

THE ANALYSIS OF SELECTED FACTORS HAVING A NEGATIVE IMPACT ON LAND TRAFFIC SAFETY IN POLAND

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Abstract – The selected factors determining land traffic safety in Poland from 2017 to 2023 were enumerated in the article. To assess the causes of road and railway accidents, among others, road users who were most often responsible for them were selected, as well as some inappropriate behaviours of drivers of motor vehicles and pedestrians that resulted in the highest number of dangerous traffic incidents were listed. The assessment of the causes of accidents also included the direct involvement of the railway system and the influence of a so-called third party. The number of accidents was also compared across different times of the year and day, identifying the greatest danger on Polish roads and railway lines.

Key words – accident perpetrators, land transport safety, railway accidents, road accidents

JEL Classification – K32, R41

INTRODUCTION

The safety of road traffic participants is one of the most significant challenges facing the authorities in Poland and many other countries, as the number of accidents and injured individuals in road and rail transport is significantly greater than the total in other ways of transportation – water and air. In Poland, from 2017 to 2023, the number of fatalities in road and railway accidents was 100% higher than in commercial air and maritime transport. Similar significant differences can also be observed in the example of European Union countries, as during the evaluated period there were 99.96% more fatalities in land accidents than in air and water transport [1]. The unfavourable situation on Polish roads, in the form of a large number of accidents, is certainly influenced by the choice of vehicles, both cars and trains, for fulfilling the daily travel needs of society and businesses, more frequently than is in the case of airplanes, ships, or ferries. The choice of land transport in order to meet private and business needs is also influenced by their availability, which results from the possibility of purchasing one's own car or from the possibility of using services offered by numerous road and rail carriers. The availability of land transport also means a dense network of communication connections and affordable costs of road and rail transport services for individual and business clients. Road transport vehicles, apart from private and commercial purposes, are also used to perform many special tasks as municipal, police, fire and rescue, or prison vehicles [2].

Traffic accidents are not only a threat to human health and life but are also connected with high costs of repairing personal and property damage. In order to limit the expenses resulting from the negative effects of traffic accidents it becomes reasonable to analyse the potential factors influencing road and rail safety, such as road and climatic conditions [3]. The responsibility of all road users, including drivers of motor vehicles, especially passenger cars, pedestrians, cyclists, and motorcyclists, plays an important role in reducing the number of land accidents in Poland, as they are most often the ones who negatively impact road and railway safety. It is extremely important to adhere to the existing rules of land traffic, to make decisions that minimise the risk of dangerous traffic incidents, to monitor the condition of the fleet and transport infrastructure, and to impose high penalties for irresponsible behaviour of traffic participants, such as driving at excessive speed, under the influence of alcohol and other substances [4-6], or ignoring warning signals at road-rail crossings. Investments in infrastructure for the construction of new safer routes, repairs of existing surfaces, and improvements in

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traffic organisation are of a great importance in improving the unfavourable situation, especially on Polish roads, where there are increasingly more vehicles.

The aim of the article is to analyse selected factors that pose a significant threat in reducing the sense of safety on roads and railway lines in Poland. This low level of safety on land routes concerns not only the society that travels daily by car or train for private or business purposes, but also relates to owners of various goods that should be delivered on time to individual and business clients, as the uncertain situation on the transport routes threatens their effective operations. The subject of the research presented in this article is primarily the irresponsible behaviour of drivers and pedestrians, the consequences of which are not only traffic accidents but also railway accidents. The aim of the article is to determine who is most often the perpetrator of road and railway accidents in Poland, as well as the reasons and time periods when such dangerous traffic incidents most frequently occur.

1. TRAFFIC ACCIDENTS IN LAND TRANSPORT ACCORDING TO THEIR PERPETRATORS

Traffic accidents on land are a serious problem for many countries, including Poland, which is a leader in the European Union in the ranking of places where the highest number of serious railway accidents has occurred. In 2023 there were 1567 serious railway accidents across the European Union, resulting in the deaths of 841 people; in Poland alone, there were as many as 159 fatalities, in Germany – 129, and in Romania 77 [1]. The negative impact on road safety in Poland from 2017 to 2023 was primarily created by drivers of passenger cars, trucks, and buses, as they were responsible for causing over 120.5 thousand accidents (Table 1). Among drivers of motor vehicles, the greatest threat on Polish roads was posed by owners of passenger cars – their share in this regard was around 85.6% during the assessed period [7]. Data on accidents caused by train drivers, shown in Table 1, refer only to situations where they displayed their irresponsible behaviour on railway lines (excluding incidents in sidings), i.e. [8]:

- failure to stop the train before the signal 'Stop' or at the designated place,
- starting the locomotive without the required permission,
- exceeding the maximum allowed driving speed,
- performing a dangerous manoeuvre,
- failure to secure against the runaway of a rail vehicle,
- colliding with a traction vehicle or another obstacle (e.g. brake shoe, luggage cart, postal cart, etc.),
- collision with a road vehicle (another road machine, agricultural machine).

In case of perpetrators of road accidents in Poland, caused by drivers of passenger vehicles, a positive trend can be observed in the years 2017-2022, namely a steadily decreasing number of dangerous incidents they contributed to. This means that in 2022, the number of accidents decreased compared to 2017 by 7,788 incidents, unfortunately, in 2023 there was a slight increase in such traffic events by 68 incidents. Analysing data on accidents caused by drivers of cars and trains in Poland from 2017 to 2023, it is worth noting that the involvement of train drivers was small – around 1.16%.

Table 1. Accidents in road traffic according to perpetrators – drivers of road and railway vehicles [7-8]

Perpetrators \ Years	2017	2018	2019	2020	2021	2022	2023
Drivers of passenger vehicles	21733	20622	19833	15429	15066	13945	14013
Drivers of service vehicles *	2695	2619	2503	1981	2259	2090	1831
Drivers of railway vehicles	258	255	228	186	255	222	232

* buses and trucks

The impact of selected road users on safety on Polish roads in the years 2017-2023 was subjected to further assessment. The data presented in Table 2 allows us to notice that apart from the drivers of motor vehicles who contributed to the greatest threats in road traffic, a significant share of the number of traffic accidents during the evaluated period also involved intoxicated individuals, pedestrians, and foreigners [9-11]. In the years 2017-2023, the number of accidents caused by certain perpetrators - road traffic participants - steadily decreased, for example, in the case of intoxicated individuals there was a decrease of 714, and in the case of pedestrians - there were 1371 fewer dangerous incidents. This is obviously a positive outcome, which may have

been influenced by numerous actions taken by those responsible for road safety in Poland. The situation could have been improved by the introduction of stricter penalties for violating existing rules, as well as various educational campaigns about proper behaviour on communication routes. Among the intoxicated participants in road traffic were drivers who under the influence of alcohol, caused 1600 accidents in 2023 (in which 251 people died). Traffic accidents caused by drunk drivers accounted for about 7% of all such incidents involving this group of road users. Their number decreased by 5.9% compared to the year 2022 [7].

Unfortunately, not in all cases analysed in Table 2 an improvement in the situation can be observed, for example, foreigners during the assessed period caused a smaller number of accidents only in 2020 compared to previous years, after which they cyclically posed an increasing threat to themselves and others. In 2021, compared to the previous year, foreigners caused 229 more accidents, in 2022 their number increased by 724, and in 2023 by another 162 dangerous traffic incidents. The significant increase in threats posed by perpetrators - individuals from outside the territory of the Republic of Poland - could have been caused by the large influx of refugees in 2022, resulting from the war started by the Russians in Ukraine. Among the perpetrators of road accidents in Poland who came from abroad, the majority were drivers of motor vehicles, as their share in the analysed years was over 52% and has been steadily increasing since 2020. Ukrainian drivers were the leaders among foreigners in road accidents in Poland, as their share in such traffic incidents in 2023 alone was over 88% compared to other nationalities. The reason for such a situation could be the unfamiliarity with the applicable traffic regulations among Ukrainians to a greater extent than among other foreigners, or reluctance to comply with the existing rules. In 2023, the next spots in the ranking of the most dangerous foreign drivers – responsible for the highest number of road accidents in Poland – were held by Georgians (143) and Belarusians (117) [7].

Table 2. Traffic accidents according to perpetrators [7]

Perpetrators \ Years	2017	2018	2019	2020	2021	2022	2023
Drivers	28359	27556	26534	20999	20623	19373	19058
Intoxicated individuals	2788	2779	2717	2540	2488	2248	2074
Pedestrians	2378	2119	1879	1385	1218	1084	1007
Foreigners	1260	1404	1445	1071	1300	2024	2186
Complicity	369	380	306	228	226	194	193
Passengers	130	116	126	100	125	130	128

Participants in road traffic, namely drivers of motor vehicles and pedestrians also pose a serious threat, as indicated by the information provided in Table 3, for the safe and timely delivery of passenger and freight railway services [12-14]. The leaders among the perpetrators of railway accidents, just as was the case with road traffic incidents, were car drivers in Poland from 2017 to 2023. They caused 950 accidents in railway traffic, the most in 2017 and the least in 2020. An important observation regarding the serious threats posed by road users to the safety of railway transport in Poland is the fact that the offenders listed in Table 3 – drivers of only certain vehicles – caused just 328 fewer accidents than train drivers in the years 2017-2023.

Table 3. Railway accidents according to perpetrators – selected participants of road traffic [8]

Perpetrators \ Years	2017	2018	2019	2020	2021	2022	2023
Passenger car driver	162	140	135	106	157	123	127
Van driver	5	13	9	15	13	5	19
Truck driver	11	19	10	15	15	18	8
Agricultural tractor driver	7	9	5	8	3	5	5
Pedestrian	18	23	26	15	20	17	22

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Table 4. Traffic accidents by perpetrators' age [7]

Perpetrators \ Years	2017	2018	2019	2020	2021	2022	2023
Do 18 lat	586	641	576	429	462	481	484
Od 18 do 24 lat	5550	5113	4910	3774	3653	3059	2898
Od 25 do 39 lat	9230	8726	8326	6699	6546	5855	5570
Od 40 do 59 lat	7328	7308	7142	5699	5682	5600	5643
Powyżej 60 lat	4428	4537	4465	3478	3418	3551	3571

2. TRAFFIC ACCIDENTS ON LAND ACCORDING TO THEIR CAUSES

The most serious threat to land traffic in Poland is the dangerous behaviour of road and rail participants, which results in traffic accidents and high costs for repairing the personal and material damages that occur during them. Among the perpetrators of traffic accidents, drivers of motor vehicles take the lead [2, 7]. Among their biggest transgressions are neglecting the applicable right-of-way rules, not adjusting driving speed to the conditions on the road, improperly performing manoeuvres (e.g., overtaking, turning, changing lanes), failing to yield to pedestrians, and not maintaining a safe distance between vehicles (Table 5). Analysing the most common causes of road accidents caused by drivers of motor vehicles in Poland, a significant improvement can be observed in 2023 compared to 2017. However, unfortunately, over the analysed years, there is no constant decreasing trend in the case of, for example, failing to yield the right of way and failing to yield to pedestrians. In addition to drivers of motor vehicles, pedestrians who are careless when crossing the road, cross it in prohibited places, or do so while the red light is on also contribute to the high accident rate on Polish roads (Table 6) [15-16]. The number of road accidents in Poland due to this pedestrian carelessness decreased from 1988 in 2017 to 829 in 2023.

Table 5. Causes of traffic accidents caused by drivers of motor vehicles [7]

Causes \ Years	2017	2018	2019	2020	2021	2022	2023
Failure to yield the right of way	7416	7488	7252	5708	5566	4526	4576
Inadequate speed for traffic conditions	6837	6256	6268	5516	5254	4468	4216
Inadequate speed for traffic conditions*	4600	4690	4405	3791	3914	4320	4260
Failure to yield to pedestrians	4094	3759	3535	2780	2606	2796	3054
Not maintaining a safe distance between vehicles	2555	2292	2216	1535	1607	1662	1538

* overtaking, circumventing, passing, turning, reversing, changing lanes, U-turns, crossing bicycle crossings)

Table 6. Causes of road accidents caused by pedestrians [7]

Causes \ Years	2017	2018	2019	2020	2021	2022	2023
Careless entry onto the road in front of an oncoming vehicle	1184	1031	941	701	614	539	516
Careless entry onto the road from behind a vehicle, obstacle	268	241	201	129	145	138	106
Crossing the road in a prohibited place	289	262	218	160	139	110	109
Entering the road at a red light	247	202	155	134	106	96	98
Lying, sitting, standing on the road	129	129	118	110	89	80	80
Walking on the wrong side of the road	107	103	103	72	63	76	57

Many land accidents occur at road and railway crossings, which are intersections where the movement of cars, pedestrians, cyclists, and trains intersects. These are some of the most critical points in the railway system from the perspective of traffic safety, which is why they meet the applicable technical conditions regarding visibility, lighting, the gradient of the road leading up to the crossing, the angle of intersection of the road with the track, as well as the provision of appropriate signage and devices warning of an approaching train and those used to close the crossing or passage with barriers. Despite many specialised devices, security measures, and strictly enforced rules at railway crossings and intersections, accidents still occur there, the causes of which can primarily be attributed to improper behaviour of the public and to a lesser extent to equipment failures and errors by rail transport personnel [17-19].

The causes of accidents in rail transport in Poland should be considered in two important areas. The first is the railway system and the second is the involvement of the so-called third party [20-21]. The analysis of the data presented in tables 7 and 8 shows that from 2017 to 2023, accidents due to the railway system had a significantly smaller negative impact on the safety of rail traffic in Poland, accounting for about 27%. The railway system, which can adversely affect the safety of passengers and cargo being transported by trains, includes issues related to the technical condition of rolling stock (locomotives, passenger and freight cars), elements of transport infrastructure, decisions made by traffic management personnel, and train drivers [22-23]. In 2023, the number of accidents caused by the railway system decreased by 26 compared to 2017. Among the most serious causes of accidents in railway transport in Poland between 2017 and 2023 are:

- damage, poor maintenance of the railway track or engineering structure – 155 dangerous traffic incidents,
- collision with a railway vehicle or another obstacle – 147 dangerous traffic incidents,
- not stopping a train in front of the signal 'Stop' or at the indicated location, as well as starting a train without the required permission – 145 dangerous traffic incidents.

Table 7. Causes of accidents at railway crossings dependent on the railway system [8]

Causes \ Years	2017	2018	2019	2020	2021	2022	2023
Total	170	160	149	92	141	147	146
Damage, poor maintenance of the railway track or engineering structure	37	21	28	16	22	17	14
Colliding with a train or another obstacle	28	18	23	15	22	20	21
Failure to stop the train at the 'Stop' signal or at the location where it should stop, operating without the permission	17	27	22	6	23	24	26
Damage, poor technical condition of the car (including running onto its structural part)	21	14	20	8	12	9	11
Dispatching, receiving, and operating the train on an improperly laid, unsecured track; improper handling of railway traffic control devices	23	11	13	8	11	12	18
Premature release of the track section or annulment of the closure and changing the switch under the railway vehicle	9	12	13	10	11	7	7

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Table 8. Causes of accidents at railway crossings dependent on third-party involvement [8]

Causes \ Years	2017	2018	2019	2020	2021	2022	2023
Total	451	447	376	314	370	370	377
Running over pedestrians on the tracks in prohibited places	179	203	142	133	137	175	165
Suicides	112	105	156	115	138	170	128
Running over pedestrians on the tracks at road-rail crossings	18	23	27	16	20	20	25
Suicidal attempts	12	16	15	27	13	13	19
Incidents involving individuals related to the movement of the railway vehicle (jumping, falling from the train)	27	21	19	3	7	9	16

Table 8 presents railway accidents in Poland from 2017 to 2023, caused by the involvement of a so-called third party. The largest contribution, almost 42%, to the reduction of railway transport safety due to the involvement of the so-called third party had incidents where trains collided with irresponsible individuals crossing the tracks in prohibited areas. The crossing of irresponsible individuals over tracks in unmarked places also contributed to more than half of the fatalities in railway accidents in the EU in 2023. Railway crossing users in Poland, including drivers ignoring signals, accounted for 27% of fatalities in 2023. During this period in Poland, as a result of intrusions onto the tracks, 114 people died, and another 39 fatalities were recorded at railway crossings. The victims also included three railway workers and one passenger [1]. A major problem was also the people who decided to die under the wheels of oncoming trains; there were as many as 924 suicides in Poland from 2017 to 2023, with the highest number in 2022 - 170. In the European Union, the number of suicides on the tracks - 2371 was higher in 2023 than the number of victims of railway accidents. Germany was the leader in this shameful ranking, with a number of 690 suicides, which accounted for almost one third of all such cases in the entire European Union [1]. Desperate people who decide to commit suicide on the railway tracks and no longer hope for improving their tragic situation, of course in their opinion, because the effectiveness of such a way of taking their own life is very high. It is assumed that over 90% of those attempting suicide on railway tracks involving a train die, and most of the remaining survivors suffer severe injuries [24].

3. TRAFFIC ACCIDENTS ON LAND ACCORDING TO THEIR TIME

An important factor in assessing road safety in Poland are also the weather conditions, which depend on the seasons and the varying availability of daylight during the day, where increased accident rates can be observed on roads and rail lines [4,25]. Variable traffic intensity, depending on whether these are summer months rich in holiday trips, vacation periods, or times with so-called long weekends, holidays or festivities, can have an adverse impact on safety in land transportation. A significant impact on the accident rate can also come from various seasonal difficulties, such as fog, rainfall, or snowfall. Tables 9 and 10 show information about road and railway accidents that occurred in Poland from 2017 to 2023 in different quarters [7]. Analysing the data presented in Table 9, it can be observed that the highest number of traffic accidents in Poland occurred in the third quarter of the evaluated years, namely in the months of July, August, and September, during which there are generally good driving conditions. The cause of the high number of accidents during this period, when the days are still long and visibility is very good, can be attributed to the heavy traffic on routes leading to the most popular vacation spots, haste, recklessness, and driver fatigue, as well as a lack of focus on what is happening around them on the road. The number of accidents in all periods of 2023 has decreased significantly compared to 2017 but unfortunately, it cannot be stated that the situation is improving cyclically from year to year. The safest periods for road users in Poland were the first quarters of 2021 and 2023, as the number of accidents during those times was 3695 and 3807 respectively, while the worst period was in 2017 in the third and fourth quarters, when there were as many as 9465 and 9123 such unfortunate traffic events.

Table 9. Road accidents by quarters [7]

Period \ Years	2017	2018	2019	2020	2021	2022	2023
Quarter I	5741	5872	5944	5279	3695	4104	3807
Quarter II	8431	8676	7894	5108	6073	5947	5518
Quarter III	9465	8985	8544	7369	7017	6293	6403
Quarter IV	9123	8141	7906	5484	6031	4963	5208

Table 10. Rail accidents by quarters [8]

Period \ Years	2017	2018	2019	2020	2021	2022	2023
Quarter I	138	140	127	105	123	114	129
Quarter II	137	139	149	80	112	113	111
Quarter III	171	176	108	111	137	140	131
Quarter IV	175	152	137	110	139	150	152

According to the safety assessment on railway lines in Poland from 2017 to 2023, the most accidents occurred in the fourth quarter, which includes months such as October, November, and December, accounting for about 27% of the total number of such negative traffic events. The worsening weather conditions, fog, rainfall, and snowfall, as well as the increasingly shorter access to daylight – a significant reduction in visibility for all road users – may have influenced such a situation. A lot of accidents also happened during the holiday and vacation months of July, August, and September - about 26%.

This article also evaluates the influence of times of day on accidents in road and rail transport in Poland from 2017 to 2023 (tables 11 and 12). Traffic intensity over the course of a day, as was evident from the example of different months of the year, can vary and depends on the existing demand to meet the transportation needs of society and economic entities at different hours. Certainly, different traffic on the roads and rail lines can be observed in the morning and midday hours compared to nighttime. The so-called peak communication times, which have a significantly higher traffic intensity than at other hours, are caused by the aforementioned transportation needs of society, arising from professional obligations, the necessity of commuting to and from workplaces, dealing with various administrative matters, as well as pursuing health, educational, and cultural-recreational goals. On the other hand, the supply of many institutions as well as manufacturing, service, and trade enterprises with everything that allows them to operate effectively also takes place at specific times of the day, and thus also affects the intensity and safety of road traffic.

Table 11. Road accidents by times of day [7]

Times of day \ Years	2017	2018	2019	2020	2021	2022	2023
6.00 – 9.59	5850	5575	5472	4009	4178	3892	3858
10.00 – 13.59	7539	7317	7034	5361	5417	4871	4733
14.00 – 17.59	9947	9757	9113	7183	6808	6653	6497
18.00 – 21.59	6174	6033	5730	4591	4207	3816	3859
22.00 – 1.59	1826	1694	1639	1315	1191	1146	1095
2.00 – 5.59	1424	1298	1300	1081	1015	944	894

The data presented in table 11 regarding the number of road accidents in Poland in the selected years for analysis indicates that the most threats to road users occurred in the afternoon hours from 2 PM to 5:59 PM, specifically during the time when people return from workplaces, offices, health centres, and educational institutions to their homes, during commutes for those who work in a two-shift system fulfilling their professional duties, as well as during the period of shopping in retail chains or utilizing other still available services. An important

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problem related to the high number of accidents on Polish roads from 2017 to 2023 in the aforementioned afternoon hours is evidenced by the fact that over 48,000 more such traffic incidents occurred during that time than in the safest hours between 2 and 5:59. Similar conclusions about the impact of the time of day on traffic safety, obtained from the analysis of the number of road accidents, can also be drawn from the assessment of such traffic incidents on railway lines. The data presented in table 12 allow us to establish that on railway lines in Poland from 2017 to 2023, the least safe hours were between 2 PM and 5:59 PM with 828 accidents, while the calmest hours were between 2 AM and 5:59 AM with 394 accidents.

Table 12. Rail accidents by times of day [8]

<div>Years</div> <div>Times of day</div>	2017	2018	2019	2020	2021	2022	2023
6.00 – 9.59	112	103	91	56	91	82	84
10.00 – 13.59	111	114	90	93	89	114	95
14.00 – 17.59	140	147	116	84	129	111	101
18.00 – 21.59	118	103	107	93	94	102	104
22.00 – 1.59	60	61	76	48	55	57	83
2.00 – 5.59	78	79	45	32	53	51	56

CONCLUSIONS

The analysis of road traffic safety in the years 2017-2023 presented in this article allows us to observe that there were significantly more traffic accidents on Polish roads than on railway lines. An important conclusion drawn from the conducted analyses is also the fact that the largest number of road accidents at that time were caused by drivers of passenger cars, as they were responsible for a total of over 120.6 thousand such dangerous traffic incidents. The number of railway accidents - 950 - also testifies to how irresponsible car drivers were on the roads in Poland, as they contributed to these incidents in the analysed years. When evaluating the number of traffic accidents caused by passenger car drivers in the years 2023 and 2017, a significant improvement can be observed, as there has been a reduction of over 35% in road traffic and 21% in railway traffic.

The most common causes of accidents on Polish roads caused by drivers of motor vehicles were failure to give way and excessive speed not adapted to traffic conditions, totalling over 81,000 incidents. However, the reason for the largest number of railway accidents in Poland was the involvement of so-called third parties – individuals whose irresponsible actions contributed to the occurrence of over 2.7 thousand such dangerous traffic incidents between 2017 and 2023.

Evaluating the impact of weather conditions during different seasons on road accidents in Poland, one can conclude that the most dangerous period from 2017 to 2023 was the third quarter, the time of summer holiday travels, which accounted for almost 30% of the total number of traffic incidents. On the other hand, in rail transport, the most dangerous period was the fourth quarter, which includes the last months of autumn and the beginning of winter, thus the worsening weather conditions, as its share in the total number of traffic accidents was over 27%.

ANALIZA WYBRANYCH CZYNNIKÓW WPŁYWAJĄCYCH NEGATYWNIE NA BEZPIECZEŃSTWO RUCHU LĄDOWEGO W POLSCE

W artykule wymieniono wybrane czynniki kształtujące bezpieczeństwo ruchu lądowego w Polsce w latach 2017-2023. Do oceny przyczyn wypadków drogowych i kolejowych wytypowano m.in. uczestników ruchu, którzy byli najczęściej ich sprawcami oraz wymieniono niewłaściwe zachowania kierowców pojazdów samochodowych i pieszych skutkujące największą liczbą niebezpiecznych zdarzeń komunikacyjnych. Do oceny przyczyn wypadków wytypowano także bezpośredni udział systemu kolejowego i wpływ tzw. strony trzeciej. Porównano także liczbę wypadków w różnych porach roku i dnia, w których było najbardziej niebezpiecznie na polskich drogach i liniach kolejowych.

Słowa kluczowe: sprawcy wypadków, bezpieczeństwo transportu lądowego, wypadki kolejowe, wypadki drogowe.

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