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DOMINANT GROUPS OF FACTORS INFLUENCING THE OCCURRENCE OF DIFFERENT TYPES OF ACCIDENTS ACCORDING TO THE SEVERITY OF THE CONSEQUENCES WITHIN DIFFERENT TYPES OF ACCIDENTS IN RAIN CONDITIONS

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Abstract: The condition of the road surface is one of the most important factors influencing the occurrence of traffic accidents, especially since it changes under the influence of various atmospheric factors. Among the most important atmospheric factors are temperature, humidity and precipitation. The risk of being involved in an accident change with the change (deterioration) of weather conditions. Factors within the H-V-R-E system (human, vehicle, road and environment) contribute differently to the increase/decrease in the risk of traffic accidents in bad weather conditions. This paper analyses groups of influencing factors associated with the occurrence of different types of accidents according to the severity of consequences within different types of traffic accidents that occurred during the rainy season. In the first step, an analysis of the most common types of traffic accidents was conducted, after which the three most common types of SN (traffic accident) were identified. Then, ordinal logistic regression was applied, in which the dependent variable was the type of accident according to the severity of the consequence, previously categorized depending on the severity of the SN consequence, while the independent variable was the groups of influencing factors. As a result of the applied statistical method, the dominant groups of influencing factors UF_G8 (vehicle malfunction), UF_G9 (impact of the road and road environment), etc. were identified.

Keywords: rain, influencing factors, traffic accidents, ordinal logistic regression.

1. INTRODUCTION

Road traffic accidents are recognized as one of the leading causes of death and injury worldwide. According to the World Health Organization, between 1.19 and 1.35 million people die each year worldwide, and between 20 and 50 million people are injured (WHO). In addition to destroying the lives of individuals, road traffic accidents and their consequences affect the entire society and the economic development of the country. A particular problem with road safety is represented in middle- and low-income countries, where the frequency of road traffic accidents is disproportionately high. For example, the number of accidents in the USA and Europe decreased by 13% and 64%, respectively, in 2018 compared to 2001. (WHO, 2023). A study by the European Road Damage Assessment Programme estimated the annual costs caused

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by road accidents at around 280 billion euros, equivalent to around 2% of gross domestic product (GDP) (Nicolosi et al., 2024).

Numerous scientific works deal with the analysis of traffic accidents and their consequences with the aim of identifying the factors that influence their occurrence and consequences. With such an etiological approach to studying traffic accidents and their consequences, the factors that influence their occurrence have been identified and systematized. Haddon systematized a large number of factors that influence the occurrence of accidents into the HVRE system (Human, Vehicle, Road and Environment/Surroundings), first in the basic, then in the corrected and finally in the expanded matrix. All of these factors, either individually or in combination, contribute to a certain extent to the occurrence of traffic accidents (PIARC, 2011). The human factor, either individually or in combination with other factors in the CRS system, contributes to the occurrence of as many as 93% of all traffic accidents. On the other hand, the road and environment factor contributes to 34%, while the vehicle contributes to 13% of the occurrence of accidents.

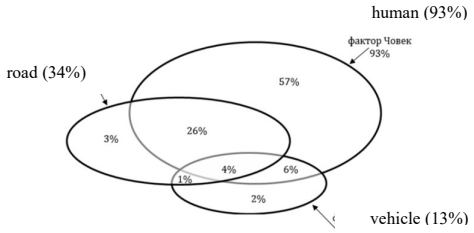


Fig. 1. Contribution of traffic safety factors to the occurrence of SN (PIARC, 2011)

The risk of being involved in traffic accidents varies because the accident itself is influenced by one or more factors individually or in combination. As weather conditions worsen, due to the appearance of rain, snow, ice, fog, etc., the risk of traffic accidents also increases. The risk of accidents in such conditions varies between the person driving the vehicle and their abilities, age, gender, knowledge, skills, as well as the vehicle participating in the traffic flow, the category of road on which traffic is carried out, modern devices on the vehicle, etc. In addition to changing the risk of being involved in an accident, bad weather conditions also affect the occurrence of different types of accidents. Under the influence of fog, accidents such as head-on collisions or vehicle skidding off the road (e.g. on a curve) are more common, while accidents under the influence of precipitation such as skidding off the road, loss of vehicle control, etc.

The aim of this research is to identify, on a sample of traffic accidents recorded in the period from 2021 to 2024 on the territory of the Republic of Serbia, the dominant groups of influencing factors that influence the occurrence of different types of traffic accidents recorded in rainy conditions, for different types of traffic accidents according to the severity of the consequences.

2. REVIEW OF PREVIOUS RESEARCH

Numerous scientific papers have investigated the risk of being involved in an accident in bad weather conditions, on different road surface conditions, and the risk of skidding accidents depending on the road resistance and road surface condition (dry, wet, humid) (McCarthy et al. 2021; Persaud, 2015). According to Farber et al. (1974), about 2% of all accidents recorded on wet roads occurred on the straight-ahead road, while Page & Butas (1986) concluded that the accident rate was highest on sections extending through horizontal curves, when the lateral adhesion coefficient was less than 0.25. Viner et al. (2006) concluded that the most dangerous driving conditions are those caused by low grip coefficients in conditions of heavy rainfall in

combination with poor road geometry, pavement damage, etc. Viner et al. (2006) concluded that the most dangerous driving conditions are those caused by low grip coefficients in conditions of heavy rainfall in combination with poor road geometry, damage to the road surface, etc.

Lion & Persuad (2008) found that the number of accidents decreased by up to 57% after improving the infrastructure in locations where a large number of accidents on wet roads with low grip coefficients were identified, Mayora & Pina (2008) found that the number of accidents decreased by 68% after increasing the grip coefficient.

Zhang et al. (2026) used clustering to analyse the characteristics and influencing factors of traffic accidents on expressways in Guangdong Province, China, from 2014 to 2023. 131 traffic accidents that occurred on expressways were statistically analysed, their key characteristics, distribution patterns, and factors influencing their occurrence. By applying factor analysis, five main factors were identified, which were further classified into specific categories using the clustering method. Since 2020, the number of traffic accidents on expressways has been increasing (16 accidents on average per year). Inadequate driver behaviour was a significant factor contributing to the occurrence of accidents, accounting for 18.3% of all accidents. It was found that secondary accidents lead to significantly more severe consequences than primary accidents. A significant correlation was observed between accidents on expressways and five dominant factors: environmental factors, accident causes, vehicle-related factors, road-related factors, and weather factors. Weather conditions, road conditions, visibility, and accident causes were found to be statistically significant in several categories.

Yan et al. (2005) investigated the characteristics of overtaking accidents using a sample of traffic accident data recorded in 2001. The results show that most overtaking accidents occur during the day (71.7%), compared to 28.3% at night. An interesting finding is that the RAIR (1.06) for the day is also higher than that for the night (0.88). Based on the model, the risk of an accident for night driving conditions could be 50% lower than for daytime driving conditions. Compared to dry roads, the risk of a traffic accident on a wet road can be 1.788 times higher, while on a slippery road it can be 3.302 times higher. The results confirm that the reduction in braking ability will undoubtedly contribute to the occurrence of rear-end collisions. If both a curve and a gradient are present, the risk of a rear-end collision can be twice as high as on a straight road. In general, the gradient at an intersection approach can significantly affect the time and distance a driver needs to stop. When approaching an intersection on a gradient, drivers may not take into account the mass and momentum of the vehicle, requiring a longer time to stop.

Feng et al. (2016) investigated the factors that influence the risk of fatal bus crashes in the 50 districts of the District of Columbia from 2006 to 2010. The crashes were ranked into three levels (level 1 as the mildest and level 3 as the most severe consequences). They found that autumn (OR = 1.25; 1.48 and 1.30) had higher odds ratios (OR) than winter (OR = 1.15; 1.32 and 1.21) (respectively for each severity level).

Day of the week is also associated with crash severity, and weekend driving increases the likelihood of a serious crash (by 28%, 67%, and 43%) compared with weekdays. Evening driving (OR = 1.83; 3.45, and 2.21) carries a higher risk of a serious crash than night driving (OR = 1.67; 2.66, and 1.83). Multiple vehicle involvement (versus one vehicle) significantly increases the likelihood of a serious crash (OR (single vehicle) = 13.11, 22.45, and 16.46; OR (two or more vehicles) = 17.66, 27.38, and 17.82). The presence of two or three or more lanes, as well as the slope of the road (uphill/downhill), are positively associated with a higher degree of severity of the consequences of the accident (OR = 1.13 and 1.25; 1.12) compared to situations with one lane in each direction, that is, with a flat road. A higher speed limit is associated with a higher severity of the consequences of the accident with a bus. Compared with a speed limit of less than 25 mph, limits of 50–55 mph (OR = 1.33, 1.25 and 1.35), 60–65 mph (OR = 2.53, 5.26 and 2.66) and over 66 mph (OR = 3.62, 17.61 and 5.33) increase the likelihood of severe accidents. Fatal

bus crashes that occur on curves are less likely to be severe (28% and 25%) than those on straight roads.

When the road surface is covered with snow or ice, compared to dry roads, the likelihood of being involved in a severe crash increase sharply for all three driver groups (OR = 1.14, 2.54 and 1.39). According to Nevarez-Pagan (2008), driver involvement in traffic accidents at locations with a low coefficient of skid resistance accounted for 28.56% of cases with serious injuries (total accidents) and 30.87% of cases with serious injuries (accidents on wet roads).

Wen et al. (2023) investigated the influence of curvature and slope on the severity of truck accidents on mountain highways. The results show that in the case of side-on truck collisions, the probability of severe injuries decreases by 0.11, while the probability of minor injuries increases by 0.085. In the case of truck rollover accidents, the probability of moderate injuries increases by 0.189, while the probability of minor injuries decreases by 0.194. Head-on collisions have a negative impact on truck accidents with moderate and severe injuries. When it comes to the dimensions of the truck involved in the accident, medium-sized trucks reduce the risk of serious injuries, while in the case of medium-sized trucks, the probability of serious injuries decreases by 0.045. When it comes to road conditions, the results show that the variable related to dry road is statistically significant. Compared to accidents in which minor injuries were sustained, truck accidents on dry roads have a negative impact on the probability of serious injuries. When an accident involving a truck occurs on dry roads, the probability of serious consequences decreases by 0.057, while the risk of accidents with medium consequences increases by 0.065.

Zainuddin et al. (2023) investigated the impact of road and environmental factors on the occurrence of fatal accidents involving heavy goods vehicles. When comparing conditions on flat and sloping road sections, it was found that the majority of fatal accidents involving heavy goods vehicles (HGVs) occurred on flat roads (94.2%). Cairney et al. (2011) found that flat roads, in combination with other factors such as speeding and heavy rain, create dangerous situations. When an accident occurs at high speed, drivers unintentionally lose focus on vehicle control, resulting in a higher number of fatalities in heavy goods vehicle accidents. The highest number of fatal accidents involving heavy goods vehicles (HGVs) occurred in clear weather conditions (90.7%) and during the day (65.9%). This is because drivers tend to drive slower in bad weather than in good weather, which reduces the frequency of crashes in adverse conditions.

3. METHODOLOGY

Methodology is a path or procedure by which certain results and conclusions are reached on a sample of data systematized in a database, using various methods (Lipovac et al., 2020). The aim of this work is to identify the dominant groups of influential factors in the occurrence of different types of accidents recorded in rainy conditions, for different types of traffic accidents according to the severity of the consequences, in the period from 2021 to 2024. For this purpose, a database of traffic accidents and their characteristics was created based on the Integrated Database of Traffic Accident Characteristics of the Traffic Safety Agency.

The database was created in the MS Excel software package in such a way that one row in the database represents one traffic accident, with all its characteristics, including the date and time of the accident, the severity of the consequences of the traffic accident, the condition of the road surface, a group of influencing factors, etc. The database was created from a broader database that included all accidents that occurred on the territory of the Republic of Serbia in the period from 2021 to 2024, using a filter that the observed accident occurred during a time when it was raining. After the formation of the basic database that will be used in further analysis, an

analysis of the most common types of traffic accidents that occurred on the territory of the Republic of Serbia in the period from 2021 to 2024 was carried out.

The formed database contained five types of traffic accidents shown in the table (Table 1). After that, the three most common types of recorded traffic accidents were included in further analysis.

Table 1. Traffic accident type group and code used in the analysis

Traffic accident TYPE GROUP	CODE
Traffic accident with one vehicle	1
Traffic accident with at least two vehicles – no turning	2
Traffic accident with at least two vehicles – turning or crossing	3
Traffic accident with parked vehicles	4
Traffic accident with pedestrians	5

The second part of the research was the analysis of the collected data in the statistical program SPSS Statistic 25. The dependent variable in the statistical analysis was the type of traffic accident according to the severity of the consequences. The dependent variable has the character of an ordinal categorical variable, so accidents with the lightest consequence (SN MS - traffic accident with material damage) were assigned the value 1, accidents with light bodily injuries (SN LTP) were assigned the value 2, accidents with serious bodily injuries (SN TTP) were assigned the value 3, and accidents with a fatality (SN POG) were assigned the value 4. The independent variables in this study were the groups of influencing factors, a total of 9 groups of influencing factors coded as UF1, UF2, …UF9 (Table 1). The influencing factors were recorded in accordance with the CADaS protocol and represent all those factors that contributed to the occurrence of the accident. Within each accident, for each group of influencing factors (one roadway in the database represents one group of influencing factors) binary coding was performed in such a way that if the group of influencing factors was recognized, the value 1 was assigned, and if not, the value 0 was assigned.

Table 2. Groups of influential factors (UF) and codes used in the analysis

GROUP UF	CODE
Incorrect execution of actions in traffic by the driver	1
Taking reckless actions by the driver	2
Driver's failures due to poor psychophysical condition, inattention, distraction	3
Driver's failures due to inadequate visibility or complete perception of the road and traffic	4
Driver's failures due to inexperience, inappropriate and improper behaviour	5
Pedestrian failures	6
Special cases	7
Impact of vehicle malfunction	8
Impact of the road and road environment	9

Given the ordinal nature of the dependent variable, ordinal logistic regression was tested. As a result of the parallel lines/proportional odds assumption, the effect of the independent variables was identical for all comparison thresholds along the ordinal scale (χ^2=262.818, df=18, p<0.001 for type 1 traffic accidents). The result indicates that the influence of the observed groups of factors varies depending on the comparison threshold. This method was rejected as inadequate, and as an alternative method, the approach of cumulative thresholds of the type of traffic accident according to the severity of the consequences was applied, i.e. an individual comparison of the groups of influential factors was performed for each threshold of the severity of the accident consequences.

The ordinal dependent variable was transformed into three binary variables (m-1 thresholds for a 4-category scale), as follows:

- Threshold 1: occurrence of a traffic accident with a victim (POG, TTP, LTP=1) in relation to traffic accident with material damage (MS=0),
- Threshold 2: occurrence of a traffic accident with a serious bodily injury or fatal outcome (POG, TTP=1) in relation to traffic accident with minor bodily injury or traffic accident with material damage (LTP, MS=0),
- Threshold 3: occurrence of a traffic accident with a fatal outcome (POG=1) in relation to traffic accident with serious bodily injury, traffic accident with minor bodily injury or traffic accident with material damage (TTP, LTP, MS=0).

For each of the thresholds, binary logistic regression was applied, with nine groups of influencing factors simultaneously included in the model, i.e. independent variables as predictors. In this way, not only the influence of a group of factors on the type of accident by severity of consequences was identified, but also at which specific threshold (accident severity) the greatest influence of the independent variable occurs.

Before each model estimation, a frequency check of the dependent and independent variables was performed to identify possible rare categories of independent variables. Identification of the influence of independent variables on the dependent variable was performed at the 95% significance level.

The ranking of groups of influential factors was performed based on the absolute value of the regression coefficient (|B|) (distance from 1), since this measure represents the strength of the influence of the independent on the dependent variable. The statistical significance of each predictor (independent variable) was assessed based on the Wald test at the significance level $p<0.05$.

4. RESULTS

In the first part of the analysis, the most common types of traffic accidents were identified. The distribution of types of traffic accidents that occurred during the rainy season in the period from 2021 to 2024 on the territory of the Republic of Serbia is shown in Figure 1. A total of 11,824 SNs were analysed.

Based on the analysis of Figure 1, it can be observed that the most frequent accidents recorded during rainfall were: type 2 (accidents with at least two vehicles – no turning) with a share of approximately 30% (3589 accidents) of the total number of accidents, followed by type 1 (accidents with one vehicle) with a share of approximately 26% (3101 accidents) of the total number of accidents, and type 3 (accidents with at least two vehicles – turning or crossing) with a share of approximately 22% (2577 accidents) of the total number of accidents. In what follows, the research consisted of an analysis of the influencing factors on the occurrence of the three most common types of traffic accidents (type 2, type 1 and type 3).

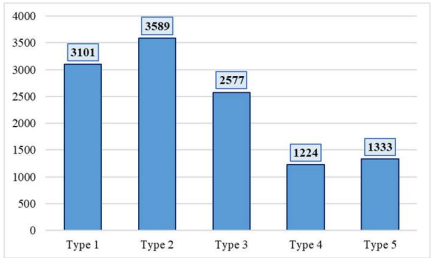


Fig. 1. Distribution of accidents by type

4.1 Identification of the dominant influencing factors in the occurrence of type 2 accidents (accidents with at least two vehicles – no turning)

When it comes to determining the significance of the groups of influencing factors on the occurrence of type 2 accidents (accidents with at least two vehicles – no turning), based on Table 3 it can be concluded that the largest number of influencing factors has a statistically significant impact on the occurrence of accidents with minor bodily injuries compared to accidents with material damage. Seven of the totals of 9 groups of influencing factors were found to have a statistically significant impact on the occurrence of accidents with minor bodily injuries in accidents with at least two vehicles (no turning), under rainy conditions. The greatest impact is exerted by the factor groups UF_G4 ("Driver's failures due to inadequate visibility, clarity, or complete perception of the road and traffic"), UF_G2 ("Taking reckless actions by the driver") and UF_G8 ("Impact of vehicle malfunction").

When it comes to the more severe consequences of traffic accidents, a statistically significant impact of 4 of the 9 groups of influencing factors was identified on the occurrence of accidents with serious bodily injuries compared to accidents with minor bodily injuries and material damage, among which the greatest impact is exerted by UF_G8 ("Impact of vehicle malfunction") and UF_G9 ("Impact of the road and road environment"). Also, a statistically significant impact of 4 of the 9 groups of influencing factors was identified for the occurrence of accidents with fatalities, compared to accidents with serious bodily injuries, minor bodily injuries and material damage. Among the identified factors, the greatest impact is exerted by the factors UF_G8, UF_G9, UF_G7 ("Special cases") and UF_G4. Looking at the whole model, it can be observed that there are three dominant groups of influencing factors in the occurrence of type 2 traffic accidents (accidents with at least two vehicles – no turning) that persist across all three observed thresholds (for each type of accident by severity of consequence), namely the factors: UF_G8 ("Impact of vehicle malfunction"), UF_G9 ("Impact of the road and road environment") and UF_G4 ("Driver's failures due to inadequate visibility, clarity, or complete perception of the road and traffic").

It can be concluded that the factors influencing the occurrence of accidents involving at least two vehicles are related to the vehicle, the road and its surroundings, and to human, i.e. driver, failures. These results confirm that accidents are simultaneously influenced by a larger number of factors within the HVRE system, i.e. that the occurrence of an accident is not caused exclusively by a single factor, but by the interaction of several factors.

Table 3. Statistical significance of the independent variables on the dependent variable (type of accident according to severity of consequences), by thresholds for TYPE 2, at the significance level p<0,05

GROUP	THR1	sig.	THR2	sig.	THR3	sig.
UF_G1	0.2356	0.0182	0.2146	0.1572	0.2865	0.4059
UF_G2	1.2626	0.0000	0.6940	0.0000	0.3219	0.3673
UF_G3	0.3899	0.0004	0.2932	0.0893	0.0718	0.8736
UF_G4	**1.2741**	**0.0000**	**0.7526**	**0.0000**	**1.1439**	**0.0022**
UF_G5	0.4760	0.0094	0.1122	0.7013	1.1498	0.2713
UF_G6	19.7940	0.9996	17.9908	0.9996	16.0414	0.9997
UF_G7	0.8659	0.0042	0.8151	0.0548	1.4555	0.0386
UF_G8	**1.1731**	**0.0013**	**1.3212**	**0.0006**	**1.8377**	**0.0018**
UF_G9	**0.6487**	**0.0000**	**1.0533**	**0.0000**	**1.4804**	**0.0000**

4.2 Identification of the dominant influencing factors in the occurrence of type 1 accidents (accidents with one vehicle)

Table 4 presents the groups of influencing factors and their statistical significance for the occurrence of different types of accidents according to the severity of consequences, specifically for the occurrence of type 1 accidents (accidents with one vehicle). Based on the table, it can be observed that 5 of the 9 groups of influencing factors have a statistically significant impact on the occurrence of accidents with minor bodily injuries compared to accidents with material damage. Among the most significant are: UF_G2 ("Taking reckless actions by the driver"), UF_G3 ("Driver's failures due to poor psychophysical condition, inattention, distraction"), UF_G4 ("Driver's failures due to inadequate visibility, clarity, or complete perception of the road and traffic"), UF_G5 ("Driver's failures due to inexperience, inappropriate and improper behaviour") and UF_G1 ("Incorrect execution of actions in traffic by the driver"). When it comes to the statistically significant impact on the occurrence of accidents with serious bodily injuries compared to accidents with minor bodily injuries and accidents with material damage, 4 of the 9 statistically significant groups of influencing factors were identified, namely UF_G8 ("Impact of vehicle malfunction"), UF_G3 ("Driver's failures due to poor psychophysical condition, inattention, distraction"), UF_G2 ("Taking reckless actions by the driver") and UF_G1 ("Incorrect execution of actions in traffic by the driver").

It can be observed that UF_G8 has no statistically significant impact on the occurrence of accidents with minor bodily injuries compared to accidents with material damage, but does have a statistically significant impact on the occurrence of accidents with serious bodily injuries compared to accidents with minor bodily injuries and accidents with material damage. This result indicates that this group of influencing factors increases the severity of the consequences of accidents involving one vehicle.

Two of the 9 groups of influencing factors were identified as having a statistically significant impact on the occurrence of accidents with one vehicle ending in a fatality, compared to accidents with serious bodily injuries, minor bodily injuries and material damage. The greatest impact is exerted by UF_G6 ("Pedestrian failures"), however, considering that only two accidents in total were recorded in which this group of influencing factors had an effect, the factor UF_G6 was excluded from further analysis due to the unrepresentativeness of the sample. The remaining group UF_G2 ("Taking reckless actions by the driver") persists across all three thresholds of the analysis of accident type by severity and stands out as the dominant group of influencing factors in the occurrence of accidents involving one vehicle.

Table 4. Statistical significance of the independent variables on the dependent variable (type of accident according to severity of consequences), by thresholds for TYPE 1, at the significance level p<0,05

GROUP	THR1	sig.	THR2	sig.	THR3	sig.
UF_G1	0.4139	0.0000	0.3192	0.0110	0.3649	0.2366
UF_G2	**0.9012**	**0.0000**	**0.4636**	**0.0004**	**0.7563**	**0.0322**
UF_G3	0.7288	0.0000	0.6601	0.0000	0.2029	0.5726
UF_G4	0.5258	0.0008	0.3267	0.1104	0.7325	0.0787
UF_G5	0.4797	0.0010	0.3321	0.0788	1.0153	0.0057
UF_G6	1.1188	0.4375	2.2628	0.1161	4.8963	0.0008
UF_G7	0.1514	0.4472	0.0602	0.8471	0.2748	0.7184
UF_G8	0.5744	0.1765	1.3414	0.0020	0.4632	0.6682
UF_G9	0.1354	0.1623	0.1101	0.4372	0.0511	0.8834

4.3 Identification of the dominant influencing factors in the occurrence of type 3 accidents (accidents with at least two vehicles – turning or crossing)

Table 5 presents the groups of influencing factors in the occurrence of type 3 accidents, i.e. accidents with at least two vehicles – turning or crossing, by thresholds depending on the type of accident according to severity of consequences. When threshold 1 is observed, i.e. the impact of the group of influencing factors on the occurrence of accidents with minor bodily injuries compared to accidents with material damage, 6 of the 9 groups of influencing factors were found to be statistically significant. Among the more significant are UF_G8 ("Impact of vehicle malfunction"), UF_G7 ("Special cases"), UG_G2 ("Taking reckless actions by the driver") and UF_G4 ("Driver's failures due to inadequate visibility, clarity, or complete perception of the road and traffic").

When the significance of the impact of the groups of influencing factors on threshold 2 is observed, i.e. on the occurrence of accidents with serious bodily injuries compared to accidents with minor bodily injuries and material damage, it is found that 4 of the 9 groups of influencing factors have a statistically significant impact. Among the most significant are UF_G8, UF_G9 ("Impact of the road and road environment") and UF_G3 ("Driver's failures due to poor psychophysical condition, inattention, distraction"), which also stand out as statistically significant factors in the occurrence of accidents with fatalities compared to accidents with serious and minor bodily injuries and material damage. The previously identified groups of influencing factors can be classified as the dominant groups of influencing factors in the occurrence of all types of accidents by severity of consequences within the type of accident with at least two vehicles – turning or crossing.

Table 5. Statistical significance of the independent variables on the dependent variable (type of accident according to severity of consequences), by thresholds for TYPE 3, at the significance level p<0,05

GROUP	THR1	sig.	THR2	sig.	THR3	sig.
UF_G1	0.1169	0.3321	0.1082	0.5772	0.3339	0.5400
UF_G2	1.3377	0.0000	0.5817	0.0050	0.1666	0.7627
UF_G3	**0.4141**	**0.0033**	**0.6751**	**0.0009**	**1.2027**	**0.0159**
UF_G4	1.3046	0.0000	0.3322	0.2192	0.8149	0.4460
UF_G5	0.1927	0.3615	0.2850	0.3602	0.4443	0.5841
UF_G6	/	/	/	/	/	/
UF_G7	1.4932	0.0005	19.1024	0.9978	16.5120	0.9981
UF_G8	**1.6069**	**0.0080**	**2.4342**	**0.0000**	**2.9751**	**0.0001**
UF_G9	**0.4503**	**0.0135**	**1.0118**	**0.0000**	**1.2564**	**0.0301**

5. DISCUSSION

The previously conducted analysis identified and presented the statistically significant groups of influencing factors that contribute to the occurrence of different types of traffic accidents (type 1, type 2 and type 3), within which an analysis of the impact on the occurrence of accidents by thresholds, i.e. by severity of consequences, was also carried out. The results showed that some groups of influencing factors, although statistically significant for the occurrence of accidents with milder consequences, do not also affect accidents with more serious consequences. For example, as statistically dominant groups of influencing factors for the occurrence of all types of accidents depending on the severity of consequences, within the type of accident with at least two vehicles – no turning, the identified factors were UF_G8 ("Impact of vehicle malfunction"), UF_G9 ("Impact of the road and road environment") and UF_G4 ("Driver's failures due to inadequate visibility, clarity, or complete perception of the road and traffic").

Similarly, the authors Zhang et al. (2026) identified statistically significant factors related to the environment, the vehicle, the road, and weather, which influence the occurrence of accidents on expressways in China. Yan et al. (2005) concluded that as pavement surface conditions worsen, the risk of rear-end collision accidents (accidents with at least two vehicles) increases 1.8 times on wet pavement and 3.3 times on slippery pavement, especially where there is a change in road alignment when passing through a horizontal or vertical curve.

When it comes to the type of accident with one vehicle, the dominant group of influencing factors is UF_G2 ("Taking reckless actions by the driver"). Novice drivers, above all, have a higher probability of taking reckless actions in traffic, caused by their insufficient experience of participating in traffic. Situations are particularly dangerous when normal traffic conditions are disrupted, such as by the occurrence of precipitation. Cairney et al., (2011), found that flat roads, in combination with other factors such as speeding and heavy downpours, create dangerous situations that often turn into traffic accidents. When an accident occurs at high speed, drivers unintentionally lose focus on vehicle control, take risky actions, which further results in a higher number of fatalities in accidents involving heavy goods vehicles. Among the most significant groups of influencing factors in the occurrence of accidents with at least two vehicles – turning or crossing are UF_G8 ("Impact of vehicle malfunction"), UF_G9 ("Impact of the road and road environment") and UF_G3 ("Driver's failures due to poor psychophysical condition, inattention, distraction"). Feng et al. (2016) found that the involvement of a larger number of vehicles in an accident (compared to one vehicle) significantly increases the probability of accidents occurring with more severe consequences. Wen et al. (2023) found that in the case of side collisions with a truck, the probability of severe consequences decreases by 0.11, while the probability of minor bodily injuries occurring increases by 0.085.

Finally, five groups of influencing factors can be singled out as dominant in the occurrence of the three most frequent types of accidents in rainy conditions on the territory of the Republic of Serbia, based on the sample of recorded accidents in the period from 2021 to 2024. The following groups of influencing factors stand out: UF_G8 ("Impact of vehicle malfunction") and UF_G9 ("Impact of the road and road environment") as dominant in the occurrence of accidents with at least two vehicles, then the factor UF_G3 ("Driver's failures due to poor psychophysical condition, inattention, distraction") in the occurrence of accidents with at least two vehicles – turning or crossing, UF_G4 ("Driver's failures due to inadequate visibility, clarity, or complete perception of the road and traffic"), in the occurrence of accidents with at least two vehicles – no turning, and UF_G2 ("Taking reckless actions by the driver") in the occurrence of accidents with one vehicle.

6. CONCLUSION

Traffic safety is a complex and growing problem, simultaneously influenced by a larger number of factors within the HVRE system, whose impact on the occurrence of an accident changes depending on the influence of external, atmospheric factors. Under conditions of precipitation, the risk of being involved in traffic accidents changes, as does the severity of the consequences should an accident occur. Also, under specific traffic conditions, different types of accidents occur, as well as different types of accidents according to the severity of the consequences. This research confirmed that influencing factors are not universal for the occurrence of all accidents, but that their influence differs within different types of accidents. Also, different groups of influencing factors affect different types of traffic accidents differently according to the severity of the accident's consequences. In this research, the three most frequent types of traffic accidents were identified, namely accidents with one vehicle, accidents with at least two vehicles – no turning, and accidents with at least two vehicles – turning or crossing.

The results show that the dominant groups of influencing factors in the occurrence of accidents with at least two vehicles (both types – no turning and turning or crossing) are UF_G8 ("Impact of vehicle malfunction") and UF_G9 ("Impact of the road and road environment"). The factor UF_G3 ("Driver's failures due to poor psychophysical condition, inattention, distraction") was identified for the occurrence of accidents with at least two vehicles – turning or crossing, while UF_G4 ("Driver's failures due to inadequate visibility, clarity, or complete perception of the road and traffic") was identified as dominant for the occurrence of accidents with at least two vehicles – no turning. When it comes to accidents with one vehicle, the factor identified as dominant is UF_G2 ("Taking reckless actions by the driver"). Also, the previously identified factors influence the occurrence of all types of traffic accidents according to the severity of consequences, i.e. according to the established thresholds.

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