# Application of Statistical Analysis for Risk Estimate of Railway Accidents and Traffic Incidents at Level Crossings

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## Abstract

Abstract This paper deals with applying statistical analysis of traffic safety to analyze the risks at level crossings. The social costs of railway accidents and traffic incidents at level crossings are very high and lead to a reduction in the levels of traffic safety. In addition to the consequences reflected in the loss of human lives, injuries, and disabilities, the stress and trauma of direct participants in traffic, accidents, and incidents at level crossings cause huge property and economic losses and significant primary and secondary traffic delays. The traffic safety analysis was conducted on 2128 level crossings, which are differently protected on the lines Joint Stock Company for Public Railway Infrastructure Management "Serbian Railway Infrastructure" with statistical data of accidents in the Republic of Serbia from 2007 to 2017. The paper analyzes the obtained results using the methods of descriptive and inferential statistics to define measures of possible improvement of safety levels at the obtained critical level crossings. Also, a proposal was made for improving and raising the level of safety on level crossings through innovative education of direct participants in traffic.

**Keywords:** level crossings; risk; railway accidents; traffic incidents; innovative education
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# Introduction

Level crossings as a place of intersection of two types of traffic (railway and road) cause safety risks in developing both types of traffic. The term "risk" means the frequency of accidents and incidents with damaging results (caused by dangerous situations) and the degree of severity of that damage. This paper analyzes the safety parameters of level crossings to reduce accidents and incidents at these dangerous places and reduce the percentage of accidents and incidents at level crossings in the total number of accidents and incidents. The largest number of accidents and incidents at the intersections of roads and railways has its causes in the subjective mistakes and omissions of participants in road traffic. Participants in road traffic who took part in accidents and incidents did not respect the light and traffic signals in every situation and to a sufficient extent. They are deciding to cross the railway, even though the devices for securing traffic are already included. In this paper, based on the analysis of safety parameters, using the methods of descriptive and inferential statistics and the obtained results, some of the measures of possible improvement of safety levels at the obtained critical crossings were defined. Also, a proposal was made to improve and raise the level of safety at level crossings, through innovative education of direct participants in traffic, as an alternative to expensive technical solutions.

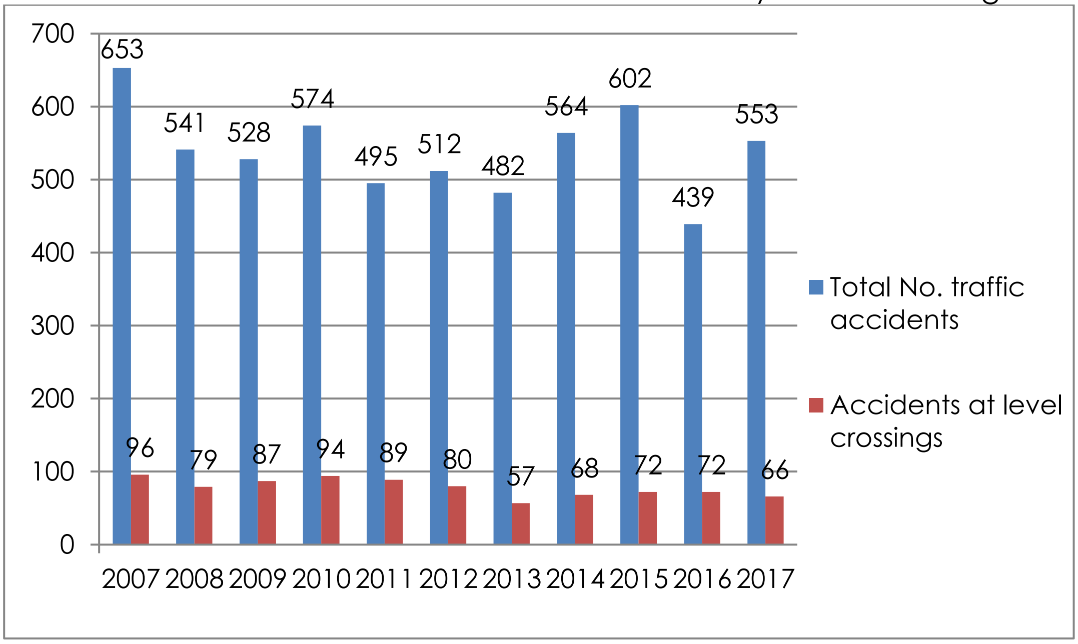
# Literature review

In addition to the recognizable social and organizational significance, accidents and incidents on the railways also have great economic significance (Evans, 2013). However, according to the access literature, it can be unequivocally established that railway traffic safety is a highly professional field, but with less participation in the scientific research approach. From the scientific aspect, some papers deal with the issue of railway traffic safety as part of the investigation procedure (Evans et al., 1996; Cedergren, A., 2013; Cedergren et al., 2011 et al.), the impact of the human factor (Baysari et al., 2008; Edkins et al., 1997) and research of safety on level crossings (Tey et al., 2011; Clark et al., 2013; Ćirović et al., 2013; Evans, 2011). A framework for systems analysis (Read et al., 2016; Wilson, 2014) and psychological scheme theories (Salmon et al., 2013; Stanton et al., 2011) were used to analyze contributing factors to the occurrence of accidents at level crossings. The connection between accidents and road geometry was completely analyzed using the function of safety and the description of how much the safety performance of road objects is related to different road characteristics. There is an evident increase in the number of works on safety research at level crossings (Clark et al., 2013). Due to the higher mortality of children in accidents and incidents, research has been implemented in this area in New Zealand, which included the design, implementation, and evaluation of a series of interventions, including extensive communication and education to raise awareness of illegal and risky pedestrian behavior in the zone of level crossings (illegal level crossings) by placing warning billboards and posters, educating young people through school curricula, setting up fences and directing pedestrians to proper level crossings as well as permanent disciplining on the spot for such behavior (Lobb et al. 2003). From 1946 to 2009 in the UK, a study was provided on the mortality rate of pedestrians and road users at over 1000 level crossings with three types of protection (Evans, 2011). It was found that the largest number of fatal accidents was at active level crossings at about 52%, at passive level crossings at about 43%, and level crossings controlled by the railway workers at only 5%. This is not surprising, given that most accidents that happen at active or passive level crossings are due to the primary responsibility of road users. The methodology of collecting data on the speed of reaction of road users to warning devices at level crossings in Australia was performed using two approaches: directly in the field with videos of selected locations and in the laboratory via "driving simulation" (Tey et al. 2011) and has contributed to improving safety at level crossings in terms of the ability to evaluate driver behavior according to innovative warning devices at level crossings. There is similar research on traffic safety at level crossings in our country (Ćirović et al., 2013) where it is using Adaptive Neuro-Fuzzy Inference Systems (ANFIS) model who was trained with the experiential knowledge of 20 experts in this field and who has selected level crossings in the area of Belgrade where it is necessary to invest in equipment to increase the level of security of level crossings. Ćirović and Pamučar (2013) conclude that: "The most common choice, which of the level crossings should be with active protection (bell and signal-flashers), is based on media assessment and pressure from society, as well as possible consequences of increasing accidents and incidents on the level crossings". In the last few years, research has been done on determining the model for assessing the risk of accidents at level crossings (Pasha et al. 2020; Keramati et al. 2020). A known technique of mathematical programming for measuring the efficiency of complex entities with diverse inputs/outputs, Data Envelopment Analysis – DEA, which makes it possible to determine whether the unit to be decided upon (Decision Making Unit - DMU) is effective or not, used in analyzing the efficiency of 12 operational units representing the nearest cities in which accidents at level crossings in the Republic of Serbia in the period from 2005 to 2014, to reduce the number of accidents (Grujić et al. 2018). The Republic of Serbia has implemented another study (Kasalica et al. 2020) to identify the necessary parameters that quantify the risk associated with level crossings, where the available statistical models are the most often used (Poisson, NB, ZIP, and ZINB). In the cited research (Kasalica et al. 2020), a new measure of risk was introduced - empirical risk. In Bosnia and Herzegovina, Blagojević et al. (2021), for eight level crossings on the Šamac - Doboj railway line, the level crossings were evaluated using the fuzzy MARCOS method (measurement of alternatives and ranking according to the compromise solution), which aimed to determine the list of critical level crossings and propose some measures to increase safety on them.

## Methodology

In this paper, data on level crossings, accidents, and incidents from the database were used Joint Stock Company for Public Railway Infrastructure Management "Serbian Railway Infrastructure" (SRI JSC). The research subject is 2128 level crossings in public transport, without the museum-tourist railway, with registered accidents and incidents that occurred from 2007 to 2017 on the territory of the Republic of Serbia (Figure 1). Also, methods of the archival collection of data on the number and type of accidents and incidents were used (sample of over 600 accidents and incidents) on over 20 railways line that is in function. The database on the number of passive and active level crossings was taken over from SRI. The passive level crossing is a crossing that is not equipped with a warning and/or protection system that is activated in the case when it is not safe for the user to cross the crossing. An active level crossing is where the crossing users are protected or warned to approach the train by activating the device in case it is unsafe to cross the crossing.

*Figure 1*
Review the relationship between the total number of accidents and incidents and the number of accidents and incidents that occurred only at level crossings for 2007-2017.

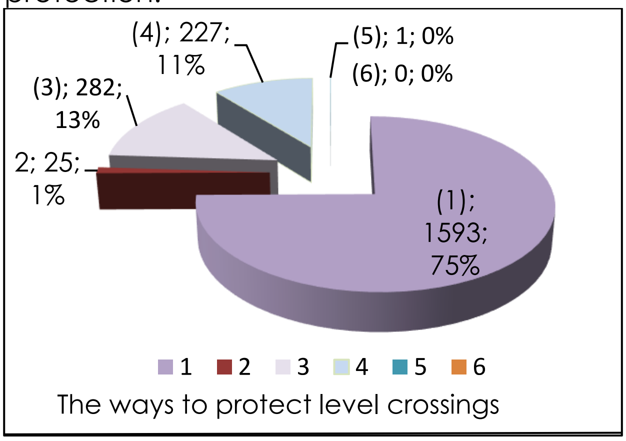



*Source:* Author's illustration

Figure 2 shows the number of level crossings for each type of protection crossing with a percentage share in the total number. Traffic at level crossings is always protected with one of six levels of protection:

1. traffic signs on the road and the zone of necessary visibility;
2. light traffic signs and traffic signs on the road;
3. automatic half-barriers (half-bumpers) with light traffic signs and traffic signs on the road;
4. barriers (bumpers) and traffic signs on the road;
5. direct regulation of traffic at the level crossing and special measures and,
6. protective fences and traffic signs or bypasses and traffic signs at level crossings for pedestrians and cyclists.

*Figure 2*
Review the total number of level crossings for SRI JSC 2017 with different levels of protection.




*Source:* Author's illustration

## Statistical analysis with Discussion

In the sample, only SRI level crossings on the lines on which the railway traffic is active are singled out and considered. In the observation period of 11 years, 625 traffic accidents and incidents were realized in the observed sample. The participants include pedestrians, harnesses, cyclists, passenger vehicles, trucks, motorcyclists, buses, working machines - mostly tractors with a small share of combines and excavators and, in one case, the working machine of a road sustenance company (asphalting machine).

The most represented participants in accidents and incidents at level crossings are passenger vehicles, with 79.84%. The number of dead and injured is proportional to participation. For cyclists, motorcyclists, harnesses, buses, trucks, and tractors (working machines), we can conclude that the number of dead and injured at level crossings is proportional to participation in traffic accidents and incidents. The most endangered group is pedestrians, whose total share is 3.68% have a disproportionate share among the dead participants in accidents and incidents at level crossings of 12.50% (every other accident is fatal). Contrary, tractors dominated the other group of vehicles (in addition to two harvesters, one excavator, and one asphalt machine ) with a share of 9.12% (57 in total); there are only four dead or 4.16%. The result should be taken into account that 50 accidents and incidents occurred at level crossings with the lowest level of protection (level of protection 1): traffic signs on the road and the zone of necessary visibility - on uncategorized and rural roads.

Table 1 shows the participants and distributions, with results. The total number of dead was 96, and 218 were injured.

*Table 1*
Distributions of participants and results of accidents and incidents at level crossings in SRI JSC for 2007-2017.

| Participants in accidents and incidents | Pedestrian | Bicycle | Motorcycle | Harness | Passenger vehicle | Bus | Truck | Tractor |
|---|---|---|---|---|---|---|---|---|
| **Number and review of accidents and incidents** | 23 | 4 | 7 | 2 | 512 | 9 | 24 | 57 |
| **%** | **3.68%** | **0.64%** | **1.12%** | **0.32%** | **79.84%** | **1.44%** | **3.84%** | **9.12%** |
| **Dead's** | 12 | 1 | 2 | 0 | 74 | 0 | 3 | 4 |
| **%** | **12.50%** | **1.04%** | **2.08%** | **0.00%** | **77.08%** | **0.00%** | **3.12%** | **4.16%** |
| **Injured** | 11 | 2 | 2 | 0 | 164 | 5 | 12 | 22 |
| **%** | **5.04%** | **0.91%** | **0,91%** | **0.00%** | **75.22%** | **2.29%** | **5.50%** | 10.09% |

*Source:* Author's work

Out of the total 2128 level crossings, 625 traffic accidents and incidents in the observed decade were realized at 385 level crossings, at only 18.08%. This data should be taken with the obligatory reserve cause of the reduced volume of traffic on the railway's lines Bečej-Senta, Bečej-Vrbas, Vladimirovac-Kovin, Čoka-Kneževac, Sombor-Bački Breg, Sombor-Riđica and Paraćin-Stari Popovac.

Therefore, on the SRI JSC lines, we can consider that the railway traffic is active at 1928 level crossings, or 90.60% of the level crossings. The expected Poisson distribution has not verified the distribution of traffic accidents and incidents at the practical level crossings. The parameters of the distribution of accidents and incidents at level crossings have a mathematical expectation of $\mu$= 0.32313 and standard deviation σ=0.87093. The quotient of standard deviation and mathematical expectation, coefficient of variation shows significant variability (1):

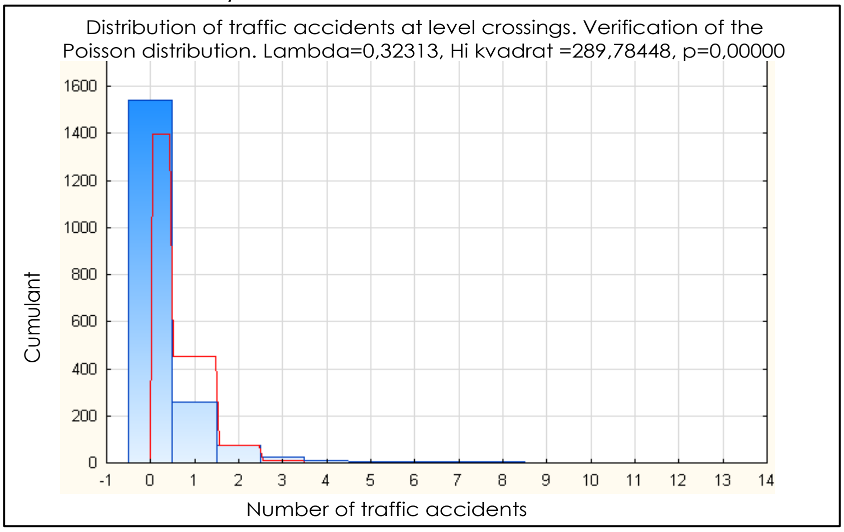
$$c=\frac{\sigma}{\mu}=\frac{0.87093}{0.32313}=2.69529 \tag{1}$$

This value is significantly higher than the coefficient of variation in the case of the Poisson distribution for the basic parameter λ=μ=0.32313:

$$c_{Poisson}=\frac{\sqrt{\lambda}}{\lambda}=1.75918 \tag{2}$$

Verification of the nonsignificant Poisson distribution has an extremely high value on the Chi-square test $\chi^2$ =289.78 (figure 3)

*Figure 3*
Verification of the nonsignificant Poisson distribution of traffic accidents at level crossings in Joint Stock Company for Public Railway Infrastructure Management "Serbian Railway Infrastructure".




*Source:* Author's work

The absence of the Poisson distribution in the basic set determines the absence of exponentially distributed time between successive traffic accidents and accidents at all level crossings SRI JSC. The absence of the property of "no consequence", the obligatory feature of the exponential distribution, directly indicates the influence of one or more factors on traffic accidents and incidents. In support of this hypothesis, we list 11 critical level crossings (0.57% of level crossings), at which 82 (13.12%) traffic accidents and incidents were realized in the analyzed period (Table 2).

In the balance of traffic accidents and accidents is, 96 dead and 218 injured participants. At 67 level crossings, 96 dead participants were registered; at 130 level crossings, 218 injured participants were registered in noted accidents and incidents. Of that, 22 level crossings died and injured participants in traffic accidents. Traffic accidents and accidents with the dead and injured were realized at 175 level crossings.

The cumulative balance of the severity of traffic accidents and incidents is not pronounced correlated with the number of accidents and incidents. A characteristic example is the level crossing, which in the observed period had the largest number of traffic accidents and incidents (on the railway line Belgrade Center-Vršac-state border, at km 17 + 545). There were no fatalities in 12 traffic accidents at this level crossing, with "only" 3 injured participants.

*Table 2*
Display of critical level crossings.

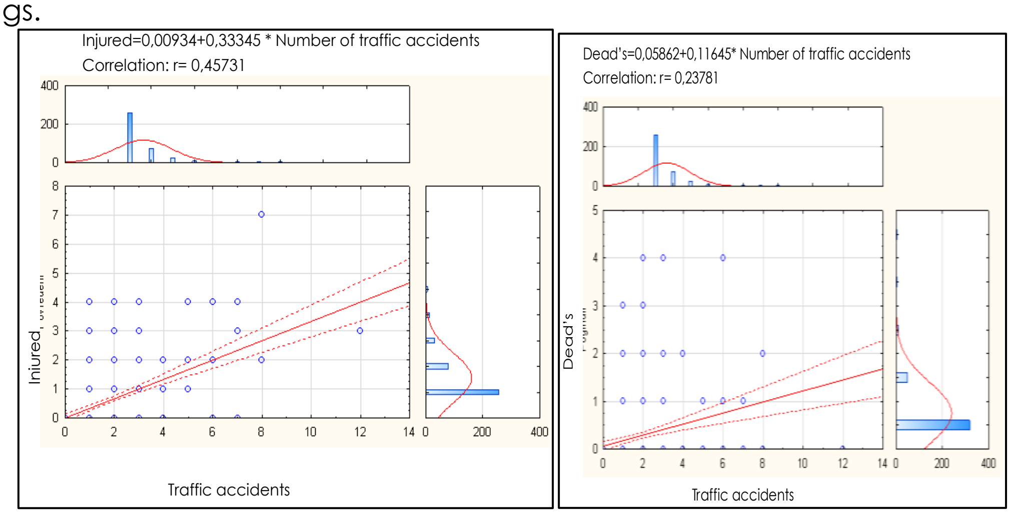
| | The railway line | Kilometer position | Location | Number of traffic accidents |
|---|---|---|---|---|
| 1. | Belgrade Center-Vršac- state border | 17+545 | Pančevo | 12 |
| 2. | Ruma-Šabac-Rasp. D. Borina-state border | 4+038 | Šabac | 8 |
| 3. | Novi Sad-Bogojevo | 57+306 | Odžaci | 8 |
| 4. | Niš-Dimitrovgrad-state border | 74+243 | Pirot | 8 |
| 5. | Ruma-Šabac- Rasp. D. Borina-state border | 3+285 | Buđanovci | 8 |
| 6. | Stalać-Kraljevo-Požega | 41+715 | Trstenik | 7 |
| 7. | Ruma-Šabac- Rasp. D. Borina-state border | 49+004 | Loznica | 7 |
| 8. | Ruma-Šabac- Rasp. D. Borina-state border | 36+390 | Loznica | 6 |
| 9. | Belgrade Center-Šid- state border | 62+008 | Kraljevci | 6 |
| 10. | Lapovo-Kraljevo-Gen. Janković- state border | 30+832 | Kragujevac | 6 |
| 11. | Lapovo-Kraljevo-Gen. Janković- state border | 93+138 | Konarevo | 6 |

*Source:* Author's work

The linear correlation coefficient of traffic accidents and the number of dead (Figure 4) can be declared weak with the value (=+0.23, and the linear correlation coefficient of traffic accidents and the number of injuries can be declared moderate with the value $\rho$=+0.45.

Complementary, 265 traffic accidents were realized at 210 level crossings, which had no consequences for the life and health of the participants. This result can be attributed to the well-predict speed limits in the zones of risky level crossings, as well as the mind of train drivers, who noticed the danger in time and started braking so that the contact was realized at the speeds of railway vehicles that were not fatal. Also, the adaptation of all participants to risky level crossings is evident (especially with the first level of protection on uncategorized roads).

*Figure 4*
Linear correlation of deaded and injured participants in traffic accidents at level crossings.




*Source:* Author's work

Table 3 presents data on the two-dimensional distribution of the number of traffic accidents of independent variables: months of the year and hours of the day.

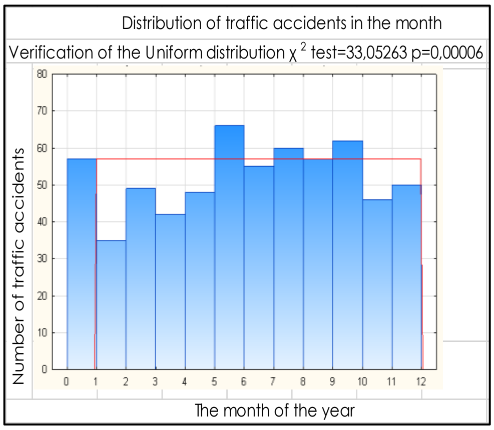
Marginal distributions of traffic accidents are not uniformly distributed. For both independent variables, the significance threshold is nonsignificant.

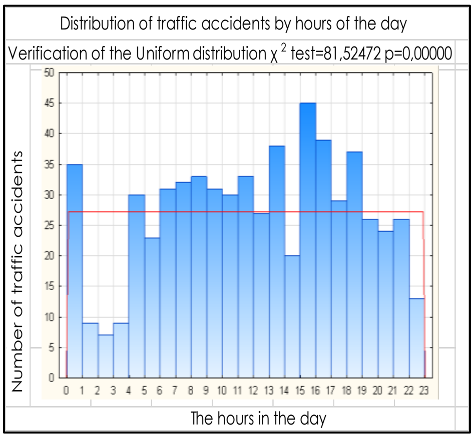
*Table 3*
Distribution of traffic accidents at level crossings in the function of the month of the year and hours of the day.

| Hours of the day | The month of the year | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **0** | 3 | 1 | 0 | 0 | 2 | 3 | 1 | 2 | 2 | 0 | 2 | 0 |
| **1** | 4 | 0 | 1 | 2 | 1 | 0 | 1 | 2 | 3 | 1 | 2 | 2 |
| **2** | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 2 | 1 | 1 | 0 | 0 |
| **3** | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| **4** | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 0 | 0 |
| **5** | 3 | 3 | 2 | 0 | 4 | 5 | 1 | 2 | 2 | 3 | 1 | 4 |
| **6** | 1 | 0 | 1 | 0 | 0 | 3 | 3 | 3 | 7 | 2 | 2 | 1 |
| **7** | 0 | 0 | 2 | 3 | 2 | 2 | 5 | 2 | 3 | 3 | 3 | 6 |
| **8** | 3 | 1 | 2 | 3 | 2 | 6 | 1 | 6 | 1 | 4 | 1 | 2 |
| **9** | 4 | 1 | 3 | 3 | 2 | 5 | 1 | 3 | 1 | 4 | 3 | 3 |
| **10** | 2 | 1 | 2 | 3 | 2 | 1 | 7 | 3 | 2 | 5 | 1 | 2 |
| **11** | 2 | 3 | 6 | 0 | 2 | 6 | 2 | 3 | 1 | 0 | 4 | 1 |
| **12** | 6 | 3 | 1 | 0 | 5 | 1 | 1 | 5 | 5 | 2 | 1 | 3 |
| **13** | 3 | 4 | 3 | 2 | 2 | 4 | 3 | 1 | | 2 | 0 | 3 |
| **14** | 4 | 1 | 0 | 3 | 2 | 5 | 5 | 2 | 3 | 5 | 4 | 4 |
| **15** | 2 | 1 | 0 | 0 | 0 | 3 | 1 | 3 | 1 | 6 | 1 | 2 |
| **16** | 3 | 6 | 3 | 4 | 3 | 7 | 3 | 3 | 4 | 4 | 3 | 2 |
| **17** | 2 | 2 | 2 | 2 | 9 | 3 | 3 | 2 | 6 | 4 | 2 | 2 |
| **18** | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 6 | 3 | 1 | 4 | 5 |
| **19** | 2 | 3 | 8 | 3 | 6 | 1 | 4 | 1 | 2 | 3 | 2 | 2 |
| **20** | 2 | 1 | 3 | 4 | 0 | 2 | 0 | 2 | 2 | 3 | 4 | 3 |
| **21** | 2 | 0 | 1 | 2 | 0 | 3 | 4 | 3 | 3 | 4 | 1 | 1 |
| **22** | 2 | 0 | 5 | 3 | 1 | 2 | 3 | 3 | 2 | 1 | 2 | 2 |
| **23** | 3 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 2 | 1 | 3 | 0 |

*Source:* Author's work

*Figure 5*
Uneven distribution of traffic accidents in the month of the year and by hours of the day.

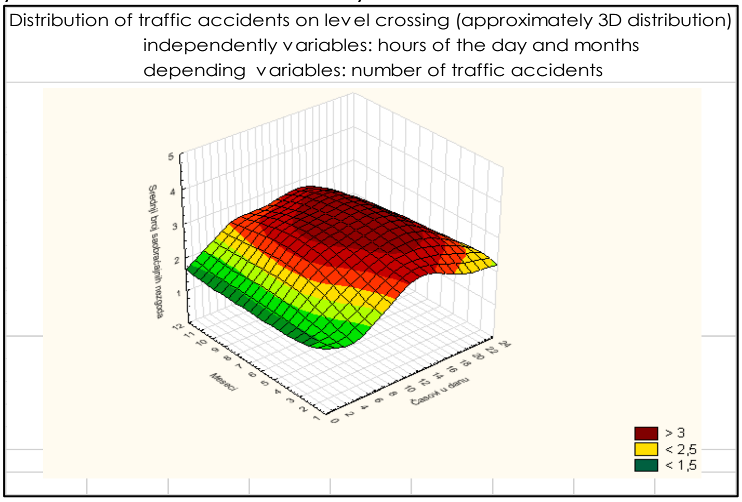



*Source:* Author's work

Distribution histograms, chi-square test values, and significance thresholds are given in Figure 5.

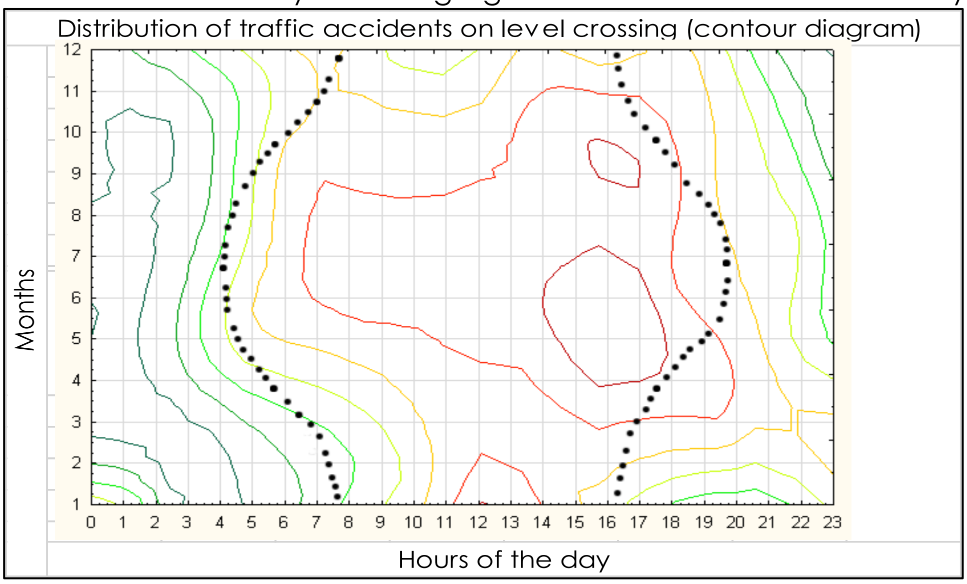
*Figure 6*
Approximate graph of the number of traffic accidents in the function months of the year and hours of the day.




*Source:* Author's work

Figure 6 shows an approximate two-dimensional distribution of data on the random variable of traffic accidents and incidents at level crossings from Table 3 for independent variables: hours of the day and month of the year. This distribution represents the convolution of declared independent random variables. The maximum number of traffic accidents and incidents in the afternoon of the summer months is observable. A more precise determination of the critical period can be seen from the contour diagram (Figure 7). Astronomical borders of day and night in the territory of the Republic of Serbia have been added to this presentation.

*Figure 7*
Contour graph of the number of traffic accidents in the function months of the year and hours on the day with a highlighted astronomical border of day and night.




*Source:* Author's work

The average number of traffic accidents and incidents at level crossings has two local maximums. The first maximum number of traffic accidents and incidents is from 2 pm to 6 pm, in the visible part of the day during the months: of April, May, and June.

The second maximum number of traffic accidents and accidents is in the interval from 3 pm to 5 pm, in the visible part of the day, mostly during September. Analysis of variance confirmed the statistical significance of graphically highlighted maxima.

In the above periods, the average number of traffic accidents and incidents at level crossings was 3.4667, and in the complementary period, the average number of traffic accidents and incidents was 2.1062. The difference between the displayed mean values is statistically significant, with the significance threshold ***r=0.002330***. This result is likely due to the spatial mobility of the population of the two public and private labor market activities: return from work and continuation of agricultural activities. These two migrations significantly increase the intensity of road traffic flows, the spatial relationship of the road and railway traffic network, and the load of level crossings. The increase in frequency inevitably leads to a statistically significant increase in traffic accidents and incidents at level crossings in the above periods. At 214 level crossings under the supervision of the Public Company "Roads of Serbia", the average number of traffic accidents in the observed period was 0.57353. At all other level crossings, it was 0.29350. Analysis of variance also confirmed a significant statistical difference between the calculated values, with a significance threshold r=0.000021. Level crossings under the supervision of the Public Company "Roads of Serbia"are dominantly at the level of protection with half-bumpers (with light traffic signs on the road) and bumpers (and traffic signs on the road). However, Level crossings under the supervision of the Public Company "Roads of Serbia "are also on higher-ranking roads (state roads) loaded by the dominant flow of road traffic.

A study by a group of authors (Ercegovac, P. et al., 2021) was done on the same sample, where a specially developed model was used to estimate and compare the risk of accidents and incidents on the level crossing in the group of five crossings, for the two critical levels crossing in Table 2, reliability (R) and risk (r) were determined. For the crossing in Budjanovci, these values were R=0,999617130 r=0,00038287, and for the crossing in Kraljevci, R=0,999908404 and r=9,15965 x$10^{-5}$. In both types of research, a high risk of crossing in Budjanovci can be detected, for which specific measures should be taken to improve traffic safety.

Technical measures and solutions for raising the level of protection of the crossing are very expensive, considering that for automation, that is, equipping the level crossing with an automatic device for securing relay or electronic type, over 140,000.00 euros should be given. Until a fundamental solution and provision of financial resources for increasing safety at level crossings, it is necessary to apply some conventional measures immediately and propose innovative measures to educate direct participants in traffic.

Level crossing "Buđanovci" is a passive crossing, where participants in road traffic have full responsibility to watch over the railway traffic and decide when it is safe to cross the level crossing. Still, they often don't know how fast railway vehicles are moving.

On this level, the crossing is a smaller frequency of road traffic. This level crossing is located in a rural area, and it's used mostly for the needs of the local population and by agricultural producers. The smaller number of trains per day may have led road users gradually develop dangerous practices when crossing the railway and with a reduced level of caution.

A study by a group of authors (Ercegovac, P. et al., 2013) found a high functional relationship between the average number of accidents and the reaction time of traffic participants (the correlation coefficient r = 0,99905 in the case parabolic curve y = 0,12x2 - 0,512x + 0,695). The conclusion is that the mistakes that lead to accidents and incidents in the implementation of traffic are made by very young or older participants in traffic. Young people, because of inattention and hurry, and older participants in traffic because of a slower reaction to dangerous situations. Also, a high functional dependence was observed between the average number of accidents and incidents and the basic characteristics of system reliability (the correlation coefficient r=0,96581 in the case exponential curve $y=0{,}1495e^{0{,}2082x}$ ). The target group for innovative education, in this case, would be very young participants in road traffic and older than 65, as well as all active railway persons who directly participate in the implementation of traffic in the following way:

- very young participants in road traffic, who would undergo training on the safe crossing of the level crossing during additional training (≥50) during training in driving schools before taking the driving test;
  older than 65 years, to be subject to preventive training on the safe crossing of the railway, which modifications legal provisions and regulations will regulate;
- as well as all active railway persons who directly participate in the implementation of traffic through additional classes of regular teaching (≥2 per month), planned only for this problem with a special accent on proper and timely signalling No. 67 "Watch out", according to the regulation on types of signals, signal signs, and signs on the railway, the existence of railway warnings on the railway, correctness of signaling devices that indicate the position of the half-bumper, so that the train driver can control the situation at the level crossing in front of which he comes into, as well as taking measures for the safe organization of railway traffic in cases of failure of the device of level crossings or in the case when the traffic at that level crossing is not protected for any reason, etc.

The general public can raise the consciousness of traffic safety at level crossings through media campaigns and social media. In addition to the above methods, one of the suggestions is the distribution of flyers. On flyers, print warnings next content: (don't walk or drive in the level crossing area when the bumpers or half-bumpers are put down, don't try to be faster than the train, do not stop your vehicle in the level crossing area, report the irregularities to the authorities, keep in mind that the stopping distance of the train is from 700 to 1000 meters, etc.). Also, in the curricula of subjects that deal with traffic safety in primary and secondary schools and the curricula for driver training in driving schools, elements of safe behavior of traffic participants over level crossings should be specially developed.

## Conclusion

This paper used statistical processing of the sample of the number of accidents/incidents at level crossings SRI JSC in 11 years (on active lines where traffic takes place). The expected Poisson distribution has not verified the distribution of traffic accidents and incidents at the practical level crossings. The absence of the property "no consequence" directly indicates the influence of one or more factors on traffic accidents and incidents. Eleven critical level crossings were analyzed, making up 0.57% of the total level crossings. 82 (13.12%) accidents and incidents were realized in the analyzed period.

The cumulative balance of the severity of traffic accidents and incidents is not pronounced correlated with the number of accidents and incidents. The analysis determined a high risk for the Budjanovci level crossing. To influence and increase caution when crossing level crossings, a proposal was given for innovative education of risk groups of traffic participants.

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