been as significant as in Poland, except maybe for Czech Republic.

Table 11. The number of injuries per 1000 road accidents in the selected countries between 2002 and 2012.

Year	Injuries per 1000 accidents				
	Czech Republic	France	Germany	Poland	Great Britain
2002	1293,5	1303,0	1315,8	1260,4	1360,6
2003	1297,1	1281,3	1303,6	1251,2	1350,8
2004	1291,8	1269,8	1297,1	1266,3	1347,0
2005	1276,2	1282,8	1287,6	1272,3	1354,3
2006	1271,3	1345,8	1287,6	1261,2	1356,8
2007	1265,9	1256,6	1284,6	1276,3	1351,1
2008	1267,8	1385,5	1275,8	1265,9	1345,0
2009	1255,1	1316,6	1279,5	1268,1	1352,0
2010	1239,3	1255,2	1287,5	1260,6	1409,2
2011	-	-	-	1235,5	-
2012	-	-	-	1235,9	-

Having such prepared indicators at disposal not only comparisons can be made, but also trends of these indicators identified (6), i.e. forecasting of their changes in the close future, under certain road traffic conditions, number of vehicles and changes in road infrastructure. Example of such analysis is presented in the form graph (figure 1) showing the dynamics of changes in the number of fatalities in 1000 accidents from the point of view of trend analysis.

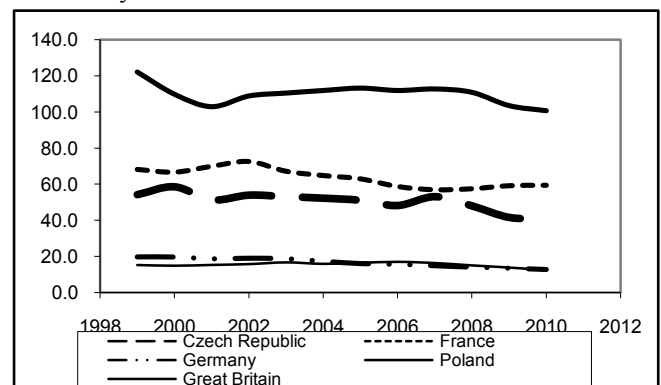


Figure 1. Dynamics of the change in the number of fatalities per 1000 road accidents for the compared countries.

Analysis of the possible influence of changes in road infrastructure on the causes of accidents was the subject of [6] and [7] for the period between 1995 and 2008. In these papers hypotheses were raised concerning reduction of the number of fatalities in road accidents by removing different types of users off the same road. Those are confirmed by

the results of studies presented above for the subsequent period.

The above considerations do not mean, however, that the data presented in absolute terms are in general unnecessary. Presenting them with a suitable interpretation may comprise a justification for the drawn conclusions.

Table 12. The number of accidents in the selected countries from 2002 to 2012 with division into accidents on motorways, in and outside built-up areas.

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Accidents on motorways											
Czech Republic	442	444	455	450	449	481	447	412	432	-	-
France	7596	6161	5285	5160	5094	5327	4703	4368	4756	4139	-
Germany	24625	22646	21458	20943	20434	20466	18269	18394	18829	18290	-
Poland	238	219	215	228	b.d.	551	283	237	274	232	-
Great Britain	8942	8746	9072	8718	8506	8116	7249	-	6500	-	-
Accidents in built-up areas											
Czech Republic	16901	16936	16517	15636	13551	13719	13443	12987	12005	-	-
France	68683	60162	57790	58676	54981	56049	52057	50864	46846	45377	-
Germany	233865	230521	223314	225875	221504	228717	221306	213361	195833	210427	-
Poland	38652	36912	36694	34234	b.d.	42768	34881	31599	27836	29144	-
Great Britain	161236	154995	148377	91737	87843	86473	128104	-	114238	-	-
Accidents outside built-up areas											
Czech Republic	9243	9940	9544	9153	8115	8860	8591	8307	7239	-	-
France	29191	23897	22315	20688	20234	19896	17727	17083	15686	15508	-
Germany	103564	101367	94538	89801	86046	86662	81039	79051	73635	77549	-
Poland	14907	14166	14375	13636	b.d.	19905	13892	12360	10722	10689	-
Great Britain	51573	50289	49961	43201	42149	40232	41330	-	33676	-	-

Table 13. Total length of motorways and other road types in the selected countries between 2002 and 2012.

Year	motorways					Other road types				
	Czech Republic	France	Germany	Poland	Great Britain	Czech Republic	France	Germany	Poland	Great Britain
2002	518	10223	12037	405	3611	127204	984131	-	377839	416469
2003	518	10379	12044	405	3611	127856	987622	-	382789	417185
2004	546	10486	12174	552	3657	127880	992000	644467	384956	412582
2005	564	10800	12363	552	3629	127872	998308	644480	386963	409309
2006	633	10848	12531	663	3665	129871	1003177	644359	388115	415764
2007	657	10958	12594	663	3669	129846	1016225	644181	388553	416330
2008	691	11042	12645	765	3673	129882	1016749	643999	388813	415961
2009	729	11163	12813	849	3674	129909	1030010	644969	389604	416001
2010	734	11392	12819	857	3673	129937	1038725	-	411622	415953
2011	-	11412	12845	1070	3686	-	1041803	-	412264	416067
2012	-	-	-	-	-	-	b.d.	-	-	-

Table 14. The number of accidents on dry road surface and other road conditions between 2002 and 2008.

Year	Dry road surface					Other conditions (wet, icy, etc.)				
	Czech Republic	France	Germany	Poland	Great Britain	Czech Republic	France	Germany	Poland	Great Britain
2002	18071	83142	244276	35850	140096	8515	22328	117778	17627	81655
2003	20082	75546	263049	34722	149756	7238	14674	91485	16356	64274
2004	18190	b.d.	-	32782	-	8326	-	-	18287	-
2005	16869	67112	-	32172	138262	8370	17413	-	15928	65420
2006	15363	63214	-	-	132195	6752	17095	-	-	62594
2007	16191	63467	-	-	128875	6869	17805	-	-	59230
2008	15669	56840	-	32831	116923	6812	17647	-	16223	59891

A dataset in table 12 presents the number of accidents with division into the accidents that occurred on motorways, in and outside built-up area. It should be noted that making any comparisons between the selected countries for the separate years is unfounded. Drawing conclusions on the basis of trends of presented values is more fruitful. In general, in all compared countries most accidents occurred in built-up areas. It is, however, important that on the number of accidents in and outside built-up areas (except for motorways) for all five countries decreasing trend was reported. As for the accidents on motorways, in Poland in the presented period there had been a slight increase in their number, while in Czech Republic it remained moderately stable. In other countries a decreasing trend can be observed. This status may be related to the development of motorway network. During the selected period the most dynamic growth of this road type took place in Poland, taking into account the differences between the beginning and the end of the period (table 13).

3. Influence of Road Conditions on the Occurrence of Accidents

Analysis of the causes of road traffic accidents can be run on the basis of the influence of road conditions and the resulting number of fatalities and injuries. By virtue of incomplete data it was possible to present the discussed indicators only for the period 2002 – 2008. In table 14 the number of accidents on dry road and other road conditions (wet, icy, etc.) is presented for the compared countries. As it can be seen, in any case the number of accidents on dry road surface, in good driving conditions had been dominant. No danger of driving on dry roads results from this dataset, but rather more cautious approach of road users in case of worse conditions.

Because of incomplete data no analyses in relative terms (e.g. in relation to 1000 accidents) were run. Basing on table 14 and observing the trend of the number of accidents,

it is possible to draw general conclusion about road safety improvement in all compared countries, except for Germany, where it was possible to obtain data only for the first two years of the selected period.

4. Analysis of Road Accidents Considering Different Types of Road

Analysis of road accidents statistical data with the division of road users into certain groups was run for the period 2002 – 2010, since for the years 2011 and 2012 data were incomplete or, in general, not available.

Having certain indicators expressed in relative terms at disposal (here in relation to 100000 vehicles) it is feasible of course to make comparisons of fatalities and injuries among different road users, such as pedestrians, vehicle drivers and passengers, motorcyclists, cyclists and moped drivers. In table 15 comparison between the number of fatalities, whereas in table 16 – injuries among the users of the selected groups is presented.

In Poland least fatalities were among motorcyclists and moped drivers, since the number of these vehicles are probably relatively smaller than in other countries, while for pedestrians, vehicle drivers and passengers and cyclists relative numbers of fatalities are the largest among selected countries in the same period. This is undoubtedly caused, inter alia, by general status of road infrastructure and non-collision solutions, particularly in urban areas.

The greatest relative value of injuries in the group of pedestrians was observed in the United Kingdom. In Germany there were the most injuries among vehicle drivers and passengers, motor cyclists and cyclists. This is probably due to greater traffic intensity and safer infrastructure (motorways, non-collision solutions), in which injuries dominate over fatalities, which number is limited. For moped drivers it was not possible to develop full comparison in view of the major shortcomings in the available data.

Table 15. The number of fatalities per 100000 vehicles among the selected groups of road users between 2002 and 2010 for the compared countries.

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
Pedestrians									
Czech Republic	7,7	7,1	6,6	6,8	4,4	4,8	4,7	3,5	3,1
France	2,5	1,8	1,6	1,8	1,5	1,5	1,5	1,3	-
Germany	1,8	1,7	1,7	1,4	1,4	1,6	1,5	1,3	1,1
Poland	12,8	11,8	11,9	10,4	10	10	8,8	6,7	5,4
Great Britain	2,7	2,6	2,2	2,2	2,2	2,1	1,8	1,6	1,3
Vehicle drivers and passengers									
Czech Republic	8,3	8,3	7,7	6,3	4,8	4,9	11,3	14,3	7,5
France	4,5	3,4	3	2,8	2,3	2,2	6	10,2	-
Germany	2,6	2,4	2,1	1,7	1,6	1,7	5,4	8	4,1
Poland	8,3	7,9	7	7,2	6,4	6,1	11,9	14,1	8
Great Britain	2,4	2,3	2,1	2	2,1	1,8	4,1	5,7	2,6
Motorcyclists									
Czech Republic	2,9	2,5	2,3	2,6	2,5	2,8	2,4	1,7	-
France	3,1	2,5	2,5	2,5	2,2	2,3	2,2	2,5	-
Germany	1,9	2	1,8	1,8	1,6	1,8	1,5	1,5	-
Poland	1,1	0,9	1,1	0,9	0,9	1,1	1,2	1,3	-
Great Britain	2	2,3	1,8	1,7	1,9	1,9	1,5	1,5	-
Cyclists									
Czech Republic	4	3,9	3,1	0	-	2,4	1,8	-	1,5
France	0,6	0,5	0,5	0,5	-	0,4	0,4	-	-
Germany	1,2	1,3	1	1,2	1	1	1	-	0,9
Poland	4,8	4,4	4,5	2	-	2,6	2	-	1,2
Great Britain	0,4	0,4	0,4	0,5	-	0,4	0,4	-	0,3
Moped drivers									
Czech Republic	0,4	0,3	0,1	0,2	0,1	0,1	0	0,2	-
France	1,1	1,1	1	1	0,9	0,9	0,8	0,8	-
Germany	0,3	0,3	0,3	0,2	0,2	0,2	0,3	0,2	-
Poland	-	-	-	-	-	-	0,3	0,3	-
Great Britain	0,1	0,1	0,1	0,1	0,1	-	0,1	0,1	-

When examining trends of these indicators a decreasing trend can be noted in the group of pedestrians and cyclists and slightly for moped drivers in all countries compared. This status may indicate at least partial separation of such road users from the vehicle traffic. With this may also be associated creation of non-collision passages for pedestrians, as well as cycle paths.

Table 16. The number of injuries per 100000 vehicles among the selected groups of road users between 2002 and 2010 for the compared countries.

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
Pedestrians									
Czech Republic	124,1	111,2	107,6	94,4	85,2	82,6	75,5	71,5	-
France	46	40,2	39	38,2	36,9	36,6	35	33,7	-
Germany	76,6	73,3	70,7	69,3	67,2	77,2	74,7	71,3	-
Poland	113,7	104,3	96,1	88,3	77,8	76	65,2	54,6	-
Great Britain	129,7	119,4	110,5	103,4	99,2	94,8	88,9	84,8	-
Vehicle drivers and passengers									
Czech Republic	521,7	534,2	500,1	443,2	-	-	335,4	466,9	-
France	224,5	172,3	156,4	150,9	-	-	110,5	211,4	-
Germany	615,2	571,1	538,4	505,3	-	-	512,5	824,9	-
Poland	232,1	210,4	210,7	246,8	-	-	164,6	199,9	-
Great Britain	652,8	611,6	576,4	549	-	-	477,2	630,7	-
Motorcyclists									
Czech Republic	55,7	60,8	57,8	60	-	-	49,1	44	-
France	50,4	44,9	b.d.	b.d.	-	-	46,2	45	-
Germany	78,7	80,2	71,5	71,2	-	-	68,4	67	-
Poland	10,3	9,1	8,3	9	-	-	10,6	10,4	-
Great Britain	76,4	75	79,3	75,4	-	-	54,2	53,8	-
Cyclists									
Czech Republic	99,6	100,8	90,6	59,8	-	-	58	-	-
France	13,1	13,8	12,5	12,9	-	-	12,1	-	-
Germany	147,9	158,3	151,7	159,1	-	-	180,1	-	-
Poland	49,2	47,2	42,3	17,9	-	-	21,1	-	-
Great Britain	56,6	55,5	52,3	51	-	-	50,7	-	-
Moped drivers									
Czech Republic	4,7	4,7	-	-	-	-	2,7	8	-
France	48,2	46,2	-	-	-	-	40,2	36,2	-
Germany	37,7	38,1	36,8	36,3	-	-	50,4	44,7	-
Poland	-	-	-	-	-	-	10,4	10,1	-
Great Britain	16,2	15,9	-	-	-	-	12,4	10,6	-

5. Conclusion

When analysing statistical data in relative values, a plane for comparisons can be created both for individual years, as well as between different countries. Data in table 1 – 3 and 5 – 7 show that proper and full analysis can be made with datasets in relative terms, since it is possible to both run comparative analyses, as well as the examination of

change in trends of the presented indicators.

It should also be taken into account that collection of so detailed data may involve certain errors due to the ambiguity or discrepancy. For example for one of the colliding vehicles the type of the crash they are involved in may be rear, whereas for the other the front. On one hand accident analysis run by police officers, who would dispose a very exact division of road crash types could lead to

lengthening the procedures and, on the other, lead authorities to organise training in order to correctly identify and describe the accident scene.

Comparisons and trends identification can be easily made when examining e.g. dynamics of changes of a specified indicator. When disposing complete data an attempt to make overall assessment of road traffic safety in any country is possible, along with determination of possible neuralgic aspects for which deeper analysis is necessary. The results may also be used as a background for further research, e.g. issues related to modelling collisions of a specified type. Analyses showing which tendencies occur in collisions types, which one is the most common and what are their major effects is also possible, which may be background of examination of vehicle collision processes.

Presented data show inconsequence of their collection, due to a large quantity of gaps in full statements. It is therefore essential to introduce a uniform method of road traffic accidents data collection and storage.

The most important in the comparison is having access to both current road accident data and information on planned or implemented activities in road infrastructure or up to date trends in the automotive industry. Such datasets, comparing them by means of appropriate indicators, as well as drawing conclusions from the obtained information may indicate trends of changes and facilitate estimation of close future, when it regards road traffic safety and road accidents. Also segmentation of such factors as the influence of using the same roads by various groups of users allows enrichment the full analysis of more detailed elements.

REFERENCES

- [1] <http://statystyka.policja.pl/portal/st/1302/>
- [2] <http://w3.unece.org/pxweb/Dialog/>
- [3] <https://www.destatis.de/DE/Publikationen/StatistischesJahrbuch/StatistischesJahrbuch.html>
- [4] <http://databank.worldbank.org/ddp/home.do>
- [5] <http://www.czso.cz/eng/redakce.nsf/i/home>
- [6] Kisilowski J., Zalewski J., Chosen problems of road accidents analyses in Poland in the period between 1995 and 2004, *Maintenance and Reliability*, nr 1 (37)/2008.
- [7] Kisilowski J., Zalewski J., Chosen aspects of analysis of road traffic safety in Poland between 1995 and 2008, *Journal of KONBIN*, No 2,3 (14, 15) 2010.
- [8] Zalewski J., Modelling of the influence of car body disturbances on the stability of motion of road vehicle, *Doctoral Thesis*, Warsaw University of Technology, 2011.
- [9] De Blaeij A., Florax R. J. G. M., Rietveld P., Verhoef E., The value of statistical life in road safety: a meta-analysis, *Accident Analysis and Prevention*, Vol. 35, Issue 6, Elsevier 2003.
- [10] Elvik R., Høy E., Vaa T., Sørensen M., *The Handbook of Road Safety Measures*, Second Edition, Emerald Group Publishing Ltd., UK, 2009.