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Analysis of possibility for traffic safety improvement based on Serbian traffic violation database analysis

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In order to improve traffic safety, both reactive and proactive approaches are used. Unlike the reactive, the proactive approach 'does not wait' for traffic accidents to happen to start analysing traffic safety conditions. The proactive approach implies traffic safety improvement based on the analysis of so-called indirect traffic safety indicators, like the behaviuor of traffic participants, and the analysis of unsafe traffic participants behaviours that are detected and registered in traffic violations database, are specially interesting. This paper analyzes the possibilities of traffic safety improvement based on Serbian traffic violation database analysis. It was noticed that not all data from database can be used for traffic safety improvement, and at the same time, this paper represents a method in selecting so-called relevant data, which can be used for traffic safety improvement by using adequate preventive activities and measures. In order to define the measures for traffic safety improvement, a possible way of further analysis for some of the relevant data was also presented in this work.

Key words: Traffic safety improvement, traffic violation, traffic accident, relevant data, countermeasures.

INTRODUCTION

The best way of realizing the importance of traffic safety problem, traffic safety improvement and developing new methods for traffic safety improvement is to notice the traffic accidents and their consequences data. The data show that every year round the world more than 1.3 million people die in traffic accidents, and about 50 million are injured (WHO, 2009). Average, it is about 3,500 killed people every day, or one killed person every 25 seconds. Bearing in mind this kind of traffic safety conditions, it is necessary to influence on the decrease of the number of traffic accidents and the consequences of traffic accidents by appropriate measures and actions.

Through the system of traffic safety management (ETSC, 2001, Figure 1) it is possible to detect traffic safety problems and potential problems on different levels, and then to influence on removal of those problems by appropriate measures and actions.

Identifying and removing the problems is possible using reactive and proactive approach. Reactive implies applying the measures for traffic safety improvement based on the analyses of the direct traffic safety indicators, such as traffic accidents and the consequences of traffic accidents (so-called final outcomes). On the other hand, the proactive implies that based on the indirect indicators (so-called intermediate outcomes) traffic safety problems are detected and appropriate measures are applied in order to provide traffic safety preventive actions. The proactive approach is 'more humane' because it 'doesn't wait' for traffic accidents to happen and some person to be killed in it, so that the appropriate measures could be suggested based on the analysis of such an accident. For example, detecting that a small number of drivers use a seatbelt and defining the appropriate measures in order to change that state is a proactive approach in traffic safety management and improvement.

The indirect indicators, which can be used for proactive movements towards traffic safety improvement, are mostly related to traffic participants behavior. Besides, a man, as a traffic safety factor, alone or in interaction with the other factors (vehicle, road, environment), causes

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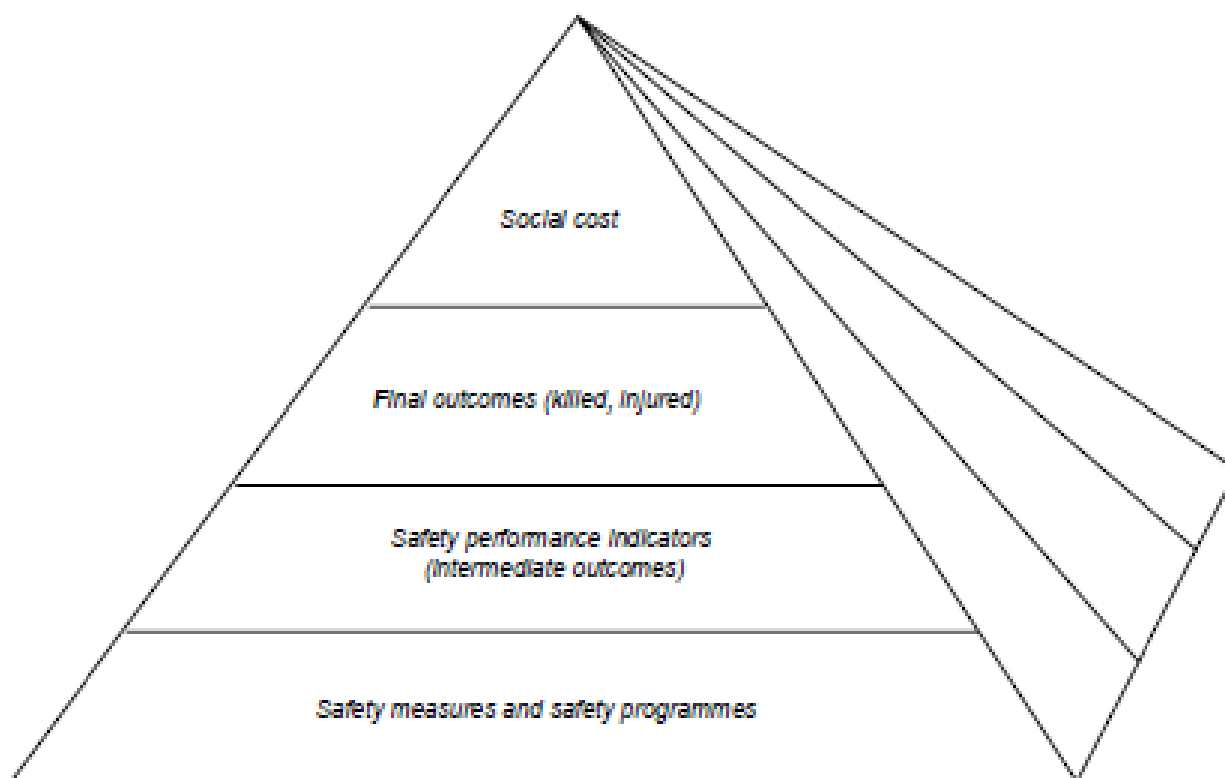
Figure 1. Traffic safety management system (ETSC, 2001).

more than 95% of traffic accidents. Bearing that in mind, it can be concluded that the largest potential in traffic safety improvement lays precisely in the actions directed towards the man, or the traffic participants. Of all road users, drivers, with over 80%, have the largest share in causing traffic accidents (Vujanic et al, 2010), so the analysis of drivers behavior, specially unsafe behavior, might indicate some possible ways of actions directed towards traffic safety improvement.

A certain number of unsafe traffic participants behaviour (traffic violations) are being detected and registered in traffic violations database. On the other hand, irregular and unsafe traffic behaviour is also a kind of traffic violations and might create some dangerous situations, even a traffic accident. For example, if a driver crosses a red light, that situation can easily cause a traffic accident.

Because of the mentioned importance which traffic violations have, and the real and obvious possibility that the drivers who make traffic violations, in the same time cause traffic accidents, it is necessary to use the potentials of traffic violations database analyses. Traffic violations database analysis aims to determine certain relations related to unsafe traffic participants behavior, or to investigate the possibilities of traffic safety improvement based on the traffic violations database analysis. After determining certain relation between traffic violation and some others indicators, it could be possible

to define preventive activities and measures.

In this paper, the analysis of the possibility of proactive management and traffic safety improvement in Serbia was conducted, based on the analysis of the official traffic violations database. It was noticed that not all data from traffic violations database could be used for traffic safety improvement. The analysis shown in this paper consists of two steps. The first step is determining the relevance of the data for further use and analysis, and the second step is a more detailed analysis of the determined relevant data with the aim of determining a certain relation which would define appropriate measures. Therefore, in this work, a method for selecting the relevant data from the database, which can be used for traffic safety improvement, is shown, and for some of the relevant data, a possible way of further analysis, conclusions and defining the preventive activities and measures for traffic safety improvement. It is shown that the data from the official traffic violations database in Serbia can be used for traffic safety improvement.

LITERATURE REVIEW

Mc Farland and Moore (1957) pointed out the possibility of a preventive traffic accidents decrease through a minimal influence on the behavior of drivers. The behavior of drivers and other traffic participants depends

largely on the police enforcement, and some researches show that a higher enforcement might significantly reduce the number of drivers who make traffic violations. In one of those researches, Vaa (1997) showed that a high enforcement had reduced the number of drivers who made speeding violations. Reason et al. (1991), De Waard et al. (1994), Parker et al. (1995a), Hakkert et al. (2001), Newstead et al. (2001), Papaioannou et al (2002), Redelmeier et al. (2003) and Elvik (2011) also proved the fact that the enforcement, through prevention, has positive effects on traffic safety and the decrease of the number of traffic accidents. Redelmeier et al. (2003) emphasized that the adequate analysis of the police enforcement might point at appropriate measures, especially the use of new, modern enforcement technologies, such as red-light cameras and speeding cameras (photo radars, speed cameras) (Retting et al, 2003 and IIHS, 2002). A research made by Redelmeier et al. (2003) showed that a speeding enforcement might reduce the risk of a traffic accident in 19%, a red-light crossing enforcement in 11%, and driving under influence enforcement in 4%.

Aberg (1998) and Parker et al. (1995b) emphasized that the enforcement is necessary in order to increase respect for traffic regulations. Elvik and Christensen (2007) pointed out that traffic safety improvement is possible by increasing the risk for traffic violations to be detected and punished. Mehmood (2010) emphasizes that the number of traffic violations depends on three factors: driver's attitude, perceived consequences of violations and adequacy of traffic monitoring capacity. Practically, Mehmood points out that the number of traffic violations depends on the enforcement level. Löbmann (2002) says that there are two ways to reach a higher risk of punishing and they are both connected to police enforcement. The first one is a more frequent traffic violations control, and the second one is a more efficient control, meaning an improved quality of violation control (for example modern alcohol testers, modern speeding radars etc). A higher enforcement would imply a larger number of traffic violations to be detected and punished, and therefore the objective risk of punishing would be higher. In PIN project (ETSC, 2007), it was shown that, as drivers, a higher enforcement implies a larger awareness of traffic safety through attitude and behavior changes.

Researchers (Rajalin, 1994; Elvik, 1997; Makinen and Wuolijoki, 1999) have shown that there's a relation between traffic violations, and traffic accidents, meaning that a decrease in the number of traffic violations implies a decrease in the number of traffic accidents. Elvik (1997) stated that eliminating most frequent traffic violation, there might be a significant decrease in the number of traffic accidents and the consequences of traffic accidents. Pesic (2009) also showed in his research that, there's a dependence of the number of traffic accidents, with fatalities and other consequences on the number of

recorded or detected traffic violations. Similarly to previously mentioned researches, Nishida (2009) showed that there is a strong dependence between certain kinds of traffic violations and the probability of traffic accidents to happen, but, on the other hand, in his research, he emphasized the key problem concerning the analysis of relation between traffic accidents and traffic violations, and that there is the lack and unavailability of the appropriate quality accidents and violations database. Tillyer et al. (2010) elaborated the significance of the data at traffic participants control, and therefore at violations detection control. They emphasize the importance of questions why, when, how and which data should be collected and sent to database.

Some researchers analyzes that there are relations between violations and accidents bearing in mind drivers' sex, age and level of education (Lourens et al., 1999). Are there relations between age and sex and traffic violation? (Yagil, 1998). Are there relations between age and driving under alcohol influence and accidents occurring? (Pereira et al., 2011), or are there some other indicators that have influence on traffic violations and accidents, such as four-wheel car drivers (Bener et al, 2008) and so on. These researchers try to find reasons and relations of high number of traffic violation and accidents and in the same time that reasons and relations could give possible direction to define preventive activities and measures. Nishida (2009) also emphasizes that in analyzing traffic violations data, one can learn a lot about possible measures, but in the first place, he emphasizes drivers education, based on traffic violations analysis. In order to improve drivers safety, after violations analysis, Pesic (2009) also proposed drivers education, but only for those drivers with numerous traffic violations in their dossier. McKnight and Tippetts (1997) also showed positive effects of the education on traffic safety, stating that the largest part of drivers education program influences on the decrease of both traffic violations and traffic accidents.

MATERIALS AND METHODS

For the needs of this research, data from the official traffic violations database of Ministry of Internal Affairs of the Republic of Serbia were analysed. Traffic violations in Serbia during a five-year period, from the 1st of January 2003 till the 31st of December 2007, were analysed, and this analysis covered almost 3,000,000 traffic violations.

For every recorded traffic violation in the official traffic violations database in Serbia, there is an appropriate data set. Those data are related to the offender, the time, the place and kind of the committed offense, sanctions. Therefore, the data review and further analysis would be done more easily if the data related to the traffic violations are grouped (Figure 2). The data relating to traffic violations are highlighted thus:

1. The data related to the offender – name and surname, sex, date and place of birth, address, personal number, and the rest of the identification data which define and accurately determine the
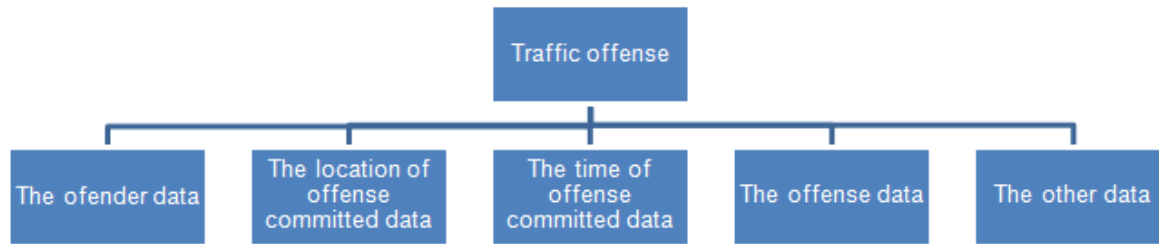
Figure 2. The structure of the data contained in traffic violations data.
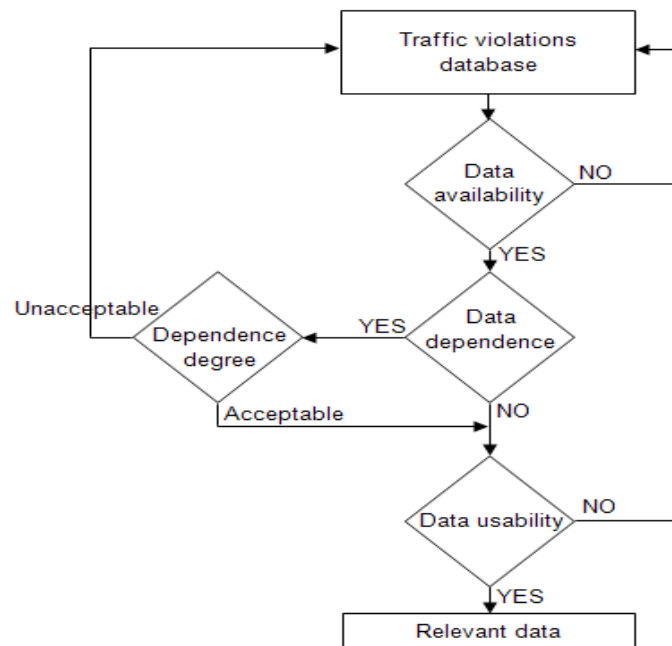
Figure 3. Algorithm of the relevant data selecting process from the traffic violations database.

offender.

2. The data related to the place of the offense committed – place, road, sections of the road, intersection, address with house number, GPS coordinates and so on.

3. The data related to the time of the offense committed – year, month, day of the week and the hour of the offense committed.

4. The data related to the offense committed – the type of the offense, or the legal qualification of the offense and the punishment for the offense committed.

5. The other data – the ID mark of the offense, the data about the patrolman who registered the offense, the police station.

The analysis of the possibilities for traffic safety improvement by using preventive measures based on traffic violations database analysis consists of two steps. The first step implies determining the relevant data, and the second one analyzes the existence of certain relation concerning such data, which can define preventive activities and measures for traffic safety improvement.

For each one of the violations, traffic violations database contain certain data set, wherein it was noticed that not all the data from the database can be used for traffic safety improvement. So, for example, certain data depend on the so-called external influences. As an example, we can state the data of the place of the offense, which, largely depends on the planning of enforcement. In other words, spatial distribution of traffic violations doesn't indicate the precise locations where traffic participants make offenses, but is conditioned by location where traffic police controlled the offense, or by the locations where the devices for violations detection are. For these reasons, it is necessary to analyze and determine which offense data are valid or relevant for further analyses and defining the measures. Relevant data are those data that can be used for analyses and conclusions, directly or indirectly, and can contribute to proposing appropriate measures for traffic safety improvement. The method of selecting so-called relevant data, which can be used for traffic safety improvement, is shown in the algorithm of relevant data selecting process from traffic violations database (Figure 3).

The presented model for determining relevant data from traffic violations database defines that a certain data is relevant only if the envisaged conditions from the algorithm are fulfilled. The algorithm of the relevant data selecting process includes steps such as: To check if the 'availability' condition is fulfilled; To check if the 'dependence' condition is fulfilled and lastly, to check if the

Table 1. Review of the relevant data selection analysis from traffic violations database.

Data set	Data	Availability	Interdependence	Usability	Relevance
	Name and surname	No	-	-	NO
	Personal number	No	-	-	NO
	Date of birth	Yes	No	Yes	YES
Offender data	Sex	Yes	No	Yes	YES
	Place of birth	Yes	-	-	NO
	Address	Yes	-	-	-
	...	-	-	-	-
Offense location data	Address of the place where the offense was committed	Yes	Yes, unacceptable	-	NO
	...	-	-	-	-
	The date when the offense was committed	Yes	Yes, acceptable	Yes	YES
Offense time data	The time when the offense was committed	Yes	Yes, unacceptable	-	NO
	...	-	-	-	-
	Type of the offense	Yes	Yes, acceptable	Yes	YES
The offense data	Punishment	Yes	No	Yes	YES
	...	-	-	-	-
	The ID of the offense	No	-	-	NO
The other data	The ID of the police station	No	-	-	NO
	...	-	-	-	-

'usability' condition is fulfilled. Bearing this in mind, the relevance of a certain data from the database is determined by: availability of the data (for example, if the data is subjected to the data protection according to the law and regulations), dependence of that data on other influences (for example, if and to what extent the data depends on the planning of enforcement), and the usability of the data (for example, could that data indicate the possible measure for traffic safety improvement). It is necessary to emphasize that the algorithm can be used only by the experts in traffic safety field, because it is the only reliable way to recognize if the conditions from the algorithm are being fulfilled.

Having determined the relevant data, the second step implies a detailed relevant data analysis. Depending on the relevant data, and previously defined courses of action, one or more data which were separated as relevant, are being analysed and certain relation and interdependences, which might indicate concrete preventive activities and measures for traffic safety improvement, are being established. In order to determine certain relations or interdependences, it is possible to use statistic methods, regression analysis of traffic accidents and other traffic safety indicators (traffic accidents and their consequences), and other well-known methods for traffic safety analysis, which depend on the concrete analysed data.

RESULTS

Data relevance analysis

Methods needed for relevant data selection, by using the algorithm of relevant data selecting process from traffic violations database (Figure 3), are well-known methods: Analysis, synthesis, induction, deduction, abstraction and generalization. The examples of the results of the analysis made in order to select relevant data from the official traffic violations database in Serbia, are given in Table 1.

Determining the relevance (Table 1) of a certain data from the database can be clarified on the example of "the date when the offense was committed" data. Relying on this data, it is possible to determine the time distribution of the offense committed, or to determine the periods during a week, month or a year when the offenses are more frequent. "The date when the offense was committed" data can be classified in the group of the available data, considering that it fulfills the first condition ('availability') of the algorithm given in Figure 3. However, through further analysis of that data, it was noticed that there is a certain dependence of that data on the police enforcement planning and guidiance. Enforcement planning could mean that enforcement is more present during certain time of the day, day of the week and season. Prolonging the period when the interdependence between the data and enforcement planning is being observed, it was noticed that the interdependence decreases, or becomes acceptable. For example, the annual number of traffic violations, based on "the date when the offense was committed" data, would be acceptable from the dependence aspect, so in that way, the second condition of data relevance ('dependence') would be fulfilled. The annual number of violations might be used in determining certain dependences and relation, which would determine appropriate measures for traffic safety improvement, implicating that "the date when the
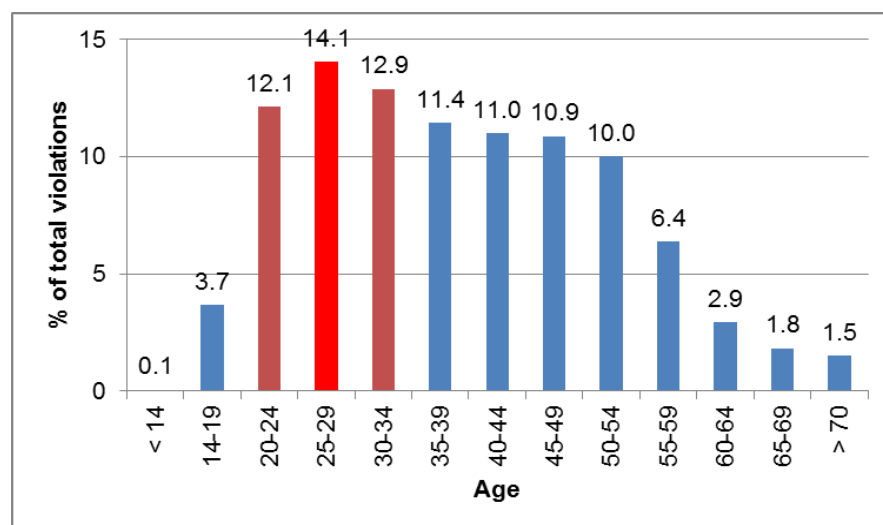
Chart 1. Distribution of total violations by age of offenders in percentage (%).

offense was committed" data could be considered usable ('usability' condition fulfilled). Fulfilling all three conditions, "the date when the offense was committed" data can be stated as relevant. In a similar way, as it was presented for "the date when the offense was committed" data, all the rest of data from the traffic violations database, can be analysed. Interpreting the examples of the analysed data from Table 1, it can be concluded that beside "the date when the offense was committed" data, there are also other relevant data, such as "date of birth of the offender" and "type of the offense". Unlike previously mentioned, in the database there are also some irrelevant data, such as "name and surname of the offender", "ID of the police station", "place of birth of the offender" and so on, because they don't fulfill one, two or three conditions from the relevant data selecting algorithm.

Determining the existence of relevant data interdependence

For some of the selected relevant data from traffic violations database, possible ways of further analysis were shown, and all in order to determine the existence of certain relation and dependences, which would indicate determining the measures for traffic safety improvement.

Relevant data - "date of birth of the offender"

In analyzing the data concerning the date of birth of the offender, it's possible to come to distribution of traffic violations by age of offenders. As a result of the age of offenders analysis (Chart 1), it is possible to conclude

that it is more likely for younger population to committ violations. Namely, offenders aged 20 to 34 committed almost 40% of violations, and the largest number of violations was committed by offenders aged 25 to 29.

The results of these analysis indicates the need for measures and actions directed towards young traffic participants, especially young drivers. The proposed measures should significantly improve their safety, and therefore total traffic safety. As possible measures, additional training and education of young drivers are imposing, and also different kinds of programs, courses and specially designed traffic safety campaigns directed towards young drivers. The fact that young drivers are more endangered and unsafe and that they more often participate and are being killed in traffic accidents (WHO, 2009) only confirms the previous conclusion based on the age analysis, and justifies the actions directed towards young drivers. The noticed endangerment of the young in traffic and their tendency to commit traffic violations, indicates the need for taking measures in order to make them behave more safely in traffic.

Relevant data - "the date when the offense was committed"

Previously in this paper a possibility was mentioned, that "the date when the offense was committed" data might be used for analysis of the number of violations committed during a certain observed period (a week, month or year). We came to the conclusion that, an annual time distribution of the violations could be used for determining certain relation and dependences, so in order to get adequate conclusions, along with the annual traffic violations distribution, we also observed the annual distribution of the number and consequences of traffic
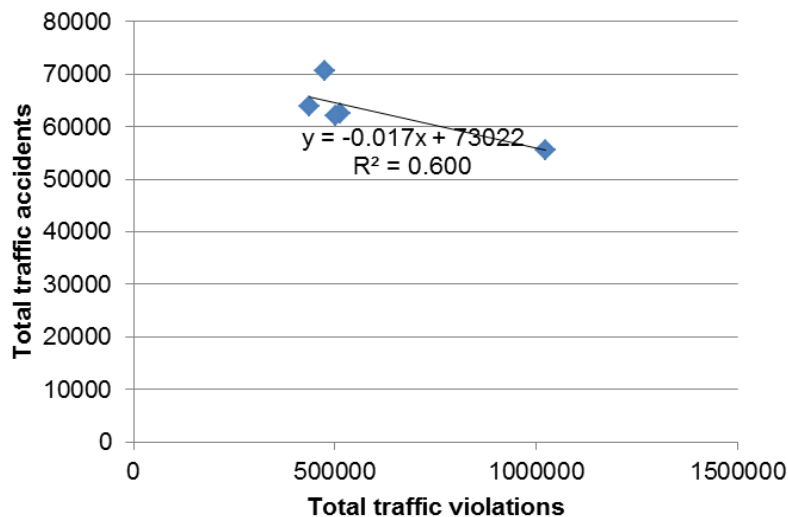
Table 2. Number of traffic violations, accidents and consequences.

Year	Total violations	Total traffic accidents	Traffic accidents with consequences	Property damage only accidents	Total consequences	Fatalities	Injured
2003	1,024,570	55,660	12,415	43,245	16,821	868	15,953
2004	513,932	62,434	13,397	49,037	18,510	953	17,557
2005	501,312	62,036	12,769	49,,267	17,713	841	16,872
2006	435,572	63,913	13,912	50001	19,305	900	18,405
2007	476,931	70,735	16,585	54,150	23,163	962	22,201
SUM	2,952,317	314,778	69,078	245,700	95,512	4,524	90,988

Source: (Republic of Serbia - Ministry of interior affairs).

Table 3. Correlation between violation, accidents, and consequences.

| Variable 1	Variable 2	Function of linear correlation between variable 1 and variable 2	Coefficient of determination R^2	Coefficient of correlation R
The number of traffic violations	The number of traffic accidents	$y = -0.017 \times +73.022$	0.600	-0.775
	The number of traffic accidents with victims	$y = -0.003 \times +15.821$	0.252	-0.503
	The number of property damage only accidents	$y = -0.013 \times +57.201$	0.735	-0.857
	The number of traffic accident fatalities	$y = -0.00008 \times +953.5$	0.147	-0.384

Chart 2. Correlation between total traffic violations and total traffic accidents.

accidents (Table 2). Analyzing the number of traffic violations data and the number of traffic accidents data (Table 3), we have concluded that in the analysed five-year period, the number of traffic violations decreased, whereas the number of traffic accidents increased. In 2007, as compared to 2003, the number of traffic violations decreased in 53%, whereas, in the same period the number of traffic accidents increased in 27%.
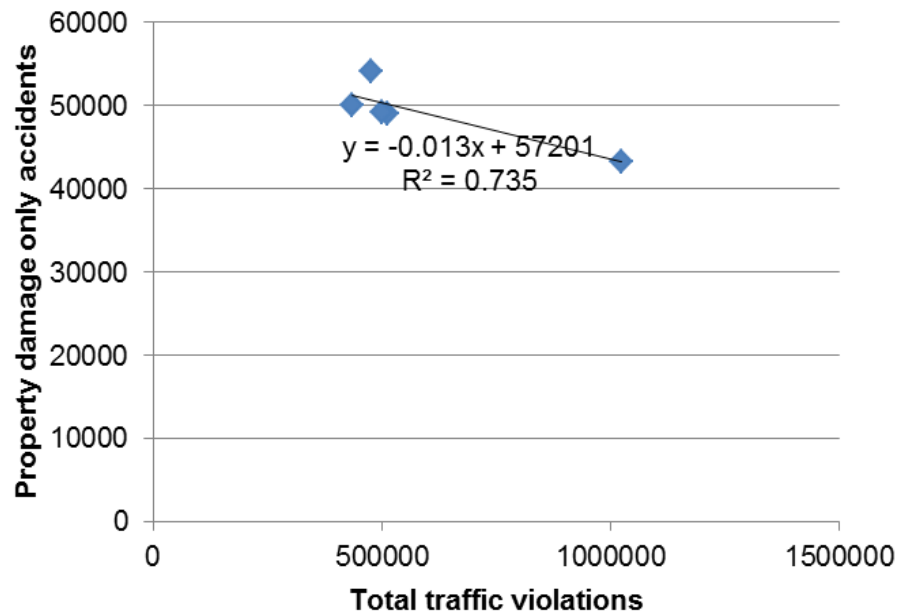
In order to determine and define more precisely the dependence between the number of traffic violations and the number and consequences of traffic accidents, we have made a correlative analysis, meaning the determination of the coefficient of correlation, or determining the degree, that is the strength of the concordance of the correlation between the violations and the accidents with the linear distribution. The results of the analyses are shown in Charts 2 to 5 and Table 3.

In order to determine if and to which extent there is a
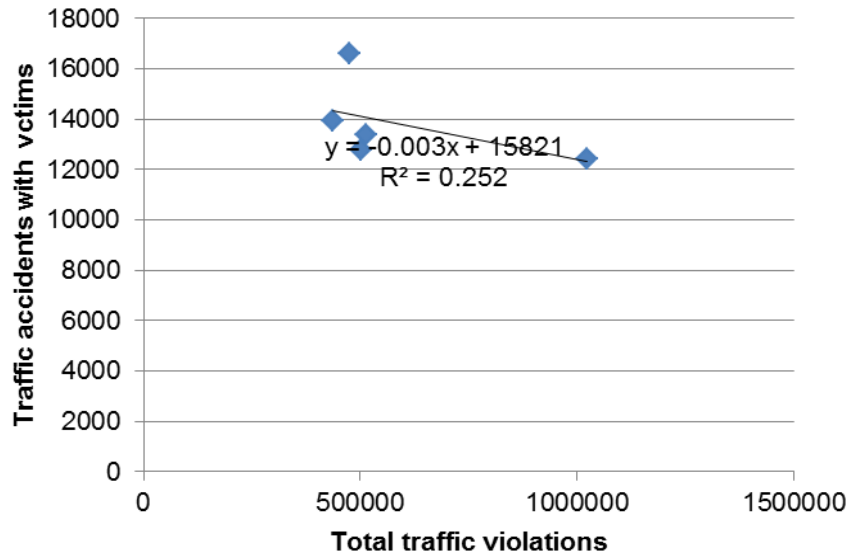
Chart 3. Correlation between total traffic violations and total accidents with victims.

The chart shows data points with a trend line:
$$y = -0.003x + 15821$$
$$R^2 = 0.252$$

Chart 4. Correlation between total traffic violations and property damage only accidents.

The chart shows data points with a trend line:
$$y = -0.013x + 57201$$
$$R^2 = 0.735$$

correlation between the number of traffic violations and the number of traffic accidents and the consequences, we used coefficient of determination (R^2) and to determine whether the correlation is positive or negative we used coefficient of correlation (R) and concluded that:

1. The number of traffic violations and the number and consequences of traffic accidents are in negative correlation,
2. There is a strong negative correlation between the

number of traffic violations and the number of traffic accidents, and also the number of traffic accidents with material damage only,
3. There is a negative correlation of medium strength between the number of traffic violations and the number of traffic accidents with victims,
4. There is a weak negative correlation between the number of traffic violations and the number of killed in traffic accidents,
5. None of the observed dependences doesn't show the
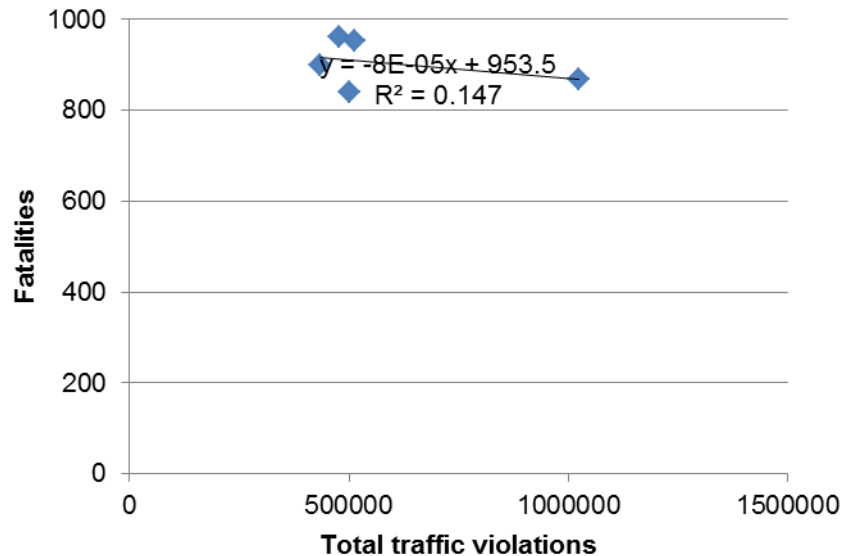
Chart 5. Correlation between total traffic violations and fatalities

Table 4. The most frequent traffic violations by violation type.

Violation type	The number of violations	% of the total number
Speeding	467,788	16
Technical vehicle malfunction	389,305	13
driving under influence of alcohol	316,335	11
Unregistered vehicle	238,792	8
No seatbelt	135,250	5
No driving license	116,235	4
Red-light crossing	89,007	3
Limit signs disobedience	85,287	3
Improper traffic actions	73,527	2
Non halting in front of a pedestrian crossing	60,228	2
...	...	...

Source: Republic of Serbia - Ministry of interior affairs.

so-called "sole factor".

As the coefficient of determination is not greater than 0.9 (Table 3), it means that there is no the so-called "sole factor", so it can be concluded that the number of traffic violations is not the only factor that influences on the number and consequences of traffic accidents. This is, of course, a logical conclusion, but what we wanted to prove is that there is a dependence between the detected number of traffic accidents and the number and consequences of traffic accidents, and that by managing the number of traffic violations it is possible to manage also the number and consequences of traffic accidents. Duress planning and implementation imposes as one of the most important measures which might affect the number of violations and therefore traffic safety improvement in Serbia.

Relevant data – "offense type"

Table 4 shows the first ten "offense types" by frequency. The largest number of violations were related to speeding (16%); technical vehicle malfunction (13%); driving under influence of alcohol (11%) and so on. From the noticed, most frequent violations, the violations directly related to drivers behavior in traffic are: 1) Speeding; 2) Driving under influence of alcohol; 3) no seatbelt; 4) Red-light crossing.

The previously mentioned four violations, apart from being directly related to drivers behavior, are also related to the larger traffic accidents consequences, if the accidents happen in the moment of committing such violations. Forinstance, if collision rates are larger, traffic accidents consequences will also be larger, driving under

influence will cause more traffic accidents, consequences will be more serious if seatbelts aren't used and also in cases of red-light crossing. The most noticed frequent offense types indicated the necessity of defining certain measures. Some of the possible measures for traffic violences decreasing might be: An increase of duress and punishments for violations, drivers behaviour improvement courses and education, or campaigns. Among other most frequent violations, the most important, are related to technical vehicle malfunction, unregistred vehicle and no driving license. In certain situations, these violations could also influence to traffic accidents and serious consequences of traffic accidents. Some of the possible solutions for reducing these type of violations are changing and harmonization of tariff, or penal policy.

DISCUSSION

The importance of traffic safety improvement possibility analysis, based on traffic violations database analysis, is reflected in the proactive action potential. As traffic violations are not traffic accidents, the possibility of using traffic violations data for traffic safety improvement should be questioned. For this reason, the analysis of traffic safety improvement possibility based on traffic violations database, presented in this work, comprises a two-step analysis. The first step implies the implementation of relevant data selection algorithm, that makes it easier to select the data from traffic violations database, which eventually might be used for traffic safety improvement. Relevancy of the data is being determined using the analyses if the conditions of data availability, dependence and usability are fulfilled. Having determined the relevant data, the second step in traffic safety improvement analysis, is to determine if there are certain relation and dependence of relevant data. By determining the existence of relation and dependence of relevant data, a base is made for a possible and more precise planning of the preventive actions and measures for traffic safety improvement and in reducing the number of victims in traffic and traffic accidents. Unlike the previously mentioned, in traffic violations database, there are also some irrelevant data, such as name and surname of the offender, place of birth of the offender, ID of the police station etc, because they don't fulfill one, two or all three conditions defined by the relevant data selection algorithm. Namely, the data such as identification marks of the offender, are unavailable, so these kinds of data cannot be analysed. On the other hand, certain data are largely dependable on other influences and factors, for example the place of the offense. By planning the police enforcement, a police patrol is being directed to the previously defined place, where they will control the traffic and the violations. According to that, traffic violations place distribution data cannot imply the place where

traffic violations will be committed, but only the spatial distribution of police patrols that control the regulations compliance, or the spatial distribution of the systems and devices for traffic regulations compliance control. These mentioned data and other similar data heavily depends on police enforcement and they could not be used for any preventive actions in order to improve traffic safety.

For instance, in a case where data from the official traffic violations and traffic accidents database in Serbia were used, the way of relevant data selecting was shown. According to the model, presented in this work, a relevant data is the data which fulfills all three conditions, availability, dependence and usability. It is very important that the data fulfills all three conditions, because that would mean that there are no important external influences on the data, so therefore, the data can be used properly and through further analysis get correct conclusions, notice real problems, and define appropriate measures for traffic safety improvement. Examples for relevant data from traffic violations database are "date of birth of the offender", "the date when the offense was committed" and "the type of the offense". For the examples of the selected relevant data in this paper, possible ways of further analysis of the selected relevant data are shown. Date of birth of the offender data determined the age of the offender, and age analysis of the offender also showed that young traffic participants are more endangered than the other age groups. As the results of the analysis of the recorded traffic violations concurs with the data and the researches made all over the world (WHO, 2004, 2009), which implies the increased endangerment of the young population in traffic. Therefore, the validity of the analysis of traffic violations was proved.

Through results of a comparative analysis of the number of traffic violations and traffic accidents it was shown that there's a negative interdependence, so it can be concluded that by increasing the number of the recorded traffic violations in traffic violations database, the number of traffic accidents decreases and vice versa. The interdependence degree of the violations, accidents and consequences is still not high enough as if to conclude that only by managing and controlling traffic violations we can influence on the number of victims in traffic accidents, because the value of the coefficient of correlation can vary from $R = -0.384$, for the correlation between an offense and the victims killed in traffic accidents, to $R = -0.857$, for the correlation between an offense and traffic accidents with property damage only accidents. The established negative correlation could be interpreted in a way that by higher enforcement a larger number of traffic violations could be detected and recorded, and a larger number of violations means a higher risk of punishment, so the drivers drive more carefully and more safely, a less number of traffic accidents happen, and traffic safety improvement is accomplished. In other words, the existence of the

analysed correlation and the knowledge about the characteristics of that correlation allows us to plan certain measures like enforcement and education.

Conclusion

As a conclusion of this research, it can be stated that there is a possibility of traffic safety management, based on the analysis of traffic violations database, and that this possibility should be used for proactive traffic safety management. Some of these data heavily depends on police enforcement planning and other external influences and that data could not be used for traffic safety improvement. In order to increase the possibility of traffic safety management based on the traffic violations analysis, it is necessary to take measures for traffic safety database improvement, or most of these data should be more available, they should be more independent and usable. This can be accomplished, for example, by determining the database jurisdiction, by planning more independent enforcement, and by other measures which would provide a better utilization of traffic violations database. In further researches it could be useful to analyze the influences of certain types of traffic violations on traffic accidents and consequences of traffic accidents. This might also be an entrance to a more precise planning of police enforcement (where, when and to what extent), but also for more precise planning of other measures (education and campaigns) for traffic safety improvement.

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