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ASSESSING THE IMPACT OF TRUCKING INFRASTRUCTURE ON FREIGHT EFFICIENCY AND SAFETY

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Resume

The change in people's lifestyles, their desire or compulsion to move constantly and the development of technology, have forced development of communications, which has led, among other things, to an intensive increase in traffic. For this reason, the purpose of the article is to identify the main causes of traffic delays and the factors affecting the sense of safety on the road. It is followed by the analytical part, which presents the effect of a survey conducted on a group of 401 respondents. The respondents' answers show that the most common causes of road accidents and collisions are: failure to adjust the speed to road conditions (89 %), failure to give priority (84 %), which is in line with the 2019 police report. The results show a clear difference between Western Europe and Eastern Europe.

Article info

Received 20 October 2022

Accepted 19 January 2023

Online 22 February 2023

Keywords:

road infrastructure
Poland
Europe
road safety
road transport

Available online: <https://doi.org/10.26552/com.C.2023.029>

ISSN 1335-4205 (print version)

ISSN 2585-7878 (online version)

1 Introduction

Year after year, people are changing their lifestyles. This is due, among other things, to the need for constant movement and the development of technology. This leads to the increased development of communications and an intense increase in traffic.

As we read in the article by Hoy, women's motivating factors for travel are shopping, accompanying others, including children to school and with administrative errands. It should also be noted that "motivations to travel are not fixed, but depend on specific life situations and change with the stages of a person's life, [1]. The key stages affecting travel behaviour are: becoming employed, having children and retiring." The article also notes that men are more likely to use cars and women are more likely to use public transportation. In the article below, women make up 18% of respondents and men 82%.

Road safety is worth leaning into. However, as the author Racynska-Bulawa noticed, increasing the road safety requires intervention in many aspects of public policy [2]. The road safety policy directions for 2011-2020, set by the European Commission, clearly indicate that a forward-looking road safety policy should be taken into account in other EU policy areas, while at the same time such a policy should take into account

the objectives of other policy areas. Road safety is closely linked to policies on energy, environment, employment, education, youth, public health, research, innovation and technology, justice, insurance, trade and foreign affairs, among others.

Among the factors that have a decisive impact on the road safety (human-road-vehicle as a causal factor in accidents), the first place is definitely occupied by humans. It is the behaviour of particular groups of road users, in general, that affects the occurrence of traffic accidents - argue author of [3]. When driving on the road, certain rules and regulations must be observed [4]. Improving road safety is influenced by many elements, related not only to the promotion of correct driver behaviour [5-7], but to the proper organization of traffic and the proper technical condition of roads and vehicles, as well, [8-11]. Training and examinations for future drivers should also be considered. The road safety is a scientific field that includes the above-mentioned aspects, as well as issues related to traffic supervision, emergency medical services and transport psychology [12]. The problem of using the road as a means of transportation in terms of safety is discussed in [13-23].

The European Commission's efforts to further improve the road safety are based on the adopted long-term EU goal of achieving zero fatalities and serious injuries in the road transport by 2050, i.e. "Vision

Zero” and “Safe System.” Published on the European Commission’s website, the document sets the goal of to reduce road fatalities and serious injuries by 50% by 2030 compared to 2020 [24]

2 Research

2.1 Purpose and methodology of the survey

The survey was conducted in late 2021 and early 2022 among residents of Poland. The collection of respondents’ opinions needed for the survey was carried out through two research methods: an online survey and through direct collection of information. The survey was posted on forums, related to transportation, on social media and among friends. The survey was fully anonymous, contained 12 questions and consisted of

three parts: a brief driver metric, questions about drivers’ feelings about the road safety and an assessment of infrastructure in European countries.

The main purpose of the survey was to find out the opinions of the road transport users on road safety and the causes of traffic delays and to compare European countries in terms of infrastructure. The countries that were pitted against each other in the survey are: Poland, Austria, Belgium, Czech Republic, France, Germany, Hungary, Lithuania, the Netherlands, Romania, Slovakia, Spain and the United Kingdom. Those countries were selected based on a report by OCRK (the National Center for Driver Accountability), which indicates to which countries Polish drivers travel the most often [25]. The survey includes mainly adult respondents with a driver’s license, although this is not a prerequisite. One of the main goals was also to acquire at least 350 responses, including the opinions of at least

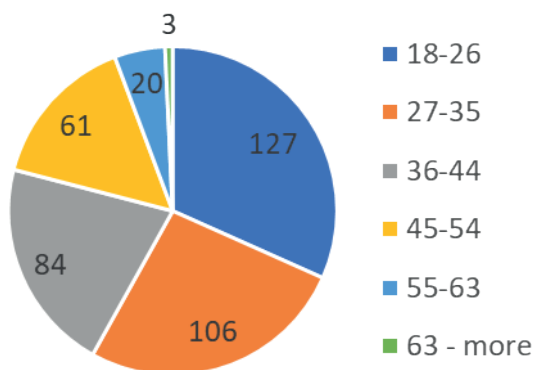


Figure 1 Age of respondents

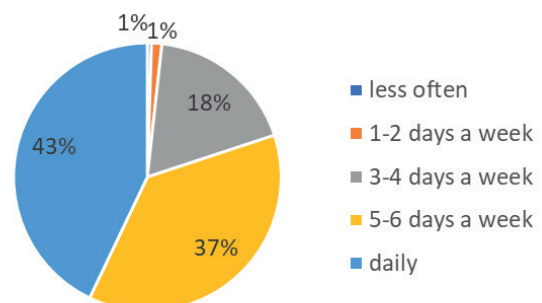


Figure 4 Frequency of vehicle use per week by respondents

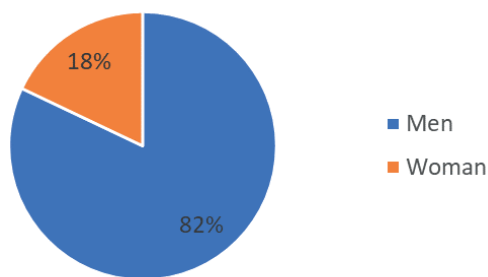


Figure 2 Gender of respondents

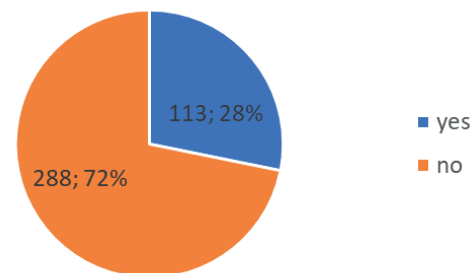


Figure 5 Number of professional drivers

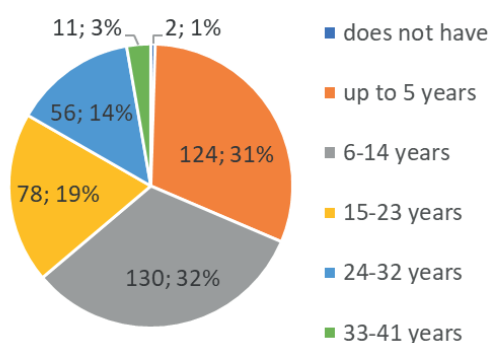


Figure 3 Length of time respondents have held a driver’s license

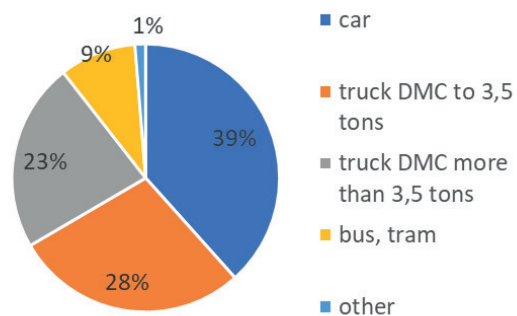


Figure 6 The mode of transportation most frequently used by respondents

100 professional drivers. The next step in implementing the survey was to calculate the research sample. For Poland (population 38151 thousand), assuming a confidence level of 95 % and a maximum error of 5 %, the required number of survey respondents was 384. The survey was completed by 401 respondents.

Respondents' responses were also analysed for metric questions, namely. Gender, age, seniority of driver's license, professional driver, frequency of use of transportation and mode of transportation. In addition, two analyses (by gender and age) were considered in the context of the Chi-square statistics. This statistical test is used to make hypotheses for random variables. One can test, whether the variables are related to each other by the common pattern of the results obtained. If the theoretical Chi-square was less than the calculated one, then there is a significant relationship between the variables. The formula for the chi square test of concordance has the following form [25]:

$$\chi^2 = \sum_{i=1}^r \frac{(f_i - np_i)^2}{np_i}, \quad (1)$$

where: χ^2 - Chi-square test,

f_i - the number of observed values from a given interval,
 np_i - number of units (n) that should be in a given interval (expected values of the intervals).

2.2 Results

The survey was completed by 401 respondents in different age ranges: 18-26, 27-35, 36-44, 45-53, 54-62, 63-71. Above the age of 71 there were no respondents. The largest group of respondents was in the 18-26 age range (32 %), followed by 27-35 (26 %), 36-44 (21 %), 45-53 (15 %), 54-62 (5 %) and 63-71 (1 %). Efforts were made to have respondents in each age range, which presented some difficulty especially in the 54-62 (5 %) and 63-71 (1 %) age ranges (Figure 1). Women accounted for 18 % of the respondents and men 82 %. (Figure 2).

Next, the question asked was how long they have held their driver's license. The largest range is those who have had a driver's license for 6 to 14 years (32 %), followed by up to 5 years (31 %), 15-23 (19 %), 24-32 (14 %), 33-41 (3 %) and over 42 years (1 %). Two people did not have a driver's license (Figure 3).

In the next question, respondents were asked to specify the frequency of use of transportation. By far the largest number of respondents use means of transportation daily and 5-6 times a week, 43 % and 37 % respectively. This was followed by 3-4 times a week (18 %), 1-2 times a week (1 %) and less often (1 %) (Figure 4).

The fifth question concerned the breakdown of professional drivers. A professional driver is a person who has an entry in the driving license document with code 95 and a valid certificate of professional qualification. This includes driving license categories C, C+E, D [26]. Among the respondents, there were 113

professional drivers (28 %). This result was achieved mainly by posting the survey on groups, forums specifically related to this profession, as well as through their own acquaintances (Figure 5).

In the sixth question, respondents were asked to indicate which mode of transportation they use the most often. Respondents most often use cars (39 %), followed by vans, trucks up to 3.5 tons (28 %), trucks over 3.5 tons (23 %), bus, streetcar (9 %) and others (Figure 6).

Analysis of responses by gender. The first question concerned the age of the respondents. Here we can see a significant difference between some age ranges. From the Chi-square test with a significance of 0.05, one can conclude that the variables are not independent, as χ^2 is 41.80 and the theoretical χ^2 is 11.07. The next question shows the respondents' answers regarding the time of holding a driver's license. The Chi-square test with a significance of 0.05 shows that there is a relationship between gender and the time of holding a driver's license, as χ^2 is 34.55 and χ^2 theoretical is 11.07.

The third question concerns the frequency of use of means of transportation. The answers showed that respondents most often use means of transportation 5-6 times a week and daily. The number of degrees of freedom was 4 that is, the critical value of the Chi-square test is 9.488. The result of the Chi-square test was 17.73, this means that the results are statistically significant for a significance level of $p = 0.05$.

Question four asks whether the respondent is a professional driver. The number of degrees of freedom is 1, so the critical value of the Chi-square test is 3.841. The result of the Chi-square test was 12.287. This means that the results are statistically significant for the significance level of $p = 0.05$. The fifth question asks what type of transportation respondents use most often (multiple choice). The respondents' answers show that they most often use a personal car (Table 1).

The results of question six show that there is a relationship and this is confirmed by a Chi-square test result of 723.09 with a theoretical 43.77. (Number of free degrees 30). Respondents are most likely to take their driving test just after they turn 18.

The next table shows the respondents' answers on the use of any means of transportation. The Chi-square test with a significance of 0.05 shows that there is a relationship between gender and the time of holding a driver's license, as χ^2 is 42.80 and χ^2 theoretical is 26.30 (number of degrees of freedom 16). Question eight - where the result of the Chi-square test indicates that there is no correlation between these concepts. The χ^2 test result is 6.67, while χ^2 theoretical is 11.07 (number of degrees of freedom 5). Another analysis looks at the frequency of transportation use in relation to gender (Table 2).

People in the age range of 18-26, 54-62 and over 62 are less likely to use means of transportation during the week. Item 11 of the table shows that those with a driver's license for up to 5 years, 6-14 years and 15-23

Table 1 Research results

Category	Fermale (%)	Male (%)
1. Age		
18-26 years	61.11	25.34
27-35 years	26.39	26.74
36-44 years	8.34	23.1
45-53 years	4.16	17.63
54-62 years	0.00	6.08
63-71 years	0.00	0.91
2. Time to hold a driver's license		
I do not own	2.77	0.00
Up to 5 years	52.77	26.13
6-14 years	29.16	33.16
15-23 years	11.1	21.27
24-32 years	4.6	16.1
33-41 years	0.00	2.26
Over 42 years	0.00	1.08
3. Frequency of transport use		
Less often	2.77	0.00
1-2 times a week	4.16	0.6
3-4 times a week	15.3	18.84
5-6 times a week	43.05	45.28
Daily	34.72	52.28
4. Is the respondent a professional driver?		
Yes	11.11	31.91
No	88.88	68.09
5. Type of means of transportation		
Passenger car	79.16	70.51
Light truck with GVW up to 3.5T	8.33	46.8
Vans with a gross vehicle weight of more than 3.5T	9.72	31.3
Bus streetcar	19.44	9.72
Other	2.77	1.82

years are using transportation most frequently. The likely reason for these results is that these people are the most active and travel daily or 5-6 times a week.

Not surprisingly, professional drivers use means of transportation much more often (Table 3).

Of the professional drivers surveyed, 92.93% are men. This is a very difficult profession, which generally requires leaving home even for several weeks. In recent years, however, more and more female professional drivers can be observed. The largest number of professional drivers is among respondents who have held a driver's license for 6-14 and 15-23 years (item 14). This is due to the fact that professional drivers can become professional drivers after the age of 21 and the fact that it is quite an expensive course. Professional drivers move much more frequently 5-6 days a week and every day. In those who are not professional drivers, the

frequency of transportation use is more spread out (item 15) (Table 4).

Since most of the women surveyed are young, they most often hold a driver's license for up to 5 years. As the age of holding a driver's license increases, the prevalence of men in this aspect increases (item 16) (Table 5).

Another part of the questions dealt with drivers' feelings about delays in transportation and road safety. Respondents were asked to select factors related to delays and safety, which were given by the authors of the paper. According to respondents, the most common causes of transportation delays are traffic congestion (82%) and poor road class (69%). As other factors, respondents pointed to weather conditions (53%), the condition of the road surface (39%), poor information flow between companies (33%), the quality of rolling stock (30%), poor company storage facilities (loading,

Table 2 Research results

Criterion	Number of responses (%)					
6. Age breakdown of respondents regarding holding a driver's license						
Age	18-26	27-35	36-44	45-53	54-62	63-71
Don't own	0.24	93	0.00	0.00	0.00	0.00
Up to 5 years	81.25	8.41	3.68	0.00	0.00	0.00
6-14 years	17.96	81.3	7.31	1.63	0.00	0.00
15-23 years	0.00	9.34	75.6	9.83	0.00	0.00
24-32 years	0.00	0.00	13.41	85.24	22.53	0.00
33-41 years	0.00	0.00	0.00	3.27	77.47	0.00
Over 42 years	0.00	0.00	0.00	0.00	0.00	0.00
7. Breakdown of respondents by age versus frequency of transportation use						
Age	18-26	27-35	36-44	45-53	54-62	63-71
Less often	1.56	0.00	0.00	0.00	0.00	0.00
1-2 times a week	2.34	0.93	0.00	1.63	5	33.33
3-4 times a week	22.65	14.01	17.07	13.11	30	33.33
5-6 times a week	40.62	40.18	30.48	32.78	45	0.00
Daily	32.81	44.85	52.43	54.09	20	33.33
8. Responses of respondents by age regarding professional driver						
Age	18-26	27-35	36-44	45-53	54-62	63-71
Yes	20.31	29.9	32.92	31.14	40	33.33
No	79.59	69.1	67.08	68.86	60	66.66
9. Respondents' responses by frequency regarding gender						
frequency	less frequently	1-2 per week	3-4 per week	4-5 per week	daily	
Female	100	60	15.06	20.8	14.53	
Male	0.00	40	84.94	79.8	85.47	

Table 3 Research results

Criterion	Number of responses (%)				
10. Respondents' answers by frequency regarding age					
Frequency	less frequently	1-2 per week	3-4 per week	4-5 per week	daily
18-26	100	50	39.72	34.89	24.41
27-35	0.00	16.66	20.54	28.85	27.9
36-44	0.00	0.00	19.17	16.77	25.00
45-53	0.00	0.00	10.95	13.42	19.18
54-62	0.00	16.66	8.21	6.04	2.32
above 62	0.00	16.66	1.36	0.00	0.58
11. Respondents' responses by frequency regarding having a driver's license					
Frequency	less frequently	1-2 per week	3-4 per week	4-5 per week	daily
I do not own	50.00	0.00	1.36	0.00	0.00
Up to 5 years	50.00	33.33	21.91	31.2	25.00
6-14 years	0.00	33.33	17.18	30.2	33.13
15-23 years	0.00	0.00	8.21	20.8	22.67
24-32 years	0.00	0.00	6.84	12.75	15.11
33-41 years	0.00	16.66	1.36	5.36	5.23
over 42 years	0.00	16.66	0.00	0.00	0.58
12. Respondents' answers by frequency regarding professional driver					
Frequency	less frequently	1-2 per week	3-4 per week	4-5 per week	daily
Yes	0.00	0.00	6.84	27.51	38.95
No	100.00	100.00	93.16	67.49	61.05

Table 4 Research results

Criterion	Number of responses (%)	
13. Responses of respondents by professional driver regarding gender		
Professional driver	Yes	No
Female	7.07	22.22
Male	92.93	77.88
14. Responses of respondents by professional driver regarding the length of time they have held a driver's license		
Professional driver	Yes	No
I do not own	0.00	0.69
Up to 5 years	12.98	38.19
6-14 years	32.74	32.19
15-23 years	30.08	15.27
24-32 years	17.69	11.8
33-41 years	6.19	1.04
Pow 42	0.88	0.69
15. Respondents' answers by professional driver regarding frequency		
Professional driver	Yes	No
less often	0.00	0.69
1-2 per week	0.00	1.73
3-4 per week	4.42	23.61
5-6 per week	36.28	37.5
daily	59.29	36.45

Table 5 Research results

Criterion	Number of responses (%)						
16. Responses of respondents by time of holding a driver's license regarding gender							
Driving license time	I don't have	Up to 5 years	6-14 years	15-23 years	24-32 years	33-41 years	above 42
Female	100.00	30.64	16.15	10.25	5.35	0.00	0.00
Male	0.00	69.36	83.85	89.75	94.65	100.00	100.00

unloading) (29 %), the method of loading and unloading (25 %), a road accident (20 %), vehicle breakdown (17 %) and driver or GPS navigation errors (14 %) (Figure 7).

Another issue concerned respondents' feelings about factors affecting the road safety. According to respondents, the sense of safety on the road is most influenced by driver experience (71 %), followed by driver's rest (65 %), class of the road (highway, expressway) (60 %), psychomotor efficiency (55 %), weather conditions (45 %), technical condition of the vehicle (43 %), adapted traffic volume to the road capacity (26 %), condition of the road surface (25 %), use of road junctions (type WA - completely collision-free junction, where the tracks do not intersect; WB type - partially collision-free, on one road the tracks of some relations intersect) (20 %), proper signage and signalling (19 %), road controls and speed cameras (12 %), road safety barriers (6%) and proper lighting of roads, tunnels (4%) (Figure 8).

The respondents' answers show that the most common causes of traffic accidents and collisions are: failure to adjust speed to the road conditions (89 %), failure to give priority (84 %), improper overtaking,

turning, turning around, changing lanes, stopping (64 %), failure to maintain a safe distance between vehicles (41 %), failure to give priority at a pedestrian crossing (54 %), improper overtaking (37 %), fatigue, falling asleep (31 %), distraction (ringing phone, smoking, drinking beverages, talking) (16 %), failing to obey other signs and signals (23 %), driving under the influence of alcohol or psychoactive substances (23 %), weather conditions (16 %), crossing the road in a prohibited place by a pedestrian (11 %), driving without the required lighting (10 %), sudden braking (7 %), vehicle breakdown (5 %), psychological stress (distress) (4%) (Figure 9).

The last part of the survey questions was to rate each European country in terms of the road safety and infrastructure. Drivers had to rate 14 countries, the rating scale was as follows: 1 - terrible, 2 - poor, 3 - average - 4 good and 5 - very good. Questions included an assessment of the feeling of safety on the country's roads, the density of the road network, the density of gas stations, the quality of roads, signage and parking lots (Table 6).

The survey showed the most common causes of

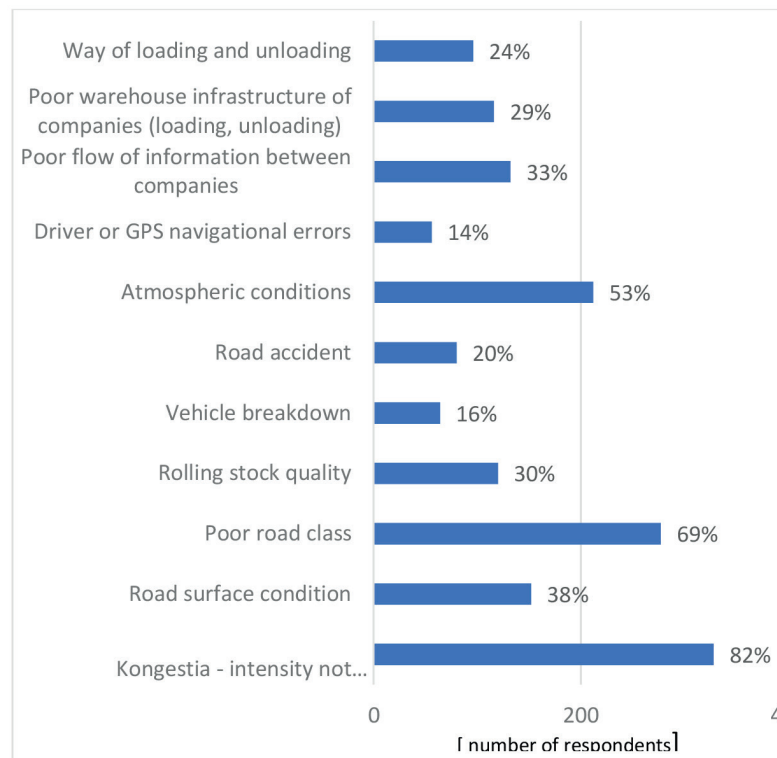


Figure 7 Factors affecting transportation delays

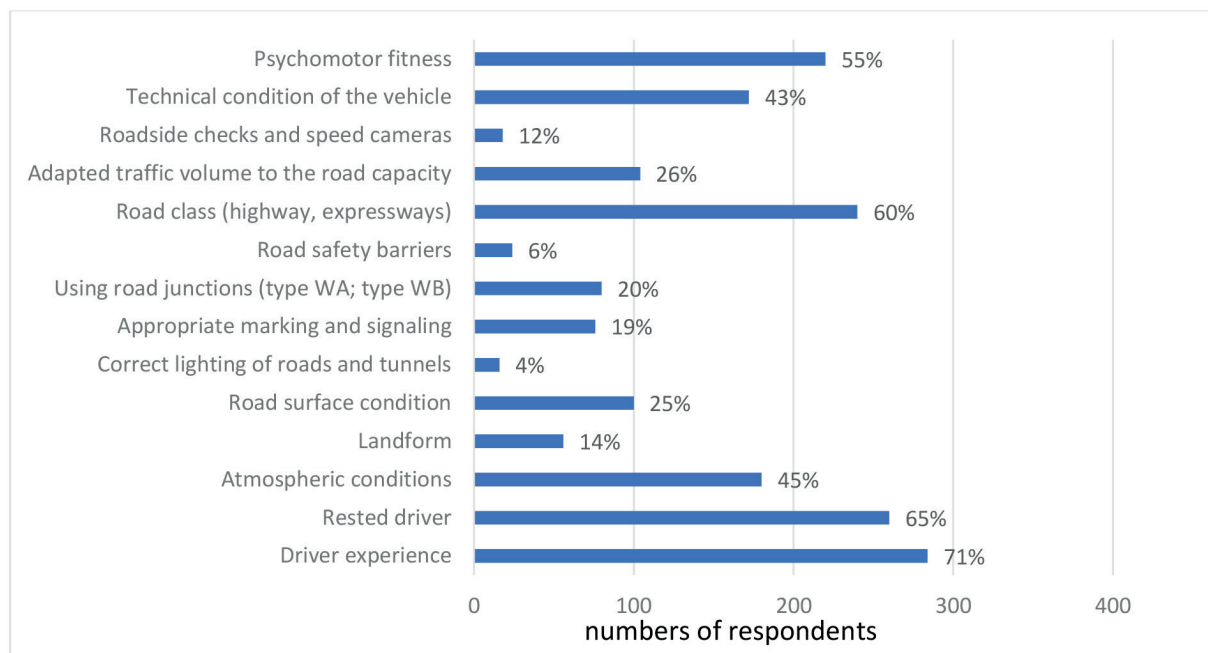


Figure 8 Factors affecting feelings of safety on the road

delays in transportation. These include traffic congestion (82%) and poor road class (69 %). These reasons are somewhat interrelated, as it is common for a road in a given location to have insufficient capacity. A high score was given to the factor of weather conditions (53 %). Considering recent years in Europe, weather conditions can be extreme and changeable. In the summer, drivers especially have to contend with hot weather, which causes fatigue and thus reduced

concentration. Precipitation can be very intense, due to which the average speed of vehicles decreases. In winter, the main obstacles to transportation are ice and snow. Most of the surveyed people working as drivers marked at least one answer from the following: poor flow of information between companies (33 %), poor storage infrastructure of companies (loading, unloading) (29 %), method of loading and unloading (25 %). From these responses it can be concluded that companies still need

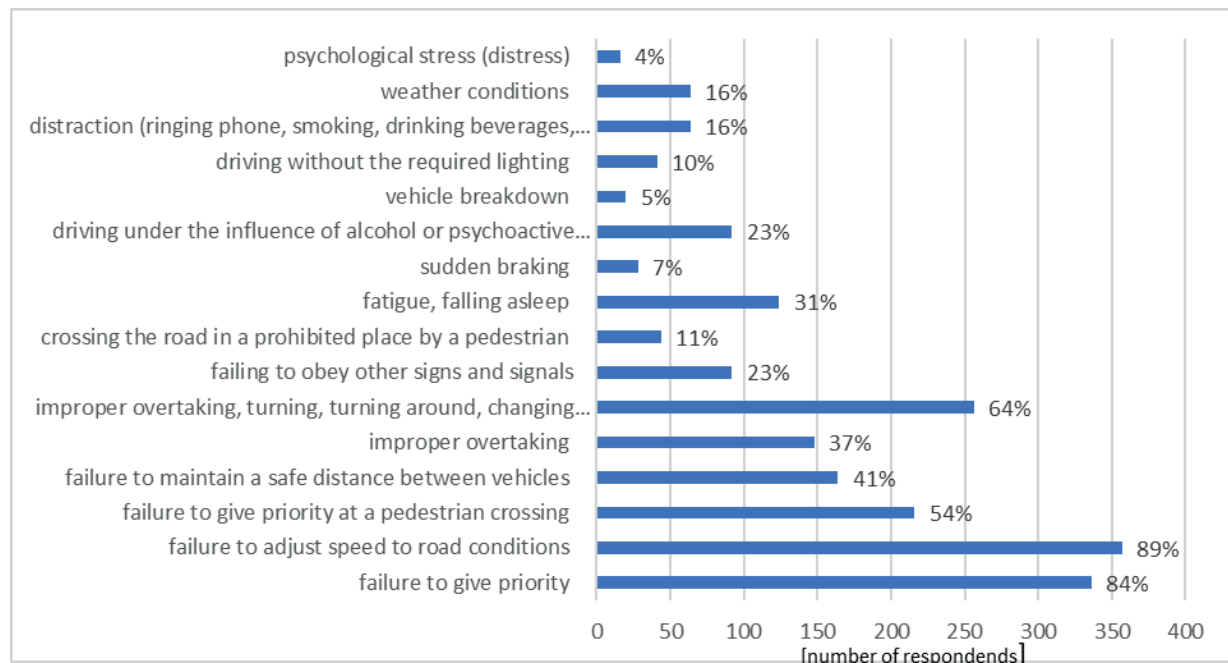


Figure 9 Most common reasons for accidents, traffic collisions

Table 6 Places and ratings of European countries in each statement [27]

Country	A sense of security	Density of the road network	Fuel station density	Quality of roads - condition of pavement	Signage	Parking lots
Austria	4 4.02*	4 4.07*	6 3.98*	2 4.25*	3 4.05*	4 3.17*
Belgium	8 3.31*	2 4.5*	1 4.52*	9 3.1*	7 4*	10 2.91*
Czech Republic	9 3.16*	10 3.53*	5 4.04*	12 2.62*	10 3.6*	13 2.59*
France	6 3.71*	5 4.01*	10 3.79*	5 3.75*	5 4.08*	2 3.47*
Spain	5 3.77*	6 3.93*	9 3.86*	4 3.91*	4 4.16*	3 3.42*
Netherlands	1 4.41*	1 4.59*	2 4.46*	1 4.36*	2 4.64*	1 3.61*
Lithuania	12 2.9*	13 2.95*	13 3.18*	7 3.41*	13 3.58*	12 2.65*
Germany	2 4.04*	3 4.22*	4 4.27*	3 4.12*	1 4.35*	7 3.01*
Poland	13 2.88*	12 3.06*	8 3.86*	10 2.85*	8 3.65*	5 3.15*
Romania	14 2.13*	14 2.5*	14 2.83*	14 2.11*	14 3.66*	14 2.24*
Slovakia	7 3.5*	11 3.09*	12 3.43*	13 2.51*	11 3.46*	11 2.67*
Hungary	10 3.09*	8 3.7*	11 3.53*	11 2.66*	9 3.29*	6 3.07*
United Kingdom	3 4.02*	7 3.86*	7 3.92*	6 3.62*	6 3.96*	8 2.96*
Italy	11 3.02*	9 3.68*	3 4.31*	8 3.21*	12 3.71*	9 2.94*

* evaluation of respondents

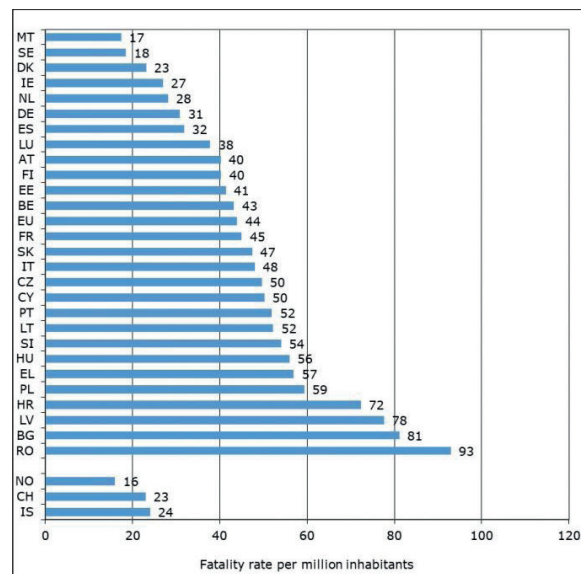


Figure 10 Number of road fatalities per million inhabitants by country, 2021 [28]

to improve their work organization, as well as their storage infrastructure.

According to respondents, the feeling of safety on the road is most often influenced by the experience of the driver (71%) - almost 85% of responses to the driver experience factor were given by those who have more than 6 years of driving license. This is followed by driver rest (65 %), class of the road (highway, expressway) (60%) and psychomotor efficiency (55 %), weather conditions (45%) and technical condition of the vehicle (43 %). This shows that drivers' sense of safety is influenced by a number of factors, ranging from the general condition of the driver to road infrastructure and natural phenomena.

Respondents' answers regarding the main causes of traffic collisions and accidents show that the public is knowledgeable on the subject. Comparing the respondents' surveys with the report Road accidents in Poland in 2021, created by the Traffic Bureau of the Police Headquarters, many similar conclusions can be found. Respondents identified as the main factors in traffic collisions and accidents: failure to adjust speed to road conditions (89 %), failure to give priority (84 %), improper passing, turning, turning around, changing lanes, stopping (64 %), failure to maintain a safe distance between vehicles (41 %), failure to give priority at pedestrian crossings and in other circumstances involving pedestrians (54 %), improper overtaking (37%) and fatigue, falling asleep (31%) In the Police report, these factors statistics account for the following number of accidents: failure to adjust speed to road conditions (5,254; 23% of all accidents), failure to give precedence to pedestrians (5,566; 24% of all accidents), improper bypassing, turning, reversing, turning, changing lanes, stopping, stopping (4,185; 18% of all accidents), failure to maintain a safe distance between vehicles

(1,607; 7% of all accidents), failure to give priority at pedestrian crossings and in other circumstances involving pedestrians (2,487; 11 %), improper overtaking (1,012; 4%) and fatigue, falling asleep (538; 2 %). Adding up these factors, they caused about 95% of all the traffic collisions and accidents caused by drivers in 2019. This shows that people are aware of what causes lead to incidents on the roads and yet Poland has a very high road fatality rate of 77 people per million. A very positive note is that as many as 23% and 16% got the answers in turn: driving under the influence of alcohol or psychoactive substances and distractions (a ringing phone, smoking, drinking a drink, talking), respectively. In police statistics, these responses do not appear. That is because they are attributed to other factors, such as failure to adjust speed to road conditions or under the term "other." This is because they often appear together. The large number of votes cast by respondents for these factors shows that all the advertising spots and media campaigns work.

3 Assessment of the feeling of security in European countries

Another issue was to assess the state of the feeling of safety in European countries. The averages obtained were compared to the statistics in 2021 of fatal accidents per million inhabitants of a country. The country with the highest average of deaths per million of population is Romania (93), followed by Bulgaria (81), Latvia (78), Croatia (72), Poland (59), Greece (57), Hungary (56), Slovenia (54), Latvia and Portugal (52), Cyprus and Czechia (50), Italy (48), Slovakia (47), France (45), Belgium (43), Estonia (41), Austria and Finland (40), Luxembourg (38), Spain (32), Germany (31), Netherlands

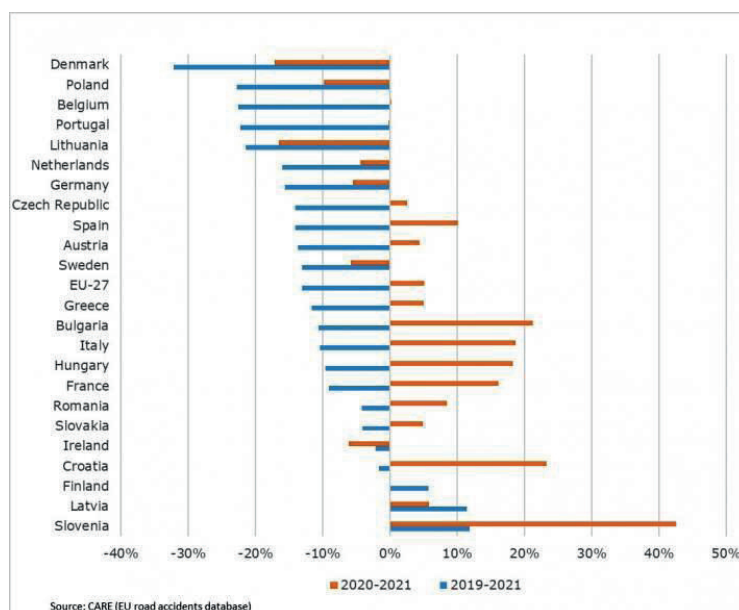


Figure 11 Short-term trend in the number of road fatalities (2021 compared to 2019 and 2020) [28]

(28), Ireland (27, Denmark (23), Sweden (18) and Malta (17) (Figure 10).

Comparing 2019 to 2021, it is Slovenia that has the largest increase in road fatalities, up 43%. This represents the largest increase in the EU. The next country is Croatia with an increase of 23%, followed by Bulgaria with an increase of 21%, Italy with an increase of 19%, Hungary with an increase of 18%, France with an increase of 16%, Spain with an increase of 10% and Romania with an increase of 8%. The country with the highest decrease in the number of fatalities per million inhabitants in 2021, compared to 2020, is Denmark 17% - Lithuania 17% decrease. In Poland, the number of fatalities per million inhabitants fell by 23%. Across the EU, there were an average of 44 traffic fatalities per million residents in 2021, up 5% from 2020, but down 13% from 2019, before the pandemic (Figure 11).

4 Summary

The purpose of the above work was to analyse and evaluate the impact of trucking infrastructure on freight efficiency and safety. This allowed to draw relevant conclusions that in the future can improve transport efficiency, safety of drivers and cargo. The conclusions also show the state of infrastructure in Europe and the direction of development of the road infrastructure.

The respondents' answers show that the most common causes of road accidents and collisions are: failure to adjust speed to road conditions (89 %),

failure to give priority (84 %), which is in line with the 2019 police report. Countries were compared in terms of: sense of the road safety, density of the road network, density of the gas stations, quality of the road condition, road markings and number of parking lots. The results show a clear difference between Western Europe and Eastern Europe. The best rated country in all the aspects is by far the Netherlands, followed by Germany, Austria, France, the UK, Spain and Belgium. Poland's performance is very average and places it further down the list. The worst country among those compared is Romania, which ranked as the last in all the assessments. The survey confirms that despite the visible progress and huge investments in recent years, Poland still lags behind Western countries. For this reason, the transport infrastructure must continue to be improved.

Grants and funding

The authors received no financial support for the research, authorship and/or publication of this article.

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- [1] NOSAL HOY, C. The gender factor in transportation behaviour/Czynnik płci w zachowaniach komunikacyjnych (in Polish). *Urban and Regional Transport/Transport Miejski i Regionalny*. 2018, **5**, p. 5-11. ISSN 1732-5153.
- [2] RACZYŃSKA-BULAWA, E. Road traffic safety in Europe - EU policy assumptions and evaluation of measures taken from the perspective of statistical data (in Polish). *Buses - Technology, Operation, Transport Systems/Autobusy - Technika, Eksploatacja, Systemy Transportowe*. 2016, **17**(10), p. 8-14. ISSN 1509-5878, eISSN 2450-7725.
- [3] PODGORSKA, A., RAJCHEL, J. Legal issues of safety and order in road traffic and road accidents (in Polish). *Roads / Drogownictwo*. 2019, **11**, p. 328-335. ISSN 0012-6357.
- [4] CELINSKI, I. Mobile diagnostics of vehicles as a means to examine and define speed limits in a road (in Polish). *Diagnostics / Diagnostyka*. 2017, **18**(1), p. 67-72. eISSN 2449-5220.
- [5] TOPOLSEK, D., CVAHTE OJSTERSEK, T. Do drivers behave differently when do you drive a car or a motorcycle? *European Transport/Trasporti Europei*. 2017, **66**, 7. ISSN 1825-3997.
- [6] GOLAKIYA, H. D., CHAUHAN, R., DHAMANIY, A. Assessment of safe distance for pedestrians on sections of downtown city blocks with the use of trajectory plots. *European Transport / Trasporti Europei*. 2020, **75**, 2. ISSN 1825-3997.
- [7] MOHANTY, M., SAMAL, S. R. The role of young drivers in road accidents: a case study in India. *European Transport/Trasporti Europei*. 2019, **74**, 1. ISSN: 1825-3997.
- [8] PRENTKOVSKIS, O., PRENTKOVSKIENE, R., LUKOSEVICIENE, O. Investigation of potential deformations caused by elements of transport and pedestrian traffic restricting the gates during interaction of the motor vehicle with the gate. *Transport* [online]. 2007, **22**(3), p. 229-235. ISSN 1648-4142, eISSN 1648-3480. Available from: <https://doi.org/10.1080/16484142.2007.9638130>
- [9] PRENTKOVSKIS, O., SOKOLOVSKIJ, E., VILIUS, B. Investigating traffic accidents: collision of two motor vehicles. *Transport* [online]. 2010, **25**(2), p. 105-115. ISSN 1648-4142, eISSN 1648-3480. Available from: <https://doi.org/10.3846/transport.2010.14>
- [10] PRENTKOVSKIS, O., BELJATYNSKIJ, A., PRENTKOVSKIENE, R., DYAKOV, I., DABULEVICIENE, L. A study of the deflections of metal road guardrail elements *Transport* [online]. 2009, **24**(3), p. 225-233. ISSN 1648-4142, eISSN 1648-3480. Available from: <https://doi.org/10.3846/1648-4142.2009.24.225-233>
- [11] LUKE, R., HEYNS, G. J. Reduction of risky behaviour of drivers by implementing a driver risk management system *Journal of Transport and Supply Chain Management* [online]. 2014, **8**(1), a146. ISSN 2310-8789, eISSN 1995-5235. Available from: <https://doi.org/10.4102/jtscm.v8i1.146>
- [12] Reflectors for vulnerable road users - Driving school portal (in Polish) [online] [accessed 2022-10-22]. Available from: <https://www.portalnaukikuje.pl/aktualnosci/odblaski-dlaniechrononychuczestnikowruchu-road-2152.html>
- [13] GORZELANCZYK, P., KACZMAREK, L. The influence of modern information systems on the operation of passenger vehicles (in Polish). *Buses - Technology, Operation, Transport Systems/Autobusy - Technika, Eksploatacja, Systemy Transportowe*. 2019, **227**(1-2), p. 211-215. ISSN 1509-5878, eISSN 2450-7725. Available from: <https://doi.org/10.24136/atest.2019.038>
- [14] GORZELANCZYK, P. Expert systems in diagnostics of means of transport (in Polish). *Logistics / Loistyka*. 2012, **3**, p. 661-668. ISSN 1231-5478.
- [15] MICHALSKI, R., WIERZBICKI, S. Analysis of the degradation of used vehicles (in Polish). *Maintenance and Reliability/Eksploatacja i Niezawodność*. 2008, **1**(37), p. 30-32. ISSN 1507-2711, eISSN 2956-3860.
- [16] GOLAKIYA, H. D., CHAUHAN, R., DHAMANIYA, A. Evaluating safe distance for pedestrians on urban midblock sections using trajectory plots. *European Transport/Trasporti Europei*. 2020, **75**, 2. ISSN 1825- 3997.
- [17] DELL'ACQUA, G., DE LUCA, M., PRATO, C. G., PRENTKOVSKIS, O., JUNEVICIUS, R. The impact of vehicle movement on exploitation parameters of roads and runways: a short review of the special issue. *Transport* [online]. 2016, **31**(2), p. 127-132. ISSN 1648-4142, eISSN 1648-3480. Available from: <https://doi.org/10.3846/16484142.2016.1201912>
- [18] GORZELANCZYK, P. Study of the tread wear process based on bus tyres operated by PT operator in Pila (in Polish). *Buses - Technology, Operation, Transport Systems / Autobusy - Technika, Eksploatacja, Systemy Transportowe*. 2017, **18**(12), p. 891-896. ISSN 1509-5878, eISSN 2450-7725.
- [19] WACHOWIAK, P., GORZELANCZYK, P., KALINA, T. Analysis of the effectiveness of shock absorbers in light of Polish and Slovak regulations (in Polish). *Buses - Technology, Operation, Transport Systems/Autobusy - Technika, Eksploatacja, Systemy Transportowe* [online]. 2018, **19**(6), p. 764-770. ISSN 1509-5878, eISSN 2450-7725. Available from: <https://doi.org/10.24136/atest.2018.172>
- [20] GORZELANCZYK, P., GORNIK, W. Assessment of the technical condition of forklift tyres used in internal transport by investigating damage and operating conditions. *Engineering Science and Technology/Nauki*

- Inzynierskie i Technologie* [online]. 2019, **2**(33), p. 44-59. ISSN 2080-5985, eISSN 2449-9773. Available from: <https://doi.org/10.15611/nit.2019.2.03>
- [21] GORZELANČZYK, P., ROCHOWIAK, L. Assessment of the technical condition of tyres used in agricultural and forestry machines. *Engineering Science and Technology / Nauki Inzynierskie i Technologie* [online]. 2019, **2**(33), p. 60-70. ISSN 2080-5985, eISSN 2449-9773. Available from: <https://doi.org/10.15611/nit.2019.2.04>
- [22] GORZELANČZYK, P., PYSZEWSKA, D., KALINA, T., JURKOVIC, M. Analysis of road traffic safety in the area of the district of Pila. *Scientific Journal of the Silesian University of Technology* [online]. 2020, **107**, p. 33-52. ISSN 0209-3324, eISSN 2450-1549. Available from: <https://doi.org/10.20858/sjsutst.2020.107.3>
- [23] Where do Polish truck drivers go and what should they watch out for? (in Polish) [online] [accessed 2022-10-22]. Available from: <https://www.ocrk.pl/wp-content/uploads/2019/01/Dok%C4%85d-je%C5%BCd%C5%BC%C4%85-Polscy-kierowcy-ci%C4%99%C5%BCar%C3%B3wek-i-na-co-powinni-uwa%C5%BCa%C4%87-4.09.2018.pdf>
- [24] Vision Zero [online] [accessed 2022-12-23]. Available from: <https://visionzero.global>
- [25] Chi-square consistency test (in Polish) [online] [accessed 2022-10-22]. Available from: www.naukowiec.org/wzory/statystyka/test-zgodnosci-chi-kwadrat_20.html
- [26] How to become a professional driver? (in Polish) [online] [accessed 2022-10-22]. Available from: <https://www.prawo-jazdy-360.pl/aktualnosci/jak-zostac-kierowca-zawodowym>
- [27] Road safety: European Commission rewards effective initiatives and publishes 2020 figures on road fatalities [online] [accessed 2022-10-22]. Available from: https://transport.ec.europa.eu/news/road-safety-european-commission-rewards-effective-initiatives-and-publishes-2020-figures-road-2021-11-18_en
- [28] 2021 road safety statistics: what is behind the figures? [online] [accessed 2022-12-23]. Available from: https://transport.ec.europa.eu/2021-road-safety-statistics-what-behind-figures_en