THE ANALYSIS OF THE USE OF PROTECTIVE SYSTEMS IN SERBIA

Dalibor Pešić, Boris Antić, Jelica Davidović

*Faculty of Transport and Traffic Engineering, Vojvode Stepe 305, Belgrade, Republic of Serbia, d.pesic@sf.bg.ac.rs
*Faculty of Transport and Traffic Engineering, Vojvode Stepe 305, Belgrade, Republic of Serbia, b.antic@sf.bg.ac.rs
*Faculty of Transport and Traffic Engineering, Vojvode Stepe 305, Belgrade, Republic of Serbia, jelicadavidovic@yahoo.com

Abstract: During the accident the human body is exposed to large forces, resulting in injury and/or death. As the consequences of the accident were less developed systems of protection for users of motor vehicles, two-wheelers and pedestrians. The most important protection systems are seatbelts, child restraint systems and protective helmets and they fall in road safety performance indicators, based on which it can assess the state of road safety in the area, and to take appropriate preventive measures. The aim of this study, based on data collected observational research in the Republic of Serbia, a correlation between the use of seat belts in the front seat (driver and front passenger) in passenger cars and goods vehicles. Also, to determine the correlation between the use of helmets by cyclists, moped drivers and motorcyclists, three, or two times at all observed road categories. After determining the current situation, based on the performance indicators of traffic safety measures have been proposed in order to reduce suffering and difficulty result of traffic accidents.

Keywords: protection systems, seat belts, protective helmets, correlation, road safety performance indicators

1. INTRODUCTION

During the accident the human body is exposed to large forces, resulting in injury and/or death. According to the design of the vehicle is not enough to protect passengers, were developed protection systems. The most important protective systems used in passenger cars are: air bags, seat belts and child restraint systems. Toward the project SAFETYNET (Wegman et al., 2008) among road safety performance indicators include, between others, use of seat belts and the use of helmets that are the subject of this paper. Many countries, such as Serbia, have regulated by the law seat belts use and helmets use for moped and motorcycle riders.

According to data obtained by analysing survey SARTRE 3 (2004), which included 23 different European countries, the use of seat belts has become problematic. In fact, only 63.1% of drivers said they always use a seat belt, and 36.9% said they do not use a seat belt. Brijs et al., (2011) conclude that seat belts use increased slightly between 2005 and 2007.

Koushki and Bustan (2006) by research in Kuwait showed that men are eight times more vulnerable to the consequences of accidents than women. Only 18.2% of men and 64% of women have always travelled using a seat belt. The main conclusion of their study is that seat
belts use has a very large impact on reducing the severity of injuries in traffic accidents - especially injuries to the face, head and neck.

In Turkey, seat belts use in the front seat is under 20%. Bilgic et al. (2006) conducted a study to determine the percentage of seat belts use in Eskisehir in which it was determined that only 9.15% of the observed participants at four major intersections using a seat belt in the front seat.

Kulanthayan et al. (2004) showed that seat belts use in the front seat in Selangor (Malaysia) 76% of drivers and 50% for the front passengers.

Globally, there is a trend increase in the number of motorized two-wheelers (a term that includes all categories of mopeds and motorcycles), for transportation and recreation. As a result, there is a growing number of deaths and injuries users of motorcycles, which are injuries to the head major problem. Protective helmets for drivers of mopeds and motorcycles are effective in preventing head injuries and reduce the severity of injuries they suffered (Hongsranganon, 2011).

Head injury is a common cause of serious disability and death in accidents involving two-wheelers, as confirmed by numerous studies. In the early nineties, the use of helmets was very rare, and the debate about their effectiveness usual, so a lot of research at the time showed that helmets reduce the severity of injuries to the head and spine, hospitalization costs, and mortality in accidents. Then they introduced regulations for the use of protective helmets and required standards (Xuequan, 2010). Motorcycle riders who do not wear protective helmets are 40% more likely to have severe head injuries. Glasgow coma scale, which is an indicator of the severity of head injuries, was significantly lower in those people who do not wear protective helmets, in relation to those persons who wear those (Abbas, 2011).

The aim of this study was to determine the strength and direction of relationships between seat belts use in the front seat of passenger cars and goods vehicles, and the use of helmets by cyclists, mopeds and motorcyclists, in the settlement, outside the settlement and on the highway. In this paper we conducted an observational study on the territory of the Republic of Serbia in order to determine the performance indicators of traffic safety. The survey was conducted in the autumn and repeated in the spring, during the weekend, from 8:00 to 12:00 am or 13:00-18:00 pm. Applying software SPSS Statistics 20.0 were tested normal distribution, then the correlation of zero order.

2. METHOD

According to the SAFETYNET project, as road safety indicators have been proposed and adopted, among others, seat belts use and protective helmets use.

For the purposes of this study was investigated seat belts use, namely:
- Seatbelts wearing rate in front seats (%) in passenger cars (SBPC)
- Seatbelts wearing rate in front seats (%) in goods vehicles (SBGV) and protective helmets use, namely:
- Proper use of protective helmets by cyclists (%) (PHC)
- Proper use of protective helmets by moped drivers (%) (PHM)
- Proper use of protective helmets by motorcyclists (PHMc)

Due to the drastic reduction in efficiency by improper use of the protection system, the emphasis is placed on the proper use and indicators relating to the seat belts use and protective helmets use only include information on the proper use of these systems.
Observational research, the most reliable method of measurement, has been used in measuring indicators of protective systems. Measurement points were chosen, so that the field researcher able to see the all the necessary features proper use / non-use of the observed indicators.

The measurement was carried out at places where vehicles, as a rule, are moving at lower speeds or stand (intersections, toll gates, fuel stations, etc.).
Measurement of use of the restraint systems, was carried out during the weekend, daily conditions of visibility in all regional offices, including:

- on the highway
- out of the settlement
- in the settlement.

Measurement of the observed indicators use is performed periodically, twice, in:

- spring (April and May)
- autumn (September and October)

Related to periods during the day, measurement is performed in the daily visibility conditions:

- in the morning (from 8:00 to 12:00) or
- at the afternoon (from 13:00 to 18:00)

At weekends:
- Saturdays
- Sundays

We did not analysed vehicles for which a researcher, for any reason, did not manage to record all the necessary information of safety belts use, or protective helmets.

The study was carried out on the territory of the Republic of Serbia according to the police departments (27 police districts), in the settlement, outside settlements and on the highway.
At the end of the study, in order to indicate the relationship between observed indicators in the settlement, out of the settlements and on the highway, using the statistical program SPSS Statistics were tested normality, and then calculated the corresponding coefficients of correlation and determination.

Inputs:
- seatbelts wearing rate in front seats (%) in passenger cars (SBPC)
- seatbelts wearing rate in front seats (%) in goods vehicles (SBGV)
- proper use of protective helmets by cyclists (%) (PHC)
- proper use of protective helmets by moped drivers (%) (PHM)
- proper use of protective helmets by motorcyclists (PHMc)

Outputs:
- the coefficient of correlation
- the coefficient of determination
- statistical significance

3. RESULTS

Database analysis of the collected data show that seat belts use in the front seat is 63% in the settlement, 70% outside of the settlement and 78% on the highway, while seat belts use in
goods vehicles far less and amounts 12% in the settlement, 20% outside of the settlement and 28% on the highway (Figure 1).

![Figure 1. Distribution of the use of seat belts in the front seat](image)

![Figure 2. Distribution of protective helmets use in the settlement and out of the settlement](image)

### Table 1. Coefficient of correlation, determination and level of significance for use of safety belts and protective helmets

<table>
<thead>
<tr>
<th>Relationship between Variables</th>
<th>Road category</th>
<th>Correlation Coefficient Value</th>
<th>Relationship strength</th>
<th>Determination Coefficient Value</th>
<th>Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBPC</td>
<td>SBGV settlement</td>
<td>0.309</td>
<td>Medium</td>
<td>0.095481</td>
<td>0.117</td>
</tr>
<tr>
<td></td>
<td>out of settlement</td>
<td>0.005</td>
<td>No</td>
<td>0.000025</td>
<td>0.982</td>
</tr>
<tr>
<td></td>
<td>highway</td>
<td>0.279</td>
<td>Small</td>
<td>0.077841</td>
<td>0.468</td>
</tr>
<tr>
<td>PHC</td>
<td>PHM settlement</td>
<td>0.051</td>
<td>No</td>
<td>0.002601</td>
<td>0.800</td>
</tr>
<tr>
<td></td>
<td>out of settlement</td>
<td>0.277</td>
<td>Small</td>
<td>0.076729</td>
<td>0.162</td>
</tr>
<tr>
<td>PHC</td>
<td>PHM settlement</td>
<td>0.128</td>
<td>Small</td>
<td>0.016384</td>
<td>0.525</td>
</tr>
<tr>
<td></td>
<td>out of settlement</td>
<td>0.004</td>
<td>No</td>
<td>0.000016</td>
<td>0.983</td>
</tr>
<tr>
<td>PHM</td>
<td>PHM settlement</td>
<td>0.489</td>
<td>Medium</td>
<td>0.239121</td>
<td>0.072</td>
</tr>
<tr>
<td></td>
<td>out of settlement</td>
<td>0.125</td>
<td>Small</td>
<td>0.015625</td>
<td>0.263</td>
</tr>
</tbody>
</table>

Conducted preliminary analyses to demonstrate satisfaction of the assumptions of normality, linearity and homogeneity of variance. Pearson’s Linear Correlation Coefficient indicates that the relationship between seat belts use in passenger cars and goods vehicles in the settlement, outside of the settlement and on the highway is small. Where the use of seat belts in passenger cars follows the use of seat belts in goods vehicles at all observed road categories, or positive direction of the correlation.

The coefficient of determination shows proportion of the variance shared by two observed variables and its values are shown in Table 1.

Pearson’s linear correlation coefficient can take values between -1 and 1, with the value -1 indicates complete negative correlation, while a value of 1 indicates complete positive correlation. The analysis of Pearson's coefficient for the variable SBPC and SBGV in each observed road category, it can be concluded that the highest correlation between the SBPC in the settlement and outside of the settlement, that the strongest link between the use of seat belts in the front seat of a passenger car in the area of police departments in the settlement and
outside of the settlement, and it is considerably less connection between seat belts use in passenger car and good vehicles in all areas of research (Table 2).

Table 2. Pearson’s Linear Correlation Coefficient between SBPA and SBGV

<table>
<thead>
<tr>
<th>Variables</th>
<th>Road category</th>
<th>SBPA settlement</th>
<th>SBPA out of settlement</th>
<th>SBPA highway</th>
<th>SBGV settlement</th>
<th>SBGV out of settlement</th>
<th>SBGV highway</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBPA</td>
<td>settlement</td>
<td>-0.653</td>
<td>0.552</td>
<td>0.309</td>
<td>0.005</td>
<td>0.279</td>
<td></td>
</tr>
<tr>
<td></td>
<td>out of settlement</td>
<td>-</td>
<td>0.429</td>
<td>0.301</td>
<td>0.177</td>
<td>-0.618</td>
<td></td>
</tr>
<tr>
<td></td>
<td>highway</td>
<td>-</td>
<td>-</td>
<td>0.110</td>
<td>-0.082</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td>SBGV</td>
<td>settlement</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.609</td>
<td>-0.160</td>
<td>-0.343</td>
</tr>
<tr>
<td></td>
<td>out of settlement</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>highway</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Protective helmets used by cyclists and moped drivers have been studied in the settlement and out of the settlement. The results show that only 0.8% of cyclists in the settlement, and 1.8% out of the settlement used protective helmets. A lot better, but the results were unsatisfactory in protective helmets use among moped drivers, 86% in the settlement and 83% out of the settlement. Motorcyclists in the highest percentage use of protective helmets and 93% in settlement 94% outside of the settlement (Figure 2) and 100% on the highway.

Examination of normality in the variables related to the use of protective helmets showed a deviation from the normal distribution. For this reason, to determine the correlation between the observed variables used non-parametric alternative to Pearson’s linear correlation coefficient – Spearman’s rank correlation.

The results have shown no or little connection between the use of protective helmets by cyclists and moped drivers in the settlement and out of the settlement. The results show that the relationship between using of protective helmets by cyclists and motorcyclists, too little, or no in the settlement and out of the settlement, while the relationship established between the use of protective helmets by motorcyclists and moped drivers is medium in the settlement. Given that the correlation coefficient is low, the values of the coefficient of determination are very small. There was no statistically significant between the observed variables (Table 1). Therefore, no significant correlation between uses of protective helmets by cyclists, moped and motorcycle in the settlement and outside the village.

Table 3. Spearman's rank correlation coefficient for the variables PHC, PHM and PHMc

<table>
<thead>
<tr>
<th>Variables</th>
<th>Road category</th>
<th>PHC settlement</th>
<th>PHC out of settlement</th>
<th>PHM settlement</th>
<th>PHM out of settlement</th>
<th>PHMc settlement</th>
<th>PHMc out of settlement</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHC</td>
<td>settlement</td>
<td>-0.251</td>
<td>-0.051</td>
<td>0.277</td>
<td>-0.128</td>
<td>0.004</td>
<td></td>
</tr>
<tr>
<td></td>
<td>out of settlement</td>
<td>-</td>
<td>-0.046</td>
<td>-0.123</td>
<td>-0.255</td>
<td>-0.193</td>
<td></td>
</tr>
<tr>
<td>PHM</td>
<td>settlement</td>
<td>-</td>
<td>-</td>
<td>0.410</td>
<td>0.489</td>
<td>0.125</td>
<td></td>
</tr>
<tr>
<td></td>
<td>out of settlement</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.352</td>
<td>0.223</td>
<td></td>
</tr>
<tr>
<td>PHMc</td>
<td>settlement</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.522</td>
</tr>
<tr>
<td></td>
<td>out of settlement</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Spearman's rank correlation coefficient as well as Pearson's correlation coefficient takes values between -1 and 1, the obtained values are shown in table 3. The highest correlation was found between the use of protective helmets by motorcyclists and mopeds drivers in the settlement ($r_o=0.489$). In contrast to the use of seat belts which was positive, with the use of protective helmets in some cases determined by the negative correlation (for example, the use of protective helmets by cyclists in the settlement and mopeds drivers in the settlement).

4. DISCUSSION

Comparing the results presented by Bilgic et al. (2006) 9.15% of seat belts use in Turkey, Kulanthayan et al. (2004), that 76% of drivers and 50% of the passengers properly use seat belts in Malaysia, Pickrell et al. (2014) that the use of seat belts in the United States is 87%, it is concluded that Serbia belongs to the group of countries with a medium level of seat belts use. The desired level is still not satisfactory.

The results have shown a normal distribution between the use of seat belts in the front seat of passenger cars and commercial vehicles. On the other hand, it was deviation from normal distribution with the use of helmets by cyclists, mopeds drivers and motorcyclists.

Road Traffic Safety Law prescribes the mandatory use of seat belts and protective helmets when riding mopeds and motorcycles. Law do not mandate the use of helmets for cyclists. Centre for Traffic Safety in the Netherlands (SWOW Fact Sheet, 2009) dealt with the issue of children's safety as a cyclist in traffic and indicate that children 12-14 years suffer more because they are more represented independently in traffic as cyclists. Also indicate that children as cyclists in traffic most likely to die in accidents with commercial vehicles, and passengers in vehicles due to some obstacles. The use of helmets leads to a weight reduction of injuries of the head, reducing the likelihood of damage to the brain, thus reducing the risk of casualties. Bearing in mind the facts should, in Serbia, the law oblige cyclists to use safety helmets.

As shown in Table 1 were not statistically significant between groups of variables (the group means safety belt and protective helmet), because the level of significance in all observed cases is greater than 0.05 (the threshold of statistical significance was set at 0.05).

5. CONCLUSION

Safety belts use in the front seat is in positive correlation between the observed types of vehicles at all road observed categories. Pearson’s linear correlation coefficients show the highest correlation between the use of seat belts in passenger car in the settlement and out of the settlement.

The results indicate that it is necessary to take measures to improve seat belts use, especially at the professional drivers. Bearing in mind that there was no significant correlation between the use of seat belts in passenger car and goods vehicles concluded that awareness of professional drivers about the importance of seat belt use is less developed than for drivers of passenger cars, on the space of all police departments.

The most efficient measure for improving traffic safety is considered education of road users. Since the use of seat belts by drivers of trucks away from the desired suggests the implementation of education in transport companies. It should be borne in mind that in this way did not include all the truck drivers involved in traffic on the territory of the Republic of Serbia, but it would cover a significant part. In this regard, every transport company should make a plan of actions for road safety improvement, which will include mandatory training...
programs to be used in drivers ‘remind’ on the individual provisions of traffic safety low, and in addition to the theory, point out to them on the practical importance of obeying the law.

For a group of drivers who will not be included in the program of education design campaigns that will be reach through the Internet, television, radio a wide audience. To Serbian drivers and drivers who perform transit through Serbia. The aim of the campaign is to act on the consciousness of the general public to as many drivers saw the importance and started to use seat belts. Today, in the era of the Internet, the campaign can easily reach the target groups. Forming internet sites, a group of social networks on a daily basis effect on society, not only on the drivers but the whole society. Make a website that will be interesting and useful to as many as users of social networks followed. On them display a realistic picture of the Serbian roads, foreign and domestic experience, simulation (what happens if you use a seat belt, but what if it is not used).

For drivers who do not use social networks, or the Internet in general, send a message through television and radio, for foreign nationals at the border distribute leaflets printed in multiple languages.

Apart from education and campaigns increase control of the traffic police. Take advantage of available human resources and implement repressive measures. With them begin 15 days after the start of the campaign in the media. During this time, the campaign will reach a large number of drivers, and those who nevertheless continue to ignore the law to punish. Tighten monetary fines and thus reduce the circle of drivers who cannot afford to “afford” punishment.

The aim of protective helmets is to prevent head injuries and constitute the most important part of the protective equipment. Only if the Protective helmet is used in a proper manner (buttoned, homologated, right type) may significantly contribute to the prevention or reduction of head injuries the driver or passengers. Often, drivers do not use the proper protective helmets and thus loses its function and increases the risk of injury.

It is necessary to conduct training of drivers primarily on the importance of wearing protective helmets, and then the right choice of helmets. It is proposed to implement training in several phases. The first phase is the acquisition of basic skills in primary schools, as children need to develop positive attitudes about the use of protective equipment, and therefore protective helmets. The second phase is in the process of training in driving schools, give those examples, the method of selection of protective helmets. The third stage is the implementation of knowledge seminars and training rides at various events that congregate large number of two-wheeler drivers.

Apart from education is proposed and the implementation of media campaigns, in order to inform the general public about the importance of using protective helmets, but only for moped drivers and motorcyclists, but also cyclists. Particular attention should be paid to children up to 14 years in transport as cyclists.

As mentioned in the discussion, to revise the legislation. Oblige cyclists by Low to use protective helmets when participating in public transport.

In addition to the proposed preventive measures, as well as the use of seat belts implement repressive measures, where the traffic police to punish drivers and passengers who are not used (or not used properly) protective helmets.
4. REFERENCES


