bslz.org

ROAD SAFETY IN LOCAL COMMUNITIES

DECADE OF ACTION FOR ROAD SAFETY 2011-2020

XI International Conference

ROAD SAFETY IN LOCAL COMMUNITY

BERGISCHE UNIVERSITÄT WUPPERTAL

SVPT
www.svpt.de

Faculty of Transport and Traffic Sciences

КРИМИНАЛИСТИЧКО ПОЛИЦИЈСКА АКАДЕМИЈА

ACADEMY OF CRIMINALISTIC AND POLICE STUDIES

Academy of Criminalistic and Police Studies

XI International Conference

ROAD SAFETY IN LOCAL COMMUNITY

– CONFERENCE PROCEEDINGS –

Vrnjacka Banja, Hotel Zvezda
April 13 – 16, 2016.

XI International Conference
ROAD SAFETY IN LOCAL COMMUNITY
Serbia, Vrnjacka Banja, April 13 – 16, 2016.
– CONFERENCE PROCEEDINGS –

Publishers

Academy of Criminalistic and Police Studies, Belgrade, Serbia
Bergische Universität Wuppertal, Germany
Faculty of Transport and Traffic Sciences, University of Zagreb, Croatia
Serbian Road Safety Association, Novi Sad, Serbia

Publishers representative

Prof. Dragana KOLARIĆ, Ph.D,
Academy of Criminalistic and Police Studies, Acting Dean

Editors

Prof Krsto LIPOVAC, Ph.D, Conference Program Committee, chairman
Asst Prof Miladin NEŠIĆ, Ph.D, Conference Organizing Committee, chairman

Technical Editor

Filip FILIPOVIĆ, M.Sc.

Circulation
100 pieces

Printed by
Univcrzal Čačak

THE CONFERENCE IS ORGANIZED BY:
Academy of Criminalistic and Police Studies, Belgrade, Serbia
Faculty of Transport and Traffic Engineering Belgrade
Faculty of Technical Sciences, Novi Sad
Faculty of Transport and Traffic Sciences, Zagreb, Croatia
National Technical University of Athens, Greece
The School of Higher Technical Professional Education, Niš
Road Safety Agency, Republic of Serbia
Road Safety Agency, Republic of Srpska
Road Safety in Local Communities, Belgrade
Road Safety Council, Belgrade
Serbian Road Safety Association, Novi Sad
Automobile and Motorcycle Association of Serbia
Traffic Safety Group
BBN Congress Management

THE CONFERENCE IS BEING SUPPORTED BY THE
MINISTRY OF EDUCATION AND SCIENCE OF REPUBLIC OF SERBIA

ISBN 978-86-7020-371-6

PROGRAM COMMITTEE

ORGANIZING COMMITTEE

Asst Prof Miladin NEŠIĆ, Ph.D, Chairman
Academy of Criminalistic and Police Studies, Belgrade, Serbia

Slobodan MALEŠIĆ,
Ministry of Internal Affairs – Road Safety Directorate, Serbia

Milan BOŽOVIĆ
Republic of Serbia - Road Traffic Safety Agency

Assist Nenad MARKOVIĆ
Faculty of Transport and Traffic Engineering, University of Belgrade, Serbia

Milija RADOVIĆ
Republic of Serbia - Road Traffic Safety Agency, Republika Srpska

Boban MILINKOVIĆ
Ministry of Internal Affairs – Road Safety Directorate, Serbia

Assist Boško MATOVIĆ
Faculty of Technical Sciences, University of Novi Sad, Serbia

Milan BOŽIĆ
Automobile and Motorcycle Association of Serbia, Belgrade

Marko POPOVIĆ, MSc
BBN Congress Management, Serbia

PEER-REVIEWERS

Prof Krsto LIPOVAC, Ph.D, Chairman
Prof Milan VUJANIĆ, Ph.D.
Prof Dragan JOVANOVIĆ, Ph.D.
Asst Prof Miladin NEŠIĆ, Ph.D.
Asst Prof Boris ANTIĆ, Ph.D.
Asst Prof Dalibor PEŠIĆ, Ph.D.
Svetlana BAČKALIĆ, Ph.D.
Prof Vladan TUBIĆ, Ph.D.
Prof Davor BRČIĆ, Ph.D.
Prof Osman LINDOV, Ph.D.
Prof Vujadin VEŠOVIĆ, Ph.D.
Dejan BOGIĆEVIĆ, Ph.D,
Nenad MILUTINOVIĆ, Ph.D.
Dragoslav KUKIĆ, Ph.D.

FOREWORD

Conference “Road safety in local communities” has become recognizable on the map of expert meetings in the field of road safety. From year to year more and more experts are gathering and discussing the topics of importance for local communities, share experiences and discuss various problems and ways to overcome them.

In the past we have presented various knowledge and practical experiences in road safety. We have recognized and commended numerous good initiatives at the state and local level, that have contributed to improvement of road safety. We are giving argumented criticism to the negligence and omissions in the work. We have pointed out omissions in the application of regulations, especially omissions in the use of funds intended for improvement of road safety. We have contributed to formation of local bodies for road safety in many cities and municipalities, supported the preparation and implementation of annual Traffic Safety Program, encouraged the work of government institutions, encouraged a revival of the NGO sector...

We have promoted the most important international documents and initiatives in road safety. We have established and improved risk mapping in local communities, which is now widely accepted in the region and in Europe. In this Proceedings, we devoted special attention to the maps of the most important indicators of road safety. We create the conditions for a new, science-based, concept of road safety management, based on the performance indicators of road safety.

We have contributed to the preparation of the first National “Strategy for road traffic safety in the Republic of Serbia *2015-2020*[1]*"*. In an effort to tighten the responsibility for road safety, within the traditional analysis of the traffic safety situation, since this year, we will add comparative analysis of the results achieved with the objectives set by the national strategy.

In Serbia, during the 2015, more than 100 people were killed in traffic accidents than predicted by Strategy[2]. Other Strategy defined goals have not been achieved in terms of final outcome (number of traffic accidents, number of injured and total socio-economic costs are much higher than predicted), neither in terms of performance indicators (use of seat belts, child car seats, helmet wearing, speeding, driving under the influence of alcohol etc.). This failure is the result of poor performance and requires scientific analysis, preparation and implementation of well thought out system of measures and activities at all levels. It's necessary to carry out very important systemic measures to improve road safety and enhance coordination and cooperation in the work of the most important subjects. We hope that this Conference will contribute to the improvement of work on the local level and to achievement of ambitious goals set by the National Strategy for road traffic safety.

ORGANIZING COMMITTEE
Chairman
Ass Prof Miladin Nešić, Ph.D, T.E.

PROGRAM COMMITTEE
Chairman
Prof. Krsto Lipovac, Ph.D, T.E.

[1] 05 No. 344-1721/2015-1 (Official Gazette RS, from 20 july 2015)

[2] Instead of planned 510 persons killed, in 2015 over 600 persons were killed in traffic accident.

TABLE OF CONTENTS

INVITED PAPER

THE IMPORTANCE OF CREATING AND USING LOCAL ROAD ACCIDENT DATABASES - A CASE STUDY OF REPUBLIC OF SRPSKA 2015

Krsto Lipovac[1], Bojan Maric[2], Milan Tesic[3], Milija Radovic[4]

Abstract: The third round of the professional training dedicated to local databases on road accidents was held in September 2015. The aim of the training was strengthening capacities of local self-government units. To that end, the Road Safety Agency of the Republic of Srpska, in cooperation with the Ministry of Interior of the Republic of Srpska and the Public Enterprise "Putevi Srpske", have prepared basic data on road crashes with fatalities and seriously injured, for all municipalities and cities of the Republic of Srpska. Among other things, the data have included verified coordinates of the road crash scenes. All the trainees have been trained to use the existing road accident database, create an Excel spreadsheet and, based on this table, create a map of road crashes for their municipality or city. The seminar also included a variety of possibilities for using these databases, especially the risk mapping and analysis of spatial distribution of road accidents.

Keywords: road accidents, coordinates of a road accident scene, local databases, risk mapping, spatial distribution of accidents.

[1] Ph.D, Lipovac Krsto, Regular Professor, Faculty of Transport and Traffic Engineering, 305, Vojvode Stepe street, 11000 Belgrade, Serbia, e-mail: k.lipovac@gmail.com

[2] Ph.D, Maric Bojan, Senior Assistant, Faculty of Transport and Traffic Enginerring in Doboj, 52, Vojvode Misica street, 74000 Doboj, Republic of Srpska (BiH), e-mail: bojomaric@yahoo.com

[3] Tesic Milan, M.Sc., Senior Associate, Road Safety Agency of the Republic of Srpska, 18, Zmaj Jove Jovanovica, Banja Luka, Republic of Srpska, e-mail: m.tesic@absrs.org

[4] Radovic Milija, B.Sc., Director, Road Safety Agency of the Republic of Srpska, 18, Banja Luka, Republic of Srpska, e-mail: m.radovic@absrs.org

1. INTRODUCTION

Databases are the indispensable segment of the road safety management system. Having recognized that, the World Health Organization prepared and published in 2011 a document named Data Systems (WHO, 2011). It highlights the need for developing databases from several aspects, focusing on stakeholders which must be included in the making of databases and data collection quality system.

When making road accident databases on national/local level, it is very important to include as many stakeholders dealing with road accident records as possible. They are traffic police, health institutions (emergency medical services, hospitals) and insurance companies. Road accident databases of highest quality are those databases that contain the largest number of details on these accidents (TRL - Transport Research Laboratory, IRTSD - International Road Traffic and Accident Database and CARE - Community Road Accident Database of the EU member states). Globally, the mentioned road accident databases look a bit different. In fact, the need for defining, i.e. adjusting the definition of variables, their scales of values, structure and format has been met so that such created databases could be mutually comparable (CAREPLUS protocol). At the same time, the European Commission has developed a common minimum set of road accident data, the so called CADaS protocol, which may be used by any EU country wishing to improve and update its national road accident data collection system (Pesic et al., 2014).

Generally speaking, in order to manage road safety, it is necessary to analyze the existing situation, define desired (real) objectives and undertake optimal managerial measures. The basis for the system cognizance is monitoring of road safety features at the local level, since monitoring at the national level does not yield the level of detail and accuracy necessary for the quality assessment of the situation present at lower levels. Monitoring road accidents by means of a quality database offers possibilities for diverse analyses and assessments which will clearly indicate the priority issues and guide the activities of authorities in charge towards their solutions.

According to this, the present paper shows and describes a concrete and very practical way of using road accident data which may be visually and spatially displayed in various ways, depending on the purpose.

2. METHODOLOGY

2.1. Scope and objective

The Ministry of Administration and Local Self-government and the Road Safety Agency, in cooperation with the United Nations Development Program (UNDP), within the “Training System for the Employees in Local Self-

Government Units", implemented the thematic workshops named "THE ANALYSIS OF ROAD ACCIDENT DATA AND THEIR IMPORTANCE FOR ROAD SAFETY MANAGEMENT". These workshops were organized by the Road Safety Agency of the Republic of Srpska and the civil organization "Centre for Road Safety Improvement".

The objectives of the workshops organized in the third round, and intended for the employees in the local self-government units who are in charge of road traffic, and for the officers from the Ministry of Interior, included the following tasks:

- Improving practical knowledge related to road safety;
- Highlighting the importance of databases in road safety;
- Presenting the methods and tools for mapping and spatial distribution of negative consequences of road crashes;
- Training all people present for risk mapping and spatial distribution of negative consequences of road crashes.

Assessing the current state of road safety by the local community, defining the vision and objectives, and particularly the selection of measures and activities aimed at improving road safety, should be based on good information on the number and consequences of road accidents, spatial and temporal distribution, category of road users involved in road crashes, circumstances in which road crashes occurred, etc. Therefore, road safety issues can be defined in a professional way only on the basis of permanent monitoring of quality road accident data.

On the other hand, the first and the most important step towards solving these issues would be to have a professional insight and definition of the problem. Certain local communities face the issues of incomplete reporting and unavailable road accident data. When there are no data, or when data are scarce or not available, monitoring the existing state of road safety is of poor quality. It is also difficult to define the problems in a professional way, and is therefore difficult to find a solution for them. Undertaken measures are not optimal, they are not effective or their effects are negligible.

***Figure 1**. A wider (mapping) and detailed (spatial distribution) display of road safety indicators*

According to the abovementioned, the existence of a quality database on the local level will provide the road traffic authorities with quality data on the basis of which they can carry out various analyses. The aim of these analyses is to determine the current situation in road safety (mapping, spatial distribution), after which it will be possible to precisely define the problem and undertake optimal measures (Figure 1).

2.2. Time and space

The workshops were held in four regional centers (Banjaluka, Bijeljina, Istocno Sarajevo and Trebinje), on 5-8 October, 2015 (Figure 2). Representatives of the Ministry of Interior of the Republic of Srpska coming from police stations and representatives of local self-government units in charge of road traffic, gravitating towards the four centers above, were invited to each of these four cities, as previously planned.

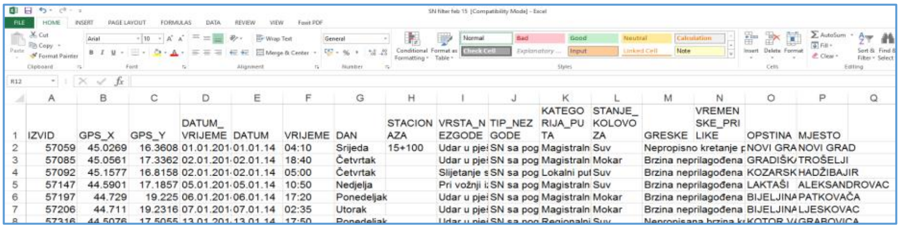
Figure 2. *Workshops held in regional centers*

The workshops lasted from 10:00 to 16:00 hours, but before they started, briefings were held (from 8:30 to 9:30 hours) in each of the Public Security Centers (Trebinje, Istocno Sarajevo, Bijeljina and Banjaluka), with commanders/deputy commanders of police stations belonging to the corresponding center. At these meetings, they were briefed and also informed about the workshop themes.

2.3. Method

Lecturers and workshop participants followed the proposed program. Once the lectures have been completed, the participants were able to ask questions and give their comments on the themes presented at the workshops. Also, after the lecturers have finished with their lectures, all the participants underwent practical training. In fact, the teams were formed of several participants coming from the same local community. Each team was assigned with a task of allocating a certain amount of money to various measures and activities intended for road safety, in their own local communities. After the completion of their tasks, each team had to present the measurement plan made according to available funds and explain in details those foreseen measures and activities.

After that, and assisted by the lecturers, all the participants had to make individually a spatial map of road accidents for their local communities. This task related to the integrated database management (Figure 3), adjusting data from the Ministry of Interior database into the form of data recognized by the Google Earth program (Figure 4), filtering necessary data, and making a visual presentation of desired road accident data shown on maps, in the same program.



IZVID	GPS_X	GPS_Y	DATUM_VRIJEME	DATUM	VRIJEME	DAN	STACIONAZA	VRSTA_NEZGODE	TIP_NEZGODE	KATEGORIJA_PUTA	STANJE_KOLOVOZA	GRESKE	VREMENSKE_PRILIKE	OPSTINA	MJESTO
57059	45.0269	16.3608	01.01.201	01.01.14	04:10	Srijeda	15+100	Udar u pje	SN sa pog	Magistraln	Suv	Nepropisno kretanje p		NOVI GRA	NOVI GRAD
57085	45.0561	17.3362	02.01.201	02.01.14	18:40	Četvrtak		Udar u pje	SN sa pog	Magistraln	Mokar	Brzina neprilagođena		GRADIŠK	TROŠELJI
57092	45.1577	16.8158	02.01.201	02.01.14	05:00	Četvrtak		Slijetanje s	SN sa pog	Lokalni put	Suv	Brzina neprilagođena		KOZARSK	HADŽIBAJIR
57147	44.5901	17.1857	05.01.201	05.01.14	10:50	Nedjelja		Pri vožnji i	SN sa pog	Magistraln	Suv	Brzina neprilagođena		LAKTAŠI	ALEKSANDROVAC
57197	44.729	19.225	06.01.201	06.01.14	17:20	Ponedeljak		Udar u pje	SN sa pog	Magistraln	Mokar	Brzina neprilagođena		BIJELJINA	PATKOVAČA
57206	44.711	19.2316	07.01.201	07.01.14	02:35	Utorak		Udar u pje	SN sa pog	Magistraln	Mokar	Brzina neprilagođena		BIJELJINA	LJESKOVAC

Figure 3. *Display of an Excel spreadsheet containing road accident data from the Ministry of Interior database*

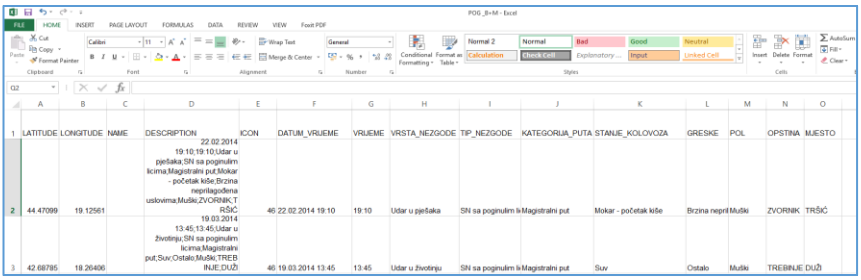


Figure 4. *Layout of a completed spreadsheet for the Google Earth program*

Such a „free“ form has proved to be a very successful one, as it enabled and encouraged active participation of all participants present. The atmosphere during the workshops was very dynamic. After lecturers’ presentations, active discussion took place and comments were made mainly concerning concrete dilemmas, either theoretic or practical.

3. RESULTS

Spatial display of adverse consequences of road accidents, but also of road safety performance indicators, is of significance for a detailed analysis of road crashes. The most efficient tool for presenting a “wider” spatial distribution (image) of road safety indicators in an area is mapping. Thus road safety situation on a certain territory, road, road section, etc. is clearly and visually presented using the mapping tool. Therefore, mapping is used to get an insight into the current road safety situation of particular spatial units (figure 5), in a very simple manner.

When the actual state is determined, it is possible to mutually compare and obtain as a result the information on where the concrete observed spatial unit is located (local community, police station, road, road section …) in relation to other units in the region, as far as road safety is concerned.

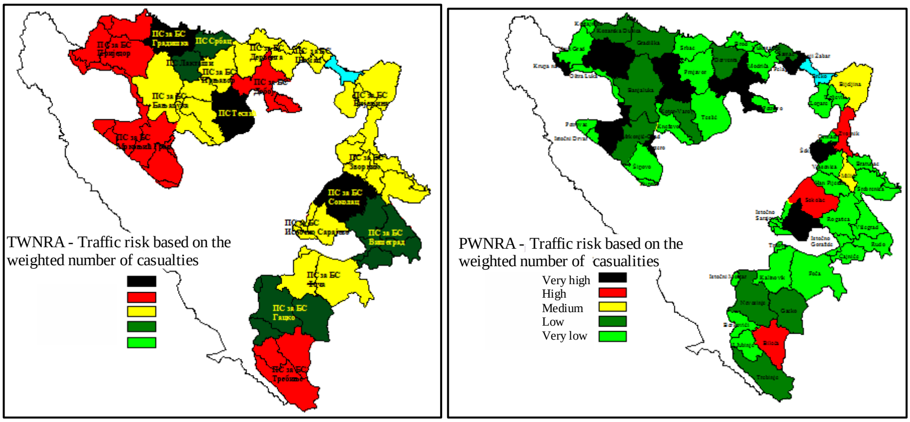


Figure 5. *Mapping per police stations and self-government units (Maric et al., 2014 a,b)*

After the completion of the risk mapping per certain spatial units, it will be possible to “lower” road accidents using GPS coordinates, to a far lower level (exact location of a road accident), according to road type, to a road section, a street in an urban area, etc. (Figures 6, 7 and 8). This process is possible in units with the observed high risk of road accidents (if road accidents are observed).

Spatial display of road accidents enables the analysis and selection of seemingly important road crashes. It is thus possible to recognize those locations where aggregation (concentration) of road accidents is taking place and to further focus on their more detailed in-depth analysis, i.e. to look for “common ties” that are linking them together.

Conducted analyses of road crashes and their consequences thus make possible to clearly perceive and define the problems at the level of observed spatial unit (local community, police station, road section, urban street), i.e. to detect common circumstances in which road accidents occur, such as: road infrastructure deficiencies, absence of police enforcement (since unsafe behavior of road users have been noticed on these sections), potentially risky sections: straight directions and curves with a small radius, intersections with poor sight distance …

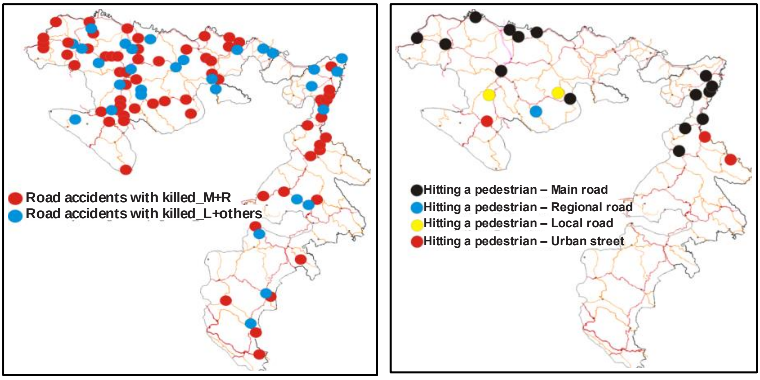


Figure 6. *Spatial distribution of road accidents in the area of the Republic of Srpska (Tesic et al., (2015); Maric et al., (2015))*

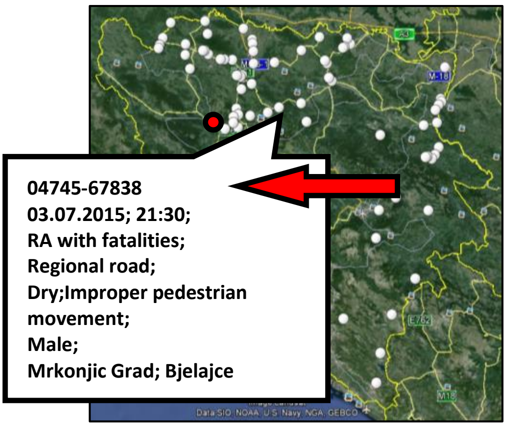


Figure 7. *Spatial distribution of road accidents in the area of the Republic of Srpska with basic road accident data (Lipovac et al., 2015)*

Apart from the visual display of road crashes, the method of entering road accident data into a database allows to check its accuracy, i.e. verification of data obtained from police officers from the Ministry of Interior who made the investigation at the scene of the particualr road crash and also entered the related road accident data into investigation records. Therefore, upon the completion of the workshops, each trainee was able to check the road accident data in his/her local community (police station) and present them visually using the appropriate maps.

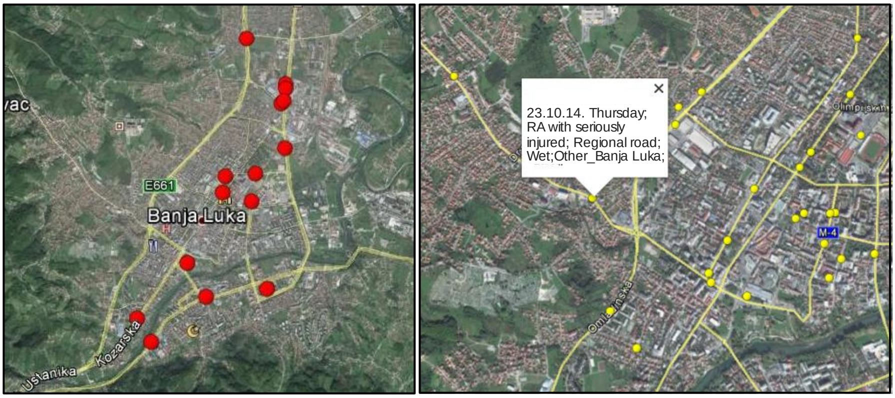


Figure 8. *Examples of spatial distribution of road accidents with seriously injured, in the area of the city of Banjaluka (Tesic et al., 2015)*

Finally, at the end of each workshop in those four centers, participants were asked to evaluate the quality and usefulness of workshops, but also of lecturers who represented the civil organization „Center for Road Safety Improvement“. Obtained results and comments of the workshop participants have been more than positive and showed that it will be necessary to have in the future as many such practical workshops as possible, to tackle similar road safety topics (figure 9).

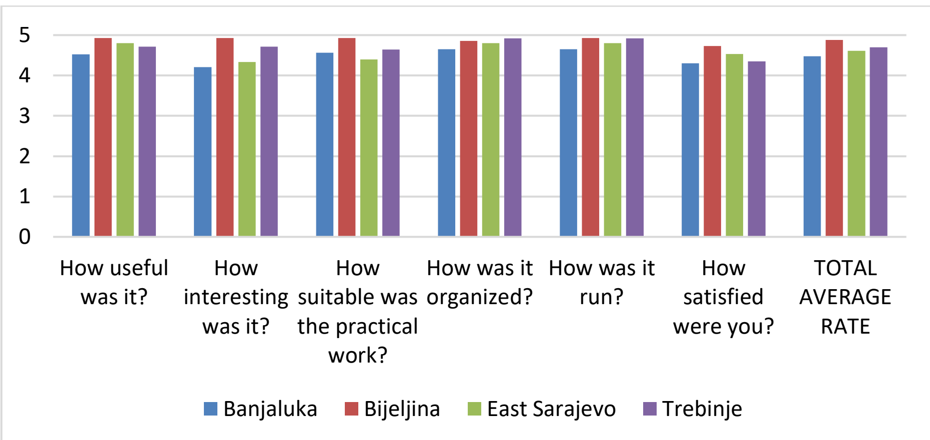


Figure 9. E*valuation results of workshop's success (Lipovac et al., 2015)*

4. CONCLUDING REMARKS

Only local databases of high quality will enable a visual display, i.e. mapping/spatial distribution of road accidents on the basis of which it will be possible to precisely perceive risky sections/locations, obtain a “wider” image of the problem and a more simple overview of basic details pertaining to a road crash (data from investigation documents). Local databases are of great significance for the spatial distribution of road accidents, and vice versa, since accurate/inaccurate location of a road accident is obtained on the basis of entering data from the road accident database, which enables the verification of basic (location, type and category of road accident, road type …) and additional (participants, injuries, circumstances, characteristic data …) road accident data. Further on, an accurate spatial distribution of road crashes with necessary details is consequently made, serving as a basis for in-depth analyses of road accidents.

Therefore, workshops have been completely conducted according to the objectives set. The success is far bigger due to the fact that for the first time, there were police officers from the Ministry of Interior of the Republic of Srpska and representatives of local communities in charge of road traffic, sitting together and exchanging their opinions and experiences. Only joint cooperation and mutual understanding and consideration of various road safety stakeholders will provide progress in this area.

The level of lectures was professional, as well as understandable and equally interesting and relevant for those involved in the issue, i.e. the employees in charge of road traffic in local self-government units and police officers from the Ministry of Interior of the Republic of Srpska.

The fact that the workshops had a very practical aspect, apart from having the introductory theory lectures, adds to the quality of the workshops held. Thus the trainees mainly got the information related to the concrete problems they were facing in their everyday work.

The objective of the workshop was to train each individual participant who passed the training at the workshop, in order to make him/her able to apply immediately the acquired knowledge of monitoring and analysis of road safety situation in his/her local community.

Based on participants' evaluation results, the experiences of the lecturers themselves and conversation with the colleagues, it has been concluded that the project should continue in the future.

5. LITERATURE

[1] Липовац, К., Тешић, М., Марић, Б., Радовић, М. и Џевер, М. (2015). ПРИРУЧНИК ЗА ЈАЧАЊЕ КАПАЦИТЕТА ЈЕДИНИЦА ЛОКАЛНЕ САМОУПРАВЕ ИЗ ОБЛАСТИ БЕЗБЈЕДНОСТИ САОБРАЋАЈА. Трећи циклус стручног усавршавања: Анализа података о саобраћајним незгодама и њихов значај за управљање безбједношћу саобраћаја. Агенција за безбједност саобраћаја Републике Српске, Бањалука.

[2] Марић, Б., Шмитран, Г., Тешић, М. и Средић, З. (2014а). Мапирање саобраћајног ризика на подручју Републике Српске - по центрима јавне безбједности и полицијским станицама за безбједност саобраћаја, Безбједност саобраћаја у локалној заједници, (стр. 1-8), III међународна конференција, Бањалука. ИСБН 978-99976-618-2-1.
[3] Maric, B., Tesic, M. and Djeric, M. (2014б). Risk mapping in the Republic of Srpska (2011-2013). IX International Conference „Road Safety in Local Community“, April 9-11, Zajecar, Serbia.
[4] Марић, Б., Шмитран, Г., Тешић, М. и Ђерић, М.(2015). Безбједност пјешака на путевима Републике Српске. БЕЗБЈЕДНОСТ САОБРАЋАЈА У ЛОКАЛНОЈ ЗАЈЕДНИЦИ, (стр. 87-94), IV међународна конференција, Бањалука. ИСБН 978-99976-618-5-2
[5] Пешић, Д., Вујанић, М., Липовац, К. и Антић, Б. (2014). Значај CADAS протокола у хармонизацији прикупљања података о саобраћајним незгодама. III Међународна конференција, Безбједност саобраћаја у локалној заједници, Бањалука, стр. 9-15.
[6] Тешић, М., Шмитран, Г., Марић, Б. и Средић, З. (2015). Просторна расподела саобраћајних незгода - студија примера: Република Српска. X Међународна конференција „Безбедност саобраћаја у локалној заједници“. Крагујевац, 22-25.април, Србија, стр. 59-69.
[7] World Health Organisation (2011). Data Systems - A road safety manual for decision makers and practitioners. Geneva.

INVITED PAPER

EXPERIMENTAL GROUNDS FOR WAYS TO INCREASE TRAFFIC SAFETY ON LIMITED VISIBILITY ROAD SECTIONS

Irina Makarova[1], Rifat Khabibullin[2], Dmitry Zhdanov[3], Eduard Belyaev[4], Denis Davletshin[5], Danila Tikhonov [6]

Abstract: The paper analyzes possible situational variants of driving in limited visibility. Simulation models created with the help of traffic parameters field observation results on these sections of the road network are considered to be an appropriate tool to improve decision-making quality. The paper gives examples of experiments on simulation models which were carried out to analyze appropriateness of the proposed solutions and selecting the best of them with different parameters of traffic flows. Proposed solutions will improve the situation on difficult road sections.

Keywords: Transport, security, simulation modeling, limited visibility, traffic accident.

[1] Ph.D., Makarova Irina, Professor, of Transfer System Service department, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, kamIVM@mail.ru.
[2] Ph.D., Khabibullin Rifat, Professor, Dean of Automotive Faculty, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, hrg_kampi@mail.ru.
[3] Zhdanov Dmitry, senior lecturer, department of foreign languages, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, jdanof@mail.ru
[4] Belyaev Eduard, Assistant Professor, department of Transfer System Service, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, bomund@mail.ru.
[5] Davletshin Denis, M.Sc., department of Transfer System Service, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, zloi.genii@mail.ru.
[6] Tikhonov Danila, M.Sc., department of Transfer System Service, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, danggbit@mail.ru.

1. INTRODUCTION

Analysis of cities transport system status and functioning in Russia indicates that its stability and security have been declining every year because of rapid growth rates of motorization to a level of infrastructure development of road network. These trends persist despite the measures taken to ensure transport safety, as well as the fact that the level of motorization in Russia is far from similar indicators in Europe.

Infrastructure development in particular road network should outperform or at least match the changes of motorization level for the safe functioning of the transport system. It is extremely difficult to forecast the change in intensity of vehicular traffic on the road network of the city due to the reconstruction of road sections, the construction of new centers of attraction, residential areas, since it is necessary to take into account the large number of stochastic factors.

In most cases the reconstruction of the road network is carried out without taking into account traffic growth and density flows, whereby measures such as the extension section of the road network, construction of new turns and lanes do not give a positive effect, and in some cases lead to a deterioration of the situation on the roads.

Growth of the vehicle fleet is often not taken into account in the construction of the centers of attraction of the population, which creates problems for drivers and pedestrians at points of entry into the territory of the newly constructed shopping centers, causes an increase in the number of accidents and increases probabilities of traffic jams.

In addition, numerous objects of the transport system are sources of increased danger for road users and the environment. This applies to vehicles, the objects of the road network, infrastructure, providing the transportation process. The greatest problems are road traffic accidents, especially those connected with human victims. Numerous state programs illustrate the urgency of this problem. In the different countries use various approaches to safety on roads. Striking example - Sweden which, after acceptance in 1995 of the law on traffic safety builds strategy of traffic safety reforms on the basis of Zero mortality Concept approach. The vision zero regards road transport system as a whole, the components of which (roads, cars and pedestrians) guarantee the safety of each other. In the official publication of the Swedish road administration it is stated that the concept is in the responsibility for safety rests with all of the creators of the transport system: the road services, manufacturers, carriers, politicians, government officials, legislators, and the police.

Since the transport system belongs to a class of large systems, the optimization of processes in them associated with the processing of large datasets and processes modeling. This involves the use the information and communications technologies. No coincidence that such research is united by a single term “Intelligent transport systems” (ITS). Along with the systems of artificial intelligence this area of research is one of the most dynamic and combines a variety of tasks.

Assessing the significance of ITS for perfect functioning of transport system, the authors note that ITS contribute to enhancing its effectiveness (Jingxin Xia and Mei Chen Defining, 2007:15-24), ensure sustainable development of the territories (Zhou Fengqi and Shen Jun, 2010:39-51) are used for reduce the negative impacts of the transport sector for the environment, as well as for reduce power consumption (Konstantina Gkritza and Matthew G. Karlaftis, 2013:1-2). Currently, ITS becomes a tool for transport planning, applied to conducting surveys (Mohammad R. Tayyaran et al, 2003:171-193), to reducing traffic congestion (Rami Harb et al, 2011:52-61) and planning joint visits (Gärling T et al, 2004:189-194).

2. PROPOSED SOLUTION TO INCREASE TRAFFIC SAFETY

Since the road network (RN) in main parts of large cities was formed when traffic has not existed there yet, its configuration is not designed for the current traffic. Besides, most of the streets and roads are not subject to reconstruction. The main drawback of such RN configuration is a large number of road sections with limited visibility such as driveways and exit roads, turns and U-turns. The main elements that limit visibility are buildings and structures, relief of the sections and green plantations.

These RN sections are places of increased accidents concentration. Naberezhnye Chelny is a relatively young city which was built “for the future”, taking into account a possible increase in the intensity of urban traffic. However, there are RN sections in the city with limited visibility. 20-25% accidents take place on these road sections (Kapsky D.V. et al, 2010:35-39).

Every driver faces driving in difficult road conditions. Even taking into consideration the fact that most of the population live in cities, urban road network is far from ideal.

Road conditions and traffic safety cannot be separated from each other. Difficult road conditions is one of the reasons which directly affects the safety.

Difficult road conditions are a combination of factors the result of which may be either limited visibility or deteriorating drivability. It includes:

- weather;
- road conditions;
- the car itself.

Limited visibility can be determined as the driver’s visibility of the road in the direction of the traffic limited by the relief, geometric road parameters, plantation, buildings, structures and vehicles (http://pddmaster.ru/documents/pdd/1-obshhie-polozheniya-tekst-pdd 08.01.2016).

For this reason, an analysis of road accident statistics was carried out in places with limited visibility in Naberezhnye Chelny for 2014 and the first half of 2015. Data were given by State Inspection for Road Traffic Safety of Naberezhnye Chelny city. On the basis of these data it is possible to emphasize that due to non-observance of road priority caused by drivers:

- 106 road accidents or 18.9% of all accidents took place in 2014 where 2 persons were killed and 140 injured;
- 45 road accidents or 20% of all accidents took place for the first half 2015 where 1 person was killed and 65 people injured.

Supervising regulations and standards compliance on traffic safety by traffic police was carried out during project coordination of construction (reconstruction) of highways and streets of various categories and road facilities, carrying out spot checks of construction projects, participating in the working and state commissions on putting into operation, annual comprehensive inspections, control checks and daily supervision of the road network and road facilities (http://www.gosthelp.ru/text/Metodicheskierekomendacii 413.html 08.01.2016).

In time, all major transport and service properties of RN and technical means of traffic management are changing:

- natural wear of the coating and reduction of adhesion factor;
- lighting characteristics deterioration of road signs, traffic lights and markings;
- changing visibility conditions, etc.

It is necessary to assess the state of visibility on the some elements of streets and roads from time to time to ensure traffic safety.

Urban roads and streets are an important part of the city infrastructure, which represent a system of engineering structures intended for city traffic management and system of auxiliary facilities for the operation of the city road network.

To ensure safety in limited visibility road sections, the following methods are used:

1. Reconstruction of the existing city road network (Vasilyev A.P. et al, 1998);
2. Removing obstacles limiting visibility from roadsides fully or partially;
3. Installation of curved road mirrors.

In this article, all of these options were explored. It is necessary to consider in more detail the method of installation of curved road mirrors. Modern curved road mirrors (Figure 1) is a universal and indispensable tool used to ensure a high degree of traffic safety on the city highways in conditions of limited visibility on the roadways.

Photos (in-colour or black and white) should be in good quality level which is appropriate for printing.

Figure and table numeration is automated by using of mentioned styles.

Figure 1. *Examples of curved road mirrors*

Since the visibility can be limited by various factors, three types of sections with limited visibility were chosen for the study:

1. Driveway to the local road with green plantations, limiting visibility;
2. Driveway to the local road with an obstacle that limits visibility;
3. U-turn with limited visibility.

To confirm the hypothesis of the necessity for taking measures to improve traffic safety in road sectors with limited visibility a video of traffic was conducted. Data analysis was performed using the online analytical processing (OLAP) technology of multidimensional data analysis. After analysis the most dangerous sections were selected for the construction of simulation models and conducting further experiments.

The best way to build this simulation model is to use special software tool. While modeling with this special software, such factors were taken into account as traffic flow rate, flow density, average speed and traffic tie-ups. The values of these factors were determined on the basis of the field observation processed data.

The observation was carried out with 15 minutes intervals during normal load of the city road network (Table 1) and at peak load of the city road network (during rush hours) (Table 2) (Kuzmenko V.N. et al, 2013:19-27).

Table 1. *Calculations during normal load of the road network*

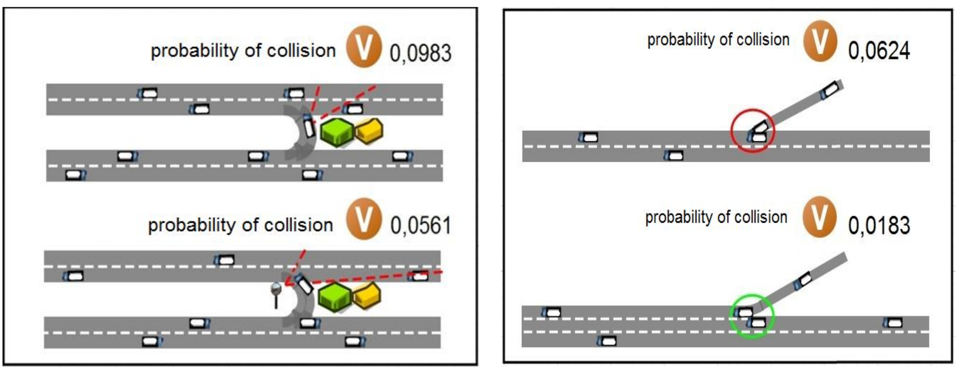
Time	**Flow rate (vehicle/hour)**	**The peak values of the flow rate(vehicle/hour)**	**Average speed (km./hour)**	**Flow density (vehicle/km.)**
10.00-11.00	480	540	72	6,6
14.00-15.00	500	508	68	7,3
19.00-20.00	420	440	74	5,7
Average value	466	496	71	6,5

Table 2. *Calculations during the peak load of the road network*

Time	Flow rate (vehicle/hour)	The peak values of the flow rate (vehicle/hour)	Average speed (km./hour)	Flow density (vehicle/km.)
8.00-9.00	640	720	61	10,4
12.00-13.00	584	596	63	9,26
17.00-18.00	692	716	58	11,9
Average value	639	677	61	10,52

At the first stage of modeling road sections schemes were built which can have a high probability of an accident in conditions of limited visibility. For this purpose two basic models were constructed. One of them dealt with U-turn in conditions of limited visibility, the other worked with leaving the local road to the main road. Verification and validation was performed for these models, so the model mapped the real system (Makarova I.V. et al, 2014:15649-15655).

The second stage was to conduct a series of experiments with the models both on the initial RN state, and after application of various security increasing methods.



a б

Figure 2. *Simulation model of collision probability*

3. SIMULATION MODELING RESULTS

The simulation results showed that the most effective way to improve safety and reduce accidents risk in road sections with limited visibility is the installation of curved road mirrors (Table 3).

Table 3. *Reducing the accident probability*

The model type (visibility limitation)	**The probability of an accident occurrence**			
	Before make changes	Reconstruction of the existing city road network	Removing obstacles limiting visibility from roadsides fully or partially	Installation of curved road mirrors
With the obstacle that limits visibility	0,0983	0,0423	0,0631	0,0561
With the departure of the main road with a local road	0,0624	0,0114	0,0285	0,0183

We calculated possibility to reduce accident risk of road priority non-observance due to the all methods. The best solution is a reconstruction of the road network. However, the cost of such a solution is ten times greater than the cost of the other two methods, and often carry out reconstruction is not possible.

The optimal solution is to install a road spherical mirrors. Calculations show that accidents risk can be reduced by 43%, decreasing to 76 accidents or 14.3% of all traffic accidents caused by drivers. The total number of road accidents could be reduced by 5.3%.

The effect in applying of the proposed solutions can result in:

- reducing the number of road accidents with injured persons, as well fatal accidents;
- improving performance capability of the urban population;
- improving traffic safety;
- reducing the level of accidents and consequences of road accidents on the city road network;
- reducing time losses of vehicles;
- reducing time losses of passengers in public and individual transport;
- improving ecological compatibility of the transport system.

4. CONCLUSION

The use of simulation models allows performing a preliminary assessment of different variants for changing traffic management that promotes the adoption of adequate and economically sound solutions for improving road safety. Example in this article show that the simulation is a good instrument for making decisions to improve the safety and efficiency of the transport system of the city. So, when performing redevelopment of urban areas, the construction of new centers of attraction, planning new transport infrastructure, simulation models help finding the best solutions and help avoid serious mistakes.

5. LITERATURE

[1] Fengqi, Z., Jun, S. (2010). Deploying an Intelligent Transportation System in Chongming County, Shanghai Journal of Urban Technology, 17 (3), Special Issue: Urban Sustainability in China, 39-51.

[2] Gärling, T., Jakobsson, C., Loukopoulos, P., Fujii, S. (2004). Adaptation of Private Car Use in Response to Travel Demand Management Measures: Potential Roles of Intelligent Transportation Systems Journal of Intelligent Transportation Systems: Technology, Planning, and Operations, 8 (4), 189-194.

[3] Gkritza, K., Karlaftis, M.G. (2013). Intelligent Transportation Systems Applications for the Environment and Energy Conservation (Part 1) // Journal of Intelligent Transportation Systems: Technology, Planning, and Operations, 17 (1), Special Issue: Intelligent Transportation Systems Applications for the Environment and Energy Conservation (Part 1), 1-2.

[4] Harb, R., Radwan, E., Abdel-Aty, M., Su, X. (2011). Two Simplified Intelligent Transportation System-Based Lane Management Strategies for Short-Term Work Zones Journal of Intelligent Transportation Systems: Technology, Planning, and Operations, 15 (1), 52-61.

[5] Kapsky, D.V., Kuzmenko, V.N., Korzhova, A.V., Polkhovskaya, A.S., Kostyukovich, E.N., Mozalevsky, D.V., Ko,t E.N., Development of planning solutions to improve traffic safety on the main streets of large and big cities. HNADU bulletin, 50, 35-39.

[6] Kuzmenko, V.N., Polkhovskaya, A.S., Ermakova, N.S., Mozalevsky, D.V. (2013). Improving traffic safety in unregulated intersection in the city center. Modern problems of the transport complex of Russia, 4, 19-27.

[7] Makarova I.V., Belyaev E.I., Mavrin, V.G., Suleimanov, I.F. (2014). City Transport System Improvement through the Use of Simulation Modeling System. International Journal of Applied Engineering Research, ISSN 0973-4562, 9 (22), 15649-15655.

[8] PDDMASTER. TRAFFIC CODE 2015 (TC 2015). URL: http://pddmaster.ru/documents/pdd/1-obshhie-polozheniya-tekst-pdd (08.01.2016).

[9] Supervising activities of traffic police for safe road conditions. Guidelines. URL: http://www.gosthelp.ru/text/Metodicheskierekomendacii413.html (08.01.2016).

[10] Tayyaran, M.R., Khan, A.M., Anderson, D.A. (2003). Impact of telecommuting and intelligent transportation systems on residential location choice Transportation Planning and Technology, 26 (2), 171-193.

[11] Vasilyev, A.P., Yakovlev, Y.M., Koganzon, M.S., et al. (1998). Reconstruction of motor roads. Technology and management of work: Textbook. MADI. – M. URL: http://www.gosthelp.ru/text/PosobieRekonstrukciyaavto.html (08.01.2016).

[12] Xia, J., Defining, M.C. (2007). Traffic Flow Phases Using Intelligent Transportation Systems-Generated Data //Journal of Intelligent Transportation Systems: Technology, Planning, and Operations, 11 (1), 15-24.

INVITED PAPER

ANALYSIS OF TRAFFIC ACCIDENTS CAUSED BY PUBLIC TRANSPORT DRIVERS IN SKOPJE

Nikola Krstanoski[1], Ile Gjorgievski[2]

Abstract: Very important task of the management of every public transport company is to develop a strategy and to continuously implement measures for increased safety record. Such strategy can only be developed by analysis of the existing data on characteristics of the traffic accidents in which the public transport vehicles are involved. Though the possibility to the public transport company to influence the outside factors are rather limited, it can define and implement measures for improved performance of their drivers. In this article, the authors focus on traffic accidents in which the professional drivers of the public transport company JSP "Skopje" have been involved. The analyzed data cover the period of April 2010 to December 2015. These traffic accidents are analyzed by location of occurrence, time of the day, type of third party involved and the type of accident in terms of point of contact. Finally, based on the results of the analysis, a set of recommendations aimed at improvement of the traffic safety record of the urban public transport drivers has been developed.

Keywords: Public transport safety, accident analysis

1. INTRODUCTION

The public transport service is the backbone of any sustainable urban transport system. However, its role can only be successfully fulfilled if it offers high quality safe and reliable service. Therefore, very important task of the management of every public transport company is to develop a strategy and to continuously implement measures for

[1] Ph.D., Krstanoski Nikola, Professor, University "St. Kliment Ohridski", Bitola, Faculty for Technical Sciences, Bitola, Republic of Macedonia, nikola.krstananoski@tfb.uklo.edu.mk
[2] Gjorgievski Ile, B.Sc., Director of Transport Sector, Public Transport Company JSP "Skopje", Skopje, Republic of Macedonia, ile.gjorgievski@jsp.com.mk

increased safety record. Such strategy can only be developed by analysis of the existing data on characteristics of the traffic accidents in which the public transport vehicles are involved. Though the possibility to the public transport company to influence the outside factors are rather limited, it can define and implement measures for improved performance of their drivers. For this purpose, an analysis of the characteristics of the traffic accidents caused by the public transport drivers is needed. This will be good basis for development of set of recommendations and measures for improvement of the safety performance of the public transport professional drivers. In this article, the authors focus on traffic accidents in which the professional drivers of the public transport company JSP "Skopje" have been involved.

2. THE BACKGROUND - GENERAL DATA ABOUT THE CITY, ITS PUBLIC TRANSPORT SYSTEM AND JSP "SKOPJE"

Skopje is the capital city of Republic of Macedonia and it is a home to 506 926 inhabitants, according to the Census data from 2002. Skopje covers an area of 1818 km^2.

The city has organized public transport system based on the bus mode of transport. The public transport service has been provided by three operators: The public transport company JSP "Skopje", and two associations of private operators - "Sloboda prevoz" and "Makekspres", who entered the public transport market after its deregulation in 1989.

The dominant and the most important operator is the Public transport company JSP "Skopje". In terms of number of lines, JSP "Skopje" covers about 85% of the public transport market.

The number and the structure of the public transport bus fleet of JSP “Skopje” is given in table 1.

Table 1. *Vehicle fleet of JSP "Skopje" (as of 31.12.2014)*

Make	Standard bus	Articulated bus	Total	Average age (years)
Sanos	77	23	100	22,05
Ikarus	9	0	9	27,63
Leyland	3	0	3	26,28
LAZ (Ukraine)	79	0	79	3,55
Yutong (China)	216	0	216	2,69
Minibus (Zastava, Yutong)	24	0	24	6,27
TOTAL	**408**	**23**	**431**	

Finally, some basic operational data as reported in the "Financial report - 2012" of JSP "Skopje" are given in Table 2.

Table 2. *Selected operational data for JSP "Skopje" (end of 2014)*

Total number of vehicles	431
Average number of buses in operation per day	254
Total number of kilometers per year	18.428.000
Average commercial speed (km/h)	19,58
Total number of passengers per year	52.990.000
Total number of employees	1331
Total number of drivers	635

1. METODOLOGY

In order to meet the objectives of this analysis, the authors collected data on traffic accidents caused by the drivers of JSP "Skopje" over the period of April 2010 to December 2015. During this period there had been 559 such accidents. The data came out from the police reports and internal company reports on traffic accidents (http://www.jsp.com.mk/dokumenti, 15.01.2016).

The traffic accidents have been analyzed by location of occurrence, type of other party involved in the accident and the type of accident in terms of point of contact.

The basic statistical analysis has been then expanded with cross-data analysis. The statistical analysis of combinations of different accident attributes has helped to discover a number of important relations between those attributes.

2. STATISTICAL ANALYSIS OF THE DATA

The total number of traffic accidents in which public transport buses have been involved over the period from 2007 to 2014 is given in table 3. The table also contains the data on the number of accidents per guilty party, as well as average number of accidents per vehicle, per day and per million kilometers.

Since the main focus in this article is the analysis of the accidents caused by JSP "Skopje" public transport drivers, the further text is limited to these accidents only. Here it should be noted that the authors have noticed discrepancy of the data obtained from the official reports versus the data from the internal JSP "Skopje" documents. This discrepancy comes from the fact that the official reports do not include minor accidents that happened in the public transport company garage or maintenance facilities. Our analysis in this article is based on data on all recorded accidents regardless of the severity of the consequences.

Table 3. *Total number of accidents in which public transport vehicles have been involved over the period from 2007 to 2014*

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Ave-rage**
Caused by JSP drivers	79	51	42	85	52	80	81	69	**67,38**
Caused by others	150	161	132	132	166	156	156	173	**153,25**
Guilty party not clear	36	41	47	28	29	52	110	67	**51,25**
Total accidents	**265**	**253**	**221**	**245**	**247**	**288**	**347**	**309**	**271,88**
Average accidents/day	0,73	0,69	0,61	0,67	0,68	0,79	0,95	0,85	**0,74**
Average accidents/vehicle	1,44	1,24	1,2	1,28	1,27	1,43	1,66	1,46	**1,37**
No. accidents/10^6 km	18,10	17,18	14,82	15,44	15,05	16,62	19,09	16,77	**16,63**
No. of injured/10^6 km	1,91	1,63	2,55	2,77	2,50	2,88	1,71	4,94	**2,61**
No. of fatalities/10^6 km	0,14	0,07	0,00	0,19	0,06	0,17	0,00	0,00	**0,08**

Over the period from April 2010 to December 2015 a total of 559 accidents caused by the bus drivers have been recorded. This amounts to an average of 8, 1 accidents per month or about 0,013 accidents per driver per month.

The analysis of the distribution of the accidents by location of occurrence is presented in figure 1.

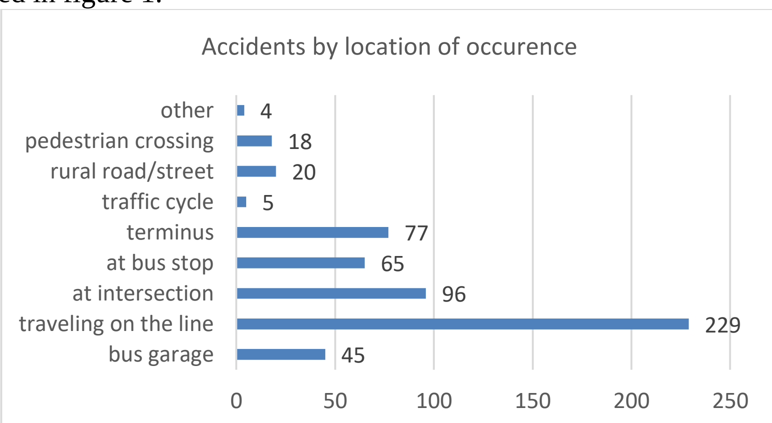


Figure 1. *Distribution of accidents caused by bus drivers by the location of occurrence*

As can be expected, most of the accidents occurred while in operation on the city streets between bus stops (229 or 40,9%). However, it should be noted that unusually high number of accidents happened in the bus garage and the end stops-terminuses of the lines (45+77 = 122 or 21,8%). Then, significant number of accidents occurred at intersections (96 or 17,1%) and at bus stops (65 or 11,6%).

Further analysis of the type of accidents that happened at each of these locations can reveal more about the nature and causes of the accidents.

All bus garage accidents and most terminus accidents happened while maneuverring the vehicles in a rather limited space. The damage to the vehicles in these cases has been only minor, mostly damages to bumpers, mirrors and scratches on vehicle body. The collisions were with other buses or objects in the garage or in some cases with parked cars at terminuses.

Out of the 96 accidents caused by bus drivers at intersections, 72 or 75% occurred at intersections regulated by traffic lights and 81 of them or 84,3% were accidents in which the other party was an automobile, while in 9 or 9,3% the other party was another bus.

The analysis of the type of collision shows that most accidents at intersections caused by bus drivers had point of contact with other vehicle with the front part of the bus that is 51 or 53,1%. (see figure 2)

Further analysis of accidents that happened at bus stops results in several interesting findings. Out of 65 accidents at bus stops 33 or 50.7% were collision with other bus and 22 or 33,8% collisions with automobiles. Dominant number of these accidents were related to collisions with parked automobiles and stopped buses in the zone of bus stop and some of them occurred while the bus was leaving the bus stop trying to enter the traffic lane.

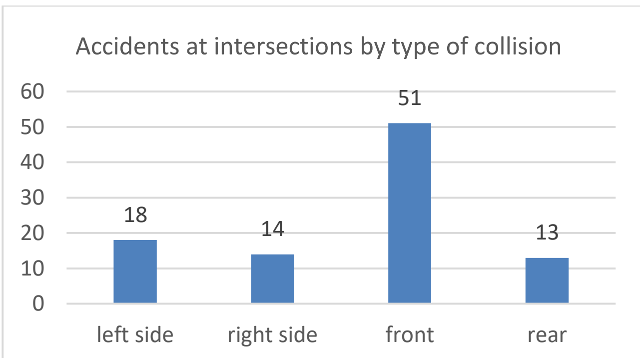


Figure 2. *Distribution of intersection accidents caused by bus drivers by type of collision*

Regarding the point of contact when accidents at bus stops occurred, most accidents involved damages at the front (29 or 44,1%) and at the rear of the bus (23 or 35,3%). This is shown in figure 3.

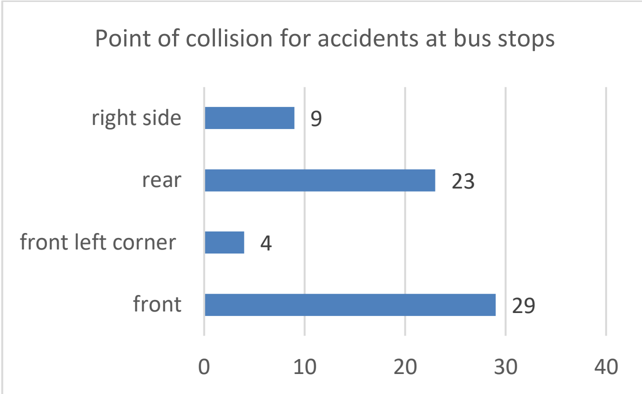


Figure 3. *Bus stop accidents caused by bus drivers by type of collision*

Finally, regarding the distribution of accidents by location of occurrence, it is worth to notice the significant number of accidents that happened on the narrow rural roads and city streets, mostly on lines that serve the surrounding suburb areas and villages. Out of 559 accidents caused by bus drivers, 20 or 3,5% happened on narrow roads or streets. Most of them occurred while passing by another vehicle and during the winter time.

The distribution of accidents caused by bus drivers by hour of the day has been given in figure 4. The data shows that number of accidents is somewhat higher during the late morning and afternoon hours. These are the times near the end of the driver's shift.

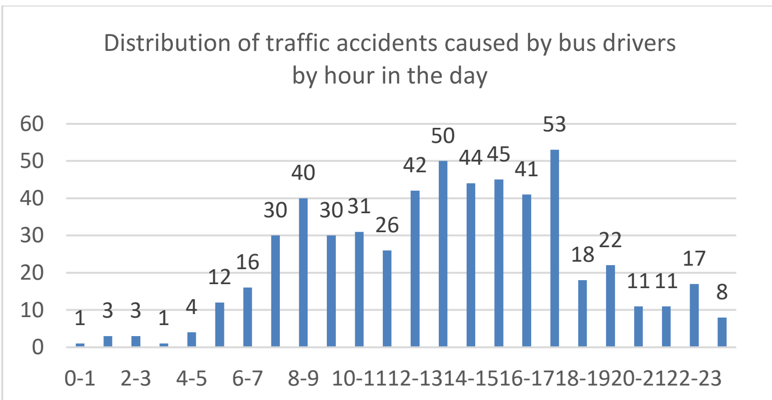


Figure 4. *Distribution of accidents caused by bus drivers by time of the day*

3. DISCUSSION OF THE RESULTS AND CONLUSION

Regarding the total number of accidents in which public transport buses are involved, it is interesting to compare the data with public transport safety records of other cities and countries.

The number of public transport bus accidents in Belgrade, Serbia has been reported to be between 17 accidents per million km in 2008 to 13 accidents per million km in 2011. (Zivanovic et al.,2012:131).

The same data for the city of Zagreb, Croatia (Brcic et al. 2013:67) show similar values: 16,7 accidents per million kilometers in 2008 to 12 accidents per million kilometers in 2008 accidents per million kilometers in 2011.

According to the data in table 3, it appears that JSP "Skopje" has slightly higher rate of accidents per million kilometers. The numbers vary from 14,82 to 19,09 with average of 16,63 over the period from 2007 to 2014.

The results of the analysis of traffic accidents caused by the bus drivers calls for several facts that need to be highlighted.

The public transport company "JSP Skopje" went through a process of significant renewal of its bus fleet during 2011 and 2012. It was the time when 216 new double-decker buses were bought from Yutong bus company and another 79 standard buses made by LAZ in Ukraine.

The introduction of new double-decker buses also required significant adjustments in the design of the bus parking and maintenance facilities.

Even the experienced bus drivers needed to adjust to the new vehicles with very different dimensions and steering characteristics. This is why, an unusually high number of accidents occurred at the bus garages and the terminuses while maneuvering the vehicles in a space that was not designed for this type of vehicles.

This factor, certainly has influenced a number of other types of accidents caused by bus drivers: while in operation on the line, at bus stops, intersections, while changing the traffic lane, narrow rural roads etc. This is confirmed by many accidents at bus stops that involved collision with another bus or parked automobile in the zone of the bus stop and the accidents on narrow roads.

Picture 1. *The new double-decker and standard buses in Skopje*

Another important fact that has influenced the safety record of the company was the one that "JSP Skopje" has employed 145 new drivers over the last 5 years. This is 26% of the total number of drivers. Most of these newly employed drivers were replacement for the retired drivers while some were employed due to the increased quantity of transport work. These new drivers have little experience as a bus driver in a public transport company and this is something that certainly contributed to a number of accidents described in the above text. Though there are 26% of the total number of drivers, they were involved in 35% of accidents.

The management of the public transport company also points out that given the amount of transport work and the number of buses in operation, still the number of drivers employed by “JSP Skopje” is below the industry standards. As a consequence, the work schedule of the drivers is very tight and of the verge of legal requirements for the maximum working hours allowed per driver per day and per week.

The analysis of distribution of accidents by time of the day shows strong relation with the general traffic volumes. The number of accidents increases during the peak hours of the day. When the number of accidents caused by JSP "Skopje" drivers are considered, it appears that somewhat higher percentages are found during the late morning and afternoon hours. These are the times near the end of the driver's shift, so some influence of driver fatigue and reduced concentration can be contributed as a factor for higher occurrence of accidents.

Regarding the results of the analysis related to the location of the accidents and type of the impact, it is interesting to notice that high level of similarity can be found when compared data for public transport safety records in USA (Yang, 2007:127). Yang concluded that most of the accidents involving public transport buses are impacts at the front and then at rear of the vehicle, while regarding the location of occurrence, intersections control by traffic lights are the most likely place to have an accident.

4. RECOMENDATIONS

The analysis of traffic accidents caused by bus drivers can help the public transport company management to develop a strategy and specific measures in order to improve the performance of the drivers and the safety record of the company.

The recommendations that can be derived from the analysis presented in this article are listed below:

- Improvement of the monitoring and data collection on traffic safety of public transport
- Implementation of good practice for driver selection and hiring
- Improvement and enhancement of the program for education and training of drivers
- Establishment of system for tracking driver's work history and introduction of incentives for good drivers and disincentives for bad drivers
- Definition and respect of the standard for number of drivers to be employed, for given amount of work and vehicle fleet

- Establishment of special programme for drivers who are repeated offenders.

5. LITERATURE

[1] http://www.jsp.com.mk/dokumenti - Godisen izvestaj za rabotata na JSP Skopje (2010, 2011, 2012, 2013, 2014, 2015)

[2] Добродолац М., Јовановић М., и Дабовић М., (2012), Упоредна анализа броја међусобних судара возила ГСП „Београд“пре и после примене новог закона о безбедности саобраћаја VII Међународна kонференција Безбедност саобраћаја у локалној заједници Србија, Доњи Милановац, 19 – 21. април 2012, 135-138

[3] Живановић М., Пешић Д,, Говедарица Н., и Грујић И, (2012), Стање безбедности саобраћаја у ГСП Београд и предлог мера за унапређење безбедности саобраћаја стање безбедности саобраћаја у ГСП Београд и предлог мера за унапређење безбедности саобраћаја, VII Међународна kонференција Безбедност саобраћаја у локалној заједници Србија, Доњи Милановац, 19 – 21. април 2012, 129-134

[4] Kharola P. S.,Tiwari G., and Mohan D., (2010), Traffic Safety and City Public Transport System:Case Study of Bengaluru, India, Journal of public transportation, Vol. 13, No. 4, 63-91.

[5] Brcic D., Slavulj M., Šojat D. and Bolsevic Turcic D., (2013), Traffic safety indicators for urban public transport, 8th international conference road safety in local community Serbia, Valjevo, April 18 – 20, 2013. 67-72.

[6] Jovanovic M., and Vuksic V., (2015), Overview of the database of traffic accidents in GSP„Belgrade“,10th international conference road safety in local community Serbia, Kragujevac, april 22 – 25, 71-80.

[7] Yang D. C., (2007) Trends in Transit Bus Accidents and Promising Collision Countermeasures, Journal of Public Transportation, Vol. 10, No. 3, 119-136.

[8] European Transport Safety Council (2008), Road accident data in the enlarged European Union: Learning from each other, Brussels

[9] Cerovac, V. (2001). Tehnika i sigurnost prometa, Fakultet prometnih znanosti Sveucilišta u Zagrebu, 23. – 25.

[10] Драгач, Р., Вујанић, М. (2002).Безбедност саобраћаја II део, Саобраћајни факултет, Београд.

[11] Powers, G. (2002). Transit safety & security statistics and analysis: 2000 annual report. FTA-MA-26-5011-02-1. Washington, DC: U.S. Department of Transportation.

[12] Transit cooperative research program TCRP (2001), Effective Practices to Reduce Bus Accidents, Report, Report No. 66.

ROAD SAFETY
IN LOCAL COMMUNITIES

WE INVITE YOU TO

XII International
Conference
ROAD SAFETY IN LOCAL COMMUNITY

APRIL, 2017

www.bslz.org

11th International Conference
"Road Safety in Local Community"
Serbia, Vrnjacka Banja, Hotel Zvezda,
April 13 – 16, 2016

INVITED PAPAER

EXCEEDING SPEED LIMITS ON TWO-LANE STATE ROADS IN SERBIA – A GENERAL ANALYSIS

Vladan Tubić[1], Marina Milenković[2], Draženko Glavić[3], Marijo Vidas[4]

Abstract: Speed limit is an important element of any speed management policy. However, setting a limit does not automatically result in required speed behaviour. One of the reasons why drivers exceed the speed limit is inadequately posted speed limit. The aim of this paper is to examine the suitability of the posted speed limits and the compliance of drivers with the posted speed limits on two-lane state roads in Serbia. Out of the 480 modern ABS devices detecting the speed on the road network in Serbia, this paper focuses on 45 locations covering 405 km of the network and a sample of 135.988.980 vehicles. Empirical research has determined the values of speed limits at selected locations and the values of maximum speed in a traffic flow. Comparing the vehicle speeds obtained from the ABS devices with the posted speed limits, it was found that 71% (96.164.383) of drivers did not comply with the posted speed limit. Furthermore, using analytical models, this paper shows the values of free-flow vehicle speed, operational speed of the flow, real speed of vehicles from automatic speed counters and the analyzed difference between the free-flow and limited speeds. The study has shown that the bigger the difference between the free-flow and limited speed is, the greater is the percentage of drivers disregarding speed limits. Vehicle speed is the core road safety problem, and therefore speed

[1] Ph.D., Tubić Vladan, Regular Professor, Faculty of Transport and Traffic Engineering of the University of Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, vladan@sf.bg.ac.rs
[2] Milenković Marina, M.Sc., Assistant, Faculty of Transport and Traffic Engineering of the University of Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, marina.milenkovic@sf.bg.ac.rs
[3] Ph.D., Glavić Draženko, Assistant Professor, Faculty of Transport and Traffic Engineering of the University of Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, drazen@sf.bg.ac.rs
[4] Vidas Marijo, M.Sc., Assistant, Faculty of Transport and Traffic Engineering of the University of Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, m.vidas@sf.bg.ac.rs

management must be a compromise between road safety and efficiency of road traffic. The results of this paper indicate that posted speed limits are not suitable in majority of cases and that the concept of speed management must be reviewed completely.
Keywords: two-lane roads, automatic speed counters, speed limit, free-flow speed, operational speed

1. INTRODUCTION

Speed limit represents an important measure for achieving appropriate vehicle speeds and more significant benefits for road safety. Ideally, road environment and speed limit should be coherent and consistent, so that most drivers could drive in accordance with the posted speed limit.

When defining speed limit for a particular road section, one should take into account the impact of that speed limit on safety, mobility, environment and quality of life of people living in the immediate vicinity of the road. Appropriate speed depends on road type and takes into account different values of weighting factors (weights) which should be assigned to different elements in different parts of the road network.

Speed brings about significant consequences for the environment and road safety which must be paid due consideration when making decisions on speed limits. Speed limit is often perceived only in negative context, but there are undoubtedly practical and positive benefits related to the increase in average speed of circulating vehicles. For individuals, this means reduced time of travel and improved mobility. There are also benefits for the economy in terms of reducing the time needed for the transportation of goods and time of travel. Therefore, when defining speed limits, a compromise between road safety and efficiency of road traffic should be made.

Speed is the core problem of road safety. Very strong correlations have been found between the speed and the risk of accidents, as well as between the speed and severity of road accidents (Aarts and van Schagen, 2006; Elvik et al., 2004). One of the most commonly used models in road safety is Nilsson's "Power Model", which indicates that the increase in average speed by 5% leads to the increase in the number of road crashes with injured and fatalities, by 10% and 20%, respectively. However, a great dispersion of speeds in a vehicle flow also has a significant role in road safety. The greater the difference in vehicle speeds is, the greater is the number of road accidents (Aarts and Van Schagen, 2006; Montella et al., 2015) and severity of their consequences (Yu and Abdel-Aty, 2014a, 2014b). Hashim (2006) found that the absolute difference between the speed limit and the 85th percentile speed in vehicle flow plays an important role in road accidents with fatalities or seriously injured. In fact, in his work, Hashim (2006) came up with the results according to which the number of road crashes with fatalities and seriously injured is growing with the increase in this difference. Milton and Mannering (1998) drew similar conclusions earlier.

Apart from the impact on road safety, driving speed influences mobility, fuel consumption, gas emissions, noise and quality of life of the entire society. Speed management must therefore represents a compromise between road safety, mobility and pollution of environment (OECD/ECMT, 2006).

Speed limit is an important element of any speed management policy. However, setting speed limits will not automatically lead to compliance with the required speed. Exceeding speed limits happens very often on all road types. Generally speaking, it was found out that 40-50% of drivers exceeded posted speed limits (OECD/ECMT, 2006).

In a survey conducted by Brake (2004), 68% of drivers said that they exceeded the posted speed limit in the year that preceded the survey, while 85% admitted that they sometimes did not respect posted speed limits. Drivers often report to have exceeded posted speed limits, as an activity they have been involved in (DfT, 2010).

One of the reasons why drivers exceed posted speed limits refers to the credibility of the posted speed limit (Fildes and Lee, 1993; van Schagen et al., 2004). Credibility of speed limits means that drivers consider the speed limit a logical or appropriate action in terms of road features and its immediate surroundings. The concepts that are very similar to credibility are “real” speed limits (Fildes and Lee, 1993) and “acceptable” speed limits (Risser and Lehner, 1998).

Many studies on speed have shown that sensible and cautious drivers will be most likely to drive at speeds dictated by road and traffic conditions, rather than at speeds that depend on posted speed limits. However, in order to discuss road and traffic characteristics when choosing (making a selection of) the most comfortable, safest and most efficient speed limit, engineering studies dealing with analysis of already posted speeds should be also carried out.

It has been assumed that, if drivers do not find the posted speed limit credible for the given section, they will ignore this limit to a great extent and make their own decision on which speed is appropriate for them. And finally, if, as a rule, speed limits are not in accordance with the road features and road environment, drivers may put in question the system of setting speed limits in general. This assumption has been confirmed by several studies. Kanellaidis et al. (1995) concluded that the most important reason for not observing a posted speed limit is that drivers are of opinion that speed limits are not always realistic.

In OECD/ECMT countries, on rural roads, speed limits generally vary from 70 km/h to 100 km/h (Table 1). Different countries use different methodologies for defining appropriate speeds (and hence speed limits) on their road network.

Table 1. *General speed limits in OECD countries (OECD, 2014)*

50 km/h	60 km/h	70 km/h	80 km/h	90km/h	100 km/h	110 km/h
Jamaica	Japan*	Belgium*	Canada*	Belgium*	Australia*	Argentina
Japan*	Korea*	Korea*	Denmark	Cambodia	Austria	Australia*
		Sweden*	Finland	Canada*	Germany	Columbia
			Ireland*	Czech Rep.	Ireland*	Italy*
			Israel*	France	Israel*	Poland*
			Korea*	Greece	Italy*	
			The Netherlands	Hungary	New Zealand	
			Norway	Island	Poland*	
			Serbia	Israel*	South Africa	
			Switzerland	Italy*	Spain*	
			USA*	Lithuania	Great Britain	
				Luxembour g	USA*	
				Malaysia		
				Poland*		
				Portugal		
				Slovenia		
				Spain*		
				Sweden*		
				USA*		

**States in which several speed limits for the same road type are applied*

Determining a speed limit is one of the most controversial and challenging issues of transport policy. The following concepts (TRB, 1998) have been proposed for use when setting speed limits:

• Adjust the speed limit to the actual (current) speeds, such as the 85th percentile of speed distribution, in order to ensure that speed limits are acceptable for drivers and are not largely disrespected (neglected).

• Set the speed limit in accordance with the road geometry (low limited speed on narrow and winding roads, high limited speeds on straight and wide roads).

• Set the speed limit according to the type and degree of development of the road environment (low limited speed in residential and commercial areas, high limited speeds in rural areas).

• Set the speed limit so as to minimize the total social costs of transport. Speed limits that are set in this way are generally referred to as optimal speed limits.

Setting speed limits in practice is often based on a combination of these principles, as well as of other factors that are not explicitly taken into account in the above-mentioned principles.

The aim of this paper is to analyze the appropriateness of posted speed limits and how they are observed by drivers travelling on two-lane state roads in Serbia.

2. MATERIAL AND METHODS

Out of 480 modern automatic speed counters, which, among other things, are able to detect speeds of the vehicle flow in the rural road network in Serbia, this paper focused on 45 locations covering 405 km of road network of two-lane roads. 2012 data have been analyzed in the paper, with the sample consisting of 135.988.980 vehicles. Empirical surveys helped determine the values of speed limits on selected locations and values of maximum vehicle flows speeds.

Using analytical models and methods in the paper, free vehicle speeds, operating speeds of vehicle flows, real operating vehicle speeds from ABS counters have been also identified and differences between free and limited speeds analyzed as well.

The database has been created in the Microsoft Office Excel v. 2010 program. Data have been analyzed using the statistical software package IBM SPSS Statistics v. 21, along with the standard methods of descriptive and analytical statistics. Absolute (n) and relative frequencies (%) have been used for description.

Assessment of correlation significance has been made using the non-parametric Spearman’s rank correlation (ρ), since the distributions of intermittent variables statistically significantly deviated from the normal distribution.

The zero hypothesis (H_0) has been set, reading that: There is no statistically significant correlation between the difference in free speed and posted speed limit and the percentage of drivers who are not obeying the posted speed limit. A working hypothesis (H_a) has been also set, reading that: There is a statistically significant correlation between the difference in free speed and posted speed limit and the percentage of drivers who exceed the posted speed limit. The threshold of the statistical significance (α) is set to 5%. Therefore, if $p \leq 0{,}05$, H_0 is rejected and H_a will be accepted. If $p > 0{,}05$, H_0 will be accepted.

3. RESULTS

Out of 135.988.980 vehicles, whose speeds were recorded on 45 sections of two-lane state roads, 96.164.383 (70,71 %) vehicles did not obey the speed limit (Table 2 and Chart 1). The largest number of drivers who failed to obey posted speed limits included those who exceeded the speed by 10 km/h (23,76 %), followed by those exceeding it by 10 km/h to 20 km/h (21,87 %), then by 20 km/h to 30 km/h (13,87 %) and finally those who exceeded the speed limit by over 30 km/h (11,21 %).

Table 2. *Exceeding speed limit on observed sections of two-lane roads in Serbia*

Exceeded speed limit	Number of vehicles	%
Observed speed limit	39.824.597	29,29
Exceeded speed limit by up to 10 km/h	32.306.987	23,76
Exceeded speed limit by 10-20 km/h	29.740.968	21,87
Exceeded speed limit by 20-30 km/h	18.866.088	13,87
Exceeded speed limit over 30 km/h	15.250.340	11,21
Did not observe the speed limit	96.164.383	70,71
Total number of vehicles	135.988.980	100,00

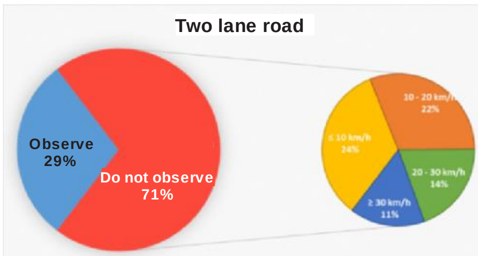


Chart 1. *Exceeding speed limit on observed sections of two-lane state roads in Serbia*

After the analysis of the level of observance of posted speed limits for all sections of two-lane state roads concerned has been completed, exceeded speed limits on road directions in question has been also subject to analysis. Based on obtained results, it can be concluded that all road directions, except the one of Knezevici–Beljina (M-5), have similar distribution of speeds (similar percentage of drivers who (do not) observe posted speed limits). Over 70% of drivers on these road directions fail to observe posted speed limits, while the percentage of drivers who exceeded the speed limits on the road direction Knezevici–Beljina is 13% (Table 3). As an illustration, the paper contains a graphic display only of characteristic results for Belgrade access road sections and the road direction Knezevici–Beljina (Charts 2-3). Additional analysis has shown that higher speed limits have been posted on road sections of the road direction Knezevici– Beljina than on other road directions, which may be the reason for a larger number of drivers who obeyed posted speed limits on this road direction.

Table 3. *Observing speed limits per surveyed road sections*

	Access roads to Belgrade	Belgrade Preljina (M-22)	Ostruznica Mali Zvornik (M-19)	Grdelica Vranje (M-1)	Knezevici Beljina (M-5)
	%	%	%	%	%
Observed speed limit	28	21	26	22	87
Exceeded speed limit up to 10 km/h	26	24	25	16	0
Exceeded speed limit 10-20 km/h	23	25	25	18	8
Exceeded speed limit 20-30 km/h	14	17	15	18	3
Exceeded speed limit over 30 km/h	10	13	9	26	1
Did not observe speed limit	72	79	74	78	13
Total number of vehicles	100	100	100	100	100

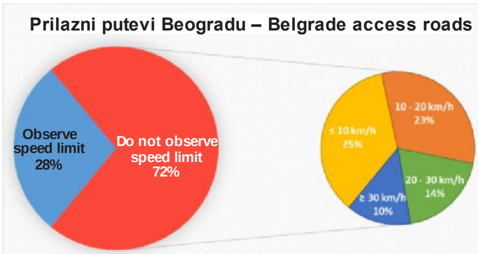


Chart 2. *Observing speed limits on access roads to Belgrade*

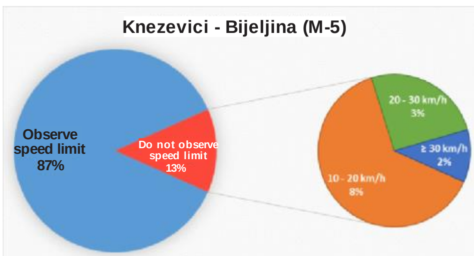


Chart 3. *Observing speed limits on the road direction Knezevici-Beljina (M-5)*

Overspeeding was also analyzed in terms of posted speed limits (Table 4). As an illustration, only results for the road sections with posted speed limits from 60 km/h to 80 km/h have been shown (Charts 4-5).

Table 4. *Observing speed limits depending on the value of posted speed limit*

	40 km/h	50 km/h	60 km/h	70 km/h	80 km/h
	%	%	%	%	%
Observed speed limit	4	11	15	62	66
Exceeded speed limit by up to 10 km/h	18	22	26	21	19
Exceeded speed limit by 10-20 km/h	41	32	22	10	9
Exceeded speed limit by 20-30 km/h	27	20	17	4	4
Exceeded speed limit over 30 km/h	10	15	19	2	2
Did not observe speed limit	96	89	85	38	34
Total number of vehicles	100	100	100	100	100

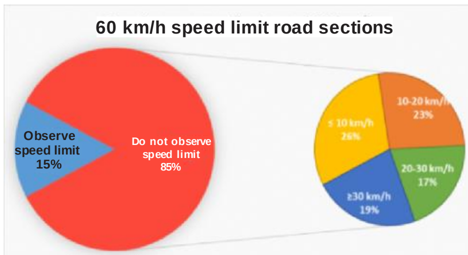


Chart 4. *Observing speed limits on sections with the 60 km/h speed limit*

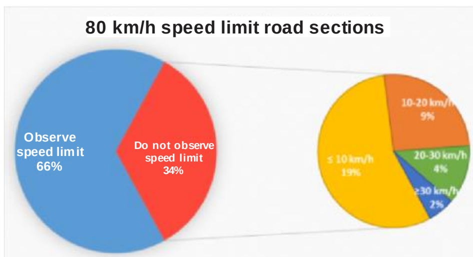


Chart 5. *Observing speed limits on sections with the 80 km/h speed limit*

Analysis results have shown that there is a smaller number of drivers who exceeded posted speed limits on road sections with higher speed limits and vice versa. Table 4 shows that the percentage of drivers failing to observe posted speed limits is similar for sections with speed limits of 40 km/h, 50 km/h and 60 km/h and for sections with speed limits of 70 km/h and 80 km/h. On sections where speed limit is 40 km/h, as much as 96% of drivers did not observe posted speed limits. 89% of drivers failed to respect posted speed limits on sections where speed limit is 50 km/h, while posted speed limit was disregarded by 85% of drivers on sections with speed limit of 60 km/h. Between 30% and 40% of drivers did not observe posted speed limits on sections where speed limit is 70 km/h and 80 km/h.

Free vehicle flow speeds have been determined for all 45 sections in this paper. Obtained values have been compared with posted speed limits, i.e. a difference between the free vehicle flow and posted speed limit Δ(Vsl-Vog) has been calculated for each section concerned. As an illustration, Table 5 shows data for 5 out of 45 analyzed locations.

In order to examine the link (correlation) between the difference in the free and limited speed Δ(Vsl-Vog) and percentage of drivers who did not obey posted speed limits, a non-parametric Spearman's rank correlation (ρ) has been used, the results of which are shown in Table 6. Having in mind that the value of Spearman's correlation coefficient is positive, and given that this value is higher than 0,5, it can be concluded that there is a statistically significant – strong positive correlation between the difference in the free and limited speed and the percentage of drivers who do not obey posted speed limit. Obtained results confirm the initial hypothesis according to which the bigger the difference between the free and limited speed is, the higher is the percentage of drivers who fail to observe the posted speed limit (ρ=0,608; p<0,001).

Based on the values of operating vehicle speeds obtained from the automatic speed counters, the values for the 85th percentile speed in a vehicle flow have been also set in this paper for each of the analyzed sections (Table 5). It can be seen in Table 5 that the values for the 85th percentile vehicle speed are higher than posted speed limits.

Table 5. *Values of free speeds, speed limits, difference between free speed and limited speed and class of speed including the 85th percentile speed*

Road section	Vfree	Vltd	Δ(Vfree – Vltd)	Not observing speed limit (%)	85th percentile speed
Vranic - Stepojevac	82	60	22	89,32	88 km/h
Nova Pazova - Batajnica	87	50	37	86,83	78 km/h
Lipnicki sor- Loznica 1	91	60	31	82,66	92 km/h
Knezevici - Bela zemlja	87	80	7	26,25	82 km/h
zaMarkovicu - Beljina	91	60	31	63,43	76 km/h

Table 6. *Spearman's correlation coefficient (rho)*

		Percentage of drivers not observing the speed limit
Difference between free speed and speed limit Δ(Vfree-Vltd)	**ρ**	0,608
	p	0,001
	n	45

4. DISCUSSION

The results of this study have shown that majority of drivers do not observe posted speed limits on the surveyed two-lane state roads in Serbia. In order to solve this problem, it will be necessary to have an insight into all possible causes for such driving behavior. Having in mind that obtained values of free vehicles speeds are significantly higher than those of posted speed limits, inadequately set speed limits may be one of the reasons for such driving behavior.

A comparative analysis of results obtained in this survey and results of foreign studies (Table 7) shows that the road sections with speed limits of 40 km/h, 50 km/h and 60 km/h hold a far higher percentage of drivers who fail to obey posted speed limits in Serbia than it is in other countries. Results are different for sections with speed limit of 80 km/h. Majority of other countries face a situation in which a higher percentage of drivers do not obey posted speed limit than they do it in Serbia. This comparative analysis also indicates that there is not only the problem of driver's attitude and behavior, but that the validity of posted speed limits should be also reexamined.

Table 7. *Comparative analysis of results obtained in this survey and the results of foreign studies*

Speed limit	State	% of excessive speed
40 km/h	**Analyzed sections**	**96 %**
	Ireland	75 %
	USA	73 %
	Great Britain	27 %
50 km/h	**Analyzed sections**	**89 %**
	The Netherlands	73 %
	Denmark	60 %
	France	59 %
	Austria	51%
	Switzerland	21 %
60 km/h	**Analyzed sections**	**85 %**
	South Korea	19 %
	Great Britain	9 %
80 km/h	**Analyzed sections**	**34%**
	Denmark	61 %
	Canada	45%
	The Netherlands	45 %
	Switzerland	24 %

5. CONCLUSION

The analysis of real operating vehicle speeds on two-lane state roads in Serbia, recorded by the automatic traffic counters, has shown that a large percentage of drivers do not observe posted speed limits (around 70%). Having in mind that the sample was made of 135.988.980 vehicles, it can be concluded that the examined sample is representative and that obtained results reflect the real situation of observance of posted speed limits on two-lane state roads in Serbia.

Further analysis of the free vehicle flow and posted speed limit, per analyzed sections of two-lane state roads in Serbia, revealed that there is a big difference between mentioned speeds and that the bigger the difference is, the higher is the percentage of drivers who fail to observe posted speed limits. Results obtained indicate that road and traffic conditions allow for the vehicles to move at higher speeds than permitted, and that therefore appropriateness of posted speed limits should be questioned.

The analysis of exceeding the posted speed limits per road directions concerned has shown that all road directions, except the one of Knezevici–Beljina (M-5), have a similar percentage of drivers who disregarded posted speed limits. Having in mind that analyzed road directions are similar in vehicle flow features, one of the reasons for a lower percentage of drivers who have exceeded the posted speed limit on the road direction M-5 are higher speed limits.

Since rural roads pass through urban settlements at some points of road network, this study relates to a certain extent to conditions in vehicle flows typical for built-up areas. Having in mind that the paper revealed that higher percentage of drivers failed to observe posted speed limits, except on sections with lower speed limits (40 km/h, 50 km/h), that are, as a rule, posted in urban areas, it can be concluded that critical sections are those passing through these urban areas.

It will be necessary in some future studies to conduct a more detailed survey of exceeded speed limits on the roads in urban areas, since the motives and circumstances in which speed limits are exceeded by drivers differ from those on rural roads.

The methodology used in Serbia to determine the values of speed limit should be also reexamined. Methodologies used in foreign literature should be taken into account and consulted. After that, it will be necessary to carry out detailed engineering analyses on the basis of which optimal speed limit would be set and posted on each road section.

6. LITERATURE

[1] Aarts, L., van Schagen, I. (2006). Driving speed and the rate of road crashes: a review of recent studies. Accident Analysis & Prevention, 38, 215–224.

[2] Department for Transport. (2010). Understanding Public Attitudes to Road user Safety – Literature Review: Final Report, Road Safety Research Report No. 112.

[3] Elvik, R., Christensen, P., and Amundsen, A.(2004). Speed and road accidents: an evaluation of the power model. TØI Report 740/2004, Oslo, Norway.

[4] Fildes, B.N., Lee, S.J. (1993). The speed review: road environment, behaviour, speed limits, enforcement and crashes. Report CR127. Federal Office of Road Safety, Department of Transport and Communications, Canberra, Australia.
[5] Hashim, I. (2006). Exploring the relationship between safety and the consistency of geometry and speed on rural single carriageway. In: Proc.of 38th UTSG annual meeting. Dublin, Ireland: Trinity College Dublin.
[6] Kanellaidis, G., Golias, J., and Zarifopoulos, K. (1995). A survey of drivers' attitudes toward speed limit violations. Journal of Safety Research. 26, 31–40.
[7] Milton, J., Mannering, F. (1998). The relationship among highway geometrics, traffic-related elements and motor-vehicle accident frequencies. Transportation, 25, 395–413.
[8] Montella, A., Imbriani, L.L. (2015). Safety performance functions incorporating design consistency variables. Accident Analysis and Prevention, 74, 133–144.
[9] Organisation for Economic Co-operation and Development and European Conference of Ministers of Transport. (2006). Speed management, Paris, France.
[10] Risser R., Lehner U., 1998. Acceptability of speeds and speed limits to drivers and pedestrians/cyclists. Master Report D6, European Commission, MASTER Deliverable D6, CEC DG-TREN, Brussels.
[11] Transportation Research Board. (1998). Special Report 254: Managing Speed: Review of Current Practice for Setting and Enforcing Speed Limits. TRB, National Research Council, Washington, D.C.
[12] Yu, R., Abdel-Aty, M. (2014a). Analyzing crash injury severity for a mountainous freeway incorporating real-time traffic and weather data. Saf. Sci. 63, 50–56.
[13] Yu, R., Abdel-Aty, M. (2014b). An optimal variable speed limits system to ameliorate traffic safety risk. Transport. Res. Part C: Emerg. Technol. 46, 235–246.

11th International Conference
"Road Safety in Local Community"
Serbia, Vrnjacka Banja, Hotel Zvezda,
April 13 – 16, 2016.

INVITED PAPER

MAPPING AND ANALYSING ROAD ACCIDENTS INVOLVING VULNERABLE ROAD USERS IN THE CITY OF ZAGREB

Mario Ćosić[1], Ljupko Šimunović[2], Davor Brčić [3]

Abstract: Pedestrians and cyclists are the most vulnerable road users, and thus belong to the so-called vulnerable road user group, together with the motorcyclists, who demand special attention in order to increase the level of their safety. In the Republic of Croatia, three quarters of the total number of road accidents occur in the urban environment, in which two thirds of the total number of casualties are pedestrians and cyclists. The causes of the significant number of road accidents and the general picture of pedestrian and cyclist safety in the urban road network are incomplete and unsystematic data collection and their partial analysis. Therefore, this requires additional research in the scope of road safety and the general level of service in the road network. The goal and the purpose of the paper is, based on the available data, to make a high-quality and a high-quantity road accident analysis for pedestrians and cyclists in the road network of the City of Zagreb. Using modern computer techniques (modern software tools), it is possible to detect and significantly improve road safety.

Keywords: road safety, pedestrians and cyclists, space-time analysis, City of Zagreb

1. INTRODUCTION

It was estimated that in 2008, more than 1,2 million people died on roads worldwide (United Nations Road Safety Collaboration, 2011). Among people

[1] Ph.D., Ćosić Mario, Candidate, Faculty of Transport and Traffic Sciences, Vukelićeva 4, 10000 Zagreb, Croatia, mario.cosic@fpz.hr
[2] Ph.D., Šimunović Ljupko, Associete Professor, Faculty of Transport and Traffic Sciences, Vukelićeva 4, 10000 Zagreb, Croatia, ljupko.simunovic@fpz.hr
[3] Ph.D., Brčić Davor, Associete Professor, Faculty of Transport and Traffic Sciences, Vukelićeva 4, 10000 Zagreb, Croatia, davor.brcic@fpz.hr

who died on roads worldwide, 50% belong to the vulnerable road user group (23% motorcyclists, 22% pedestrians, 5% cyclists). Injuries from road accidents are the eighth cause of death, and the leading cause of death in the age range from 5 to 29, which is a serious global problem in terms of health and economy.

The probability for road accidents to occur and their severity can be reduced by performing a systematic accident analysis, and by using appropriate solutions which include applying necessary devices for traffic control, appropriate infrastructure design and an efficient interventions of the traffic police. The adoption of the efficient solutions requires a space-time analysis, which is accomplished by applying geospatial technologies (Prasannakumar et al., 2011). The GIS (Geographic Information System) applications are practical tools for an efficient manipulation, critical spot analysis and spatial data visualization. By using GIS to identify accident focal points, a more complete understanding of accident causes can be gained. Accident focal points reveal concentrations of accidents belonging to the same type, and indicate spatial relations between individual cases that can be a consequence of the same causes (Anderson, 2009). As such, GIS technologies can be very useful tool for road safety management.

2. REVIEW OF THE LITERATURE

Road accidents involving vulnerable road users and vehicles are subject to analysis in many scientific areas such as medicine, sociology and urban traffic planning. Each of these areas analyses and explains road accidents from its own perspective.

The medicine analyses the severity of physical injuries and accident frequency (Mackay, 1969; Graw and König, 2002; Mehan et al., 2009).

The sociologists and the psychologists seek to identify human behaviour patterns leading to road accidents. Tiredness, speeding and intoxication are recognizable social factors contributing to road accidents. The connections between socio-demographic factors, socio-economic factors, way of life and road accidents were studied by Holz-Rau and Scheiner (2013) and Summala et al. (1996) studied pedestrian and cyclist visibility on roads, in which wrong pedestrian and cyclist perception led to an accident. Noland and Quddus (2004), Quddus (2008) and Wang et al. (2009) analysed the influence of road infrastructure and demographic space characteristics on road accidents. Rasanen and Summala (1997) conducted an in-depth analysis of wrong driver perception. Their study provided a high-detail motion analysis for pedestrians and cyclists as well as mistakes in perception among cyclist and drivers that led to an accident.

Since the main attention of this paper is put onto influence of road infrastructure and the environment on road accidents, an overview of the world literature is given below.

Schneider et al. (2004), Pulugurtha et al. (2007) and Aguero-Valverde and Jovanis (2006) studied and identified areas with high number of pedestrian and cyclist accidents in urban environment. They analysed spatial and physical factors contributing to road accidents involving pedestrians and cyclists. Wedagama et al. (2006) developed generalized linear models in order to research the influence of land-use, population density and the number of intersections on frequency of accidents involving pedestrians and cyclists. Dumbaugh et al. (2009) developed a negative binomial regression model for testing the relations between the urban road network and accident density. The analysis includes a road plan, road network, sidewalk condition, speed limitations and their influence on accident frequency. Kim and Yamashita (2007) used multimodal logit model to analyse accident probability in the urban environment. Sakshaug et al. (2010) identified numerous dangerous interactions between cyclists and drivers in roundabouts. Inouye and Berry (2008) developed a spatial analysis based on GIS to estimate safety of cycling network. Prasannakumar et al. (2011) conducted research in order to identify and analyse accident focal points that resulted from inappropriate road network development. The results of the analysis of spatial groups showed spatial and temporal focal point variations, confirming that road accidents depend on time and space variables. Xie and Yan (2008) and Plug et al. (2011) also used space-time patterns for studying road safety.

In accordance with the literature stated, there is a significant impact of road design and the environment related to the analysis of pedestrian and bicycle accidents. The accidents occur when pedestrians, cyclists and drivers conflict on roads due to their behaviour influenced by the road characteristics. Pedestrian islands, bicycle lanes and pedestrian crosswalks can influence road user behaviour and improve road safety.

3. RESEARCH METHODOLOGY

Road accidents are rare events which are not uniformly distributed on the road network. In the relative past, road accidents were considered as completely random events. Therefore, the most commonly used models for predicting and determining road accident frequency were the ones based on statistics.

The number of road accidents on particular locations vary on yearly basis. The annual number of road accidents also differs when considering various locations. Thus, the number of accidents is subject to spatial and temporal variations. Some of the accidents are completely random, while the others can be explained in terms of space and time by indicators influencing accident frequency. The occurrence of similar road accidents in space can be grouped by space and time.

Since the point-like accident visualization on a map is not usually robust due to the imprecise collision location (x and y coordinates), individual and subjective collision interpretation, and difficulties in visualizing collision location in frequent collision areas, it is acceptable to define clusters of collision locations on the road surface (Austin et al., 1995). By connecting the independent space and time variables in specific time period on a specific location, it is possible to establish relationships between road accidents with those variables. In order to perform accident data processing and analysis, it is often enough to possess location coordinates, together with the connected attributes such as speed, traffic volume, type, pedestrian crosswalk width, bicycle lane existence, type of parking, land use and similar. In terms of spatial data and their analysis results (in this case the road accidents), the best method for results visualization is in form of a graphic presentation.

Data processing is based upon the creation of focal points for accidents with particular characteristics by using Kernel Density Estimation (KDE). The word kernel literally means the core or the central part of the object. In geospatial analysis, KDE relates to methods which include calculations by a well-defined local neighbourhood. In other fields of science it can have other meanings. KDE includes placing a symmetrical surface over every location, and estimating the distance between the location and a reference location based on a mathematical function. In the KDE process, the accident density is the highest at the accident location, and it is decreasing as the distance from the accident location increases, reaching zero at the radial distance from the accident, i.e. the borders circling each accident. This is followed by a summation of values for each surface belonging to the mentioned reference location. The process stated above is then repeated for consecutive locations (Levine, 2014; Anderson, 2009; Fotheringham et al., 2000). The goal in the end is to obtain a probability density estimate based on the provided sample.

The Kernel Density Estimation is a technique of generalizing observation locations for the entire area. If the collision point cluster on the road is greater, then the risk of a collision is also greater, however, if the collision point cluster is smaller, then the probability for collision is also smaller (Chainey and Ratcliffe, 2005). In this manner, the area with increased risk of collision is defined in order to create a safer traffic environment by making efficient political decisions.

The main advantage of KDE is the determination of risk widening for road accidents. A risk widening can be defined as a surface around the defined accident cluster, in which there is a high probability for accidents to repeat based on spatial dependency. The usage of this method defines an arbitrary space unit for the purpose of analysis, which is the same for the entire area (Anderson, 2009). The KDE was developed during late fifties in the twentieth century as an alternative to the existing histogram density estimation methods.

Šimunović and Todić (2014) developed a geostatic analysis of accident space distribution for the City of Zagreb in the period from 2010 to 2013. The road accident analysis was conducted in the City of Zagreb because the city has the best OpenStreetMap (OSM) data coverage in the Republic of Croatia. The road accident data were obtained from the Ministry of Interior of the Republic of

Croatia (MUP), requested by the Faculty of Transport and Traffic Sciences of the University of Zagreb. The road network data were obtained from the OpenStreetMap server. The initial process is the development of a digital road accident map. A map is a basic layer for displaying repeating accident focal points and the analysis of influence factors within the GIS. The data is processed by using the Python programming language and entered into the PostgreSQL database. For the purpose of solving the stated traffic problems in Python, besides the programming skills, programming language syntax, options and limitations of the functions which can be recalled from certain libraries, it is necessary to familiarize oneself with the nature of road accidents (Čuljat, 2010). Road accidents belonging to the same location in specific time periods can be grouped into clusters according to the severity, circumstances, type and the event dynamics (Figure 1)

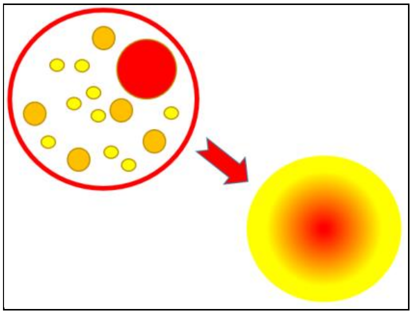


Figure 1. *Road accident clusters*

This paper used the 200 meter bandwidth. The surface area of the analysed portion in the City of Zagreb is approximately 600 km^2, which is approximately equal to a rectangle of 30x20 km. In these terms, the 200 meter value is about 1 % of the linear rectangle in the analysed area.

The results of the KDE method are shown below.

Figure 2 shows particular focal points for accidents involving pedestrian casualties and severe injuries in the City of Zagreb.

Figure 2. *Focal points for accidents involving pedestrian casualties and injuries (Šimunović and Todić, 2014)*

Figure 3a shows the most dangerous locations for pedestrians. Figure 3b shows accidents resulted from traffic violations by pedestrians and the inappropriate vehicle speeds.

a) The intersection of Selska Street and Jadran Bridge

b) Britain Square (right) and the intersection of Ilica and Sveti Duh (left)

Figure 3. *Focal points of accidents involving pedestrian casualties and injuries (Šimunović and Todić, 2014)*

The second most vulnerable road user group which was analysed in the paper were cyclists. Figure 4 shows the accidents with cyclist casualties and injuries.

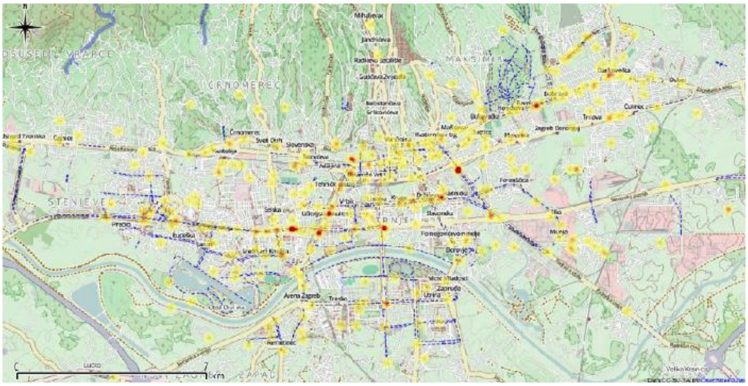


Figure 4. *Focal points of accidents involving cyclist casualties and injuries (Šimunović and Todić, 2014)*

Figure 5a shows the most dangerous locations for accidents involving cyclist casualties and injuries. Figure 5b shows the focal point of accidents involving cyclist casualties and injuries at the intersection of Slavonska Avenue and Većeslav Holjevac Avenue.

a) The most dangerous locations for cycling in the City of Zagreb

b) The intersection of Slavonska Avenue and Većeslav Holjevac Avenue

Figure 5. *Focal points of accidents involving cyclist casualties and injuries (Šimunović and Todić, 2014)*

4. DISCUSSION

It has been found that the pedestrian-vehicle and bicycle-vehicle accidents are mostly caused by inappropriate vehicle speeds and traffic violations by pedestrians and cyclists. The most common type of collision between vehicles and cyclists are side collisions. Accidents are uniformly spread during a day. The majority of accidents happened in stable weather conditions.

Figure 3a shows the focal point of pedestrian-vehicle collision at the intersection of Selska Street and Jadran Bridge, where 11 accidents occurred. The accidents were mostly caused by traffic violations by pedestrians and inappropriate vehicle speeds. The majority of accidents happened during the night in stable weather conditions. Figure 3b shows two accident focal points. The first one is at the intersection of Ilica and Sveti Duh (left), where 24 accidents occurred, and the second one is at the Britain Square (right), where 9 accident occurred. The left focal point represents mostly the accidents caused by inappropriate vehicle speeds. All of them occurred during the day in stable weather conditions. The right focal point represents mostly the accidents caused by driver mistakes, which also happened during the day and in stable weather conditions. (Šimunović and Todić 2014)

Figure 5a shows 3 accident focal points. The first one is at the intersection of Zagrebačka Avenue, Tin Ujević Street and Nehajska Street (5 accidents), the second one is at the intersection of Savska Street and Odranska Street (3 accidents), and the third one is at the Savska Street by the Faculty of Teacher Education. At the intersection of Zagrebačka Avenue, Tin Ujević Street and Nehajska Street (the bottom left point), accidents caused by traffic light violations and priority violations are dominant. The majority of accidents occurred during the day in stable weather conditions. At the intersection of Savska Street and Odranska Street (bottom right point), accidents do not have similar causes. At the Savska Street by the Faculty of Teacher Education (upper point), the accidents caused by the inappropriate traffic merging which occurred during the day and in stable weather conditions are dominant. Figure 5b shows the focal point at the intersection of Slavonska Avenue and Većeslav Holjevac Avenue. There were 5 accidents at this focal point with cyclist casualties or injuries, which were a result of traffic light violations and inappropriate traffic merging. All of them occurred during the day and in stable weather conditions. (Šimunović and Todić, 2014)

Besides the focal points mentioned, where Savska Street is especially dominant, accident clustering with the highest densities was noticed in Vlaška Street, Maksimirska Street and Vjekoslav Heinzel Street. (Šimunović and Todić, 2014)

5. CONCLUSION

In recent times, traffic planners devote a lot of attention to pedestrians and cyclists due to their advantages compared to the other modes of transport. The most recent research indicate a declining trend of venerable user casualties in traffic. Despite that, insecure roads still significantly discourage activities related to walking and cycling, primarily because of the intimidating perception on dangers leading to a road accident. In an effort to improve road safety and to develop appropriate measures, planners are trying to identify factors contributing to increased accident density. Therefore, the fundamental questions about road accidents that traffic planers ask are the ones related to how, where, and when.

This paper demonstrated tools for geospatial statistical analysis by using the Geographic Information System (GIS). The mapping and the visualisation of accident focal points provide the best overview of accident blackspots in urban areas, and a relatively simple identification and analysis of the processes happening on those locations, all these in order to identify the relationships between road accidents and the environment. In this manner, the simplest way is to identify the indicators responsible for accidents, so that the measures for preventing future accidents could be implemented as soon as possible. The paper showed the spatial analysis of road accidents in the City of Zagreb in the period from 2010 to 2013. In order to perform the analysis focused on the identification of locations with high accident frequency, the Kernel Density Estimation method was used.

6. LITERATURE

[1] Aguero-Valverde, J., and Jovanis, P. P. (2006). "Spatial analysis of fatal and injury crashes in Pennsylvania." *Accident Analysis & Prevention*, 38(3), 618–625.

[2] Anderson, T. K. (2009). "Kernel density estimation and K-means clustering to profile road accident hotspots." *Accident Analysis & Prevention*, 41(3), 359–364.

[3] Austin, K., Tight, M., and Kirby, M. (1995). "An Advanced System for the Study of Children's Safety on the Journeys to and from School." (2A:3).

[4] Chainey, S., and Ratcliffe, J. (2005). *GIS and Crime Mapping* -. Wiley.

[5] Čuljat, M. (2010). "Obrada prostornih podataka pomoću programskog jezika Python." Geodetski fakultet Sveučilišta u Zagrebu, Zagreb.

[6] Dumbaugh, E., Rae, R., and Wunneberger, D. (2009). "Examining the Relationship between Community Design and Crash Incidence." 7(2), 60.

[7] Fotheringham, A. S., Brunsdon, C., and Charlton, M. (2000). *Quantitative Geography: Perspectives on Spatial Data Analysis*. SAGE Publications.

[8] Graw, M., and König, H. . (2002). "Fatal pedestrian–bicycle collisions." *Forensic Science International*, Elsevier, 126(3), 241–247.

[9] Holz-Rau, C., and Scheiner, J. (2013). "Geographical Patterns in Road Safety: Literature Review and a Case Study from Germany." *EJTIR*, 13(2), 99–122.

[10] Inouye, D. K., and Berry, K. A. (2008). "Assessing Bikeway Networks around Public Schools: A Tool for Transportation Planning in Washoe County, Nevada." *Planning Practice and Research*, 23(2), 229–247.

[11] Kim, K., and Yamashita, E. Y. (2007). "Using a K-Means Clustering Algorithm to Examine Patterns of Pedestrian Involved Crashes in Honolulu, Hawaii." *Journal of Advanced Transportation*, 41(1), 69–89.

[12] Levine, N. (2014). "Part IV : Spatial Modeling I Chaper 10: Kernel Density Interpolation." Houston, TX.

[13] Mackay, G. M. (1969). "Some features of traffic accidents." *British medical journal*, 4(5686), 799–801.

[14] Mehan, T. J., Gardner, R., Smith, G. A., and McKenzie, L. B. (2009). “Bicycle-related injuries among children and adolescents in the United States.” *Clinical pediatrics*, 48(2), 166–73.

[15] Noland, R. B., and Quddus, M. A. (2004). “A spatially disaggregate analysis of road casualties in England.” *Accident Analysis & Prevention*, 36(6), 973–984.

[16] Plug, C., Xia, J., and Caulfield, C. (2011). “Spatial and temporal visualisation techniques for crash analysis.” *Accident Analysis & Prevention*, 43(6), 1937–1946.

[17] Prasannakumar, V., Vijith, H., Charutha, R., and Geetha, N. (2011). “Spatio-Temporal Clustering of Road Accidents: GIS Based Analysis and Assessment.” *Procedia - Social and Behavioral Sciences*, 21, 317–325.

[18] Pulugurtha, S. S., Krishnakumar, V. K., and Nambisan, S. S. (2007). “New methods to identify and rank high pedestrian crash zones: An illustration.” *Accident Analysis & Prevention*, 39(4), 800–811.

[19] Quddus, M. A. (2008). “Modelling area-wide count outcomes with spatial correlation and heterogeneity: An analysis of London crash data.” *Accident Analysis & Prevention*, 40(4), 1486–1497.

[20] Sakshaug, L., Laureshyn, A., Svensson, A., and Hydén, C. (2010). “Cyclists in roundabouts-different design solutions.” *Accident; analysis and prevention*, 42(4), 1338–51.

[21] Schneider, R. J., Ryznar, R. M., and Khattak, A. J. (2004). “An accident waiting to happen: a spatial approach to proactive pedestrian planning.” *Accident Analysis & Prevention*, 36(2), 193–211.

[22] Summala, H., Pasanen, E., Räsänen, M., and Sievänen, J. (1996). “Bicycle accidents and drivers’ visual search at left and right turns.” *Accident Analysis & Prevention*, 28(2), 147–153.

[23] Šimunović, T., and Todić, F. (2014). “Geostatistička analiza prostorne distribucije prometnih nesreća na području Grada Zagreba u razdoblju od 2010. do 2013. godine.” Geodetski fakultet Sveučilišta u Zagrebu.

[24] United Nations Road Safety Collaboration. (2011). “Global plan for the Decade of Action for Road Safety 2011–2020.” *Geneva: WHO*.

[25] Wang, C., Quddus, M., and Ison, S. (2009). “The effects of area-wide road speed and curvature on traffic casualties in England.” *Journal of Transport Geography*, 17(5), 385–395.

[26] Wedagama, D., Bird, R., and Metcalfe, A. (2006). “The influence of urban land-use on non-motorised transport casualties.” Pergamon-Elsevier Science Ltd.

[27] Xie, Z., and Yan, J. (2008). “Kernel Density Estimation of Traffic Accidents in a Network Space.” *Computers, Environment, and Urban Systems*, 396 – 406.

11th International Conference
"Road Safety in Local Community"
Serbia, Vrnjacka Banja, Hotel Zvezda,
April 13 – 16, 2016

INVITED PAPAR

INDEPENDENT ASSESSMENT OF ROAD IMPACT UPON THE OCCURENCE OF ROAD ACCIDENTS INVOLVING PEDESTRIANS IN THE CITY OF BELGRADE

Nenad Markovic[1], Milan Vujanic[2], Dalibor Pesic[3], Boris Antic[4]

Abstract: Preventive action in road safety requires an adequate consideration of influence of each factor (human-vehicle-road-environment) upon the occurrence of road accidents and their consequences. Road factor is present in almost all road accidents, often as a cause, but more frequently as a factor that had an impact on the occurrence of road accidents, either independently or in a synergy with other remaining factors. If the impact of road factor on the occurrence of road crashes is recognized in an adequate manner, it will be possible to develop models and improve the design and state of the road at characteristic locations. This would prevent the occurrence of hazards in road traffic. In order to fully understand the impact the road factor has upon the occurrence of road accidents, in-depth analyses were made and included all road accidents in the city of Belgrade that happened in 2014, in which pedestrians sustained fatal injuries, as well as all road crashes in which children sustained fatal injuries, in the period from 2010 to 2014. Based on these in-depth analyses, it was possible to examine in particular the influence of road factor on the occurrence of road accidents by identifying its impact on the occurrence of and the contribution to the occurrence of road crashes or severity of their consequences. Certain elements of the road factor have been identified, as these elements were prevailing and most often present at locations where road accidents involved pedestrians. Based on that, it was possible to determine the percentage of influence of certain elements of road

[1] Markovic Nenad, B.Sc., Assistant, Faculty of Transport and Traffic Engineering in Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, n.markovic@sf.bg.ac.rs
[2] PhD., Vujanic Milan, Regular Professor, Faculty of Transport and Traffic Engineering in Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, m.vujanic@sf.bg.ac.rs
[3] PhD., Pesic Dalibor, Assistant professor, Faculty of Transport and Traffic Engineering in Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, d.pesic@sf.bg.ac.rs
[4] PhD., Antic Boris, Assistant professor, Faculty of Transport and Traffic Engineering in Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, b.antic@sf.bg.ac.rs

factor on the occurrence of road accidents involving pedestrians in the city of Belgrade. Reduced sight distance and influence of lateral obstacles in zones where road accidents involving pedestrians occurred have been identified as prevailing elements of the road factor, present in over 80% of all road accidents with pedestrians and in 100% of all accidents involving children as pedestrians.

Keywords: independent assessment, in-depth analysis, fatalities, pedestrians, children, road accident

1. INTRODUCTION

Every year, 1.3 million people are killed and more than 50 million people are injured in road crashes worldwide (WHO, 2013). Road traffic, as a legal business activity, takes away more lives than all other businesses together, while vehicles are considered the deadliest object in today's world. In spite of these facts, road traffic represents the foundations for the normal operation of society, and as such, it brings a series of positive effects. According to the research that included 57 countries, road accidents are the leading cause (26-77 %) of deaths (Ahmed, N. & R. Andersson, 2002). There is a large number of factors contributing to the occurrence of road accidents and their severity, i.e. the size of consequences. William Haddon (1980) systematized these influences into three road safety factors (human, vehicle, environment), but soon there occurred a need to single out the road from the environment factor, as a separate factor, as its significance and frequency of its impact on road crashes became quite obvious.

According to the well known literature, road factor accounts for 34% of road accidents worldwide (PIARC, 2003). Road has been recognized as a separate cause of 3% of road crashes, in 26% of road accidents it is in synergy with the human factor, in 1% with the vehicle factor, and in 4% with all these three factors together (PIARC, 2003). According to the official statistics of the Road Traffic Safety Agency, in the Republic of Serbia, the impact of road factor on road accidents is significantly smaller, and the road factor has a share of less than 1% as a cause of a road crash. Having that in mind, Markovic et al. (2015a) highlighted the importance of making independent assessments of road impact on the occurrence or road accidents in the territory of the Republic of Serbia, with the aim of comprehending in an adequate way the impact of road and vehicle factors on the occurrence of road accidents.

Every year, over 270.00 pedestrians, which is around 22% of all road users, get killed on the roads worldwide (WHO, 2013). In Serbia, pedestrians are involved in around 24% of the total number of casualties in road traffic (ABS, 2014). If the age structure of the population in Serbia is taken into account, around 12% of the total number of population is young people, aged 15 to 24 years. This age group also accounts for 15% of the total number of fatalities in road traffic (ABS, 2014). On the other hand, children account for some 14% of the population, and around 2% of the total number of fatalities in road traffic, which in other words means that each fiftieth casualty in road accidents is a child (ABS, 2014). According to the data of the Road Traffic Safety Agency, in Serbia, in the period 2010-2014, children accounted for the largest number of casualties as pedestrians (40%). Having that in mind, it will be necessary to make a detailed analysis of road crashes involving pedestrians, with children pedestrians in particular, and to also identify the impact of the road factor on the occurrence of road accidents and their consequences.

Independent road impact assessments serve to identify the impact of the road and road environment on the occurrence of road accidents and their consequences. In-depth analyses enable researchers to observe all factors related to the occurrence of road crashes (road environment, vehicle, human) or only individual factors, as done by Penumaka et al. (2014), and others. Pesic et al. (2014) presented in their paper the best world practices in making in-depth analyses, as well as the possibility of implementing them in the Republic of Serbia. Markovic et al. (2015b) systematized methodologies of in-depth analyses and discussed their possible implementation.

Having in mind that there is no developed methodology for making in-depth analyses in the Republic of Serbia, Markovic et al. (2015c) have shown the possibility of using the results of road accidents expertise as methods of collecting factors that have an impact upon the occurrence of road crashes and their consequences.

Many authors used various ways to determine the impact of road factor on the occurrence of road crashes involving pedestrians. Gitelman et al. (2012), among other things, analyzed the characteristics of locations on which road accident with pedestrians happened and linked them to the characteristics of participants in these road accidents. Yanyong et al. (2015) analyzed the impact of horizontal signs and markings on pedestrian safety and vehicle speed in the vicinity of signalized pedestrian crossings and found a significant impact of the accurately marked signalization on the increase in pedestrian road safety and decrease in vehicle speed. Bella and Silvestri (2015) studied the influence that various signs and markings and combination of diverse equipment at sites crossed by pedestrians have on vehicle speed at these sites. They used a simulation model for their research and found that removal of objects from the roadside, parking bans and narrowing the lane width are the most effective measures for increasing pedestrian safety. Aidoo et al. (2013) used their in-depth analyses to determine the impact of road and road environment on the occurrence of road accidents and on driver's decisions to leave the site of road accident after the crash had occurred. They proved that there is an impact of road and road environment on such driving behavior. Dommes et al. (2015) tried to determine the impact of road and road environment on pedestrians' decisions to cross the road when the red light is on at the signalized pedestrian crossing, as one of the key factors for the occurrence of road accidents involving pedestrians. They found that there is a significant impact of the road and road environment on making such decisions and recognized the following as significant factors: visibility and sight distance in the intersection, width of pedestrian crossing (a road crossed by pedestrians), lane width, pedestrian refuges, etc.

2. MATERIAL AND METHOD

Road accident database has been created for the purpose of this survey on the basis of investigation data of the specialized road traffic unit in charge of investigations of road accidents of the Ministry of Interior in Belgrade. All road accident related data have been taken from the investigation documents and complemented on the basis of additional official documents of the traffic police. Geo-position data have been assigned to all road accident sites, for each road accident for which it was possible to provide such data, while remaining road crashes are located approximately, according to their description.

Applied research method included primarily a macro study of the state of endangerment of pedestrians in Belgrade, and identification of general features of road accidents involving pedestrians. After that, there followed an independent assessment of the road impact on all road accidents involving children pedestrians from 2009 to 2014 and road accidents with pedestrians in 2014.

The general analysis of road accidents involving pedestrians in the observed period indicated the need for a detailed analysis of each individual road crash. Due to limited resources in this research stage, a team of road traffic professionals from the Faculty of Transport and Traffic Engineering carried out in July and August 2015 an independent assessment of the road impact on all road crashes with children pedestrians in the observed period and road crashes involving pedestrians in 2014. Thus the independent assessment of the road impact has been made for 50 road accidents, out of which 40 accidents include pedestrian fatalities, i.e. pedestrians over the age of 18, and 10 accidents with pedestrian fatalities under the age of 18. The analysis was based primarily on the study of the impact of road factor on the occurrence and consequences of road crashes, using field research at the road accident site.

A specially trained team of road traffic professionals analyzed the available road accident data, getting familiar in that way with the conditions and circumstances in which a road crash happened. After that, the team used to go to the location of the road accident and analyzed possible road impact on the occurrence of a road accident and its consequences. Visual examination and analysis of movements made by each participant was made in the field, in order to determine possible influence of the road on the occurrence of a road accident and its consequences. Then all recorded impacts have been fixed using measurement, positioning and photographing in order to enable additional analyses of that impact later on. During the in-field analysis, the following data were collected in particular: road alignment, lane geometry, existence of access roads in the accident location zone, sight distance, road facilities intended for movement of pedestrians, existence of the “green” belt, urban furniture or horticulture, parking, horizontal and vertical signs and markings, position and number of pedestrian crossings, location lighting, lateral obstacles, state of hard shoulders, manner of traffic regulation.

Based on the identified impact of each of the mentioned factors on analyzed road accidents, there have been recognized factors that most often had an impact on road accidents involving pedestrians.

3. RESULTS

Road accidents involving pedestrians in the territory of the city of Belgrade, happened from 2009 to 2014, have been selected from the database and analyzed for the purpose of this research study. There were 5825 road crashes with pedestrians in the observed period, with 6450 pedestrian casualties. Out of the total number of the pedestrian casualties, 67,7% are pedestrians with slight bodily injuries, 27,7% with serious injuries, and 4,7% pedestrian fatalities. The structure of pedestrian casualties indicates that male pedestrians participated in 47,8% of road accidents, while female pedestrians were involved in 52,2% of road crashes. Out of the total number of casualties, the largest number falls under the age category of 15-64 years, while there were 274 casualties of children pedestrians (0-7 years) in the observed period. Most pedestrians of the age category 15-64 were killed or injured in 2013, while there was the smallest number of children casualties recorded in the same year.

The independent assessment of the road impact on the occurrence of road accidents helped perceive approximately similar influential factors, with a slight difference in relation to the central and peripheral areas of the city. In fact, peripheral parts of the city account for a more significant influence of completed construction work and the state of road infrastructure on road accidents, when compared to central parts of the city. The municipalities of Barajevo, Grocka, Lazarevac and Obrenovac were singled out as municipalities with a prevailing influence of the state of infrastructure on road accidents, since road facilities intended for the movement of pedestrians are missing to a great extent and pedestrians use the road for moving, which may pose a potential danger.

It was found that there are no constructed and well arranged sidewalks/footpaths for pedestrians at locations of analyzed road crashes in municipalities located at larger distance from the city centre. Therefore, pedestrians are forced to use the hard shoulder, if any, suitable for walking, or otherwise, they must use the road lane. It was also revealed that there are no marked pedestrian crossings in the mentioned zones of road accidents sites, and a very small number of marked pedestrian crossings were recorded in the wider zone of these road accident sites. A common specific feature was recorded on all roads of lower rank, i.e. there are no pedestrian crossings, footpaths or sidewalks on road accident sites, which may have had an influence on the occurrence of analyzed road accidents.

The analysis in question has shown that the condition of traffic signs and markings could have been one of the most common influences of road factor on road accidents in the observed sample of accidents. In fact, the lack of road signs, inappropriately set vertical signalization, physical obstacles covering the road signs, as well as a poor visibility of road signs could also have influenced to a great extent the occurrence of road accidents from the observed sample. (Figure 2). As the marked pedestrian crossings are defined by horizontal and vertical signs and markings, in order to be seen on time by other road users, in majority of analyzed road accidents, their improper marking could have been the reason for untimely observed pedestrians before the accident. The incompliance of road signs and markings with the regulations and standards in force may also represent an important impact of the road factor on road safety, as it affects the loss of confidence of road users in its meaning.

It was also found that the condition of horizontal signs and markings could have influenced the analyzed road crashes. In fact, the horizontal signs and markings were incomplete and poorly visible, in a significant number of cases, which could have had an impact on untimely observance of a marked pedestrian crossing and the occurrence of a road accident.

Poor sight distance in pedestrian crossings zones of the analyzed road accidents is the factor with potentially highest possible impact on the occurrence of road accidents, due to the presence of many lateral obstacles, primarily because of improperly parked vehicles in the close vicinity of pedestrian crossings (Figure 1 and 2). Field survey has shown that sight distance is often reduced due to objects located near the road lane, containers, polls, horticulture and other similar obstacles, which could also have had an influence on enhanced endangerment of pedestrians. The ability to notice a pedestrian on time on roads of lower rank, while driving in the night, in poorly lit location in question, was also found to have been reduced, so poor lighting has been singled out as a potential influential factor on the occurrence of road crashes involving pedestrians.

The analysis revealed that very wide traffic lanes and roadways can have an impact on occurrences of improper vehicle stopping and parking, which greatly affects the ability to observe pedestrians on time, and consequently the occurrence of a road accident. Wide roadways can also influence vehicle speeding, which, apart from untimely observance, has as a consequence inability to avoid the accident and occurrence of more serious injuries. Also, when it comes to roadway width, it was found that a larger number of crashes occurred on roadways with an uneven separation of lane width, i.e. where traffic lanes are of different width, which could have also been a contributory factor to the occurrence of road crashes.

Several road accidents were found to have the location of a bus stop as a contributory factor to a particular road accident, since the sight distance and ability to observe a pedestrian on a pedestrian crossing reduces with vehicle stopping.

Also, maneuvering of a public transport vehicle can add up to the influence on redirecting the caution of other drivers (Figure 1).

Inadequately signalized access points of intersecting side roads in the zones of road accident sites have been also identified as possible contributory factors to the occurrence of a certain number of analyzed road accidents. In fact, as pedestrians appear at locations of these access points, crossing the road most frequently at these points, the ability to avoid the hazard on time is reduced due to the absence of a timely notice that such a location is ahead.

A small number of analyzed road accidents have shown that the lack of protective pedestrian fences, as a part of road factor, on locations where pedestrian fencing is necessary, could influence the occurrence of a road accident.

***Figure 1**. Layout of selected road factors*

***Figure 2**. Layout of selected road factors*

When analyzing road accidents in which pedestrians under the age of 18 and children sustained fatal injuries, identical road factors have been recognized, as the ones previously mentioned. In addition, it is important to mention and highlight the following factors pertaining to road accidents with children: improper vehicle parking on the sidewalk or roadway within „school zones“; absence of sidewalks or pedestrian footpaths within „school zones“; inadequately and improperly marked „school zone“; absence of horizontal signs and markings and signage indicating the „school zone“.

4. DISCUSSION

Having in mind the observed road factors that contribute to the occurrence of road accidents involving pedestrians, the ranking of influence of the mentioned factors has been made in order to identify the factors that have a prevailing impact on the occurrence and consequences of such type of road accidents. As the category of children pedestrians has been singled out from the overall sample of pedestrians, as a particularly vulnerable road user group, the impact of identified factors has been analyzed particularly for that group. Comparison of influences of individual factors on all road accidents involving pedestrians and those involving children pedestrians has been also made.

It can be seen in Table 1 that in 45 out of 50 analyzed locations, i.e. road accident sites, it was noticed that the existing vertical signals (90%) could have an impact on road accidents with pedestrians. On the other hand, the analysis of the road accidents flow cannot help conclude that this factor had the biggest influence on the occurrence of road accidents involving pedestrians, but the only conclusion can be that it was present and had an influence on the largest number of road accidents occurred. Therefore, the presence of this factor has not a causal link with the occurrence of concrete road crashes, but was a dominant factor in almost all analyzed road accidents. The same applies to the horizontal signs and markings which in 82% of cases appeared to be incomplete and poorly visible. Approximately same results have been obtained in the analysis of road accidents with children fatalities.

Table 1. *Percentage of possible impact of a road indicator upon the occurence of road accidents*

ROAD INDICATORS	**POSSIBLE IMPACT (%)**	
	All road accidents	Road accidents with children
Great roadway width	**20 %**	**20 %**
Great lane width	**26 %**	**30 %**
Poor condition of the road surface	**12 %**	**30 %**
Poorly regulated lateral access points	**26 %**	**30 %**
Absence of sidewalks/pedestrian footpaths	**20 %**	**30 %**
Incomplete/improperly put vertical signs and markings	**90 %**	**80 %**
Incomplete/poorly visible horizontal signs and markings	**82 %**	**70 %**
Absence/small number of pedestrian crossings	**34 %**	**40 %**
Lateral obstacles	**84 %**	**100 %**
Poor lighting at location	**34 %**	**40 %**

Lateral obstacles contributing to reduced sight distance, and also to the likelihood of a road accident, are present in 42cases, which is actually 84%. If road accidents involving children are taken into account, it can be noticed that the presence of lateral obstacles in all road crashes is (100%). Recognized impact of lateral obstacles upon the occurrence of road crashes is in accordance with various surveys worldwide, e.g. Bella and Silvestri (2015), Aidoo et al. (2013.).

Two road factors have been singled out in particular as they have the highest impact on pedestrian safety - existing and arranged pedestrian facilities and pedestrian crossings. These factors have been recognized in the world literature as significant factors contributing to the occurrence of road crashes involving pedestrians. However, in the analyzed road accident sample, 10 out of 50 analyzed locations do not hold pedestrian facilities (sidewalks and footpaths), which accounts for 20%. Furthermore, 17 out of 50 analyzed locations do not have pedestrian crossings or the number of it is insufficient, which account for 34%.

Table 2. *Percentage of share of lateral obstacles*

LATERAL OBSTACLES	All road accidents	Road accidents with children
Trees	**12 %**	**30 %**
Horticulture	**14 %**	**20 %**
Containers	**18 %**	**10 %**
Parked vehicles	**54 %**	**60 %**
Fence	**18 %**	**20 %**
Objects along the road	**28 %**	**40 %**
Lighting column	**30 %**	**50 %**

Road accidents with children have shown that 3 out of 10 analyzed locations do not have pedestrian road facilities – sidewalks and footpaths, which accounts for 30%, while 4 out 10 analyzed locations do not have pedestrian crossings or there is an insufficient number of crossings, which accounts for 40%.

Table 2 shows that parked vehicles are the most dominant lateral obstacles in both cases. When it comes to parked vehicles which result in restricted sight distance, it is important to emphasize that these are mostly vehicles illegally parked in areas that are not intended for parking purposes. The influence of this factor was recognized by Bella and Silvestri (2015), Aidoo et al. (2013). It should be highlighted that illegally parked vehicles accounted for 60% of cases, on locations with recorded road accidents which had as a consequence fatalities of children pedestrians. Vehicles were usually improperly parked on the sidewalk. This phenomenon jeopardizes significantly the safety of children pedestrians, especially of the youngest ones who are not able to participate in road traffic independently, without the supervision of their parents (guardians). This is particularly obvious in a situation when a pedestrian is forced to take the roadway to move because of a vehicle parked on the sidewalk. Therefore, it is evident that the observed lateral obstacles have a significant impact on restricting possibilities of road users to mutually observe one another, and on reducing pedestrian safety, too.

5. CONCLUSION

The analysis of road accidents with pedestrian fatalities which is the subject of this paper helped identify potential impact of the road factor in all analyzed road accidents. In cases when road users are not able to discern one another on time, the road factor was likely to influence the occurrence of a road accident. In other accidents, road factor was likely to influence the consequences, while in some cases it was a circumstance that need not have been related to a specific road accident. In fact, as already stated, the impact of road signs and markings need not have had an impact in that specific accident, but it occurred as one of the impacts affecting the safe movement of road users.

By improving the conditions of road and road environment, some of the analyzed road accidents could be avoided, because it would provide the possibility for road users to see one another on time, as well as to avoid provoking any hazards and occurrence of road accidents.

Identification and systematization of road factor's impacts would allow for undertaking appropriate actions to eliminate observed unsafe occurrences, as well as to define preventive measures.

Regular exercise of independent assessments of road impact on the occurrence of road accidents would allow for a systemic elimination of unsafe locations, which would reduced the impact of road factor on the occurrence of road crashes. On the other hand, by identifying certain road factors, it would be possible to provide for preventive actions which would eventually decrease the number of road accidents. Systemic collection of road factor impacts would enable the road traffic system to develop to the extent in which, apart from influencing road accidents and their consequences, it will have the opportunity to influence the result of reducing the influence of other factors.

By defining the influence of a road factor on the occurrence of road accidents in the territory of a local community, and applying the independent road impact assessment, local communities would have a clear insight into locations and road traffic situations which are not safe and which are likely to influence the occurrence of road accidents. The authorities in local communities would thus be able to undertake measures, in a planned and systematic way, to reduce the number of unsafe locations and to avoid creating dangerous situations. Undertaking such activities would result in a reduced number of road accidents and raised level of road safety, and consequently in reduced costs of road crashes.

6. LITERATURE

[1] Агенција за безбедност саобраћаја (2014). Статистички извештај о стању безбедности саобраћаја у Републици Србији у 2014. години.

[2] Ahmed, N., Andersson, R. (2002). Differences in cause-specific patterns of unintentional injury mortality among 15-44 year-olds in income-based country groups, Accid. Anal. Prev. 34(4), 541-551

[3] Aidoo, E.N., Amoh-Gyimah, R., Ackaah, W. (2013). The effect of road and environmental characteristics on pedestrian hit-and-run accidents in Ghana. Accid. Anal. Prev. 52, 23-27.

[4] Bella, F., Silvestri, M. (2015). Effects of safety measures on driver's speed behavior at pedestrian crossings. Accid Anal Prev. 83,111-124.

[5] Charles, V. Z., Max, B. (2012). Pedestrian crash trends and potential countermeasures from around the world. Accident Analysis and Prevention, 44, 3-11.

[6] Dommes, A., Granié, M.-A., Cloutier, M.-S., Coquelet, C., Huguenin-Richard, F.(2015). Red light violations by adult pedestrians and other safety-related behaviors at signalized crosswalks. Accident Analysis and Prevention, 80, 67-75.

[7] Dunbar, G. (2012). The relative risk of nearside accidents is high for the youngest and oldest pedestrians. Accident Analysis and Prevention, 45, 517-521.

[8] Elvik, R., Sørensen, W.J. M., Nævestad T.O.(2013). Factors influencing safety in a sample of marked pedestrian crossings selected for safety inspections in the city of Oslo. Accident Analysis and Prevention, 59, 64-70.

[9] Gitelman, V., Balasha D., Carmel, R., C., Hendel L., Pesahov F.(2012). Characterization of pedestrian accidents and an examination of infrastructure measures to improve pedestrian safety in Israel, Accident Analysis and Prevention, 44, 63-73.

[10] Guo, Y., Liu, P., Liang, Q., Wang, W., (2015). Effects of parallelogram-shaped pavement markings on vehicle speed and safety of pedestrian crosswalks on urban roads in China. Accident Analysis and Prevention, In Press,doi:10.1016/j.aap.2015.07.001

[11] Lee, J., Abdel-Aty, M., Choi, K., Huang, H., (2015). Multi-level hot zone identification for pedestrian safety. Accident Analysis and Prevention, 76, 64-73.

[12] Marković, N., Pešić, D., Macura, D., Šelmić, M. (2015a). Nezavisne ocene saobraćajnih nezgoda sa poginulim na javnim putevima, 10. Međunarodna Konferencija ‘’Bezbednost saobraćaja u lokalnoj zajednici’’, Srbija, Kragujevac, Hotel Kragujevac, 22 – 25. april 2015.

[13] Marković, N., M. Vujanić, K. Lipovac, B. Antić, D. Pešić (2015b).Metodologija dubinskih analiza saobraćajnih nezgoda, Časopis "Put i saobraćaj", br. 2, str. 51-58, ISSN 0478-9733, Beograd

[14] Marković, N., Pešić, D., Šelmić, M., Macura, D. (2015c). Značaj vršejnja dubinskih analiza saobraćajnih nezgoda za pravilno utvrđivajnje uticaja puta na nastanak saobraćajne nezgode, XIV Simpozijum "Veštačenje saobraćajnih nezgoda i prevare u osiguranju"

[15] Pan L., Jia, H., Wei W., Chengcheng X.,(2011). Effects of transverse rumble strips on safety of pedestrian crosswalks on rural roads in China. Accident Analysis and Prevention, 43, 1947-1954.

[16] Penumaka, P.A., Savino, G., Baldanzini, N., Pierini, M., 2014. In-depth investigation of PTW-car accidents caused by human errors. Safety Sci. 68, 212-221.

[17] Pešić, D., Vujanić, M., Lipovac, K., Antić, B.(2014). In-depth analyses of road accidents, state-of the-art and the possibilities for the implementation in the Republic of Serbia, Road Accidents prevention 2014, XII International Symposium, 19-29.

[18] PIARC, (2003). Road safety manual.

[19] Reed, S., Morris, A. (2008). Glossary of Data Variables for Fatal and Accident causation databases. Deliverable 5.5 of the EU FP6 project SafetyNet, TREN-04-FP6TRSI2.395465/506723

[20] Stevens, N., Salmon, P.(2015). Reprint of “Safe places for pedestrians: Using cognitive work analysis to consider the relationships between the engineering and urban design of footpaths”. Accident Analysis and Prevention, 74, 339-349.

INVITED PAPER

ANALYSIS OF SOME DIRECT INDICATORS FOR ROAD TRAFFIC SAFETY SITUATION IN THE AREA OF THE SECTOR FOR INTERNAL AFFAIRS – SKOPJE IN THE PERIOD 2010-2014

Boris Murgoski[1], Kire Babanoski[2]

Abstract: The paper gives a description, presentation and evaluation of road traffic safety situation in the area of the Sector for internal affairs (SIA) – Skopje in the period 2010-2014. Traffic safety on the roads in this area will be analyzed through the basic criminological characteristics of traffic accidents in the last 5 years. Etiological features will be assessed by the most common causes that lead to the occurrence of traffic accidents with serious consequences, while phenomenological characteristics will be determined by the established trend and dynamics of traffic accidents and their consequences. For this purpose, firstly will be analyzed the direct absolute indicators, and then will be calculated and interpreted the direct relative indicators of traffic accidents and their consequences. In addition, it will be given analysis of the public and traffic risk of suffering from accidents on the roads within the SIA Skopje for the research period. The review and description of specific experiences from the preventive campaigns in function of the road traffic safety in this sector seek to detect problems of traffic accidents prevention and the role of various entities in achieving the preventive and repressive function. At the end of the paper, it is made an attempt to offer specific proposals and recommendations aimed at improving the preventive activities in the field of road traffic safety in the area of SIA Skopje.he volume of abstract cannot be more than 250 words.

Keywords: analysis, direct indicators, road traffic safety situation, traffic accidents

[1] Ph.D., Murgoski Boris, Professor, Faculty of security – Skopje, University "St Kliment Ohridski", Bitola, str. "1", nr. 2A, Kolonija – Idrizovo, 1000 Skopje, Republic of Macedonia, bmurgoski@fb.uklo.edu.mk, bmurgoski@yahoo

[2] Ph.D., Babanoski Kire, Assistant Professor, Faculty of Security Sciences, MIT – University, Skopje, Treta Makedonska Brigada, bb, 1000 Skopje, Republic of Macedonia, kbabanoski@gmail.com

1. INTRODUCTION

Traffic and its functioning is activity that in its nature is extremely important and danger, as well – because it is main pillar of real threat for the life of people, and their property. According to the international statistics (OECD, 2012:17) it is shown that current development level of traffic negatively affect its safety and safety of the users (data of the World Health Organization from 2010, show that each year about 1,3 million people are killed and another 50 million people are injured on roads worldwide, which represent 2,1 % from the global mortality. It means that everyday around 140.000 persons are injured, around 15.000 are disabled and more than 3.500 persons died). Beside its goal to connect places and other functions, it is particularly important the aspect of "trafficking with less negative effects" (Lipovac, 2008:4). That's why it may be concluded that safety in road traffic is one of the most complex problems in human society and therefore continuous efforts are required by the authorities and stakeholders to reduce the number of accidents and their consequences, and ultimately improve and enhance road traffic safety.

Road traffic safety (Бабаноски, 2014:18) can be defined as a state of responsible, conscientious and disciplined behavior of people without the presence of danger arising from their participation in order to achieve an optimal level of functioning in road traffic.

Measurement of road traffic safety situation should enable detection, identification, description, definition, analysis and assessment of the safety condition. Since there is no special tool, ie an instrument to measure traffic safety, as most suitable is used statistics and indicators that can be performed by it. By analyzing the statistics, coefficients and indicators of road traffic accidents it can be differentiate the main reasons for their occurrence and to connect with the movement of population, size and development of the motor vehicles, the road network, national income and so on, and their importance (Пешиħ et al, 2014:37-42) is reflected primarily in the construction of the so-called proactive approach for continuous improvement of the road traffic safety.

The assessment can be made on the basis of direct and indirect indicators (measuring instruments) and other methods, which evaluate current situation and the established trend in the road traffic safety. Direct indicators are related to accidents and their consequences, and they can be: absolute indicators of accidents, absolute indicators of the consequences of accidents, relative indicators of accidents, and relative indicators of the consequences of accidents.

For the purposes of explanation the subject of research in this paper, it will be analyzed some indicators for road traffic situation on the territory of the Sector for internal affairs (SIA) Skopje. At the beginning, it will be presented the traffic and technical characteristics on this territory, by its area, length and type of the roads, and number and type of the vehicles. From the direct absolute indicators, will be analyzed absolute indicators of accidents (total number, number of accidents with fatalities, number of accidents with casualties and number of accidents with huge material damage), as well as number of fatalities and casualties. From the direct relative indicators for assessment the road traffic safety in this sector will be calculated the public and traffic risk (Lipovac, 2008:77-96, Златковски & Јошевски, 2007), which are in direct correlation with the number of deaths, and depend on the number of population and the number of motor vehicles and trailers. Additionally, it will be presented the public and traffic risks of suffering (Veličković, 2014:26-27), which take into account the consequences of road traffic accidents for the people (human losses, seriously and slightly bodily injured persons).

Data for the mentioned indicators will be taken from the official web page of the Ministry of interior (www.moi.gov.mk) and the statistical publication of the State statistical office of the Republic of Macedonia.

2. TRAFFIC AND TECHNICAL CHARACTERISTICS OF THE TERITORY OF SIA SKOPJE

According to the Law on Police (art. 20, p. 3-1,), the Sector of internal affairs Skopje has its headquarter in Skopje, and is responsible for police affairs in the area of the city of Skopje and the municipalities of Arachinovo, Zelenikovo, Ilinden, Petrovec, Sopishte, Studenichani and Chucher Sandevo.

Skopje covers an area of 1.818 km2, 23 km in longitude and 9 km in latitude and is situated on a height of 245 metres above the sea level. The average annual temperature in Skopje is 13,5 °C, and there are an average 74 foggy days per year, and an average 940 mm rainfalls or 11 days of the year. According to the Law on territorial organization, Skopje bringing together 10 municipalities: Center, Karposh, Kisela Voda, Gjorche Petrov, Aerodrom, Butel, Saraj, Shuto Orizari, Gazi Baba and Chair. In 2014 in the City of Skopje there were 587 km of local roads, of which 377 km are asphalt, 75 km macadam, 72 km paths, 61 km irregular paths and 2 km cube. These roads have a total of 41 bridges with a total length of 1.171 m, of which 36 are permanent bridges with a total length of 1.073 m and 5 are temporary bridges with a total length of 98 m. So far, on the roads are built 6 major traffic roundabouts and other 6 are in the process of construction or preparation. The roads in Skopje have a total of 105 intersections with traffic lights that have recently been regulated by the Center for traffic management and control, which through monitoring and using the software for adaptive traffic management, collects information for the flow and density of vehicles, does forecasts and prepares a plan of traffic lights for faster traffic flow. Skopje has a total of 60 km of cycling routes along the streets, plus 21 km along the river Vardar. With the new project "Skopje 2017 Velograd" is planned by 2017 to be reconstructed 51 km, and to be constructed 4 modern cycling routes that will extend from east to west with a total length of 32.5 km, each route connecting 3 municipalities and there will be 7 connectors, which extend from north to south, with a total length of 19 km. For the management of parking areas within the City of Skopje is responsible special public enterprise, called City Parking (www.gradskiparking.com.mk). Skopje has a dozen multi-storey car parks lots, around 15 closed parking lots, more public areas in which the parking is organized in different zones through 4 zones of restricting the parking.

In 2014 in the City of Skopje there were 166.220 registered road motor vehicles and trailers, of which 11.967 were first time registered in Macedonia.

In the City of Skopje, as the capital of the state, on its area operate international, intercity and public transportation, which together with the railway station formed so called Transportation Center. Skopje bus station, comprised of international and intercity station is the biggest bus station in the country (www.sas.com.mk). It is a bus stop which conducts most of timetables, both domestically and abroad. Currently buses depart from Skopje to 20 European countries. The station has a platform with 31 places of which 7 are for arrivals and 24 for departures.

Public transportation is performed by the Public Transport Company - JSP Skopje (www.jsp.com.mk). The company covers the City of Skopje and the surrounding area in urban and suburban lines - day and night. Annually buses of JSP Skopje spend 15,5 million km with transported over 50 million passengers. Citizens are taken from 496 urban and 505 suburban bus stops, which are distributed according to the needs of 36 city and 42 suburban lines. It has two auto bases located on opposite ends of town, serving an equal number of vehicles and that practically represent the heart of public transport. The company has a total of 536 vehicles of various types, with an average age of 8,88 years.

Taxi services in the City of Skopje, go through 2,400 taxis that are licensed by the City Council. According to the last available data, the city of Skopje has a total of 132 taxi stops marked in yellow, which has room for up to 15 vehicles. This means that in total, are provided 720 parking spaces. The largest number of taxi stands have Centar and Karposh.

In Skopje, the critical time when there is most dense traffic is the morning from 08-09.00, when citizens go to work and the afternoon from 16:30-17:30, when citizens return from work.

3. INDICATORS FOR ROAD TRAFFIC SAFETY SITUATION IN THE SIA SKOPJE IN THE PERIOD 2010-2014

Table 1 provides a summary of some direct indicators of road traffic safety in the area of SIA Skopje for the period 2010-2014.

On average in the analyzed five-year period have occurred 1.883 traffic accidents. On average, 42 people died on the roads in the area of SIA Skopje per year, and 271 persons were seriously bodily injured and 2.411 were slightly bodily injured.

In terms of consequences, according to the data from the Unit for road traffic safety at SIA Skopje, can be noted that most of the fatalities and casualties (nearly half in each year) were pedestrians, which confirms the fact that they are the most vulnerable category of all road traffic users. Data for slightly bodily injured persons by category of the users, show that the most represented category are drivers of cars and trucks and their passengers and the pedestrians are on the third place.

Table 1. *Indicators for road traffic safety situation in the SIA Skopje, 2010-2014*

	2010	**2011**	**2012**	**2013**	**2014**	**average**
traffic accidents	1936	2082	1756	1756	:	1883
deaths	45	56	34	40	33	42
seriously bodily injured persons	:	277	255	277	273	271
slightly bodily injured persons	:	2.859	2.243	2.324	2.217	2411
population	604.298	607.502	610.775	614.254	617.646	610.895
motor vehicles	145.883	156.779	154.039	163.330	166.220	157.250
local roads	1.283	1.300	1.338	1.384	1.363	1.334
public risk	7,45	9,22	5,57	6,51	5,34	6,82
traffic risk	3,08	3,31	2,04	2,26	1,82	2,50
public risk of suffering	:	197,60	146,11	160,93	146,25	162,72
traffic risk of suffering	:	76,57	57,93	60,52	54,34	62,34

: = unavailable

The table lists the data on traffic and public risk, as well as the public and traffic risk of suffering. The average value of the public risk is 6,82, which means that 7 people per 100,000 residents died on the roads in the area of SIA Skopje. We can note constantly wavering in the figures of this risk through the years. On the other hand, the average value of the traffic risk is 2,50, which means that 2,5 persons per 10,000 road motor vehicles and trailers died on the roads in the area of SIA Skopje. Here, we can note a steady decline in the figures through the years. The reason is that this indicator is dependent on the number of vehicles, and in recent years, especially after 2010, when the Government adopted measure for easier import of vehicles in the country, their number has been increasing steadily.

The public and traffic risk of suffering are indicators which, besides the number of fatalities, take into account the other consequences (seriously and slightly bodily injured persons). This number is significantly larger, so they compensate the impact of random variations that exist in the case of using only the number of dead persons. If we see the data for public risk of suffering, it is noted that the situation in SIA Skopje is favorable, which means that through the years, the value of this indicator varies as low and very low (according to the scale of the magnitude of this risk). The situation with traffic risk of suffering in SIA Skopje is advantageous, too, because through the years, it kept a low value (according to the scale of the magnitude of this risk) and compared with other sectors for internal affairs, it can be concluded that SIA Skopje has the most favorable value.

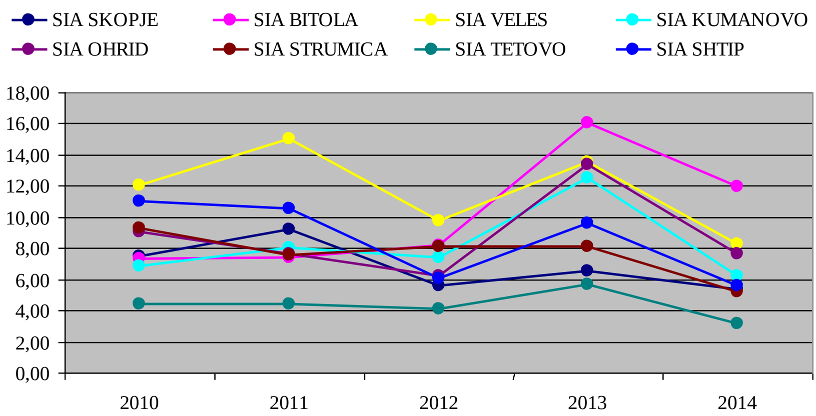


Figure 1. *Public risk per SIA in Ministry of interior, 2010-2014*

Figure 1 shows the graph of the established trend of the public risk on all roads in the Sectors of internal affairs for the period 2010-2014. Through this comparative graph can be seen the situation in SIA Skopje compared to other 7 sectors for internal affairs through Republic of Macedonia. According to the line of the graph that shows the results of SIA Skopje can be visually observed that the situation in this sector is more favorable compared to other sectors. The highest value the public risk has reached always in SIA Veles (with average of 11,73), but SIA Bitola in 2013 has reached the highest individual value of 16,03. The lowest value this indicator has reached in SIA Tetovo (with average of 4,35), especially for 2014 (3,13).

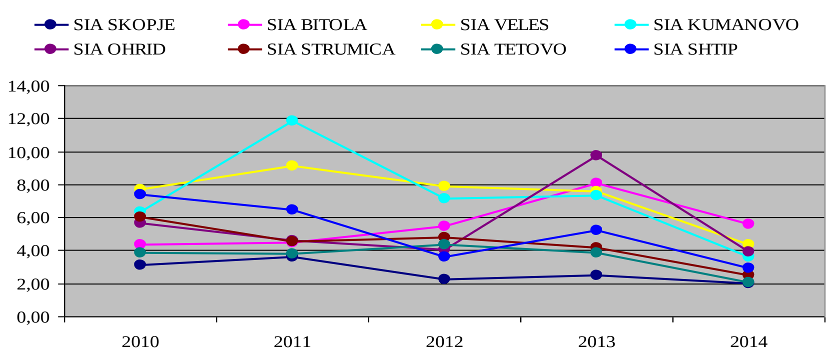


Figure 2. *Traffic risk per SIA in Ministry of interior, 2010-2014*

Figure 2 shows the graph of the established trend of the traffic risk on all roads in the Sectors of internal affairs for the period 2010-2014. The highest average value of traffic risk has SIA Veles (7,31) and the lowest SIA Skopje (2,66). The highest value the traffic risk has reached in SIA Kumanovo in 2011 (11,83), and the lowest value has reached in SIA Skopje for 2014 (1,99). After all, repeatedly, over the years, the value of this indicator for SIA Skopje has the lowest value.

The etiology of road traffic accidents (Арнаудовски, 2007:310, Inić, 1987:113-115, Мургоски, 2010:187-195) is very complex science which has studied the reasons, causes and factors of traffic accidents occurred on the roads. It "opens the black box" and examines the status of road traffic accidents. It studied the relationship in the system H-V-R-E (human-vehicle-road-environment), which led to the accident. The purpose of the etiology is not only to prevent the risk in the particular space and time, but understanding the legality that results with risk and reducing the risk of occurrence of the accident in any similar space and at any time. Etiology observes traffic accidents as a chain of events (Murgoski & Babanoski, 2015) and tries to answer the question which event in the chain and how that event contributed to the occurrence of the accident.

The causes of accidents are numerous and intertwined with each other so they are often mutually conditioned and complementary, and together contribute to the occurrence of the accident. Therefore, quite often, in many cases, it is very difficult to choose only one cause of any accident.

Table 2. *Causes of road traffic accidents in SIA Skopje, 2010-2013*

	2010	**2011**	**2012**	**2013**	**average**
speeding	549	590	341	342	456
violation of rules on priority of passage	421	418	273	313	356
driving under the influence of alcohol	40	47	31	30	37
wrong side and direction of movement	114	132	136	132	129
improperly movement and turning	278	212	236	272	250
other	534	683	739	667	656

Table 2 gives the causes (reasons, factors) for the road traffic accidents in SIA Skopje for the period 2010-2013. Data for 2014 are not available. The main cause of accidents, according to data for the analyzed period of time is speeding on roads, or disobeying the prescribed speed for driving on that road. This offense has lately been on the rise, due to the daily improvement of traffic infrastructure, ie construction and building of a large boulevards and streets. A second reason for road traffic accidents is the disregard of the rules on priority of passage. This offense is manifested especially on intersections regulated by the classic road signs and junctions where is employed the rule of priority from the right side and where the intensity of traffic on one thoroughfare is much lower compared to other. The other reasons for the accidents, according to the table, are: improperly movement and turning, and wrong side and direction of movement, which confirms the thesis that the safety of road traffic, depends on the conscientious, disciplined and responsible behavior of its participants. Driving under the influence of alcohol is a cause of occurrence of accidents on average 37 cases. It is important that by this cause occurred as well a huge number of offenses, according to the Unit for road traffic safety at SIA Skopje. It is an offense that is manifesting in the urban area, especially in the evenings and over the weekends. During the summer, however, in the city park start to operate the majority of restaurants, which are visited by a huge number of young people, and in recent times it can be seen an increased number of citizens attending parking areas on Vodno, where they consume alcohol and then driving their vehicles under the influence.

In summer, with improved weather conditions, beginning of the tourist season and the end of the school year, the intensity of traffic in Skopje is reduced, thus creating conditions for increasing the speed of movement of vehicles especially in the evening, and thus the occurrence of organized so-called "Wild races" on certain roads in the city, primarily with cars, but sometimes with motorcycles, which directly endangers their safety and safety of other road users. Offences committed by pedestrians, cyclists and drivers when they are not giving priority to pedestrians on the marked pedestrian crossings, are present on the territory of the entire city, as a result of insufficiently developed or busy pedestrian and cyclists' paths and low traffic culture of road traffic users.

In the summer it has increased the number of offenses that make drivers of motor bikes, mopeds and motorcycles, and that's why they occur as most endangered category of road users during this period.

On the other hand, there are certain offenses that interfere the normal flow of traffic, which threatens its safety, and they are: irregular stopping and parking, covering the traffic areas with agricultural and other products and so on.

Table 3. *Road traffic accidents by reasons of occurrence in SIA Skopje, 2010-2013*

	2010	2011	2012	2013	average
driving mistakes	1850	1953	1648	1650	1775
mistakes of pedestrians	77	115	87	94	93
malfunction of vehicle	1	1	-	-	1
improperly placed load	-	-	-	-	-
malfunction of the road	3	2	7	3	4
other	5	11	14	9	10

Table 3 shows the overview of the road traffic accidents by reasons of occurrence in SIA Skopje in the period 2010-2013. Data for 2014 are not available. Around 94 % of all road traffic accidents result from driver mistakes, and 5 % from the mistakes of pedestrians. The other reasons are negligible.

4. PREVENTIVE MEASURES AND ACTIVITIES FOR IMPROVEMENT OF ROAD TRAFFIC SAFETY SITUATION IN THE TERITORY OF SIA SKOPJE

It should be emphasized that in the last few years, the authorities in Skopje are engaged in improving the traffic safety situation on the roads, and they are taking a range of different measures and activities in different areas of the traffic.

In Skopje, today, are notable more construction works for expansion, upgrading and modernization of the main boulevards, equipping roads and intersections with horizontal and vertical light signals, construction of several roundabouts for faster flow of vehicles and construction of bicycle road network throughout the city. In parallel, were built several multi-storey car parks lots and were marked lots of parking spaces on the streets, to introduce order in the parking of vehicles, especially through the downtown area.

Municipal councils for traffic safety on the roads, together with the National council for traffic safety on the roads (www.rsbsp.org.mk), which operate under the Law on traffic safety on the roads, have undertaken campaigns to increase awareness in promoting road safety in the area of the city. Particular attention is paid to educational lectures and workshops for children and pupils in primary and secondary schools, as the most vulnerable road user category, for who is dedicated a special campaign entitled "Let's protect children in traffic". This campaign was supported by many well-known public figures in the country, from different spheres. Special emphasize should be given to the project "Traffic Primer" with a lot of educational videos, from which children can become familiar with the rules in road traffic. The National council is also involved in spreading awareness about safe road through modern means of communication - social networks (Facebook, Twitter), sharing of different contents about road traffic safety that will reach out to the young road users. Another very important message that is spread through the media, as part of the campaigns of the National council was: "The traffic is not a game. Participate responsibly". National council appears as the initiator and main carrier of a campaign on the World day of remembrance of victims of traffic accidents. It often occurs as a partner in preventive activities together with the Ministry of Interior - Police. Together, they organize campaigns with educational activities within the so-called Week of the pedestrians, motorcyclists, Month of the cyclists and school competitions in the field of traffic safety.

To promote the safety in road traffic in the recent years Government of the Republic of Macedonia was actively involved with the following campaigns: "Respect the rules, respect the life" and "Drive safe, drive with the seat belt".

In December 2014, the Parliament has adopted the Second National strategy of the Republic of Macedonia for improving the safety of road traffic for the period 2015-2020, which in itself contains an action program and plan for its implementation. Otherwise, its purpose is the number of deaths in road accidents by 2020 to be reduced and to reach the average value of the EU countries and the number of victims - young drivers to be reduced by 30 %, the number of seriously bodily injured persons to be reduced by 40 %, while the number of children - victims of traffic to be reduced to zero.

5. CONCLUDING CONSIDERATIONS

Problems regarding the safety of persons and property in road traffic largely need to be actualize in the scientific and wider public, because of the social-economic damages which arising from them, as well as the importance and need of improvement of traffic safety.

Namely, for the area of SIA Skopje, as was presented by data from tables that are related to traffic accidents and their consequences, can be stated the following facts:

- 1,883 traffic accidents were occurred per year, which is about more than 1/3 of the total number of accidents that occur on roads through the Republic of Macedonia,
- 42 people died per year as a result of traffic accidents, which is 1/4 of the total number of fatalities in the Republic of Macedonia,
- the biggest number of accidents in this area were occurred by speeding as the main mistake that make drivers of motor vehicles,
- on the roads in SIA Skopje, on average, 7 people per 100,000 inhabitants died, and through the years there is oscillatory trend in the value of this indicator,
- on the other hand, 2,5 persons per 10,000 road motor vehicles and trailers died on the roads in the area of SIA Skopje, and through the years there is a steadily declining trend in the value of this indicator,
- the value of public risk of suffering is a favorable, and through the years, the value of this indicator varies as low and very low,
- the value of the traffic risk of suffering is advantageous, and through the years, the value of this indicator consistently has low value.

Displayed results suggest the need for further multidisciplinary researches on the impact of subjective and objective factors in traffic safety. For rational and effective social intervention in this area, it is necessary continuously through expanded and summarized researches of phenomenological and etiological characteristics of traffic delinquency and accidents in some area, all relevant stakeholders to undertake continuous strategic preventive and repressive measures and activities in order to improve and promote the safety of road traffic.

6. LITERATURE

[1] Арнаудовски, Љ. (2007). Криминологија. 2-ри август, Штип
[2] Бабаноски, К. (2014). Безбедност и одговорност на учесниците во патниот сообраќај во Република Македонија, докторска дисертација одбранета на Факултетот за безбедност – Скопје

[3] Veličković, P., Z. (2014). Veća bezbednost u opštinama, Istražujemo – Saobraćaj u gradovima. Auto Bild, br. 84, 30.05.2014
[4] Државен завод за статистика на Република Македонија. (2011...2015). Статистички преглед: население и социјални статистики, Процени на населението на 30.06(20010-2014) и 31.12(2010-2014) според полот и возраста, по општини и по статистички региони, Скопје
[5] Државен завод за статистика на Република Македонија. (2011...2015). Статистички преглед: транспорт, туризам и други услуги, Транспорт и други комуникации во 2010...2014. Скопје
[6] Закон за безбедност на сообраќајот на патиштата, Сл. Весник на РМ бр. 54/07, 86/08, 98/08, 64/09, 161/09, 36/11, 51/11, 114/12 и Одлуки на УСРМ 114/07, 144/07, 41/08
[7] Закон за полиција, Сл. Весник на РМ бр. 114/06, 6/09, 145/12 и Одлука на УСРМ бр. 211/06
[8] Златковски, С., Јошевски, З. (2007). Анализа на сообраќајни незгоди, прв, втор и трет дел. Технички факултет – Битола
[9] Inić, M. (1978). Etiologija saobraćajnih nezgoda na putevima. Beograd
[10] Lipovac, K. (2008). Bezbednost saobraćaja. Beograd
[11] Murgoski, B., Babanoski, K. (2015). Phenomenological and etiological approach for researching traffic offences and accidents on the roads, Proceedings, International scientific conference, Researching security – approaches, concepts and policies, Faculty of security – Skopje, Ohrid
[12] Мургоски, Б. (2010). Етиолошки проблеми при истражувањето на сообраќајните несреќи, Годишник на Факултетот за безбедност, Скопје
[13] Пешић, Д., Липовац, К., Ross, A., Brčić, D. (2014). Значај индикатора безбедности саобраћаја за управљање безбедношћу саобраћаја. 9. Међународна конференција, Безбедност саобраћаја у локалној заједници, Зајечар
[14] OECD (2012). Sharing Road Safety, Developing an International Framework for Crash Modification Functions, Research report, retrieved from http://www.keepeek.com/Digital-Asset-Management/oecd/transport/sharing-road-safety_9789282103760-en#page2 [available at 23.12.2015]
[15] Републички совет за безбедноста на сообраќајот на патиштата. (2014). Национална стратегија на Република Македонија за унапредување на безбедноста на сообраќајот на патиштата 2015-2020. Скопје
[16] http://www.gradskiparking.com.mk - official internet web page of the Public enterprise Gradski Parking
[17] http://www.jsp.com.mk - official internet web page of the Public Traffic Enterprise JSP Skopje
[18] http://www.moi.gov.mk - official internet web page of the Ministry of interior of the Republic of Macedonia
[19] https://www.rsbsp.org.mk - official internet web page of the National Council for the Safety in Traffic on Roads
[20] http://www.sas.com.mk - official internet web page of the Skopje Bus Station

ROAD SAFETY
IN LOCAL COMMUNITIES

WE INVITE YOU TO

XII International
Conference
ROAD SAFETY IN LOCAL COMMUNITY

APRIL, 2017

www.bslz.org

11th International Conference
"Road Safety in Local Community"
Serbia, Vrnjacka Banja, Hotel Zvezda,
April 13 – 16, 2016.

INVITED PAPER

THE MANAGING OF SELF-EXPLAINING ROAD NETWORK IN THE REPUBLIC OF SLOVENIA

Jure Prestor[1], Barbara Klemen[2], Marko Renčelj[3]

Abstract: The paper addresses the issue of effective management of road safety in Slovenia from the point of view of road transport infrastructure. Initially, the basic concepts of modern road design are briefly described and defined. The concepts of self-explaining roads, forgiving roads and sustainable road safety are described. The introduction is followed by a description of the basic requirements of establishing self-explaining road network and a brief summary of tools for effective implementation of modern concepts. Following are the main shortcomings of the present management of the road network in the Republic of Slovenia, with a focus on established administrative - political division of the roads. A proposal of setting up road safety management as well as the gradual establishment of self-explaining road network and forgiving roads is described

In the conclusion, the activities performed by the Republic of Slovenia for the establishment of road safety management is briefly described.

[1] Prestor Jure), M.Sc., Consultant Engineer of Department for Technical Regulation of Traffic and Traffic Safety, Civil Engineering, DRI Investnemt Management, Company for Development of Infrastructure Ltd., Kotnikova ulica 40, SI-1000 Ljubljana, jure.prestor@dri.si.

[2] Klemen, Barbara, Head of Department for Technical Regulation of Traffic and Traffic Safety, Univ. Bsc CEng, Civil Engineering, DRI Investnemt Management, Company for Development of Infrastructure Ltd., Kotnikova ulica 40, SI-1000 Ljubljana, barbara.klemen@dri.si.

[3] Ph.D., Renčelj Marko, Associate Professor, Civil Engineering, University of Maribor, Faculty of Civil Engineering, Transportation Engineering and Architecture, Smetanova ulica 17, SI-2000 Maribor, marko.rencelj@um.si.

Keywords: sustainable traffic safety, categorisation of road network, perception, expectations, self-explaining roads, self-explaining measures, grey roads, traffic safe road design

1. INTRODUCTION

In the paper the concept analysis of the self-explaining (SER) roads related to the issue of design and maintenance of roads the Republic of Slovenia is discussed. The main problem with the majority of roads is that they have been designed, constructed and maintained in accordance with traffic and technical requirements, which are implemented in a deficient, inconsistent and outdated legislation. The impact of proper road and roadside design on safe behaviour of traffic participants has often times been significantly neglected.

In Europe a new concept of road designing was developed at the beginning of the 21 st century as a response to the decline in traffic safety. Human beings are positioned as the central and the most important factors of traffic safety, altogether with their limited abilities.

The new concept of road designing is included in the Dutch concept of sustainable traffic safety, which places prevention at the forefront, underlining it as more important than the curative traffic safety. A set of five guiding principles (Table 1) has been developed to achieve sustainably safe road traffic (Prestor, 2014, Wegman and Aarts, 2006)

Table 1. *Sustainable Safety principles (Wegman and Aarts, 2006)*

Sustainable Safety principle	Description
Functionality of roads	Monofunctionality of (through roads, distributor roads, or access roads) Hierarchically structured road network
Homogeneity of traffic load Homogeneity of speed Homogeneity of direction	Equality in speed, direction, and mass at medium and high speeds
Forgiving roadside	Injury limitation through a forgiving road environment and anticipation of road user behaviour
Predictability of road course and road user behaviour by a recognizable road design	Road environment and road user behaviour that support road user expectations through consistency and continuity in road design
State of awareness by the road user	Ability to assess one's task capability to handle the driving task

Road design that takes into account the concept of sustainable road safety through the above-mentioned five fundamental principles is demonstrated through two approaches: the concept of designing self-explaining and forgiving roads (Prestor, 2014).

It is necessary to emphasize the principle of functionality of roads, which is a prerequisite for a sustainable design of connecting, through roads, distributor roads as well as access roads, irrespective of the political-administrative division of the roads.

Forgiving roads are planned, designed and executed in such a way as to prevent traffic users' mistakes or lessen the severity of traffic accidents (Bekerias and Gaitanidou, 2011).

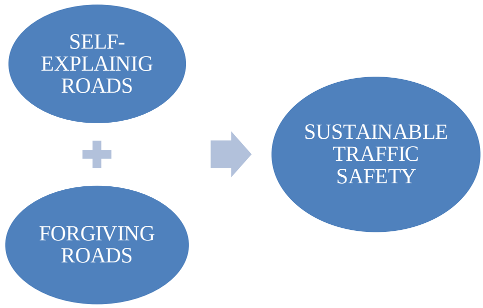


Figure 1. *Sustainable traffic safety (Prestor, 2014)*

2. THE CONCEPT OF SELF-EXPLAINING ROADS

The beginners of self-explaining roads are Theeuwes, J & Godthelp, H, who in 1992 published an article titled "Begrijpelijkheid van de weg", which means "understandable roads" in the Dutch language. The authors used an English term "self –explaining roads" because they believed that the term "understandable roads" would not appropriately describe complex mental processes (Theeuwes and Godthelp, 1992). The self–explaining roads concept has spread across the world (The Netherlands, Denmark, Germany, Great Britain, Australia, New Zealand...). Google research shows that already more than half a million web sites contains the term "self-explaining roads". By definition, the self-explaining roads are roads which only by their form induce traffic safe behaviour of all participants in traffic (EU PROJECT SPACE Del. 1, 2010, EU PROJECT SPACE Del. 4, 2011).

The characteristic terminology of self-explaining roads is categorisation, perception and expectation, road atmosphere, harmonised stanardisation, understandable road designing, readability, psychological traffic calming, consistency and feasibility (EU PROJECT SPACE Del. 4, 2011).

The key terms in the self-explaining roads concept are categorisation and perception and consequentially, the expectations of the traffic participants.

The goal of the self-explaining roads is the design of the road environment, which is aligned with expectations. An interaction between the appropriate drivers' expectation and the road environment constitutes traffic atmosphere, which is a condition for safe behaviour (Prestor, 2014).

The self-explaining roads connect the categorisation of road network and expectations of road users. The traffic environment shall induce the right expectation in the road users,regarding presence and behaviour of other participants in traffic, as well as regarding their own behaviour (Martens et al, 1997). In order to reach this goal, clearly separated categories of roads should be implemented, whereby each road category should clearly define a special behaviour of all participants in traffic.

Characteristic road categories system should meet the following conditions (EU PROJECT SPACE Del. 1, 2010):

- Each category should consist of unique road elements (homogeneous within one category and different from all other categories);
- Each category should require unique behaviour for a specific category (homogeneous within one category and different from all other categories);
- Unique behaviour displayed on roads should be linked to unique road elements;
- The layout of crossings, road sections, and curves should be linked uniquely with the particular road category;
- One should choose road categories that are behaviourally relevant;
- The same road category should connect the road section, which is psychologically interpreted as a whole;
- There should be no fast transitions going from one road category to the next;
- When there is a transition in road category, the change should be marked clearly;
- When teaching the different road categories, one should not only teach the name of, but also the behaviour required for, that type of road;
- Category-defining properties should be visible at night as well as in the day-time;
- The road design should reduce speed differences and differences in direction of movement;
- Road elements, marking, and signing should fulfil the standard visibility criteria;
- The traffic management systems should be clearly connected with special road categories.

The establishment of self-explaining road network (Figure 2) with the goal of reducing unintentional incidents must be accompanied with systematic and interdisciplinary measures concerning infrastructure and education of users (Prestor, 2014).

3. TOOLS FOR IMPROVING ROAD SAFETY OF SELF-EXPLAINING ROAD INFRASTRUCTURE AND TIMING OF APPLICATION

In this chapter an overview of the recommended tools for improving the safety of road infrastructure, including the timing of application, are presented.

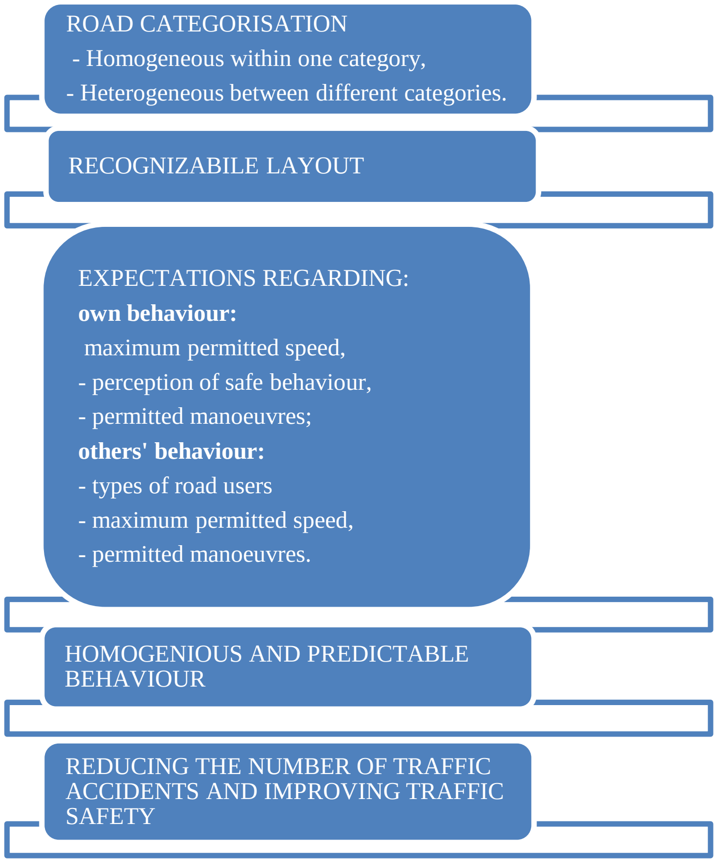


Figure 2. *Procedure for establishment of the self-explaining road network (Matena et al, 2006, SWOV 2007)*

Tools for improving road safety of self-explaining road infrastructure (EU PROJECT SPACE Del. 7, 2011):

- Road safety audits – RSA;
- Road safety inspections – RSI;
- Network screening;
- Accident prediction modelling – APM;

- Road protection scoring;
- Black spot safety management – BSM;
- Impact assessment of investments and road safety measures – RIA;
- Monitoring road user behaviour;
- Conflict studies and naturalistic driving studies;
- In-depth accident studies.

Timing of application of tools for road safety management:

The life cycle of the road can be divided into design and construction, opening to traffic in trial operation period and the initial stages of adjustment, normal operation, periodic inspection, maintenance and repair of equipment, remedying of defects and treatment of hazardous areas, general upgrading, reconstruction and renovation (EU PROJECT SPACE Del. 7, 2011).

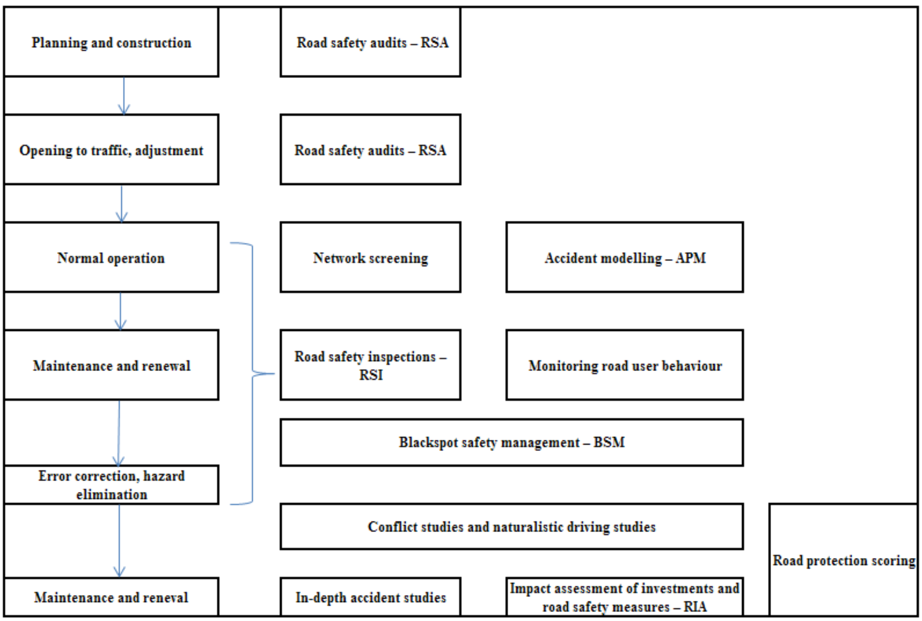


Figure 3. *The phases of the life cycle of the road and the use of each of the tools for traffic safety during the life cycle (EU PROJECT SPACE Del. 7, 2011)*

4. ANALYSIS OF THE EXISTING CATEGORISATION OF ROADS IN SLOVENIA

On the basis of an SER analysis (self-explaining roads) and the analysis of the existing road categorisation in the Republic of Slovenia, it was established that motorways and express ways have generally - more or less - been built according to SER principles. Motorways and express ways differ from other types of roads mainly in their distinctive road elements, characteristic behaviour and separate directions of travel, and as such fulfil the basic condition of homogeneity within one category and the condition of heterogeneity among different categories.

If we analyse the rest of the road network in Slovenia in accordance with SER principles, we can establish the following (Prestor, 2014):

- categories of national and local roads in the republic of Slovenia are not planned with typical road elements to provide homogeneity within an individual category and heterogeneity among different categories,
- for individual category of national and local roads no typical behaviour has been defined.,
- the typical behaviour of road users is not related to typical road elements,
- the regulation of crossroads, road crossings, road sections and road bends is undoubtedly related to the specific road category,
- the categorisation of the road network does not correspond to the behaviour of road users,
- the same road category only partly links road sections which are psychologically interpreted as one unit,
- there are no quick transitions between different road categories, transitions between road categories are often times crossings or road accesses,
- transitions between road categories are not clearly or distinctly marked,
- in giving notifications and information on different road categories, the rules on road safety behaviour for individual categories are not clearly presented in terms of specifying the road category’s denomination,
- road elements are also clearly visible at night;
- the road design and planning in itself prevents differences in speed and directions of traffic only on motorways and expressways,
- road elements, traffic equipment and traffic signalisation meet the criteria of applicable visibility standards,
- traffic control systems clearly related to individual road categories do not exist.

On the basis of the analysis, it was established that the basic rule of homogeneity within one category and heterogeneity among different categories is not taken into account in the design of the existing road network (exceptions being motorways and expressways) and that a system of credible speed limits according to road categories is also not established. It can be concluded that the national and local road network in the Republic of Slovenia is not categorised and regulated according to the SER principles of road planning.

Not taking into account the criterion of road categorisation by traffic functions, the administrative and political criterion of road categorisation causes traffic functions to be mixed leading to "grey (multifunctional) roads" and thus to a "vague (grey) road network in general" (Prestor, 2014).

5. PROPOSAL FOR INTRODUCING SER IN SLOVENIA

On the basis of the findings of the SER analysis of the national and local road network in the Republic of Slovenia, it was established that SER principles are violated in the majority of cases, since the principles are not implemented or taken into account.

Regarding the evaluated status of the road network in the Republic of Slovenia, where, the road network is in a poor or even very poor condition and, it needs to by systematically modernised/upgraded. Based on foreign practices, the improvement of the road network needs to pursue the following steps (Prestor, 2014):

- Road categories in the national and local road networks need to be re-classified (according to SER principles)
- The traffic mode of the entire road system needs to be prepared.
- The maximum travel time to the constructed motorway network for every location in the RS needs to be determined
- It is necessary to determine credible speed limits for individual road categories
- Typical cross-sections for every road category need to be determined on the basis of road safety
- The typical elements of road categories need to be determined
- A system for continuous notifications and information about road safety behaviour on individual road categories needs to be established
- It is necessary to categorise and standardise SER measures at crossings, bends, crossroads and road sections and SER measures in built-up areas

The basic purpose and meaning of SER measures follows the very definition of self-explaining roads. By definition, the self-explaining roads, forming self-explaining road network, are roads which only by their categorisation, perception and appropriate expectation induce traffic safe behaviour of all participants in traffic (EU PROJECT SPACE Del. 1, 2010, EU PROJECT SPACE Del. 4, 2011).

These are made up of smaller logically concluded self-explaining sections. In these sections standardized and categorized combinations of individual transport measures are carried out, which at the appropriate perception and the consequent expectation provides safe traffic behaviour in every micro location of the road network.

Standardized and categorized combinations of specific measures carried out in accordance with the complexity of traffic situations are called the self-explaining SER measures. SER measures on the existing road network represent rehabilitation or "retro" measures on "gray" roads and mainly affect the selection of an appropriate speed – concept of safe speed.

The basic idea of the concept of safe speed, in view of the possible types of conflicts at intersections of roads or sections, in order to prevent serious traffic accidents, to determine the maximum speed. One of the main objectives of the concept of safe speed is to avoid conflict situations of cyclists and pedestrians with motor vehicles driving faster than 30 km/h (EU PROJEKT ERASER, 2010).

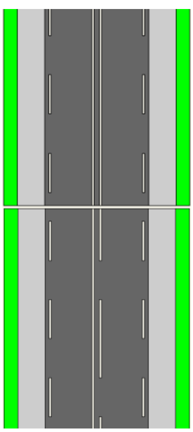
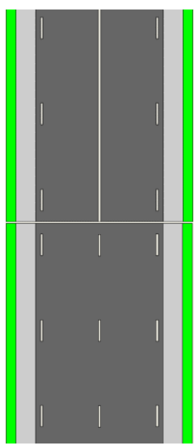
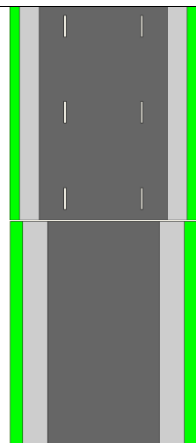
SER measures are implemented (EU PROJECT SPACE Del. 1, 2010):

- at road transitions- entrances to the built-up areas;
- SER measures at crossings – selection of an appropriate type of crossings;
- SER measures on straight sections - connections.

Marking of road sections in terms of SER, visual marking of widths of lanes that have the greatest impact on the selection of safe speed is especially important. The main characteristic elements of SER measures are alignment of the axis and longitudinal road markings (Table 2).

The travel scheme on the self-explaining road network in the Republic of Slovenia (Figure 4) shows the final destination of vehicles in the SER network. For example, vehicles travel from point A to point B on an access road with an administrative speed limit of 50 km/h. Vehicles from point B to point C travel on a distributor road with an administrative speed limit of 70 km/h. Vehicles travel from point C to point D on a through road with an administrative speed limit of 90 km/h. The total travel time on access, distributor and through road to the motorway network has to meet the criteria tp ≤ 45 min (Prestor, 2014).

Table 2. *The proposed combinations of longitudinal road markings for each category of roads (Prestor, 2014)*

Through roads:	Distributor roads:	Access roads:
		

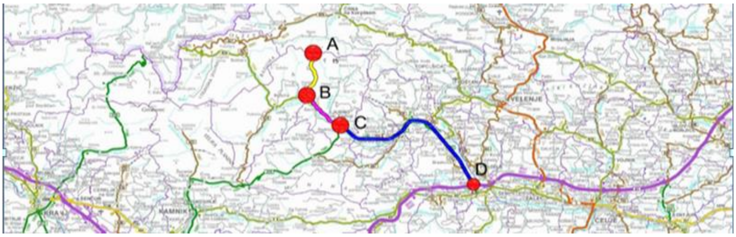


Figure 4. *Travel scheme on the foreseeable road network in the Republic of Slovenia*

6. CONCLUSION

The paper deals with modern approaches to road and road network planning. The concept of sustainable traffic safety and the concept of forgiving roads; the principles of the self-explaining roads are described in detail. The SER analysis of the road network in the Republic of Slovenia, including the proposal for the establishment of SER roads and SER road networks are given.

The final objective of the proposal for the establishment of the self-explainable road network is safe traffic flow, which, as well as road safety conditions, also establishes the conditions for more calm and smooth use of roads which is also beneficial in terms of environmental pollution as well as the traffic and economic criterion.

It is necessary to emphasize that the self-explaining road network is treated purely from the functionality criteria, regardless of the mode of road management. This means that the roads should be regulated equally by functions. The trough roads are thus functioning as region connections, they are designed for the highest level of service (high travelling speed), the distributor roads, functioning as distributors across regions are designed for lower level of service and access roads (medium travelling speed), functioning as access of traffic to the distributor roads are designed in accordance with the criterion of the lowest travelling speed.

Uniformity of road regulation according to function across the entire road network, mainly through consistent planning of distributor and access roads consequently improves road safety on local roads.

In addition to the consensus of experts, social and political agreement it is necessary to implement the concept of self-explaining roads, which significantly affects current road planning, management and usage.

In 2015, the Republic of Slovenia made the first step forward, as the SER principle of marking will be implemented in the Rules on traffic signs and equipment on public roads, which is of the basic rules for road planning apart from the Rules on road design one. Thus a good basis for the implementation of guidelines for the SER design and management of the road network has been made.

7. LITERATURE

[1] Bekerias E, & Gaitanidou E 2011, Towards forgiving in Self – Explanatory Roads, Centre for Research and Tecnology Hellas/Hellenic Institute of Transport (CERTH/HIT), Thessaloniki, Greece.

[2] EU PROJECT ERASER, Evaluation to Realise a commom Approach to Self – Explaining European Roads, SER and SER Approaches: State – of – the – art, *Report No. WP01-01*, junij 2010.

[3] EU PROJECT SPACE, Speed Adaption Control by Self-Explaining Roads, Deliverable Nr 1 – Self – Explaining Roads Literature Review and Treatment Information, 2010.

[4] EU PROJECT SPACE, Speed Adaption Control by Self – Explaining Roads, Deliverable Nr 4 – Consistent treatment in relation to the severity of a curve, a driving simulator study, 2011.

[5] EU PROJECT SPACE, Road Infrastructure Safety Management Evaluation Tools, Deliverable Nr 7 – Guidelines for development and application of Evaluation Tools for road infrastructure safety management in the EU, DECEMBER 2011.

[6] Matena, S, Weber, R, Louwerse, R, Drolenga, H, Vaneerdewegh, P & Pokorny, P et al. 2006, RiPCORD – iSEREST, Internal report D3.1: Road categorisation and design of self explaining roads, (EC Contract No.: 50 61 84, 6th Framework Programme). <http://ripcord.bast.de/pdf/RI-BASt-WP3-R1-Road_Categorisation_and_SER.pdf> [17.3.2010].

[7] Martens, M, Comte, S & Kaptein, N 1997, The effects of road design on speed behaviour: a literature review, TNO Report TM 97 B021, TNO Human Factors Research Institute, Soesterberg.

[8] Prestor, J., (2014). Predvidljive ceste, magistarski rad.

[9] SWOV 2007, SWOV Fact Sheet: Recognizable road design. <http://www.swov.nl/rapport/Factsheets/UK/FS_Recognizable_road_design.pdf> [12.6.2010].

[10] Theeuwes, J & Godthelp, H 1992, Begrijpelijkheid van de weg (Self-explaining roads), Report IZF 1992 C-8, TNO Institute for Perception, Soesterberg.

[11] Wegman, F, Aarts, L (red.) 2006, Advancing Sustainable Safety; National Road Safety Outlook for 2005–2020, SWOV, Leidschendam.

ROAD SAFETY
IN LOCAL COMMUNITIES

WE INVITE YOU TO

XII International Conference

ROAD SAFETY IN LOCAL COMMUNITY

APRIL, 2017

www.bslz.org

INVITED PAPER

USAGE OF SIMULATION MODELING FOR IMPROVEMENT OF SAFETY MANAGEMENT ON UNREGULATED PEDESTRIAN CROSSING

Irina Makarova[1], Rifat Khabibullin[2], Vadim Mavrin[3], Denis Davletshin[4], Danila Tikhonov [5]

Abstract: This paper presents the analysis of opportunities to increase road safety on unregulated pedestrian crossings. The field surveys of road traffic and pedestrian flow parameters have been executed. Parameters of road traffic and pedestrian flow have been defined, the simulation models have been developed and simulation experiments on the models have been executed. To increase road safety on unregulated pedestrian crossings, the measures have been developed which cause to decrease the probability of road accident.

Keywords: transport, safety, simulation modeling, traffic lights with button, road accident.

[1] Ph.D., Makarova Irina, Professor, Service of transport systems department, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, kamIVM@mail.ru.
[2] Ph.D., Khabibullin Rifat, Professor, head of Automobiles division, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, hrg_kampi@mail.ru.
[3] Ph.D., Associate professor, Service of transport systems department, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, vadim_mmite@rambler.ru.
[4] Davletshin Denis, M.Sc., Service of transport systems department, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, zloi.genii@mail.ru.
[5] Tikhonov Danila, M.Sc., Service of transport systems department, Kazan (Volga region) Federal University, pr. Syuyumbike, 10A, Naberezhnye Chelny, Russia, danggbit@mail.ru.

1. INTRODUCTION

One of the new Sustainable Development Goals (SDGs) targets phrased on the United Nations General Assembly in 2015 is to halve the global number of deaths and injuries from road traffic crashes by 2020 Countries that have successfully implemented these interventions have seen corresponding reductions in road traffic deaths[6]. The report "Global status report on road safety 2015" of World Health Organization shows that the plateau in road traffic deaths, set against a 4% increase in global population and 16% increase in motorization, suggests that road safety efforts over the past 3 years have saved lives [1].

Almost half of all deaths on the world's roads are among those with the least protection – motorcyclists (23%), pedestrians (22%) and cyclists (4%). Meanwhile the African Region has the highest proportion of pedestrian and cyclist deaths at 43% of all road traffic deaths, while these rates are relatively low in the South-East Asia Region (figure 1).

The report shows that insufficient attention has been paid to the needs of pedestrians, cyclists and motorcyclists, who together make up 49% of all global road traffic deaths.

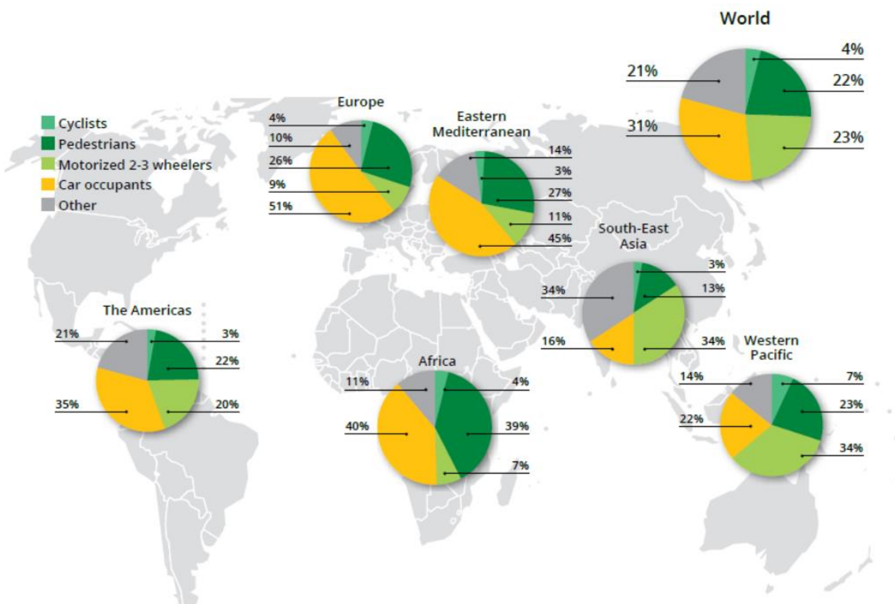


Figure 1. *Road traffic deaths by type of road users [1]*

The concept of transport development in Russia includes measures to both public transport development and ensuring safety of pedestrians, cycling and

[6]http://www.who.int/violence_injury_prevention/road_safety_status/2015/GSRRS2015_Summary_EN_final2.pdf?ua=1 11.01.2016).

routes traffic flow. In this case traffic light control is an important instrument of traffic management.

New centers of mass of people and microdistrics, reconfiguration of road network and public transport route network and motorization rate increasing cause of need changes in traffic patterns decision making. In such conditions to make science-based management decisions, simulation modeling must be used.

In view of the foregoing research and development of safety management practices in unregulated pedestrian crossings it is relevant and contributes to the improvement of road safety in General.

2. THE STATE OF THE QUESTION OF PEDESTRIAN SAFETY

2.1. Application features of light traffic control

To provide road safety the traffic lights are putted into places where road accidents are expected (crossroads, pedestrian crossings, etc.). Traffic lights have positive effects on traffic safety in the following cases:

- road accident density caused violation of the rules of journey of intersections if there are:
  - ✓ high traffic intensity or speed on major road,
  - ✓ the poor visibility,
  - ✓ low bandwidth of intersection,
- road accident density caused cars turning left at the intersection,
- road accident density caused pedestrians and cyclists crossing the road.

By using traffic lights control the capacity of both road network and intersections can be increased significantly. By correct setting of traffic light at intersections the quality of public transport and pedestrian movement and cycling. In many countries the traffic light with walking button are very popular. They allow both traffic flow does not stop in the case pedestrians don't cross the road and minimal waiting pedestrians for the green signal. The main advantage of traffic lights with buttons is pedestrians and drivers perceive situations on pedestrian crossing definitely. In this case response to the signal light as a primitive conditioned reflex replaces a difficult logical-physical problem. In addition, the driver sees from afar the signal of a traffic light, which is in gaze direction. So, a driver is not distracted on the road and brakes in advance. In addition, the driver sees from afar the signal of a traffic light, which is in gaze direction. So, a driver is not distracted on the road and brakes in advance. Also a traffic light with button doesn't increase the probability of road accident, because it stops the traffic only when pedestrians want to cross the road and press the button. Therefore if the road traffic density is high and pedestrian traffic density is low, the traffic lights with button allow both a pedestrian to cross the road safely and unreasonable stops of traffic flow not be caused. So, in the Europe there are many traffic lights with buttons and there are not unregulated pedestrian crossings across the busy multi-lane roads[7].

2.2. Research in the field of pedestrian safety

A safer all modes of transport issue is one of the most topical issues in many countries. The most problem is the sustainability of urban transport systems, because it is difficult to formalize many parameters of these systems, such as control of the interaction between pedestrian and traffic flows. According to statistics road accident victims are often pedestrians. Of particular concern is the fact that annually in the world 186 300 children were killed in road accidents[8].

Many studies in road safety are aimed at identifying the causes of this situation and finding ways to solve the problem. Because pedestrian deaths occur while crossing the road, the scientists explore the processes of interaction between vehicles and pedestrians.

To study the causes of violations of crossing the road, the scientists use survey. So, to survey the behaviour of pedestrian traffic, the authors of the paper (Sisiopiku, V.P., Akin, D, 2003:249) used surveys. The authors expected that the findings from this study will help traffic engineers, urban planners and policy makers understand pedestrian behaviors and attitudes at/towards pedestrian crosswalks.

As a rule, the behavior of children and adolescents is most dangerous. The authors have developed a special questionnaire and studied the behavior of Belgian school students (Sullman, M.J.M. et al, 2012:495). In most respects the results were similar to those found among New Zealand, English and Spanish adolescents, demonstrating the applicability of the scale to several different countries, cultures and languages.

The most important factors affecting the violation of the rules of crossing pedestrians are the pedestrian waiting time, the parameters of traffic and pedestrian flows and the type of traffic light (Brosseau, M. et al, 2013:159). The study (Stasi, L.L.D. et al, 2014:1) provides a characterization of pedestrian safety problems, with the emphasis on signalized crosswalks (i.e. traffic signal) design solutions. Another risk factor is the conflict of traffic and pedestrian flows when turning left (Alhajyaseen, W.K.M. et al, 2012:66, Quistberg, D.A. et al, 2015:99). The scientists in their work (Olszewski, P. Et al, 2015:83) note that almost 30% of pedestrian injury accidents took place at unsignalized zebra crosswalks. In order to show the effect of various factors on pedestrian fatality risk, a binary logic model with interaction terms was developed. The research was based on police accident database.

[7] http://massimoling.ru/2014/02/05/pochemu-knopochnyje-svetofory-luchshe-neregulirujemyh-perehodov/ 11.01.2016

[8] http://apps.who.int/iris/bitstream/10665 /162176 /3/WHO_NMH_NVI_15.3_rus.pdf 11.01.2016

To assess risks and to develop the measures to improve pedestrian safety, various decisions are proposed. So, the author of the paper (Li, B., 2013:17) proposes the model of assessment of waiting time influence on the number of pedestrians' violations of the rules of pedestrians' street-crossing. Thus the author notes that a multivariate approach is required, and a fruitful direction for future research would be to develop a multivariate modeling approach, on the basis of the developed model. In another paper (Li, B., 2014:18) author proposes method for multivariate risk analysis. The method consists of two hierarchically interconnected generalized linear models that characterize two different facets of the unsafe crossing behavior. The author uses Bayesian approach with the data augmentation method to draw statistical inference for the parameters associated with risk exposure.

Modeling is an important and reliable tool for assessing proposed solutions aimed at improving pedestrian safety. So, the authors of the paper (Alhajyaseen, W.K.M., Nakamura, H., 2010:35) propose a methodology for estimating the required crosswalk width at different pedestrian demand combinations and a pre-defined level of service. The methodology is based on theoretical modeling for total pedestrian platoon crossing time. Also the methodology is utilized to generate the fundamental diagrams of pedestrian flow at signalized crosswalks. To simulate the interaction between vehicles and pedestrians the authors of the paper (Chen, P. et al, 2016:68) use simulation model based on cellular automata. To determine the duration of pedestrian signal time the models of pedestrian movements with consideration of the bi-directional pedestrian flow effects are used (Lee, J.Y.S., Lam, W.H.K., 2008:1314).

3. RESULTS AND DISCUSSION

3.1. Research methodology

To analyze the situation on city roads and to optimize the management of the transport system of the city it is necessary to make field surveys of the most problematic sites of the road network. The field surveys consist in fixing a specific conditions and indicators of traffic actually occurring during a predetermined time period. The field surveys are the only way to obtain reliable information about the condition of the roads and allow an accurate characterization of existing traffic and pedestrian flows.

Currently in Russia the “Safe City” programme is implemented. This is the complex programme which must meet the basic safety requirements shown to modern city with the help of video surveillance, access control systems, the management system of housing and communal services, organizational activities.

In the "Transport safety" chapter of the programme[9] the targets for road safety are presented:

- logistics management of public and private transport;
- municipal parking organizing and management;
- modeling of traffic flows on the basis of the analysis of the predicted traffic situation;
- dynamic traffic situation prediction based on the incoming real-time data from video cameras, sensors, controllers of road traffic;
- geolocation and recording road events (accidents) with visualization on the city map.

Within the program until the end of 2016 1020 video cameras will be installed in Naberezhnye Chelny city. This will provide the possibility of both obtaining in real time the necessary information for making adequate managerial decisions and adjustment strategies for long-term development of the transport system (figure 2).

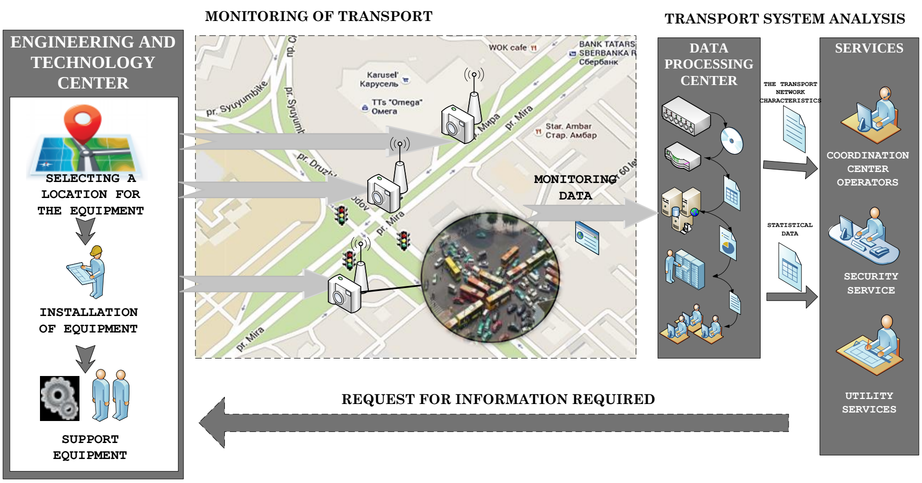


Figure 2. *Conceptual scheme of road traffic management*

The analysis revealed that place of high concentration of road accidents related to accidents with pedestrians and cyclists is a prospect "Chulman". The reason is that traffic flow density and speed are high and pedestrian light controlled crossing are absent. Withal, a significant part of the prospect borders on the places of permanent rest of the townspeople. Besides, in this part of the city there are schools, kindergartens, fitness centers.

To monitoring of traffic and pedestrian flows we have chosen three unregulated pedestrian crossing (Figure 3), located in the immediate vicinity of the sports facilities, schools, kindergartens.

[9] http://government.ru/media/files/OapBppc8jyA.pdf 11.01.2016

Figure 3. *Locations of unregulated pedestrians*

The field surveys revealed that traffic flow moves over speed (>60 km/h) along this prospect and don't miss pedestrians. As the result the cars hit pedestrian in a crosswalking.

The study was conducted using video cameras with subsequent computer image processing on weekdays during peak times according to the following schedule: 1) 07:00-10:00; 2) 17:00-20:00.

As a result of the research found that average speed of traffic flow is 50-65 km/h. When moving with the traffic flow, rate of braking distance is about 40 meters. Separating strip with green spaces throughout the prospect and low light restrict visibility for drivers. These factors are very dangerous for crossing pedestrians.

3.2. Results

The site simulation model was constructed for its more detailed analysis. The model takes into account geometry of road network site, traffic flow density, pedestrian movement intensity.

Input data for the model were the results of video surveillance (Table 1). After verification and validation of model optimizing experiment was made. This experiment allowed to define the parameters of traffic and pedestrian flows at normal and peak loads.

Table 1. *Input data for the model*

Fixing time	Number of pedestrians	Number of cases stopping traffic	Average speed of traffic (km/h)	Flow rate (number of vehicles in the reporting period)
Morning time				
7:40	23	17	52	162
7:50	16	15	49	175
8:00	19	16	50	158
8:10	19	17	52	165
8:20	14	13	52	145
8:30	8	5	48	155
8:40	5	5	56	134
8:50	23	3	51	150
9:00	27	5	58	134
Evening time				
13:30	21	15	55	130
13:40	16	10	58	151
13:50	12	11	58	153
14:00	15	9	54	161
14:10	14	10	55	131
14:20	9	8	55	129
14:30	16	11	57	136
14:40	13	14	57	147

We have offered the following hypothesis: installation of a traffic light with a button will reduce the risk of pedestrian accidents, at the same time not significantly affect the speed of traffic on this site.

In non-steady flow of pedestrians, most of which are children, this solution will reduce the influence of the conditions of behavioral factors on safety of crossing the roadway. At the same time traffic light control of crossing will increase the driver distraction and will affect slightly on average values of parameters of traffic flow.

To check the hypothesis modification of the model with the use of traffic lights control has been made (figure 4).

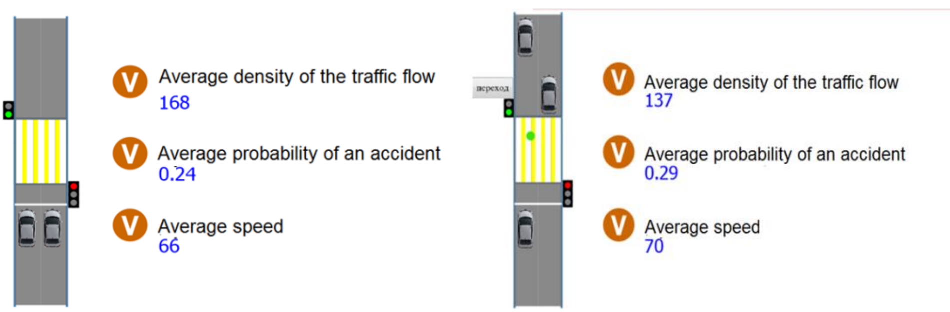


Figure 4. *View the model considered site (after the modification)*

Optimization experiment on the model is based on the metaheuristic. This experiment determined convenient traffic light control which allowed to increase pedestrian safety and to decrease traffic flow density.

4. CONCLUSION

The results of the experiment show that installation of a traffic light with a button increases average density of the traffic flow at 13%, reduces the average speed of the traffic flow at 1.4%. In this case the probability of an accident is reduced by 57% on the site of road.

Thus the simulation modeling can be a good tool for making management decisions for improving the safety of crossings pedestrians. The choice of optimal spans of traffic signal will reduce the probability of accidents with pedestrians, at the same time will affect slightly on values of parameters of traffic flow. The quality of decisions will depend on the quality of the input information and will increase after implementation of the “Safe city” programme.

5. LITERATURE

[1] Global status report on road safety 2015. URL: http://www.who.int/violence_injury_prevention/road_safety_status/2015/GSRRS2015_Summary_EN_final2.pdf?ua=1

[2] Почему кнопочные светофоры лучше нерегулируемых пешеходов. (2014). URL: http://massimoling.ru/2014/02/05/pochemu-knopochnyje-svetofory-luchshe-neregulirujemyh-perehodov/

[3] Десять стратегий обеспечения безопасности дорожного движения для детей. URL: http://apps.who.int/iris/bitstream/10665/162176/3/WHO_NMH_NVI_15.3_rus.pdf

[4] Sisiopiku, V.P., Akin, D. (2003). Pedestrian behaviors at and perceptions towards various pedestrian facilities: an examination based on observation and survey data. Transportation Research, F6, 249–274.

[5] Lipovac, K., Vujanic, M., Maric, B., Nesic, M. (2013). The influence of a pedestrian countdown display on pedestrian behavior at signalized pedestrian crossings. Transportation Research, F20, 121–134

[6] Sullman, M.J.M., Thomas, A., Stephens, A.N. (2012). The road user behaviour of school students in Belgium. Accident Analysis and Prevention, 48, 495 - 504.

[7] Brosseau, M., Zangenehpour, S., Saunier, N., Miranda-Moreno, L. (2013). The impact of waiting time and other factors on dangerous pedestrian crossings and violations at signalized intersections: A case study in Montreal. Transportation Research, F21, 159 - 172

[8] Stasi, L.L.D., Megías, A., Cándido, A., Maldonado, A., Catena, A. (2014). The Influence of Traffic Signal Solutions on Self-Reported Road-Crossing Behavior. Spanish Journal of Psychology, 17, e103, 1-7.

[9] Alhajyaseen, W.K.M., Asano, M., Nakamura, H. (2012). Estimation of left-turning vehicle maneuvers for the assessment of pedestrian safety at intersections. IATSS Research, 36, 66-74

[10] Quistberg, D.A., Howard, E.J., Ebel, B.E., Moudon, A.V., Saelens, B.E., Hurvitz, P,M., Curtin, J.E., Rivara, F.P. (2015). Multilevel models for evaluating the risk of pedestrian–motor vehicle collisions at intersections and mid-blocks. Accident Analysis & Prevention, 84, 99-111.

[11] Olszewski, P., Szagała, P., Wola´nski, M., Zieli´nska, A. (2015). Pedestrian fatality risk in accidents at unsignalized zebra crosswalks in Poland. Accident Analysis and Prevention, 84, 83-91

[12] Li, B. (2013). A model of pedestrians’ intended waiting times for street crossings at signalized intersections. Transportation Research, B51, 17-28.

[13] Li, B. (2014). A bilevel model for multivariate risk analysis of pedestrians’ crossing behavior at signalized intersections. Transportation Research, B65, 18-30.

[14] Alhajyaseen, W.K.M., Nakamura, H. (2010). Quality of pedestrian flow and crosswalk width at signalized intersections. IATSS Research, 34, 35-41.

[15] Chen, P., Wu, C., Zhu, S. (2016). Interaction between vehicles and pedestrians at uncontrolled mid-block crosswalks. Safety Science, 82, 68-76.

[16] Lee, J.Y.S., Lam, W.H.K. (2008). Simulating pedestrian movements at signalized crosswalks in Hong Kong. Transportation Research, A42, 1314-1325.

[17] Концепция построения и развития аппаратно-программного комплекса "Безопасный город". URL: http://government.ru/media/files/OapBppc8jyA.pdf

11th International Conference
"Road Safety in Local Community"
Serbia, Vrnjacka Banja, Hotel Zvezda,
April 13 – 16, 2016

INVITED PAPER

METHODOLOGY FOR BENCHMARKING ROAD SAFETY AT THE LOCAL LEVEL

Dragoslav Kukic[1], Miroslav Rosic[2], Milan Bozovic[3], Andrijana Pesic[4], Jovica Vasiljevic[5], Darko Petrovic[6]

Abstract: Having in mind the significance and potential of local communities in improving road safety, financing of road safety as defined by law and obligation of the Road Traffic Safety Agency of the Republic of Serbia to cooperate with road safety coordination bodies in local communities, the Road Traffic Safety

---

[1] Ph.D., Kukic Dragoslav, Road Safety Sector of AMSS-Motor Vehicles Center LLC, Belgrade, Serbia kukicdragoslav@cmv.rs
[2] Rosic Miroslav, M.Sc., Database Eng., Road Traffic Safety Agency, 2, Bulevar Mihajla Pupina, Belgrade, Serbia, miroslav.rosic@abs.gov.rs
[3] Bozovic Milan, B.Sc., Acting director, Road Traffic Safety Agency, 2, Bulevar Mihajla Pupina, Belgrade, Serbia, bozovicmilan@yahoo.com
[4] Pesic Andrijana, B.Sc., Head of Department, Road Traffic Safety Agency, 2, Bulevar Mihajla Pupina, Belgrade, Serbia, andrijana.pesic@ abs.gov.rs
[5] Ph.D., Vasiljevic Jovica, Head of Sector, Road Traffic Safety Agency, Doctor of technical sciences, 2, Bulevar Mihajla Pupina, Belgrade, Serbia, jovica.vasiljevic@abs.gov.rs
[6] Petrovic Darko, M.Sc., Road Safety Sector of AMSS-Motor Vehicles Center LLC, Belgrade, Serbia, darko.petrovic@ abs.gov.rs
[7] This implies the part of funds that stays in local self-governments and is intended for financing road safety activities at the local level, in compliance with the Road Safety Law.
[8] The project was implemented by the Academy of Criminal and Police Studies from Belgrade, for the purposes of the Road Traffic Safety Agency.

Agency carried out at the end of 2015 a pilot project „Benchmarking road safety at the local level and establishing a road safety system in local communities". The project included 11 local communities – municipalities and cities in the territory of the Republic of Serbia. Methodology for benchmarking road safety in local communities has been developed and implemented within the project framework and includes practical work with local road safety coordination bodies in selected municipalities and cities. Apart from evaluating activities and work of local road safety coordination bodies, identifying key institutions and organizations in municipalities and cities and evaluating their functioning within the road safety system, this methodology also included the analysis of the road safety situation, data based management and improvement of coordination among road safety stakeholders at the local level. The paper describes the methodology applied in the implementation of the pilot project, fully respecting foreign and domestic practices in the field of road safety benchmarking.

Keywords: benchmarking, local communities, methodology, rating, best practice

1. INTRODUCTION

Benchmarking (a comparison standard) is actually a strategic management technique, a new concept applied in road safety with the aim to improve the functioning of a road safety system or the parts thereof. This is the process of intermittent measuring of own performance in relation to the best practice set in a given system or system element (Kukic, D. 2014). In road safety, benchmarking may speed up the process of learning, building and taking over best practices. Such an approach should contribute to a stable improvement of road safety, with due consideration of best practical experiences (Pesic et al., 2013).

In 2015, the Road Traffic Safety Agency carried out the second iteration of the process of establishing benchmarking in local communities, in the field of road safety, with the aim of establishing a long lasting process of evaluation of system efficiency at the local level. Benchmarking process has not only helped make the evaluation of work of local communities, but each local community will have, as the final deliverable, the guidelines for further work and improvement of their own road safety system, based on examples of the so called "best practices".

1.1. Description and objective of the project

The pilot project *„Benchmarking road safety at the local level and establishing a road safety system in local communities"* was carried out by the Road Traffic Safety Agency. The project represents the continuation of activities which aimed at introducing monitoring and evaluation of operation of road safety systems in local communities of the Republic of Serbia. The project was initiated in 2014, with the implementation of the project called *„Method of benchmarking road safety institutions in local communities in the Republic of Serbia, strategic importance and potential”*. Local road safety bodies have the most significant role in the road safety system of local communities. Therefore, the project concept has been prepared so as to have the greatest part of activities focused on strengthening the role and activities of local road safety bodies.

The objective of the pilot project is establishing, i.e. strengthening the road safety system in local communities by introducing the system of benchmarking at the local level. Also, the objective is promotion of benchmarking as a tool applied in road safety and comprehension of the benefits of its practical use.

1.2. Scope and time of research

The study included eleven (11) local communities in the Republic of Serbia out of which eight (8) have the status of a city, while 3 (three) local communities are municipality by status. The following cities participated in the study: Valjevo, Zrenjanin, Kraljevo, Krusevac, Loznica, Sremska Mitrovica, Cacak and Sabac, while municipalities included: Bogatic, Kovin and Ub. The study was carried out in the last quarter of 2015.

The selection of local communities included in the project depended on the size of casualty risk of vulnerable road users, primarily of pedestrians, bicyclists, motorized two-wheelers, children and young population. All the local communities from the project have a high or very high value of casualty risk, for at least one vulnerable road user group (ABS, 2015).

Second selection criterion was the size of the local community, particularly in relation to the number of population and the number of registered motor vehicles. That is why the cities between 79.000 and 130.000 population, with the number of registered motor vehicles between 22.000 and 37.000 have been included in the survey. The reasons for involving the cities of such size can be found in the compact nature of the group of selected local communities and the good specimen of the state territory. Likewise, local communities – cities of such size may be expected to have a big influence on achieving improved state of road safety. All selected cities are located along important road directions with considerable vehicles flows, and the number of fatalities and seriously injured on the territory of selected cities makes 15% to 20% of the total number of fatalities and seriously injured at the State level. Also, the fact is that all selected cities have a stable source of road safety funding, with expected funds incurring from settled fines for traffic offences, which amount to not less than 15.000.000 RSD annually[7]. This is certainly one of prerequisites for a good organization and functioning of a road safety system.

Apart from the cities, smaller local communities have been also included in the project. They have the status of a municipality, with the number of population ranging from 28.000 and 34.000, and the number of registered motor vehicles between 7.000 and 8.500 vehicles per year.

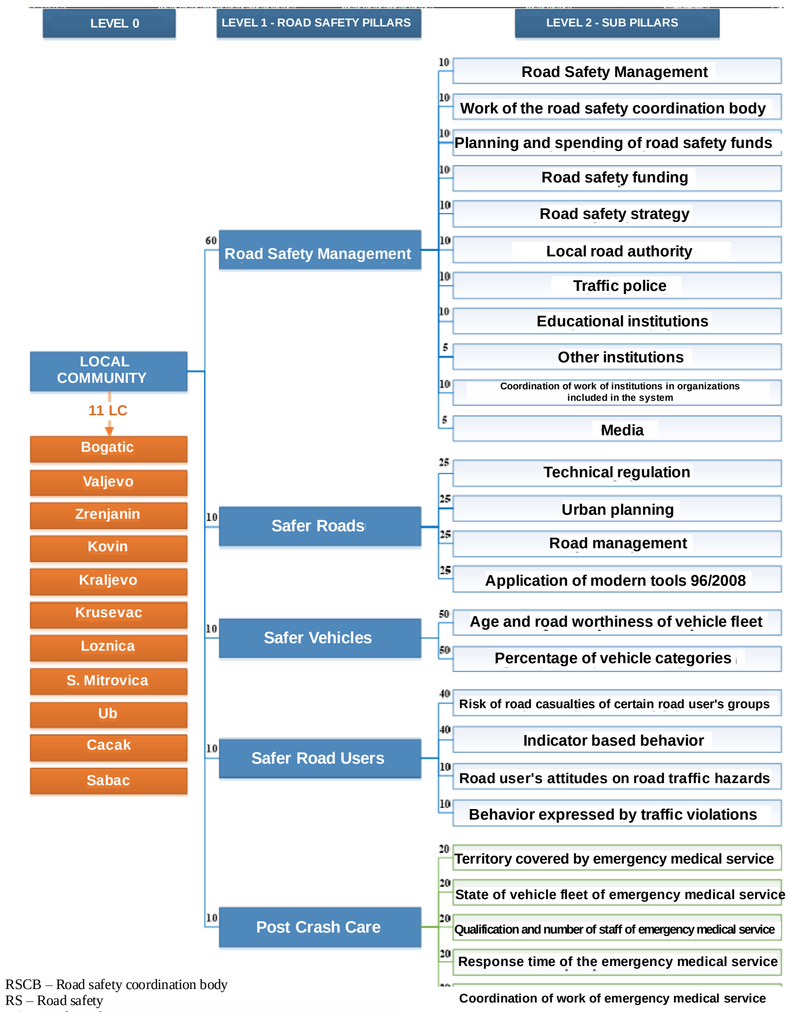
1.3. Review of selected literature

Having reviewed and analyzed the selected literature, it can be concluded that the academic and professional circles made most of the progress in theoretical approach and techniques of benchmarking the institutions, while the practical part is still looking for the best solutions and practices. Likewise, it can be concluded that each assessment and comparison, aggregation into a certain index (rating) is basically benchmarking. In their paper called “Road Safety Benchmarking”, Hermans et al. (2009) have used road safety indicators from six various groups, as well as the number of road accidents and the number of casualties for benchmarking 21 EU countries. Consolidation of various indicators has been made using the mathematical tool called DEA (Data Envelopment Analysis). This methodology is also used to identify the problems and define the objectives. For poorly performing countries, Hermans et al. (2009) have determined the so called “benchmark” State which is allocated to the poorly performing one, as the country that should be followed in terms of performance.

By publishing the paper *Benchmarking road safety performances of countries,* the first step has been made in establishing standard procedures for comparison of EU countries in terms of activities these countries carried out in the field of road safety (Wegman and Oppe, 2010). The paper called *Designing a composite road safety indicator* appeared in the same year (2010), published by Gitelman et al., 2010. This paper analyzed four basic groups of indicators: road safety policy performance (road safety programs), final road safety outcomes (fatality rates, volume of road casualties), road safety indicators (seat belt wearing rate, age of fleet, drink-driving, etc.) and benchmarking of state features (motorization rate, density of population, etc.).

Within the framework of the Research and Innovation Program “Horizon 2020” the European Traffic Safety Council – *ETSC* (2013) has recognized the significance of benchmarking as an approach with the key role in monitoring and achieving related goals, as well as in identifying road safety issues. The project *„Method of benchmarking road safety institutions in local communities in the Republic of Serbia, strategic importance and potential”* (ABS, 2014)[8] has helped define the initial benchmarking methodology focusing on the work of the local road safety coordination bodies (hereinafter referred to as RSCB). The initial project has recognized 29 various indicators, divided into four groups of indicators: quantitative, qualitative, competence and motivation wise and finally RSCB efficiency reduction indicators. All the indicators proposed by the methodology are expressed in percentages, where the values of particular indicators can only have a maximum or minimum value (the so called yes/no indicators having the values of 0% or 100%). Certain nominated indicators take into account the overall work of the council (review of the previous period) in order to obtain concrete values. The project also describes the way in which the value of each individual indicator has been precisely determined.

2. ROAD SAFETY PILLARS AND BENCHMARKING



RSCB – Road safety coordination body
RS – Road safety
RA – Road accident
EMS- Emergency medical service
(5, 10, 20, 25, 40, 60) – values of weights assigned to benchmarking indicators

Figure 1. *Benchmarking in selected local communities per road safety pillars and defined indicators per each pillar*

Road safety pillars from the document *Global Plan for the Decade of Action for Road Safety 2011-2020* (WHO, 2010), served as a basic concept for assessing local communities in the field of benchmarking.

The concept of five pillars: (1) Road safety management, (2) Safer roads and mobility, (3) Safer vehicles, (4) Safer road users and (5) Post crash care, has been adopted in the national Road Safety Strategy of the Republic of Serbia, for the period 2015-2020. Main guidelines for action, as well as basic road safety issues have been defined on the basis of this concept. Sub-activities and final deliverables that must be implemented within the Strategy have been also defined for each of these five pillars. The weights – coefficients for the pillars (5 pillars), sub-pillars (21 sub-pillars) and indicators (108 indicators) have been defined within the sub-pillars group. These coefficients have been assigned to the ratings given by experts, depending on the significance and importance of sub-pillar and pillar indicators.

3. IMPLEMENTED METHODOLOGY

The methodology has been so devised to achieve benchmarking at the local level through direct work with local communities – municipalities and cities.

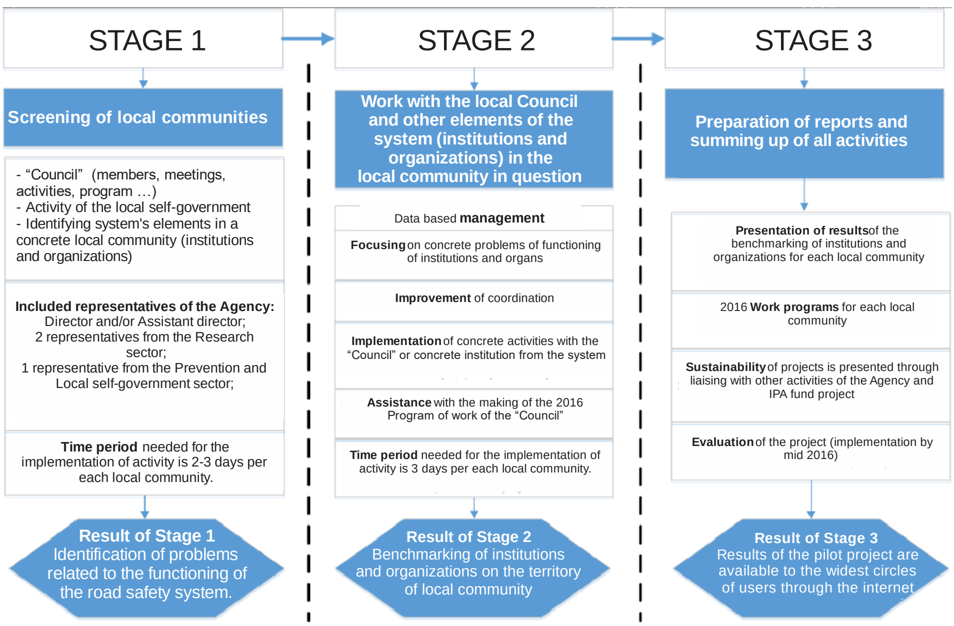


Figure 2. *The plan and phases of the pilot project implementation*

Direct work is done by the **independent team of professionals** whose task is to work directly with the most important road safety stakeholders at the local level in order to provide an independent professional assessment of operation of the road safety system in the territory of a municipality or city. The task of the team of professionals is not only benchmarking, i.e. assessing activities and stakeholders, but also urging local bodies to take action, assisting and supporting them in setting up a road safety system.

Direct work with local communities in the "Benchmarking" project should be planned in three stages (Figure 1). **Stage 1** is called „Screening of local communities" where it is necessary to plan a meeting with the political leader in the local community itself and participation at the meeting of the local road safety body. Participation at planned council's meetings gives the best insight into the council's work, its functioning, management, composition, division of tasks, topics on council's agenda, etc. Joint meeting should serve to review the activities and recognize potential problems the local road safety body is facing. Particular activitiy at the joint session should be the presentation of the project, undertaking obligations by the local road safety body – council and all the members thereof, but also the presentation of obligations of the team of experts, with the aim of implementing the benchmarking in the best possible way, in the local community in question.

Stage 2 is carried out most often 7 to 10 days after the Stage 1 has been completed, i.e. after the first visit to the local community. Stage 2 understands direct and concrete work within the local road safety body, as well as the visit to selected institutions and organizations at the local level. In fact, the members of the professional team of the Agency „become" the members of the local road safety body during Stage 2. The aim is to work directly with local communities and achieve as much as possible, primarily in terms of increasing the quality of work of the local road safety body. In that context, it is very important for the team of professionals to „win" their position in writing work programs and plans related to allocating funds from paid traffic fines which are intended for road safety funding at the local level. Identifying problems at the local level is an important precondition for the quality selection of activities that need to be funded. Therefore, it will be desirable that the professional team presents officially during Stage 2 of working with local communities a detailed analysis of the road safety situation in local communities.

Stage 3 – the final stage of the pilot project understands the presentation of results in each local community involved in the Project.

3.1. Mathematical benchmarking model

Benchmarking the work of local communities is done on the basis of specially identified system performance indicators. Values of road safety indicators are entered by the experts, at least three experts per each local community, except for the values of indicators refering to Safer road users, Safer vehicles and Post crash care. Special mathematical methods have been developed for the mentioned indicators, while data hve been collected through other projects of the Road Traffic Safety Agency (indicators, attitudes, analysis of a road safety situation, etc.). Each performance indicator is assigned an appropriate weighting factor. Values of weighting factors, likewise indicators, are expressed on the scale from 0 to 100, where the sum of all values of the weighting factors within a group of indicators (indicators with the same superior indicator at a higher hierarchical level) must be equal to the number of 100. Higher value of a weighting factor means a higher significance of the indicator. Thus, the indicator with the weighting factor of 40 assigned beside an indicator with the weighting factor of 20 is two times more significant. Values of road safety indicators are determined by means of a professional method.

Indicators belonging to the same group can be put together in a rating at the higher hierarchical level, according to the expression:

$$Rating = \sum_{i=1}^{n} \frac{w_i \cdot x_i}{100}$$

Where:

w_i – value of weighting factor for i indicator
x_i – value of i indicator
n – number of indicators belonging to the same superior indicator (at the higher hierarchical level).

The rating of indicator value (at any hierarchical level, except at the last one whereon the rating is given by the experts) is obtained as a sum of products of weighting coefficients and values of indicators at the lower hierarchical level (mutually linked with the rated indicators), divided by 100.

Presented model uses a single mathematical tool very similar to the well known method of the multi-criterion decision making - *Simple Additive Weight (SAW)*. Comparison of local communities can be made at each hierarchical level, starting from the zero level where the consolidated rating (final value) of benchmarking per each indicator or per any indicator is in each hierarchical level. This makes simple the identification of shortcomings present in the work of institutions in local communities.

4. CONCLUSION

The main difference in the current system of benchmarking at the local level can be recognized in the way that the data required for quality assessment of the system and identification of problems are collected in direct work with local road safety bodies, institutions and organizations at the local level, contrary to the survey into how the road safety system operates.

Advantages of such an approach can be seen in a more reliable method of data collection, as well as in better understanding of how the system and its elements as a whole functions. Essentially, the benchmarking rating at the local level which is obtained on the basis of direct work with local communities is the closest to the real state that exists in a particular municipality or city. The state is estimated by professionals who practically come from outside the municipality or city and who observe road safety issues and activities primarily from the professional level, without any burden of political circumstances within the local self-government.

The methodology uses a simple mathematical tool, consisting of mathematical operations of multiplication and addition, without the need for specialized software packages. It allows for the prioritization of each indicator separately, at each level and provides a "sufficiently accurate" result for comparison of local communities. The methodology also allows for identification of "weak points" in the system to be worked on and allows for a definition of objectives, which can also be expressed on a scale from 0 to 100. The list of benchmarking indicators can serve to each professional as a unique "check list" indicating precisely which aspects need to be addressed when it comes to work of road safety institutions in local communities. It is possible to use the methodology to integrate the multitude of diverse indicators into a single index, and the index value of an indicator can be created at any hierarchical level.

Disadvantages of this approach include the necessity of training the professional team at an extremely high level, which in addition to professional knowledge, needs to have a legitimate function, especially from the point of view of direct meetings with mayors and presidents of municipalities, which is not always easy to arrange for. Meetings at the local level are detailed and complex, and in this context, it is much easier to collect data on the basis of a survey. Without any political support from the mayor or municipality president, professionals involved in the project will encounter additional difficulties in trying to exercise authority at the meetings with local road safety bodies and leading road safety institutions and organizations, at the local level.

The pilot project should primarily serve as a good basis for further practical field work, and the work focused on strengthening the road safety system in local communities. Applying benchmarking tools is not just giving ratings, but assisting and supporting local communities to more easily and qualitatively overcome the road safety issues they are facing in their work, where the role of the Agency as a national body must be of crucial importance.

5. LITERATURE

[1] Агенција за безбедност саобраћаја, Криминалистичко полицијска академија (2014). Метод бенчмаркинга (Benchmarking) институција безбедности саобраћаја у локалним самоуправама у Републици Србији, стратешки значај и потенцијал.

[2] Агенција за безбедност саобраћаја (2015). Бенчмаркинг безбедности саобраћаја на локалном нивоу и успостављање система безбедности саобраћаја у локалним самоуправама.

[3] Агенција за безбедност саобраћаја (2015). Јединствена база података о обележјима безбедности саобраћја. http://serbia.gdi.net/azbs/

[4] European Transport Safety Council – ETSC (2013). Regulation Establishing Horizon 2020. The Framework Programme for Research and Inovation (2014-2020).

[5] Gitelman, V., Doveh, E., Hakkert, S. (2010). Designing a composite indicator for road safety, Safety Science 48(9), p.212-1224.

[6] Hermans, E. et al. (2009). Benchmarking road safety – Lessons to learn from a data envelopment analysis. Accident analysis and prevention 41, p.174-182.

[7] Кукић, Д. (2014). Модел квантификације ризика страдања у саобраћају, Докторска дисертација, Саобраћајни факултет, Универзитет у Београду.

[8] Пешић, Д. (2012). Развој и унапређење метода за мерење нивоа безбедности саобраћаја на подручју, Докторска дисертација, Саобраћајни факултет, Универзитет у Београду.

[9] Стратегија безбедности саобраћаја на путевима Републике Србије, (2015). Службени гласник Републике Србије бр. 65/15.

[10] Закон о безбедности саобраћаја на путевима (ЗБС), (2009). Службени гласник Републике Србије бр. 41/09, 53/10, 101/11.

[11] Wegman, F., Oppe, S. (2010). Benchmarking road safety performances of countries, Safety Science 48(9), p.1203-1212.

[12] World Health Organization (WHO), (2010). Global Plan for the Decade of Action for Road Safety 2011-2020. Доступно на: http://www.who.int/entity/roadsafety/decade_of_ action/plan/plan_english.pdf?ua=1. Посећено: 20.1.2016.

INVITED PAPER

MOBILE APPLICATIONS AS A ROAD USER ASSISTANT IN A SAFER TRAFFIC MOVEMENT

Ile Cvetanovski [1], Vaska Atanasova [2], Verica Dančevska [3], Cvetanovska Cvetanka [4]

Abstract: Consumer adoption of mobile devices has skyrocketed, changing the way people behave in many environments, including on city streets. Much of the emphasis of governments, advocacy organizations, researchers and technologists concerned with the safety implications of mobile device use in traffic has rightly focused on the behavior of drivers, pedestrians and, in particular, the dangers of texting while driving. This paper outlines the impact of vehicle-pedestrian crashes, provides a synopsis of the city's approach to traffic safety, examines research on hazards of mobile device use by distracted pedestrians, and reviews technologies leveraging smart phones and wireless networks that aim to empower pedestrians and reduce driver distraction.

Keywords: mobile applications, traffic safety, safe movement, road users.

1 Ph.D., Cvetanovski Ile, University ,,Sv. Kliment Ohridski,, in Bitola, Faculty of Technical Sciences Department of Traffic and Transport – Bitola, Macedonija, ile.cvetanovski@tfb.uklo.edu.mk
2 Ph.D., Atanasova Vaska, University ,,Sv. Kliment Ohridski,, in Bitola, Faculty of Technical Sciences Department of Traffic and Transport – Bitola, Macedonija, vaska.atanasova@tfb.uklo.edu.mk
3 Ph.D., Dančevska Verica, University ,,Sv. Kliment Ohridski,, in Bitola, Faculty of Technical Sciences Department of Traffic and Transport – Bitola, Macedonija, verica.dancevska@tfb.uklo.edu.mk
4 Cvetanka Cvetanovska, Postgrad. Student, University ,,Sv. Kliment Ohridski,, in Bitola, Faculty of Technical Sciences Department of Traffic and Transport – Bitola, Macedonija, ccvetanovska@yahoo.com

1. INTRODUCTION

Safety experts are increasingly concerned about the risk associated with distraction while walking. What are people so captivated by: responding to or sending text messages, talking on cell phones, or using some type of mobile device with headphones to listen to music while walking and driving? Preoccupied and distracted pedestrians and drivers have become common on busy city streets.. The result can be injury or death.

Pedestrians, much like drivers, have always multi-tasked by doing things such as snacking or reading on the move. Researchers are trying to determine what makes distracted walking with mobile devices so different from other types of multitasking. A study conducted at Western Washington University in Bellingham, Washington notes that talking on a cell phone takes a toll on cognition and awareness.

The research dealt with a related aspect of mobile phone use and safety: pedestrian distraction associated with mobile phone conversation. It is not clear that walking safety will be similarly affected by phone conversation distraction, since walking represents more of a natural human behavior than driving. Although driving often becomes routine, perhaps the extra effort required to manage an automobile makes drivers more vulnerable to distracted attention. Most such crashes occur when the pedestrian crosses the street (daSilva et al., 2003), and many seem to result from pedestrian inattentiveness (Bungum et al., 2005). Thus, for pedestrians using mobile phones, distracted attention may increase their risk of accidents.

The intuition that talking while walking across a road is dangerous is backed up by a large set of recent studies. A research trend is focusing on the influence of mobile phones on pedestrian safety because of the wide usage of phones as people move around during daily life. One early study on pedestrians crossing streets shows that mobile phone users exhibited more unsafe behavior than other pedestrians: that is, distracted walkers adopt less cautionary behavior (e.g., looking left and right, waiting for a walk signal) before crossing streets in comparison to non-distracted pedestrians [8, 10]. Experiments in a controlled virtual reality environment also reveal that when conversing on the phone pedestrians are less likely to recognize safe opportunities to cross the road.

1.1. Safety and distracted attention among drivers and pedestrians

It is not clear that walking safety will be similarly affected by phone conversation distraction, since walking represents more of a natural human behavior than driving. Although driving often becomes routine, perhaps the extra effort required to manage an automobile makes drivers more vulnerable to distracted attention. On the other hand, crossing a street also requires cognitive attention and pedestrians, which are shown from the latest statistics.

In 2013, 4,735 people were killed in pedestrian/motor vehicle crashes, more than 12 people every day of the year. (NHTSA Traffic Safety Facts). Most such crashes occur when the pedestrian crosses the street and many seem to result from pedestrian inattentiveness. Thus, for pedestrians using mobile phones, distracted attention may increase their risk of accidents. We conducted two studies related to this, one addressing distracted attention and the other addressing pedestrian street-crossing behavior.

Of 127 pedestrians, the observers observed 19.0% using a mobile phone, 24.2% using an i-pod, and 55.9% not using either one. Although most observations (52%) took place with a car approaching, observations also involved no car (24.4%) or a stopped car (23.6%). (Elsevier, Mobile phones, distracted attention and pedestrian safety).

The observations revealed no bumping, but a substantial number of pedestrians crossing when a car approached. Across all vehicle conditions, most pedestrians walked (60.6%), while fewer stopped (26.0%) or hesitated (39.4%). The highest percentage of pedestrians walked with no car present, followed by those who walked with an approaching car and those who walked with a stopped car. For no car, significantly higher percentage of i-pod users stopped than either of the other groups.

1.2. From life-taking to life-saving

Another study highlights cell phone history. It found that in the late 1980’s, cell phones caused a “life-taking effect” among pedestrians, and vehicle occupants. The authors found that fatalities increased even though there were fewer than a million phones, primarily because there were not enough cell phones in use to make a difference in summoning help following an accident. The “life-saving effect” occurred as the volume of phone use increased in the early 1990’s. People with cell phones were able to call 911 following accidents which resulted in improved medical response and a drop in fatalities. However, according to the study, the “life-saving effect” has been canceled out by the fact that once the number of cell phones reached about 100 million, the “life-taking effect” of increased accidents and fatalities outweighed the benefits of quick access to 911 services. Several methods should be considered when assessing how to reduce the injuries associated with distracted walking, including legislation, additional research, gathering additional statistics, and public education.

Cell phone usage and texting while driving and walking have been a concern for several years.. Several states have passed laws making the use of a cell phone illegal while operating vehicles and crossing the roads. “Handsfree” devices have become a popular way to continue operating a vehicle while talking on the phone.

Fig.1*- No pedestrian crossing while using portable devices (Mp3, iPod)*

2. WALKSAFE- SAFETY MOBILE APPLICATION

A number of recent research projects demonstrate that wireless sensor network can enhance pedestrian safety, mostly focusing on intelligent transportation systems that help drivers to be aware of potentially unsafe conditions, for example, communicating the location between pedestrians and vehicles using Dedicated Short Range Communications signals, helping vehicle drivers spot nearby pedestrians. In addition, lane, vehicle, and pedestrian detection technologies are used in auto-driven vehicles (e.g., Google cars) to enhance the safety of vehicles. However, to the best of our knowledge,this is the first car detection classification and warning system implemented directly on off-the-shelf resource-limited mobile phone.

Here, we present the design, implementation and evaluation of the application WalkSafe, the first system vehicle detection and pedestrian alert system for mobile phones. Typically, when a mobile user is speaking on the phone, the phone blocks the user’s side view (either on the right or left side depending on which ear the user is using) while crossing the road. WalkSafe protects pedestrians distracted by phone conversations while crossing streets by using the phone’s back camera to detect incoming vehicles, alerting the user via sound notifications and vibrations. To improve the detection rate performance, WalkSafe preprocesses captured images to remove artifacts due to light conditions and phone orientation – WalkSafe solves these challenging environmental, user mobility and phone orientation issues in a robust manner.

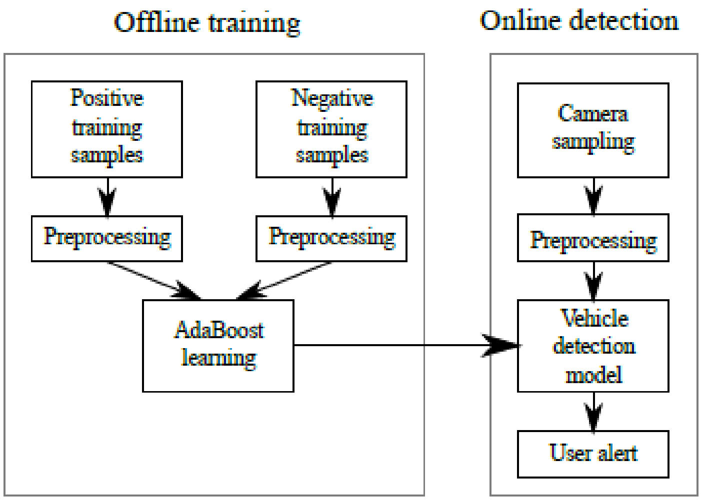


Fig.2*- Walksafe vehicle recognition architecture model*

The online vehicle recognition runs automatically wheneverthere is an ongoing phone call. WalkSafe activates the smartphone's camera and captures a picture of the surroundings. The picture is preprocessed to compensate for thephone tilt and illumination variations, and is then analyzedby the decision tree model built during the offline trainingphase, as discussed above. If the decision tree detects a car in the picture, it triggers an alert to warn the user of possible danger.

The offline training process is given a dataset of positive and negative image matches and builds a mathematical model that can be used to recognize positive matches online on the phone.

The online car detection, which runs on the Andoid smartphone, comprises four steps: image capture, image preprocess, car detection and alert dispatching. During the image capture step, WalkSafe captures a single image using the back facing camera on the smartphone.

The image preprocessing step improves the classifier performance. WalkSafe uses the *accelerometer sensor data* to estimate the orientation of the mobile phone, and aligns the test image according to the direction of gravity. After preprocessing, the test images are input to the car detection step, which uses the classification model built during the offline training. The classifier is designed to run in real time, as it can refuse the negative images very quick if the test image can not pass a stage. Only if a region of interest passes all stages does WalkSafe define that region as a car and then proceeds to dispatch a notification to the user. In the current implementation the user alert is a vibration, which notifies the user about the incoming car.

3. WALKSAFE EVALUATION AND RELATED WORK

The high rate of correctly detected cars from various experiments makes us confident that WalkSafe is very promising solution, indicating that this application is a workable, practical and robust approach to detecting on coming cars under realworld conditions (e.g., with different cars, users, user phone orientation, user mobility and light conditions). WalkSafe uses approximately 140 milliseconds to infer the car position in one frame, which means that it is capable of processing about 8 FPS. In our real world experiments, WalkSafe detects most of the cars coming towards the pedestrians.

However, under certain scenarios WalkSafe only detected cars when they were very close to the pedestrians, limiting the time for the pedestrians to react safely.

Fig.3*- True detections in a real world scenario*

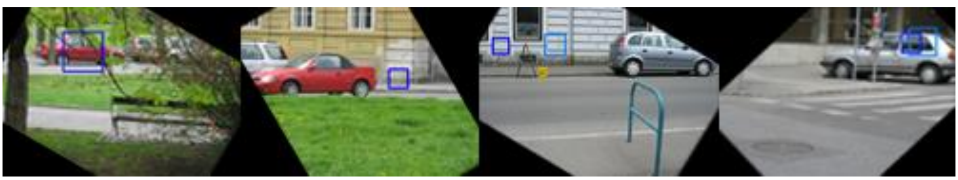


Fig.4*- False detections in a real world scenario*

There is a growing interest in using smartphones, shortrange communication systems and computer vision techniques for pedestrian safety. In what follows, we discuss the related work. There are several commercial products, (e.g., “Text and Walk” and “Walk ’n Email”) that leverage the smartphone’s back facing camera to let users write SMS and e-mails while walking safely by displaying the road ahead as application background. However, this shows that these applications can help, but people are overloaded and therefore somewhat limited in concurrent multitasks processing, thus, users may not be aware of dangers even if they are displayed as application background.

4. CONCLUSIONS AND SAFETY ADVICE

It is important to note that mobile phones offer convenience and safeguards to all of us, including use in emergencies - but they also may pose risk. We need to balance the positives with better knowledge on how cognitive distraction from mobile phone use reduces situation awareness, increases unsafe behavior, putting pedestrians at greater risk for accidents, and crime victimization.

Pedestrian distraction in general, and texting in particular, is associated with slower crossing times and unsafe pedestrian behaviors. The steady rise in the prevalence of text messaging and the use of mobile devices for a wide range of functions such as playing games suggests that the risk of distraction will increase. Solutions are likely to include the three ‘Es’ of injury prevention: education of the public about risks, engineering and environmental modifications, and enforcement. Published surveys and the lay press suggest that drivers, and pedestrians understand the risk of doing other activities while using mobile devices, believe that others should comply with the law, but continue to use devices. Individuals may feel they have ‘safer use’ than others, view commuting as ‘down time’, or have compulsive behaviors around mobile device use. Environmental modifications which separate pedestrians from traffic and promote safe crossing may be even more important in an era of growing distraction. While individuals do not feel ‘at risk’ for relatively rare events such as injury, they may feel “at risk” for a distraction citation if there is visible evidence of effective enforcement.

Mobile phones have positive values, including use in emergencies to call for help but we need to balance the positives with better knowledge on the ways in which mobile phone use may increase accidents and victimization. If using the portable technology puts the pedestrian at risk, perhaps this technology can offer a solution.

5. LITERATURE

[1] D. Gavrila. Sensor-based pedestrian protection. IEEE Intelligent Systems, 16(6):77 – 81, 2001.
[2] Governors Highway Safety Association. Pedestrian traffic fatalities by state: 2010 preliminary data, http://www.ghsa.org, 2010.
[3] Schwebel, D.C., Stavrinos, D., Kongable, E.M., 2009. Attentional control, high intensity pleasure, and risky pedestrian behavior in college students. Accident Analysis & Prevention 41 (3), 658–661.
[4] P. Viola and M. Jones. Rapid object detection using a boosted cascade of simple features. IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 1:511, 2001.

[5] "WHO | Decade of Action for Road Safety 2011-2020: saving millions of lives." [Online]. Available:http://www.who.int/violence_injury_prevention/publications/road_traffic/decade_booklet/en/.
[6] Z. Sun, G. Bebis, and R. Miller. Monocular precrash vehicle detection: features and classifiers. IEEE Transactions on Image Processing, 15(7):2019 –2034, July 2006.
[7] http://www-nrd.nhtsa.dot.gov/CATS/listpublications.aspx?Id=A&ShowBy=DocType

11th International Conference
"Road Safety in Local Community"
Serbia, Vrnjacka Banja, Hotel Zvezda,
April 13 – 16, 2016.

INVITED PAPER

EUROPEAN NIGHT WITHOUT ACCIDENT – SITUATION IN CROATIA

Marko Slavulj[1], Davor Brčić[2], Georg-Davor Lisicin[3], Julijan Jurak[4]

Abstract: European night without accidents was launched in Belgium in 1995 for the first time. The goal of the action was to draw public attention to responsible driver behaviour in traffic, with a focus on youth education, and with a clear message, in which alcohol and driving do not go together. Action is carried out across Europe every third Saturday in the month of October. Croatia has joined this campaign in 2012, and for the fourth time, the "European night without accident" was organized, sponsored by the European Youth Forum and the "Responsible young drivers" organization. The action is organized such that the volunteers in the selected night clubs ask young people between 18 and 26 to voluntary test their breath in the breathalyser. After the termination, the members of the group choose one member among themselves who agrees not to consume alcohol and to be a designated driver on the way home. The selected driver receives a bracelet for easy recognition. At the end of the night (after leaving the night club), the drivers for whom the breathalyser test found that they did not consume alcohol (0,0 ‰), receive an award and a commemorative gift. Most of which were still intoxicated are advised not to sit behind the wheel of the motor vehicle. This paper will analyse the collected data for young drivers in 2015 under

[1] Ph.D., Slavulj Marko, Faculty of Transport and Traffic Science, Vukelićeva 4, 10000 Zagreb, Croatia, mslavulj@fpz.hr
[2] Ph.D., Brčić Davor, Associete Professor, Faculty of Transport and Traffic Science, Vukelićeva 4, 10000 Zagreb, Croatia, davor.brcic@fpz.hr
[3] Lisicin Georg-Davor, M.Sc., Secretary, Udruga Sigurnost u prometu, Srednjaci 7, 10000 Zagreb, Croatia, dlisicin.sup@gmail.com
[4] Jurak Julijan, M.Sc., Research Associate, Faculty of Transport and Traffic Science, Vukelićeva 4, 10000 Zagreb, Croatia, jjurak@fpz.hr

the influence of alcohol in five Croatian cities and will also make a comparison with the data from the previous years.

Keywords: young drivers, behaviour, road safety campaign, alcohol

1. INTRODUCTION

European night without accident was first held in Belgium in 1995, organized by the Responsible young drivers (RYD) (http://www.europeannightwithoutaccident.eu 15.01.2016.). The objective and the purpose of the action was to warn and inform young citizens about the dangers caused by drunk driving, such that instead of punishing and lecturing, the approach was friendly, in form of counseling. Due to the great success among the young people, the RYD decided to continue with the action, and over the years, the number of participating countries and associations increased.

With the support of the European Commission, the action has been extended to other EU member states in 2003. In 2015, the action included 776 volunteers in 142 nightclubs in 25 countries, including Croatia. Since 2012, the campaign "European night without accident" has involved Road Safety Association (SUP), who organized the action in Croatia for the first time in a one nightclub in Zagreb (http://sup.hr 15.01.2016.). In 2013, 10 nightclubs in 5 cities participated, involving 646 voluntary young drivers, while in 2014 the number of participating clubs was the same, but for the first time sponsored by the NPSCP (National Road Safety Program of the Republic of Croatia), with a total of 613 volunteer participants. In 2015, the campaign was conducted in 10 nightclubs in 5 cities, involving 679 young drivers. During 2016, the action is also going to be supported by the National Road Safety Program. This paper will present the motivation and implementation methods of the action "European night without accident", results, discussion and conclusions stating the level of success.

2. MOTIVATION AND CONDUCTION METHODS

Young drivers (18-24 years) in the Republic of Croatia and the EU Member States represent a high-risk road user group because the number of road accidents for them is rather big, compared to their proportion in total driving population. Therefore, young drivers are particularly vulnerable when driving intoxicated as best illustrated by the following data for 2014, in which intoxicated young drivers were responsible for:

- Every 48 accidents;
- Every 36 accidents with casualties.

Among all the accidents involving young drivers, the intoxicated ones are responsible in:

• one in ten accidents;
• one in three accidents involving casualties;
• one in four casualties;
• one in four severe injuries, and one in five slight injuries.

The action is carried out such that SUP volunteers and the students of the Faculty of Transport and Traffic Sciences in Zagreb meet with young people in their recreational areas – at the nightclub entrances, in a relaxed atmosphere to establish mutual conversations. In these conversations, young drivers are introduced to dangers that arise from driving under the influence of alcohol without using the repressive parental tone. Young drivers who did not consume alcohol during the action night were given special gifts, and young drivers who have consumed alcohol were suggested, instead of driving under the influence of alcohol, to take a trip to home with the responsible driver (a responsible driver is the one who agrees not to drink alcohol that night), or to take public transport or taxi when returning home.

The main goal of this action is a life-long education of participants through raising public awareness regarding drunk young drivers and their encouragement to use joint trips by hanging out with the responsible young driver. Once acquired, this behavior pattern can be easily spread in the population, especially if there are no repressive measures required.

The action was conducted in 2013 in nightclubs in Osijek (“Old Bridge” and “Pub St. Patrick”), Rijeka (“Rich Bar” and “Garibaldi”), Split (“Versi” Bar and “Club O'Hara”) Varaždin (“Old city pub” and “Sermage2) and Zagreb (“Toad” and “San Antonio”, Sesvete), in partnership with the Zagreb Brewery. In 2014, the action was performed in Osijek (“Rockatiki” and “St. Patrick”), Rijeka (“Rich Bar” and “Garibaldi”), Zadar (“Hitch bar” and “Yachting”) Varaždin (“Old city pub” and “Sermage”) and Zagreb (“Toad” and “San Antonio”, Sesvete), with the support of the National Road Safety Program and in partnership with the Zagreb Brewery. In 2015, the measure was conducted in Zagreb (“Frog” and “San Antonio”), Varaždin (“Luna” and “Park”), Osijek (“St. Patrick” and “Exit”), Rijeka (“Rich bar” and “Pipistrellus”) and Zadar (“Svagor bar” and “Yachting”).

3. RESULTS

In the action conducted in 2013, among 627 drivers who agreed to take the breathalyzer test, 167 young drivers did not consume alcohol (26,6%), a total of 59 people had less than 0,5 per thousand of alcohol (9,4%), and 401 young drivers had more than 0,5 per thousand of alcohol (63,9%).

Table 1. *Comparison of the results, 2013 – 2015*

Year	Percentage of participants, 0,0 ‰	Percentage of participants, 0<0,5 ‰	Percentage of participants, >0,5 ‰
2013.	26,6%	9,4%	63,9%
2014.	34,3%	25,4%	40,1%
2015.	27,7%	36,7%	35,6%

In the action conducted in 2014 involving a total of 613 young drivers, 510 of them agreed to take the breathalyzer test, and 175 of them did not consume alcohol (34,3%) – 83 female and 92 male. Alcohol less than 0,5 per thousand was recorded in 130 people (25,4%), in which 51 were female and 79 male, and the breath alcohol concentration of over 0,5 parts per thousand was registered in 205 young drivers, (40,2%), in which 57 were female, and 148 male.

Results in 2015 compared to the result in 2013 showed a drop of young drivers with alcoholic condition and more drivers with 0 ‰ of alcohol in their blood (Table 1). The reason for this is the higher level of awareness of young drivers about the consequences of traffic accidents, but also the visible impact of the action, which is increasingly recognized among the youth drivers and the society.

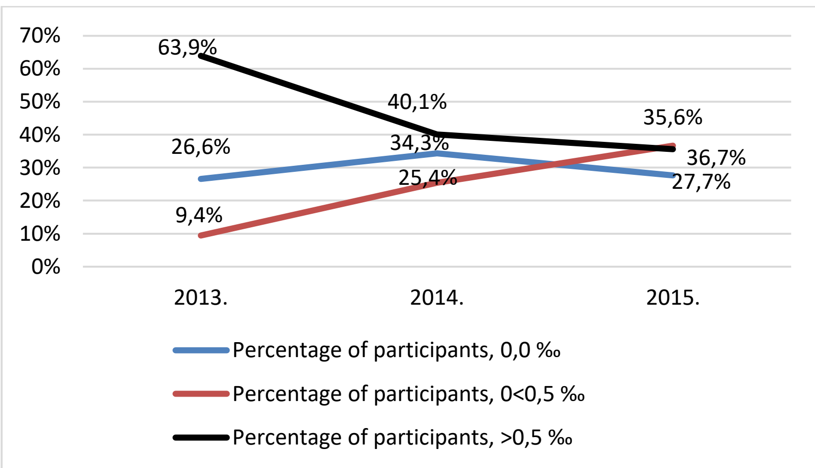


Figure 1. *Graphical comparison of the results, 2013 – 2015*

Figure 1. graphically shows relations between 0 per thousand, 0<0,5 per thousand and >0,5 per thousand alcohol in blood for years 2013, 2014 and 2015. This chart shows decline in the number of drivers with more than 0,5 per thousand of alcohol in the blood compared to the base year (2013), the number of young drivers with 0,05 per thousand of alcohol in the blood stagnates, while is

increasing the number of drivers without alcohol in their blood and their number in 2015 is the largest.

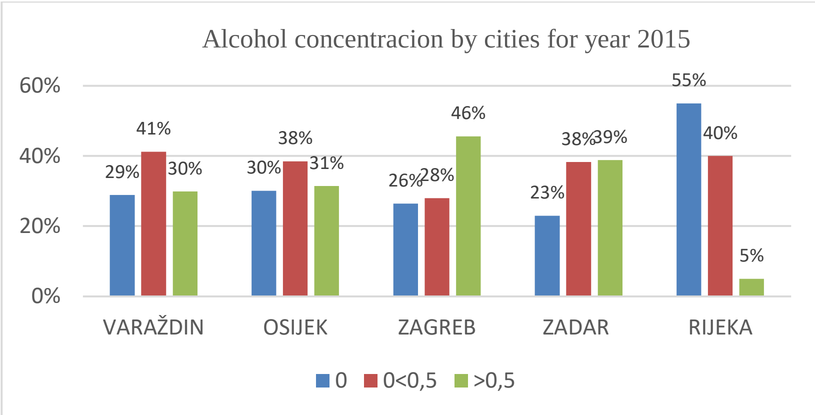


Figure 2. *Alcohol concentration of young drivers by cities in 2015*

Figure 2. shows the relationship between the number of young drivers with alcohol in their blood and those who did not consumed alcohol in cities that participated in the action. In Rijeka was the largest number of young drivers who did not consumed alcohol 55% of total number recorded, while most young people with more than 0,5 per thousand of alcohol in the blood were recorded in Zagreb represent 46% of total recorded. The largest number of young people that had 0,5 per thousand of alcohol in the blood was registered in city of Varaždin, while the remaining two cities, Osijek and Zadar had approximately equal results.

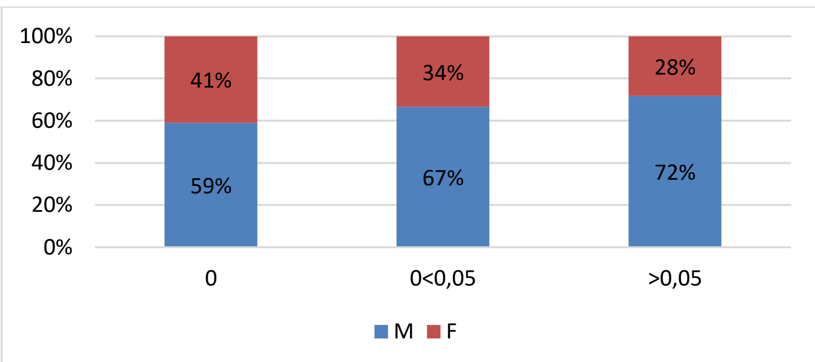


Figure 3. *Relationships between genders among drunk young drivers, 2015*

In 2015 (Figure 3.), the action was attended by 679 young drivers and it shows a higher percentage of male population compare to the female population, among which 555 agreed to take the breathalyzer test – 154 young drivers did not consume alcohol (27,7%) - 62 female and 92 male, and 203 people had less than

0,5 (36,7%) - 68 female and 135 male, and 198 were registered with over 0,5 per thousand of alcohol (35,6%) - 56 female and 142 male.

4. DISCUSSION

In the past three years of the project "European night without accident in the Republic of Croatia", the data in Table 3-1 showed that less young drivers or the participants of the action had more than 0,5 per thousand of alcohol, and an increasing number of participants had 0,0 or more than 0,5 per thousand of alcohol in their blood.

However, the concerning is 35,6% of young people in 2015 who had a high blood alcohol concentration (> 0.05 ‰), with the measurements going from 2,34 up to alarming 3,4 per thousand, with males prevailing. Compared to the results in 2014, the total number of people who voluntarily took the breathalyzer test is 12 percent higher in 2015, if the alcohol consumption within the permitted limits is considered only.

It is encouraging that in 2015, 4 percent less of total young people had a high blood alcohol concentration. This shows the positive impact of this project on the young people, especially if the rising interest (8 percent increase) of young people compared to the last year is considered. Compared to 2013, people that consumed alcohol within the legal limits are 27 percent less in 2015. But if the percentage of young drivers in 2013 whose breath had over 0,5 per thousand of alcohol is compared, in 2015 there is a visible decline of alcohol consumption – 28 percent less of people had high blood alcohol concentration. From this data, it can be concluded that the situation gradually improved – however, alcohol consumption by young drivers is still significantly present during a night out, indicating irresponsible behavior and the necessity of continuing these and similar preventive safety and education activities.

5. CONCLUSION

Despite recent years with considerable improvements of the road safety in general and reducing the number of casualties, Croatia is at the back compared to EU countries. This fact suggests the real possibility and potential to achieve even better results. One of the potential is a more efficient resolution of the issues regarding the participation of drunken drivers in road traffic. Trends related to the consequences of alcohol intoxication are similar to the ones of the Republic of Croatia (the share of the number of accidents and casualties as a result of alcohol in Croatia is even higher than the EU average) and EU countries. One of the most effective measures to alleviate the consequences caused by alcohol intoxication for drivers is to increase the frequency of police control. These controls should be specifically targeted in times and places of potentially increased alcohol consumption. Controls annually should include at least 20% of the driving population (the control covers every fifth driver). It is necessary to develop a national strategy for reducing the social impact caused by alcohol consumption. Alcohol beverage companies should be obliged to highlight the products with appropriate warnings on labels stating the dangers of alcohol for health and driving. In the places with high alcohol consumption, fixed breathalyzers should be installed in order for visitors to take a self-test before sitting behind the wheel.

Local government should provide conditions and allow the usage of cheap taxi and public transport services at night, especially on routes and locations where the increased number of drunken drivers is expected. A comprehensive media campaign stating the dangers of driving under the influence of alcohol, drugs and medicine specially aimed to young drivers (as well as other preventive and educational measures) is required. It is necessary to continue working on reducing the number and severity of accidents involving young drivers directly through actions, raising awareness and responsibilities of young drivers driving in accordance with the regulations, with an emphasis on dangers resulting from driving under the influence of alcohol.

The media, and especially the public, need to dedicate greater attention to the prevention of drinking, drugs and medicine in traffic. Currently, the approach of the media to road safety is mainly subjected to shallowness and sensationalism. Based on the successful experience in EU countries to increase road safety in the preventive manner, activities should be directly incorporated within the highest state bodies, organizations and prominent individuals (president, prime minister, other ministers, etc.). In solving the problem of alcohol, the drivers other than the police as well as other entities (Ministries of Maritime Affairs, Transport and Infrastructure, Ministry of Health, etc.) should be included.

Finally, it is desirable for young drivers to avoid drinking at all, since even the smallest amounts of alcohol in their blood gives them false courage and desire to prove themselves in front of their passengers, which leads to particularly serious accidents.

6. LITERATURE

[1] Responsible Young Drivers, European Night without Accident, http://www.europeannightwithoutaccident.eu 15.01.2016.

[2] European night without accident 2015. Traffic safety association, http://sup.hr 15.01.2016.

INVITED PAPER

PARALLELS BETWEEN COMMERCIAL AND SOCIAL MARKETING – APPLICATION IN ROAD SAFETY

Nevena Mijic[1], Milan Tesic[2], Miroslav Djeric[3]

Abstract: Commercial marketing is a scientific discipline studying activities that enable effective and efficient linking and exchange of consumption and production. At the same time, social marketing does not only use all the marketing principles and techniques typical of commercial marketing, but also adds a new target of this effective exchange **–** an individual change in behaviour by creating or changing certain attitudes. This paper presents parallels between commercial and social marketing with an emphasis on their application in road safety. The Road Safety Agency of the Republic of Srpska carried out a social marketing campaign, in cooperation with the company Mtel A.D. This marketing campaign has been presented in this work. Enhancing the level of safety of road users by changing their behavior related to mobile phone use while driving was the main goal of the Campaign. It had a great commercial success, from the commercial point of view, but the part of campaign evaluation related to road safety has been missing. The campaign presented in this paper is a good example of how a socially responsible company has been involved in activities of general interest and importance to the whole society, and how it encouraged the inclusion of smaller companies in activities that are increasing the level of road safety in their local communities.

Keywords: road safety, commercial marketing, social marketing, road safety, parallels

[1] Mijić Nevena, B.Sc. (Econ), Account executive, Fullhouse Ogilvy, 2, Andrićev venac, Belgrade, Republic of Serbia, e-mail: nevena.mijic@fullhouseogilvy.rs
[2] Tešić Milan, B.Sc. Senior professional associate, Transp. and Traffic Eng., Road Safety Agency of the Republic of Srpska, 18, Z. J. Jovanovića Banja Luka, Republic of Srpska, e-mail: m.tesic@absrs.org
[3] Djerić Miroslav, M.Sc., Professional advisor, Ministry of Transport and Communications of Bosnia and Herzegovina, 1, Trg Bosne i Hercegovine, Sarajevo, e-mail: miroslav.djeric@mkt.gov.ba

„You are not hard workers. You often delay it until tomorrow, or the day after tomorrow, what you could do today. The consequence of this is that you never do it. How many personal losses, and what is worse, how many losses you have sustained for your country due to this futile idleness! And your peasants also lose a good deal of what they could get from their very fertile soil because they are not hard workers. They do not apply modern and rational processes in agriculture since these would urge them into working more, up until they would have been accustomed to them. "Tradition" has been a pretext for not applying them."

Archibald Reiss (1875-1929)

1. INTRODUCTION

Road safety is defined as a scientific discipline studying negative consequences of road traffic and methods for their reduction[4]. Social marketing is only one of indirect methods used to decrease the number of road crashes, but also the consequences of road accidents that can be avoided. That is the reason why it is important to say that the significant contribution of social marketing in increasing the road safety is the codex of this discipline – collaboration and cooperation with all interested stakeholders. The competition the social marketers are facing does not lie in other organizations, but it is right in the focus of this discipline – current behavior of the target group. This enables a free and unburdened flow of knowledge among the individuals involved in social marketing.

Nowadays, promotion and marketing of products and services, commercial and social marketing are assigned different definitions describing their scopes of work. Observing road safety as a scientific discipline, it is possible to perceive segments that rely significantly on basic concepts of commercial and social marketing. In this regard, prevention in road safety largely depends on the promotion and marketing plan of preventive activities (Elliot, B., 1989). That is why it is important to emphasize the importance of organizing road safety campaigns at the national level, primarily with the idea of having a spill-over effect onto the local level. A positive example can move the avalanches, and positive results of local communities exceed hundred percents the capabilities of centralized action at the national level.

The implementation of the European project CAST has confirmed how important is the promotion of preventive road safety activities. Numerous documents have been published within this project and concerned the preparation, definition, implementation and evaluation of prevention campaigns in road safety (see www.cast-eu.org). The partnership between the commercial and social marketing and road safety must be seen as the only chance for achieving synergetic effects in pursuing common goals.

[4]Lipovac, K., Jovanović, D., Vujanić, M. (2014). „Osnove bezbednost saobraćaja", Kriminalističko-policijska akademija, Beograd/"Road Safety Basics", Academy of Criminal and Police Studies, Belgrade

1.1. The concept of social marketing

As a scientific discipline, marketing deals with market issues, market needs and how to satisfy those needs.[5] This is the basic definition of marketing that is identified with the definition of commercial marketing - marketing dealing with the identification of needs (of which the target group is either aware or not) and satisfying them through the sale of products and services at prices and in places suitable to the target group.

Social marketing, like any other marketing opting for a more precise definition of the selling product, is based on customized tools and techniques of commercial marketing, and each definition of social marketing is therefore based on a comparison of two definitions. Kotler and Zaltman (1971) defined social marketing for the first time as a design, implementation and control of a program created with the aim to influence the acceptance of social ideas and include prices, communication, distribution and marketing research into the product planning process. Due to specific features of social marketing, many authors have defined social marketing in different ways. Thus, Lee and Kotler (2011) introduced social marketing as a process that uses marketing techniques and principles to influence the target group’s behavior from which society and individuals will benefit. According to Smith (2011), social marketing represents a marketing technique and principles aimed at improving the public welfare.

In his paper, Anderson, A. (1994) analyzed with criticism all previous definitions and improved these using valid arguments. This has encouraged the acceptance of a new definition by the general public. According to Anderson, social marketing is the adaptation commercial marketing techniques to the programs designed with the idea to influence the voluntary change in behavior of the target audience, in order to improve both their personal and social welfare. The analysis of the definition offers a closer understanding of its meaning which will be used for comprehending the differences between the commercial and social marketing:

- **Social marketing uses the customized techniques of commercial marketing** (although in commercial marketing, these techniques are used to increase sales, and using these techniques, one should not forget that the subject of work of social marketing is the influence on behavioral change and that this has been taken as its primary goal);
- **It is applied in the program implementation** (marketing is always carelessly associated with campaigns, however, social marketing goes a step further and seeks for the program action which is more focused on the long-term consequences of a campaign);
- It focuses on target group’s **behavior**;

[5]Kotler, F., Roberto, N., Li, N. (2008), Socijalni marketing, kako poboljšati kvalitet života, Beograd/Social marketing, how to improve the quality of life, Belgrade

- **It affects the behavior** (it is important to note that, in connection with the behavior, the creators of the program may have as a goal the change in behavior, absolute termination of certain behavior, but also efforts in encouraging development of a certain type of behavior);
- **It seeks to encourage a voluntary change in behavior;**
- **It seeks to enrich/improve the lives of the target group/society as a whole** (this part of definition of social marketing goes back to the *raison d'être* which is not hidden in the provision of benefits for the individual implementing the program, but in the creation of the world as a better place for the life of an individual and society as a whole).

Accordingly, social marketing is marketing that emerges as the idea of making the world a better place to live in. To have this as a motivation guarantees a gather together of a team (decision maker), which is dedicated to the same idea as is the plan according to which the effects of this idea are seen many years in advance.

1.2. Scope and objective of the paper

The analysis of the commercial and social marketing with the special focus on implementing these in road safety represents the main subject of this paper.

The objective of the paper is to show differences and similarities between the commercial and social marketing. After these two concepts have been clearly distinguished, the example of a road safety prevention campaign implemented in the Republic of Srpska, has been shown in this paper. The campaign in question contained the elements of social marketing, with the highlighted advantages and shortcomings occurred during its practical implementation.

2. PARALLELS BETWEEN THE COMMERCIAL AND SOCIAL MARKETING

Differences between the commercial and social marketing are very clear and easily understandable. Commercial and social marketing differ from their very start, regardless of techniques that are used to achieve the goals. While people who deal with commercial marketing are led by the increase in market share, the aim of the people dealing with social marketing is to provide voluntary change in individual's behavior. Hence we can see that the market of commercial products/services is very turbulent and setting goals understands their short-term implementation, while the market where the manner of behavior is for sale (supported by people who deal with social marketing) tends to achieve long-term goals which understand the change in behavior through permanent change in attitudes.

After identifying the difference between the starting points and defined goals of the commercial and social marketing, it is of ultimate significance to point out the different definition of success applicable in these two disciplines. The difference in the definition of success appears naturally, as it is conditioned by the goals set. While the sale and achieved profit/market share is a very easily noticed and generally acceptable parameter of success in the implementation of a commercial marketing campaign, the success is achieved with difficulties in social marketing campaigns, it cannot be defined or measured easily as it is linked to the intangible parameters – target group's behavior and attitudes.

Commercial marketing campaigns are implemented without investment related problems as companies are the ones that invest funds for achieving these goals. Social marketing campaigns encounter problems very often in persuading and motivating the State to use its budget for the improvement of social welfare (i.e. of road safety, in this particular case). Apart from the State, sponsors/donations have an important role in social marketing campaigns.

Commercial marketing has been recognized as the main tool in the battle with competitors – manufacturers who are satisfying the similar or the same need. For that very reason, the knowledge possessed by companies is hidden far from the competitors. Unlike commercial marketing, social marketing has been recognized as the cooperation discipline. Competition in social marketing is not related to the people who implement various programs and struggle for better future, but is noticed in the behavior of the target group where this behavior is subject to change. Thus, social marketing recognizes various types of competition[6]:

- Behavior and behavior related benefits favored by the target group (for example, parking at a parking place reserved for disabled persons);
- Behavior that has "always" been a part of them, that they will have to renounce (for example, going to work by their own car), and
- Organizations and individuals who send messages whose contents oppose desired behavior (for example, promotion of cartoons in which children and cartoons heroes are not adequately seated in their cars).

3. APPLICATION OF MARKETING MIX

Traditional concept of marketing mix (4"P") is used in an adjusted manner, as the main tool for implementation of social marketing. Marketing mix used for the purposes of commercial marketing consists of 4 elements (product, price, promotion and place[7]), while these elements have been modified to meet the needs of the social marketing. Therefore, 4 equally significant elements have been added, and made the concept of 8 "P" (already mentioned 4 "P" plus publics, partnerships, policy, purse-strings[8]).

[6]Kotler, F., Roberto, N., Li, N. (2008), Socijalni marketing, kako poboljšati kvalitet života, Beograd/Social marketing, how to improve the quality of life, Belgrade

[7]4 „P" – product, price, promotion, place

[8]8 „P" – product, price, promotion, place, publics, partnerships, policy, purse-strings

Differences between marketing mix elements of these two disciplines will be given in the table below (empty fields remaining in the column of the last 4 elements of commercial marketing do not mean that they are never used for achieving commercial targets, but their explanation is left out with the idea to clearly represent, in a form of a table, marketing mix differences between these two disciplines (Table 1)).

Regardless of essential differences of commercial and social marketing, these two disciplines are focused on something that links them and understand a constant reexamination of their connection: consumers (target group) take the central part of their focus. Therefore, notwithstanding the differences, these two disciplines are partners and can learn from each other and improve the tools for efficient and effective achievement of their goals.

Table 1. *Marketing mix elements*

Marketing mix element	**Commercial marketing 4"P"**	**Social marketing 8"P"**
Product	Tangible product or service fulfilling already known desires, requests and needs of the people.	Behavior of the target group which is in the campaign's focus – the goal is to change, end or begin with a certain behavior.
Price	Economic calculation of the relationship between the cost price of the product/service and readiness of consumers to pay for the product/service in question.	What does it cost for the people to change certain behavior (not measured only in terms of money, the societal impact is calculated, elimination of habits or addictions).
Place	The most suitable place for people to consume the company's product.	Simplify the approach – successful campaigns allow the target groups to have an easy way to register for something. - suitable places to get tangible objects and behave in accordance with the recommendations and - suitable time to obtain services.[9]
Promotion	Communication of the product/service in the way that suits the people.	Apart from creating appropriate messages and making a precise media plan, it is very important to influence the involvement of wider public in spreading campaign's ideas.
People		The target group is still divided according to their readiness to accept new behavior – therefore, each campaign should be launched by addressing to those who are most ready for action.
Partnership		Exchange of knowledge, experience and cooperation between people who deal with

[9] Recognized element contributing to the success of campaigns of social marketing according to F. Kotler, N. Robert and N. Li (2008)

Marketing mix element	Commercial marketing 4”P”	Social marketing 8”P”
		social marketing enables spreading the voice of a company even farther.
Policy		The element of a marketing mix that, apart from those who accept the change in behavior voluntarily, also includes the rest of the society and, by creating or changing the policy, the society as a whole influences the organization and constant changes.
Purse-strings		Sponsorships in a form of donations or allocations of a part of the state budget intended for the implementation of social marketing campaigns are the only ways to achieve the goals of these campaigns.

4. PREVENTIVE CAMPAIGN “NE KUCAJ, DA SE NE BI ZAKUCAO” (DO NOT KNOCK, SO AS NOT TO BE KNOCKED)

The campaing in question is an example of a successful reconciliation of two disciplines (usage and improvement of tools of commercial marketing for the needs of the social marketing), in order to improve road safety in the territory of the Republic of Srpska.

From May to July 2015, the Ministry of Transport and Communications, Ministry of Interior, Road Safety Agency, Automobile and Motorcycle Association and company Mtel A.D. Banja Luka carried out together the preventive campaign called *„Do not knock, so as not be knocked“*, focusing on the population of drivers using a mobile phone while driving. The undesired driving behavior to be reduced by the campaign included the rate of mobile phone use while driving, and in particular writing and replying to textual (sms) messages, data searching, and conversing without ancillary devices (bluetooth earphones). This campaign had to be used to change driver's attitudes on mobile phone use while driving. A video and radio advertisment have been designed for the purpose of implementing this campaign, and broadcast on public and other media services. Moreover, printed material was distributed across the whole territory of the Republic of Srpska, while the material prepared in electronic form was promoted through official internet addresses of key stakeholders who implemented the campaign.

Design, implementation and marketing plan of the preventive campaign was made by the professional marketing agency. According to Kotler, Roberto and Li (2002), it is important to monitor the elements of success of a campaign. This paper will show only a few key elements of successful campaigns that were not included in campaign implementation in the Republic of Srpska, but needed to be the way forward and objective of this and every other future campaign:

1. Before the start of the campaign, a survey into the rate of mobile phone use while driving should be conducted, using the method of questionnaire and immediate observance, in order to determing the rate of mobile phone use while driving, the attitudes and behavior of drivers in terms of mobile phone use, and also define the groups of road users that are more likely to exhibit unwanted behavior, i.e. mobile use while driving;
2. On the basis of results obtained in the survey, a target group of road users (drivers) should be selected to exercice the change in attitudes and behavior. When implementing the campaign *„Do not knock, so as not to be knocked“*, the whole population over the age of 18 and possessing a driving licence, has been taken as a target group. This pioneering advertizing (as a product of social marketing) gathered a wide range of people whose behavior was taken as a goal. However, it did not enable a clearer and more adjusted manner and place to promote the new way of behavior. Therefore, the implementation of future campaigns should see a more precisely defined target group.
3. Think about adding and promoting tangible products or services which will make easier for the target group to adopt desired behavior – campaign message was conveyed in one way only, without leaving any space for questions (contact center) or space for a more simple/easier/cheapper purchase of devices that are considered safe for use while driving;
4. Understand potential benefits and costs and address them – an individual whose behavior should have changed has not been approached from the point of view of his/her expenses and difficulties he/she can bear with. The message was spread to the whole society, in its entirety, without any attempts to personalize the transfer of this message.
5. Provide sufficient funds for the survey – each campaign should be initiated by actual market data – pre-campaign research, research during the campaign (related to the next element of a successful campaign) and post-campaign research which will determine the rate of fulfillment of the goals set at the beggining of the communication;
6. After the completion of the campaign, the following activities should be done: conduct a reiterated survey to take into account the rate of mobile phone use while driving, make the analysis of data obtained in the research, compare the results of this survey with the results of research carried out before the start of the campaign, all in order to measure the success of the campaign, i.e. to see if the campaign has yielded reduction in the rate of mobile phone use while driving and consequently change in attitudes and behavior. What is important and worth saying is that planning and implementation of a campaign should be supported by all road safety stakeholders, depending on the level of campaign implementation (national, local level).

However, the main part that was left out in this campaign is the EVALUATION of the entire campaign. Evaluation of such campaigns is seen from two angles: commercial (in this case the visibility of the MTel company when communicating messages) and social, real effect of the campaign which is reflected in the change of unwanted behavior of the target group, i.e. in lowering the rate of mobile phone use while driving, and change in attitudes and behavior.

In fact, a part of evaluation from the point of view of „commercial marketing“ has been done. Evaluation results have shown that the campaign in question led to the increase in the volume of telecommunication traffic of the MTel. According to the marketing agency, i.e. one of the campaign partners[10], this has been a medium to intensive campaign (according to its character), with 2 daily broadcast on average, on TV stations, and has been therefore implemented with a high rate of success. As for the advertizing at external locations, the campaign was promoted on two types of carriers – billboard and city light boxes in order to cover traffic and pedestrian zones, where the outreach of these communication channels has been assessed as pretty high, too.

Unfortunately, a part of evaluation relating to the reduction in the rate of mobile phone use while driving, and change in attitudes and behavior of road users (drivers) has not been done, even though it has been the main objective of the campaign against which the success of a campaign should be measured. That is why it is not possible to give answers to the following questions: *How many drivers got familiar with the implemented campaign? How many campaign messages have been acceptable for the target group? Has the campaign led to changes in attitudes/behavior of car drivers?How many percents has the mobile phone use while driving rate been reduced by?* and many other questions indicating to a great extent the success of the implemented campaign.

When analyzing and making parralels between proposed and implemented (within MTel A.D. campaign) tools, factors of success and recommendations as to how a road safety campaign is to be implemented, local community leaders have an opportunity to learn that in order to implement a campaign whose goal is changign certain road user behavior from the point of view of road safety, much more is needed than just having a sponsor for all activities. In fact, what is needed is a mutual desire for a better future of both local communities and socially responsible companies where profit making of one entity must not stand on the path of the society as a whole. Socially responsible companies should recognize the importance of campaign implementation in the field of road safety in the way that, by supporting the campaigns whose aim is to promote safe use of their service, they will achieve higher sale of that service. Having in mind that, through the work of the road safety councils and all road safety stakeholders, among other things, and in order to improve road safety, certain campaigns are implemented at the local level, it will be necessary for a socially responsible company to recognize

[10] Aquarius LLC, 91, Skendera Kulenovića street, Banja Luka, Republic of Srpska

the significance of its role in implementing these campaigns, for the benefit and welfare of the whole community. That is actually the biggest challenge every one of us faces as an initial test when entering the world of social marketing.

5. CONCLUSION

Disciplines such as commercial and social marketing, as well as road safety, are carefully intertwined on the way to achieving the same goal, i.e. increasing the "*welfare*" of individuals (fulfillment of desires and needs and safer road user behavior). No matter how much we adapt or intermingle various techniques and tools of one in favor of another discipline, the basic idea remains the same – increasing the welfare of society through individual’s action.

The desire to connect these three disciplines calls for uncompromising cooperation, share and transfer of knowledge and constant mutual improvement, since sharing the common focus is equal to sharing responsibilities in managing road safety.

Each road safety campaign needs to be supported by the private and public sector. While the public sector has limited financial resources, private sector possesses sufficient funds that will enable the public sector to transform its institutional resources into preventive activities. In this way, and based on the sale of products and services to the population of a community, the private sector will, along with the profit made, be able to give back a part of it to that population and thus enable the community to be an active member of the economic feedback. As a result, there has been achieved a temporary change in target group behavior, a chance has been also provided to change the regulations, ensure strong media support and involvement of the wider audience in sending a message, where the change in attitudes will support the change in behavior.

Guided by the idea of increasing road safety in the Republic of Srpska, and using social marketing methods to achieve that, decision makers get into grips with extreme competition (current behavior of the target group), but also with the strongest incentives of this competition – the culture. It is necessary to study the target group well, find the ways and conditions under which the changes in road user’s behavior will be ignited. In this sense, the answers we get to the questions mentioned in this paper help obtain a "picture" of success of the implemented preventive action. Such an evaluation concept should be applied to all prevention campaigns implemented with the aim of changing the behavior and attitudes of the target group.

Decision makers should be aware that, in addition to culture, which is an obstacle arising with the change in target group attitudes on a certain kind of behavior, it is the same factor among decision makers who are engaged in the implementation of social marketing campaigns, where they themselves must overcome the shortcomings behind the culture in order to be able to succeed with the others in doing the same.

By analyzing the present state of culture of the target group (population) and the possibility of influencing their behavior in road traffic, social marketing should be a "method of packing" the product (social benefits) called "road safety". Using this concept, road safety will be to a great extent consumed in the right way by the general public. As long as road safety "sells" as it is ("unpacked"), the results of behavioral change will be less effective. The reason for this is the current unpopularity of road safety among the citizens in these areas.

Such concept in the prevention of road safety has less effects in countries that have a developed awareness of road safety, since the product called "road safety" in these countries is more popular (acceptable to the general public, produces the feeling of safety, care, etc.). Where this concept is used in the prevention, better results would be achieved in middle- and low income countries in the world.

Studying the obstacles encountered by individuals when changing behavior in order to achieve safer consuming of road traffic, one also achieves its understanding, making the message, price and distribution closer to the target group for the purpose of their acceptance. At the level of local communities, decision makers are closer to the culture of their citizens than anyone else, and local action is therefore of great potential and importance.

6. LITERATURE

[1] Andreasen, Alan R. (1994). Social marketing: Its Definition and domain, Journal of public policy & marketing; 13, 1, pp. 108-114.

[2] Andrew McAuley. (2014). Reflections on a decade in social marketing, Journal of Social Marketing, Vol. 4 Iss: 1, pp.77-86.

[3] Delhomme, P., De Dobbeleer, W., Forward, S. and Simões, A. (2009). Manual for designing, implementing, and evaluating road safety communication campaigns: Part I. http://www.cast-eu.org/docs/CAST_WP3_Deliverable%203.2a.pdff.

[4] Desphande, S., Rothschild, M. L., and Brooks, R. S. (2004). New product development in social marketing. Social Marketing Quarterly, 10(3/4), 39-49.

[5] Elliott, B. (1989). Effective road safety campaigns: a practical handbook. Publication of: Department of Transport, Australia, (CR80).

[6] Fox, Karen F. A. and Philip Kotler, (1980), The Marketing of Social Causes: The First Ten Years, Journal of Marketing 44, 24-33.

[7] Kotler, F., Roberto, N., Li, N. (2008), Socijalni marketing, kako poboljšati kvalitet života, Beograd.

[8] Kotler, P. and Zalltman, G. (1971), Social Marketing: An Approach to Planned Social Change, Jurnal of Marketing, Vol. 35, pp. 3-12.

[9] Lee, N. R. and Kotler, P. (2011). Social marketing: Influencing behaviors for good. Sage.

[10] Lefebvre, R. Craig. (2011), An Integrative Model For Social Marketing, Journal of Social Marketing, Vol. 1 Iss: 1 pp. 54-72.

[11] Lipovac, K., Jovanović, D., Vujanić, M. (2014). „Osnove bezbednosti saobraćaja", Kriminalističko-policijska akademija, Beograd.
[12] Milisavljević, M., Maričić, B., Gligorijević, M. (2006), "Osnovi marketinga", Centar za izdavačku delatnost Ekonomskog fakulteta, Beograd.
[13] Rajs, R. A. (1875-1928). „Čujte, Srbi! Čuvajte se sebe", Algoritam, Beograd.
[14] Smith, B. (2011). Defining social marketing. Social marketing: influencing behaviors for good, 4th edition. Thousand Oaks, California: Sage Publications, 2-31.
[15] Stephan Dahl , Lynne Eagle , David Low , (2015) "Integrated marketing communications and social marketing: together for the common good?", Journal of Social Marketing, Vol. 5 Iss: 3, pp.-
[16] www.i-socialmarketing.org
[17] www.socialmarketing.blogs.com

INVITED PAPER

RISK PERCEPTION AMONG DRIVERS WITH SUSPENDED DRIVING LICENSES

Svetlana Čičevič[1], Krsto Lipovac[2], Boris Antić[3], Marjana Čubranić-Dobrodolac[4], Aleksandar Trifunović[5]

Abstract: The aim of the present study was to investigate the perception of risk among drivers with suspended driving licenses, using the SRHP (Self-Reported Hazard Perception Scale). The scale has been developed for the purpose of self-reported assessment of hazard perception skills. Participants were asked to reply how often they experienced the situations given in the 6-point Likert-type scale (1= never, 6= always). Research sample consisted of 219 drivers whose driving licences have been suspended. This paper will discuss possible causes of obtained results, and practical implications thereof.

Keywords: risk perception, drivers with suspended driving licences, road safety

[1] Ph.D., Svetlana Čičević, Regular Professor, Faculty of Transport and Traffic Engineering, 305, Vojvode Stepe, Belgrade, Serbia, s.cicevic@sf.bg.ac.rs
[2] Ph.D., Lipovac Krsto, Regular Professor, Faculty of Transport and Traffic Engineering, 305, Vojvode Stepe, Belgrade, Serbia, k.lipovac@sf.bg.ac.rs
[3] Ph.D., Antić Boris, Assistant Professor, Faculty of Transport and Traffic Engineering, 305, Vojvode Stepe, Belgrade, Serbia, b.antic@sf.bg.ac.rs
[4] Mr. Čubranić-Dobrodolac Marjana, B.Sc. Psych., Assistant, Faculty of Transport and Traffic Engineering, 305, Vojvode Stepe, Belgrade, Serbia, marjana@sf.bg.ac.rs
[3] Trifunović Aleksandar, B.Sc. Transp. and Traffic Eng., Faculty of Transport and Traffic Engineering, 305, Vojvode Stepe, Belgrade, Serbia, a.trifunovic@sf.bg.ac.rs

1. INTRODUCTION

In order to correct driver's behavior in traffic, it will be necessary to improve their subjective risk perception. The aim is to develop capabilities for detecting objective hazards and risks while driving, and to primarily excercise self-assessment of own capabilities in facing driving requirements. This understands making of a picture of own behavior and encountering the consequences of inadequate driving behavior.

Risk observation and understanding of traffic behavior is most often made by means of data collected in the surveys on driver's attitudes on traffic, using the questionnaires. Knowing the attitudes to driving is a very important precondition for understanding driving behavior, and consequently for identifying measures and activities to be used to improve such behavior. On the other hand, when interpreting the attitudes to driving, it will be necessary to take into account the fact that attitudes are based on self-reported behavior, i.e. that respondents are likely to give socially acceptable responses.

The category of drivers who had their driving licences suspended is a very representative sample for studying likelihood of risk, own self-perception of this risk, as well as changes which are possible to make at the level of driver's awareness using adequate selection of methods and techniques in the rehabilitation process.

After the penalty system had been introduced in accordance with Road Safety Law in 2009 (RSL, Official gazette of RS, No 41/09, 53/10 and 101/11), the European practice of driver's rehabilitation was established in Serbia for the very first time. Penalty system included those drivers whose driving licences have been suspended due to illegal driving and assigned penalty points. For the purpose of analysis and improvement of the rehabilitation course, the Road Traffic Safety Agency has engaged the Faculty of Transport and Traffic Engineering in Belgrade to implement the project named: „Assessment of knowledge, attitudes, behavior and psychological profiles of drivers whose licence has been suspended, including the analysis of the process used so far and proposals for improvement measures“. Apart from the analysis foreseen by the terms of reference, additional statistical analyses have been made and will be presented in this paper.

2. MATERIAL AND METHODS

In addition to the questionnaire for the self-assessment of risk and hazards in road traffic (SRHP), respondents also filled out a demographic questionnaire which contained questions on basic characteristics of respondents, as well as those on characteristics of drivers whose driving licences have been suspended, which is of importance to road safety. The SRHP questionnaire was filled out by the respondents at the very beginning of the rehabilitation process, and also at the end of it.

2.1. SRHP questionnaire for the self-assessment of risk

The SRHP (Self-Reported Hazard Perception Scale) has been designed by Sümer (2003), and represents a short form of a scale for self-assessment of risk perception. Driving behavior, as interpreted by this author, understands a set of certain habits, tendencies and emotional reactions while driving, including the evaluation of quality of own driving. By using this scale that consists of six items (questions), drivers assess their capabilities of perceiving risky situations and driving behavior that may arise from own actions or other road users' behavior. Using the 6-point Likert-type scale, respondents are asked to assess how often they encounter the statements describing the most representative risky situations in traffic. Responses are scored in a simple way according to the proposed author's instructions (with the inversion of responses for negative questions). High score achieved in the questionnaire corresponds to the more efficient capability of perceiving hazards in traffic..

2.2. Research sample and statistical analysis

Observed sample was made of 219 drivers whose driving licences have been suspended in the period of observation of two months, during which 19 seminars were held across Serbia. The sample included respondents with suspended licences during the observation period of one year.

Statistical data analysis was made using the program package IBM SPSS Statistics v.18. Apart from the measures of descriptive statistics and examination of metrical characteristics of the SHRP questionnaire, the results of the applied Kruskal-Wallis non-parametric test of significant differences will be also shown in this paper.

3. RESULTS

The most relevant results according to discussed issues have been given in the charts below.

Figure 1. shows the results of the test-retest application of the SRHP instrument for risk self-reporting, for all the cities in which the survey was carried out. The highest rate of improvement of candidates, according to the observed criterion, has been recorded in the city of Zrenjanin (83,%), while the lowest rate of self-perceived risk in traffic was recorded in the city of Subotica (40%).

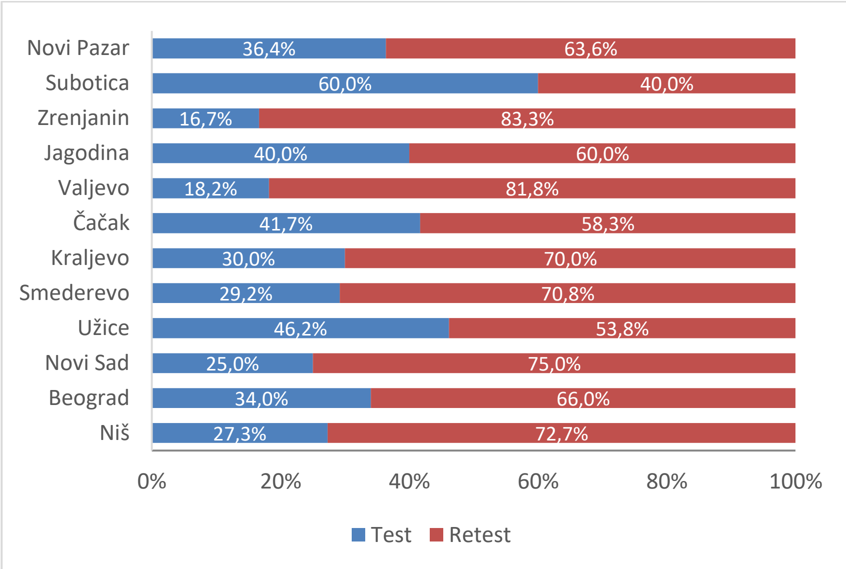


Figure 1. *Results of the test-retest application of the SRHP questionnaire, per cities*

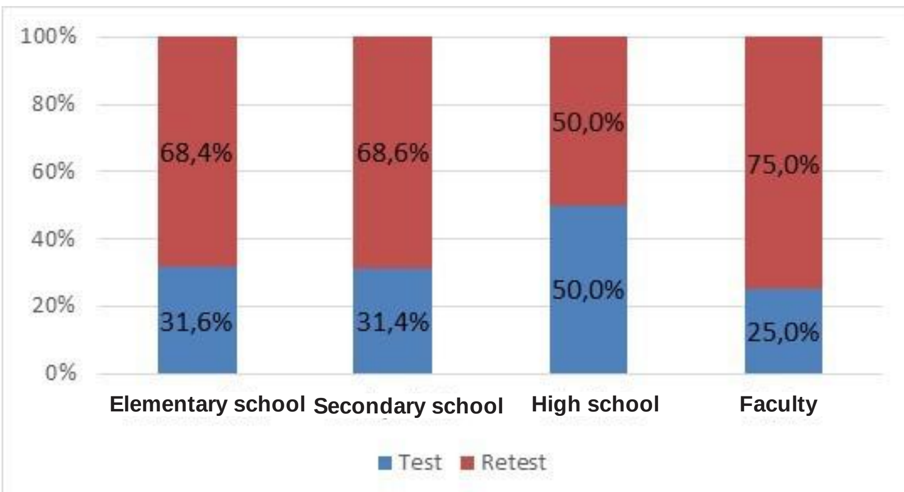


Figure 2. *Results of the test-retest application of the SRHP questionnaire in relation to respondents' education*

Figure 2. shows the results of application of the SRHP instrument at the beginning, as well as at the end of the rehabilitation process, in relation to the respondents' level of education. It can be noticed that the respondents with the highest education had the highest recorded increase in the self-reported risk (even though other results do not follow such a trend, which can be seen in the table).

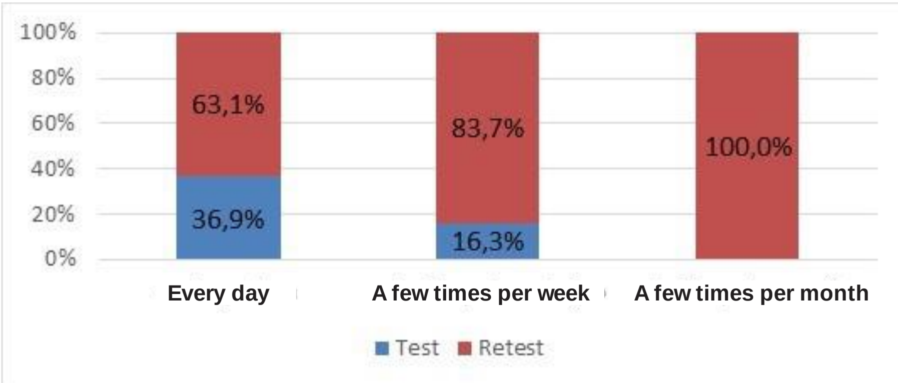


Figure 3. *Results of the test-retest application of the SRHP questionnaire in relation to the exposure in traffic*

The results of the analysis given in Figure 3. show that drivers who drive their vehicles every day, when retested, scored the lowest result for the self-reported risk.

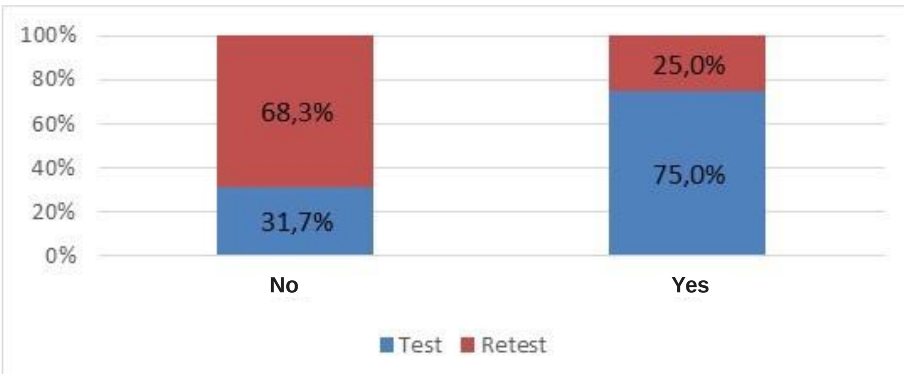


Figure 4. *Results of the test-retest application of the SRHP questionnaire in relation to experienced road accidents*

Data on Figure 4. indicate that the SRHP test score was prevailing with the respondents who faced road accidents in their driving experience, i.e. with drivers with a recorded lower rate of influence in changing public awareness about the risk.

As for the gender structure of the observed sample, according to initial expectations, male drivers dominate the sample (98,2%). Such a picture can be interpreted by a higher rate of male drivers in the driving population, especially when it concerns active drivers. On the other hand, drivers whose driving licences have been suspended can certainly be put in the group of drivers who are more likely to expose themselves to riskier forms of driving behavior. Numerous studies indicate that male drivers are more likely to make traffic offences. Due to the abovementioned, the research sample could not satisfy the gender representation, and therefore it was not important to consider this variable in the context of the subject of research of this study.

***Table 1**. Results of the analysis of significant difference (Kruskal-Wallis test)*

	Age	**Driving experience**	**Annual kilometers travelled (as a driver)**	**Frequency of driving**
Chi-Square	9,957	6,068	7,067	7,905
Asymp. Sig.	0,002	0,014	0,008	0,005

Table 1. shows the results of examined significant difference within the observed demographic and driving characteristics. Using the Kruskal-Wallis test to check the significant difference among the groups, statistically significant differences of individual variables were recorded. Obtained results show that there are statistically significant differences in relation to the achieved score of the applied SRHP test-retest questionnaire. Differences have been found in the following variables: age, driving experience, kilometers travelled on an annual basis (as a driver) and frequency of driving a vehicle.

4. DISCUSSION

When it comes to the driving experience and age of drivers, the analysis revealed a statistically significant difference between elderly and younger drivers. Elderly drivers show a lower rate of progress in terms of the self-perception of risk when compared to young drivers. These data are somewhat expected, if we take into account that attitudes are relatively permanent dispositions in the structure of personality, which are more difficult to be influenced in the later age, when the personality in question has already been fully formed.

If the exposure of respondents to traffic, i.e. frequency of driving their vehicles is discussed, the conclusion is that the least impact can be achieved on drivers who are largely exposed to traffic. Although such a result is not encouraging, it is assumed that, among drivers who drive their vehicles every day, those drivers with a longer driving experience and years of experience are more represented, which would be expected when taking into account previously discussed analysis of data.

The last criterion of the analysis included in the examination of significant differences between the groups is related to involvement in road accidents. For greater accuracy, it should be noted that the answer *Yes* in Figure 4. has consolidated all respondents who have experienced one or more accidents. The largest number of respondents has not been involved in road accidents though (36.1%), in their own driving histories. On the other hand, a significant percentage of them have been involved in one road accident so far (32%). However, when creating the program of rehabilitation, drivers who were involved in road accidents should be specially profiled in order to identify any patterns in their behavior that are likely to be influenced on.

The analysis of results also show that in addition to theoretical training, great importance in dealing with drivers whose driving licenses have been suspended is given to techniques that encourage self-perception of drivers. This opens as well the possibility for new techniques and methods for the riskiest groups within this population of drivers, through a more interactive and personalized approach that would allow for gaining self-insight into own attitudes, needs, habits and actions.

5. CONCLUSION

Correcting undesirable forms of driving behavior understands training of capacities for subjective perception of risk. An increasing number of scientific studies deals with this phenomenon and the results obtained indicate the fact that it is possible, but also necessary, to influence drivers' perception of risk (Sümer et al., 2006).

Some of the measures applied during the rehabilitation process enable the participants to gain an insight into their own behavior and deal with the consequences of inadequate behavior in traffic. Indirectly, these results should help identify individuals who are more prone to road accidents and thus direct the creation of differentiated programs, both for the rehabilitation of drivers whose driving licenses have been suspended, and for prevention of road crashes. These results may have their practical implications in the process of driver training, especially if it is not understood solely as the acquisition of skills and learning of rules of driving. The recommendations offered include the consideration of results for the purpose of road safety improvement in local communities, where the survey was conducted, and beyond.

6. LITERATURE

[1] Iversen, H., & Rundmo, T. (2002). Personality, risky driving and accident involvement among Norwegian drivers. Personality and Individual Differences, 33, 1251–1263.
[2] Sümer, N., Özkan, T., & Lajunen, T. (2006). Asymmetric relationship between driving and safety skills. Accident Analysis and Prevention, 38, 703–711.
[3] Sümer, N. (2003). Personality and behaviour predictors of traffic accidents: testing contextual mediated model. Accident Analysis and Prevention, 35, 949-964
[4] Zakon o bezbednosti saobraćaja na putevima (2009), Službeni glasnik Republike Srbije br. 41/09, 53/10, 101/11.

ROAD SAFETY
IN LOCAL COMMUNITIES

WE INVITE YOU TO

XII International
Conference
ROAD SAFETY IN LOCAL COMMUNITY

APRIL, 2017

www.bslz.org

11th International Conference
"Road Safety in Local Community"
Serbia, Vrnjacka Banja, Hotel Zvezda,
April 13 – 16, 2016

INVITED PAPER

FATIGUE AS A ROAD SAFETY PERFORMANCE INDICATOR

Dalibor Pesic[1], Boris Antic[2], Jelica Davidovic[3]

Abstract: Fatigue as a road safety performance indicator is still being developed. However, this indicator is of particular significance for determining the quality of work of a transport company, and the quality of professional drivers in the first place. Unlike determining the blood alcohol contents, for example, there is no device that can measure the level of fatigue. For this reason, various instruments for determining the level of fatigue are in use. However, none of them is suitable for testing professional drivers on a daily basis, either before they start their shift, or when making a control of them, or after a road accident has occurred. In order to create input variables for determining fatigue indicators it will be necessary to examine the link between objective indicators (hours of sleep, sleep time ...), subjective feeling of fatigue and accident occurrence. Based on research results, the aim of this paper is to try to reach the model that will be able to more reliably demonstrate the road safety performance indicator related to fatigue.

Keywords: fatigue, Road Safety Performance Indicators, professional drivers, survey method, road accidents

1. INTRODUCTION

The concept of fatigue is used in everyday life to describe the mental and physical condition of human organism. Many people often neglect it and fail to understand seriously the first symptoms of fatigue, such as agitation, numbness,

[1] Ph.D., Dalibor Pesic, Assistant Professor, Faculty of Transport and Traffic Engineering of the University of Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, d.pesic@sf.bg.ac.rs
[2] Ph.D., Boris Antic, Assistant Professor, Faculty of Transport and Traffic Engineering of the University of Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, b.antic@sf.bg.ac.rs
[3] Jelica Davidovic, M.Sc., Assistant, Faculty of Transport and Traffic Engineering of the University of Belgrade, 305, Vojvode Stepe street, Belgrade, Serbia, jelicadavidovic@sf.bg.ac.rs

absence of willingness, reduced concentration and slow movement. They set out on a journey in such a condition. During the journey, they also neglect very often the late signs of fatigue, such as drowsiness, optical illusions, dropped head, which can all lead to falling asleep and “fading out”.

The analysis of road accidents worldwide led to the conclusion that road crashes occurred as a result of fatigue are characterized by the time of occurrence, i.e. most often between midnight to 6 a.m. Also, there are no visible traces of braking left which indicates that drivers failed to use the brakes. Drivers are most often alone in a vehicle or passengers are fallen asleep. Road accidents are related to monotonous road sections with high speeds, but without heavy traffic. Having in mind all the mentioned findings, the consequences of such road accidents include fatalities or serious bodily injuries which lead to disabilities.

Road crashes occurring as a result of fatigue most often happen with professional drivers, who account for the largest number of drivers in road traffic. In order to reduce the percentage of such road crashes, which depending on the country varies from 20% to 50%, various measures have been undertaken. Fatigue as a road safety performance indicator is still in its development stage. However, this indicator is of particular significance for determining the quality of work of a transport company, and of professional drivers in particular. Before defining a road safety policy of a company, local community or state, it will be necessary to examine the existing situation, i.e. drivers’ characteristics, so that the measures undertaken could yield best possible effects.

Table 1 shows the results of some of the previous research studies that examined the subjective feeling of drivers’ fatigue. The studies have shown a significant difference in the personal feeling of fatigue over the last 20 years.

Table 1. *Results of previous research studies*

Author	Year	Target group	Conclusion of analysis
Martikainen	1992	Drivers in Finland who have been involved in a road accident	15% of drivers stated that they participated in a conflict due to falling asleep while driving
Perez-Chada	1995	Drivers in Argentina	56% of professional drivers felt sleepy while driving
Maylock	1997	Drivers in Norway who have been involved in a road accident	27% respondents felt sleepy while driving
Davidovic	2013	Drivers in Serbia	70% felt sleepy while driving, while 17% fell asleep while driving

In order to create input variables for determining fatigue indicators, it will be necessary to check the dependence between objective indicators (hours of sleep, sleep time …), subjective feeling of fatigue and occurrence of road crashes. Based on research results, the aim of this paper will be to try to reach a model that will be able to more reliably demonstrate road safety performance indicators related to fatigue. To that end, a survey was carried out across the Republic of Serbia. Professional drivers employed at a transport company, and those who are active drivers, have been surveyed for the purpose of this paper.

2. RESEARCH METHODOLOGY

Data have been collected during the survey that was carried out in December 2015 and January 2016. The survey included transport companies carrying goods and passengers, and having their headquarters in the Republic of Serbia. The survey form was anonymous. A sample of 276 survey forms has been collected, out of which 10 were excluded, due to incomplete answers, so in total 266 survey forms have been analyzed, i.e. 266 professional drivers have been surveyed, out of which 102 have been involved in at least one road accident. The “hand out and collect” method has been used in order to avoid the situation of giving socially desirable responses and thus increase the survey quality.

The survey form consisted of several parts. Part 1 had general questions (gender, age, data on driving permit and kilometers travelled). Part 2 consisted of questions concerning the quality and quantity of sleep. A part relating to road accidents they have been involved in as drivers followed after these questions. The last part of the survey form concerned the assessment of frequency of applying certain measures for eliminating fatigue. A control question was also asked in the last part in order to determine the reliability of the survey. The Cronbach’s alpha coefficient has been used to check survey reliability.

Statistical analysis of data has been made using the SPSS Statistics 20.0 program. Normality of distribution has been checked using the Kolmogorov-Smirnov test. Non-parametric tests have been also used since there have been noticed deviations of all observed variables from normal distribution. These non-parametric tests included the Pearson’s chi-square independence test and the Kruskal-Wallis test.

A zero hypothesis (H_0) has been set and read: There is no statistically significant difference among the groups, while the working hypothesis (H_a) read: There is a statistically significant difference among the groups. The threshold of the statistical significance (α) has been set to 5%. According to this, if $p \leq 0{,}05$, H_0 will be rejected and H_a accepted. If $p > 0{,}05$, H_0 will be accepted.

Since the application of the Kolmogorov-Smirnov test has revealed a deviation from the normal distribution, the Spearman’s chi-square rank correlation coefficient has been used to examine the correlation between the hours of work and hours of sleep. The binary logistic regression has been also applied to determine dependence between the involvement in road accidents and the quantity of sleep, as well as between the involvement in road crashes and the quality of sleep.

3. RESULTS

3.1. General data

The sample consists of 266 professional male drivers, employed at the transport company, and of active professional drivers. As for the age structure of those surveyed, the largest number of respondents belong to the age category from 36 to 45 years (41,9%), then from 26 to 35 years (30,9%), 17,7% of professional drivers are aged 46 to 55 years, 6,8% are aged 56 to 65 years, while the category of 18 to 25 years (2,6%) accounts for the smallest number of professional drivers.

The average driving experience of respondents is 20 years, where the oldest driver passed the driving exam in 1974 (Category D), and the youngest driver passed the driving exam in 2015 (Category D). The largest number of surveyed drivers is bus drivers operating the city, intercity and international bus lines (52,3%). They are followed by drivers of heavy goods vehicles (28%), vans (15,5%), while 4,2% are passenger cars drivers, i.e. drivers transporting the goods in passenger cars. Surveyed drivers most often travel between 2.500 and 5.000 km per year (35,2%), then 5.000-7.500 km (22,3%), over 10.000 km (17%) and less than 2.500 km and between 7.500 km and 10.000 km (12,5% each).

When taking into account dependence between the types of vehicles currently driven and average driving hours per week, it has been found that there is a statistically significant difference (Kruskal-Wallis test, $\chi2 = 63{,}92$ $p < 0{,}001$). Bus drivers are those who have the highest number of driving hours (48 hours), some of them driving even 90 hours per week. They are followed by van drivers (maximum 80 hours per week), while passenger car drivers drive the least number of hours (42 hours per week).

3.2. Quantity and quality of sleep

The binary logistic regression revealed that drivers sleeping less than 6 hours during the night are 2,5 times more likely to have had good quality sleep (Omnibus test: $\chi2=11{,}815$; $p=0{,}001$; Wald=11,44).

The binary logistic regression has not found out a statistically significant link between the quality of sleep (quality/no quality) and sleep time (before midnight/after midnight), Omnibus test: $\chi2=0{,}002$; $p=0{,}969$; Wald=0,002).

Taking into account respondents' biorhythms and considering the fact that the average sleep time is 21 hours 14 minutes, the subject of examination was the situation in which one category belongs to up to 21 hours 30 minutes group, and the other category is in after 21 hours 30 minutes group. The results have shown that there is no statistically significant link in this cross-section either (Omnibus test: $\chi 2$=1,165; p=0,280; Wald=1,151).

The analysis of the quantity and quality of sleep can help conclude that drivers who sleep longer have 2,5 times more quality sleep. It can be also concluded that sleep time of professional drivers is not a significant sleep quality indicator, which can be linked to the functioning of their biological clock as related to their work shifts.

The Kolmogorov-Smirnov test was used to examine the normality of variables "How many hours on average per week do you work" and "How many hours on average do you sleep". A deviation from the normal distribution has been found and for that reason, the Spearman's rank correlation coefficient has been applied to examine the correlation among the observed variables. It shows a statistically significant ($p<0,001$) negative link of medium strength (r=-0,304), meaning that the hours of sleep drop with the increase in the number of hours of work.

3.3. Road accidents

The analysis includes 102 respondents involved in 169 road crashes, out of which 81,7% were accidents with a small material damage, 10,1% with significant material damage, 4,2% with slight bodily injuries, 2,4% with serious bodily injuries and 1,8% with fatalities.

The binary logistic regression has been applied with the aim of determining the impact of quantity and quality of sleep on the occurrence of road accidents. The first variable represents involvement in a road accidents (0-no, 1-yes), the second variable is the quality of sleep (0-quality, 1-no quality), as well as the personal feeling of the quantity of sleep (0-sufficient, 1-insufficient). The results have shown that there is a statistically significant link between the occurrence of road crashes and the quality of sleep, i.e. a road accident is 1,6 times more likely to occur if a professional driver reports the absence of quality sleep (p=0,05; Wald=3,62). A statistically significant link has not been found between a road accident and the quantity of sleep (p=0,31; Wald=1,03). Based on these findings, it can be concluded that quality, but not quantity of sleep, should be used as an input variable representing fatigue indicator.

3.4. Measures for eliminating fatigue

The last part of the survey form contained the control question, while the reliability of the survey has been tested using the Cronbach's alpha coefficient with the value of 0,87, indicating a very high reliability of the survey.

Table 2 shows the mean, minimum and maximum values of the frequency of using mentioned measures for eliminating fatigue of professional drivers while driving. Respondents assessed the frequency of applying the mentioned measures, using the scale from 1 to 5, where 1 means never, and 5 means always. Table 2 also shows that professional drivers most often turn the radio on when they feel fatigue, while asking the passenger to drive is the most rarely asked question. This can be explained by the fact that bus drivers account for the largest group of drivers included in the sample, who most often drive on a single basis, i.e. do not have a coupled crew.

Table 2. *Frequency of applicable measures intended for elimination of fatigue while driving*

ATTITUDE	MEAN	MIN	MAX
If I feel fatigue while driving, I stop and make a break.	3,11	1	5
If I feel fatigue while driving, I sleep.	2,32	1	5
If I feel fatigue while driving, I take caffeine/energy drink.	**2,32**	1	5
If I feel fatigue while driving, I turn the radio on.	***3,38***	1	5
If I feel fatigue while driving, I converse with passengers.	2,68	1	5
If I feel fatigue while driving, I open the window/turn down the heating/turn on the air-conditioner.	3,18	1	5
If I feel fatigue while driving, I ask the passenger to drive.	1,65	1	5
If I feel fatigue while driving, I take energy drink or caffeine.	**2,33**	1	5

The Pearson’s chi-square independence test has not revealed a statistically significant link between the kilometers travelled and listening to the radio, as a measure for eliminating fatigue ($\chi2=18{,}75$; $p=0{,}538$). Also, the Pearson’s chi-square independence test has not found any statistically significant link between the kilometers travelled and taking caffeine/energy drinks ($\chi2=23{,}59$; $p=0{,}261$).

However, if the frequency of listening to the radio depending on the kilometers travelled is observed, it can be noticed that drivers travelling more than 10.000 km or less than 2.500 km (Figure 1) most often listen to the radio, while drivers travelling 7.500-10.000 km per month (Figure 2) most often have energy drinks or caffeine.

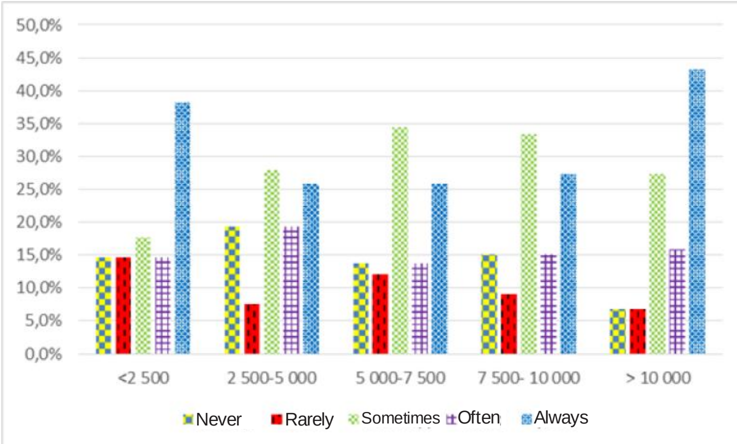


Figure 1. *Frequency of listening to radio as a measure for eliminating sleepiness while driving*

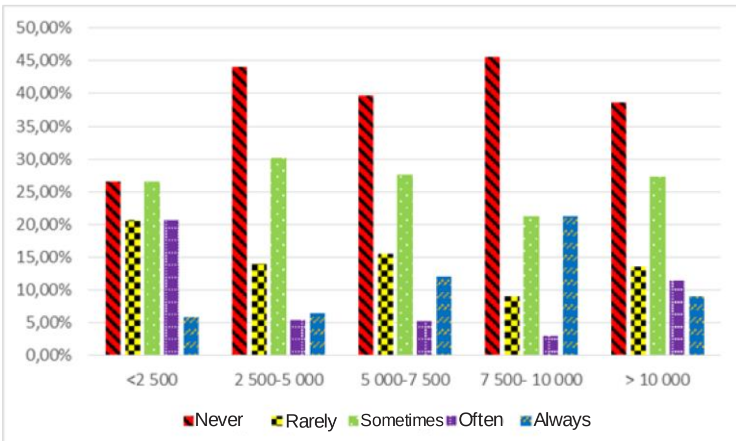


Figure 2. *Frequency of having caffeine/energy drinks as a measure for eliminating sleepiness while driving*

4. DISCUSSION

Since the beginning of the 1990s, great attention was paid worldwide to research studies that dealt with the impact of fatigue on the occurrence of road accidents and measures for their elimination. Garder et al. (1994) revealed even then that 25-50% of road accidents occurred because of fatigue, and that percentage varied depending on the scope of research. As for the Republic of Serbia, it is difficult today to determine whether a road accident has occurred due to fatigue, since there is no instrument that can indicate the quantity of driver's fatigue. Those who drive most – i.e. professional drivers, are particularly vulnerable. Additional problem lies in the fact that fatigue indicators have not been yet determined globally, which would constitute the basis for classifying drivers according to the level of driver's fatigue.

Over the last couple of years, research studies relating to fatigue have not included only the number of road accidents occurred as a result of fatigue, but have, as is the case with this paper, engaged in the research of risk factors or characteristic groups of drivers at risk, in order to undertake appropriate measures.

The survey has helped find out that the biological clock of professional drivers works depending on their work shift, and therefore, their sleep time does not have an impact on accident occurrence. On the other hand, the quality of sleep is a significant variable. Quality of sleep is linked significantly with the quantity of sleep. Taking into account that the optimal time of sleep is from 6 to 8 hours, the analysis set the limit of 6 hours. Thus the attitudes concerning the quality of sleep were determined for drivers who sleep less than 6 hours and for drivers sleeping at least 6 hours. Drivers who sleep at least 6 hours a night are 2.5 times more likely to have a good quality sleep. Various sleep disorders certainly should not be ignored as they can affect the situation in which the quality of sleep does not depend on the quantity of sleep. The study of Philips and Sagberg (2013) found that male drivers (especially young ones) suffering from a sleep disorder, are exposed to a much higher risk of occurrence of road accident.

In today's world, people often choose between health and social activities, and neglect early and late signs of fatigue. The study revealed that those drivers who work longer, sleep less on average, as is confirmed in the preceding paragraph. Therefore, when they work longer, they give up sleep in favor of their social life in order to make up for the extended time at work. These results are consistent with Vujanic et al. (2015), indicating that the increase in daily driving time of drivers involved in an accident leads to the significant decrease in driver's hours of sleep.

Maycock, G. (1995) found that, in order to eliminate fatigue, 68% of drivers open the windows or amplify the air-conditioner, 57% stop the vehicle and go out to walk, while 30% listen to the radio. Davidovic (2013) got similar results, and revealed that in Serbia, measures used to eliminate fatigue usually include listening to the radio (30%), and having caffeine (30%). This paper confirms the results obtained by Davidovic (2013). The most commonly used measures for eliminating fatigue while driving include listening to the radio and having caffeine/energy drinks. Pesic et al. (2015) examined the frequency of use of caffeine and energy drinks, depending on the age structure of drivers. They found that caffeine is consumed by all age groups, with those under the age of 55 consuming it significantly more than the elderly. They also found that energy drinks are most often taken by young people (18-25 years), while this percentage decreases significantly with the elderly drivers.

5. CONCLUSION

Fatigue as a cause of road accidents is the issue that has been worked on globally for decades. It has been the subject of research studies in the Republic of Serbia for a couple of years. Employers do not have the tools to be able to determine whether and to what extent the driver is tired. In addition, drivers often disregard the signs of fatigue, which may be the cause of road crashes characterized by crossing the opposite lane, absence of braking traces, high speed, nighttime driving, a single driver in a vehicle or sleeping passengers.

The following is the most important conclusions of this paper:

- Bus drivers drive most (48 hours), some of them even 90 hours, then drivers of vans (maximum 80 hours), while passenger car drivers drive the least (42 hours).
- Drivers sleeping at least 6 hours in the night are 2,5 times more likely to have a good quality sleep.
- Sleep time of professional drivers is not a significant indicator of sleep quality.
- Hours of sleep decrease with the increase in hours of work.
- A road accident is 1,6 times more likely to occur if professional drivers are of opinion that their sleep is not of good quality.
- When feeling fatigue, drivers most often turn on the radio, while they most rarely ask the passenger to drive the vehicle.
- Quality, but not quantity of sleep should be taken as an input variable for the fatigue indicator.

Based on these conclusions, it has been proposed to measure the following indicators:

• % of professional drivers who have a good quality sleep;
• % of professional drivers who suffer from a sleep disorder;
• % of professional drivers who use effective measures to eliminate fatigue;
• % of professional drivers with the "day-time[4]" biorhythm;
• % of professional drivers with the "night-time[5]" biorhythm;
• BIO risk - the percentage of drivers who drive in the period from 04:00 to 06:00 (when road accidents occur most due to fatigue), after having driven at least 4 hours (during the night shift) before that period, etc.

This work is a step further in trying to define the road safety performance indicator relating to fatigue. Hence, three input variables have been

[4]Drivers working during the day
[5]Drivers working during the night

separated: the quality of sleep, health status (presence of sleep apnea disorder, narcolepsy, etc.), as well as consuming caffeine.

On the other hand, the contribution of this work for the local community is reflected in determining dependence among objective indicators, subjective feeling of fatigue and occurrence of road accidents, in order to create fatigue related road safety performance indicator. Thus the quality of work would increase in all transport companies - in all local communities, as an effort in improving road safety, i.e. reducing the number of road crashes, the injured and fatalities.

Next steps should be directed towards examining of defined input variables and also examining the existence of additional contributory factors. Future research studies should deal with developing road safety performance indicators for fatigue, as they must be paid due attention.

6. LITERATURE

[1] Davidović, J. (2013). The Analysis of the Impact of Driver Fatigue on Professional Driver's Road Safety, VIII International Conference "ROAD SAFETY IN LOCAL COMMUNITY", Serbia, Valjevo, April 18-20, 2013.
[2] Martikainen, K., Hasan, J., Urponen, H., Vuori, I., & Partinen, M. (1992). Daytime sleepiness – A risk factor in community life. Acta Neurologica Scandinavica, 86(4), 337–341. http://dx.doi.org/10.1111/j.1600-0404.1992.tb05097.x.
[3] Maycock, G. (1997). Sleepiness and driving: The experience of UK car drivers. Accident Analysis and Prevention, 29(4), 453–462. http://dx.doi.org/10.1016/S0001-4575(97)00024-9.
[4] Maycock, G., (1995). Driver Sleepiness as a Factor in Car and HGV Accidents, Transport Research Laboratory, TRL Report 169.
[5] Perez-Chada D, Videla AJ, O'Flaherty ME et al. Sleep Habits and Accident Risk Among Truck Drivers: A Cross Sectional Study in Argentina, Sleep, 2005.
[6] Pešić, D., Antić, B., Brčić, D., Davidović, J. (2015). Driver's attitudes about the impact of caffeine and energy drinks on road traffic safety, Promet, accepted for publication, ISSN: 1848-4069, (IF_{2013}=0,292)
[7] Phillips, R. O., & Sagberg, F. (2013). Road accidents caused by sleepy drivers: Update of a Norwegian survey. Accident Analysis and Prevention, 50, 138–146. http://dx.doi.org/10.1016/j.aap.2012.04.003.
[8] Vujanić, M., Pešić, D., Antić, B., Davidović, J. (2015). Uporedna analiza stavova mladih vozača o uticaju energetskih napitaka na vožnju i subjektivnog osećaja umora u toku vožnje, X Međunarodna konferencija „Bezbednost saobraćaja u lokalnoj zajednici", Kragujevac, 22-25. april 2015. godine.

11th International Conference
ROAD SAFETY IN LOCAL COMMUNITY
Serbia, Vrnjačka Banja, Hotel Zvezda,
April 13 – 16, 2016

INVITED PAPER

PROMOTION AND FACILITATION OF BICYCLE USE IN PUBLIC TRANSPORT OF PUPILS AND STUDENTS – STRESS FREE AND HEALTHY ON BICYCLES

Osman Lindov[1], Adnan Alikadić[2], Adnan Tatarević[3], Jasmina Olovčić[4]

Abstract: Over the last couple of years, the number of bicyclists in general and more intensive use of bicycles in Bosnia and Herzegovina have been increasing gradually in the area of sports activities, and in the field of transport and useful activities in particular [1]. The population of pupils and students account for the largest number of bicyclists. Observing this population and also cycling as an integral part of the movement and transport would mean a significant step towards a healthier, better and more comfortable life of this population, both now and at the later age. This is due to the fact that acquiring habits and knowledge in youth will preserve the same relations in the old age. Including young people from secondary schools and of student population would be a significant progress and would certainly reflect on their attitudes to life, health and sport in response to some other evil forms of life of the young population, such as alcohol and drugs in particular. In addition to the mentioned features and defined measures, the project will have to include all secondary schools and institutions of higher education, through concrete actions, in the context of construction of adequate and secure bicycle parking lots in their institutions and yards. It will be necessary to inform and train the educators and

[1] Ph.D., Lindov Osman, Regular Professor, Faculty of Transport and Communications of the University of Sarajevo, 8, Zmaja od Bosne, Sarajevo, Bosnia and Herzegovina, olindov@gmail.com
[2] Alikadić Adnan, B.Sc., Professional Associate, Master, B.SC. Transp. and Comms., Road Directorate, Canton of Sarajevo, 1, Hamida Dizdara, Sarajevo, Bosnia i Herzegovina, adnan.alikadic@gmail.com
[3] Tatarević Adnan, B.Sc., Professional Associate, Master, B.SC. Transp. and Comms., Transport and Communications Institute, 8, Zmaja od Bosne, Sarajevo, Bosnia i Herzegovina, tatarevic@isik.ba
[4] Olovčić Jasmina, B.Sc., Professional Associate, Master, B.SC. Transp. and Comms., Road Directorate, Canton of Sarajevo, 1, Hamida Dizdara, Sarajevo, Bosnia i Herzegovina, jasmina.olovcic@gmail.com

young people from the target groups on the key risk factors leading to mistakes made by bicyclists, as young road users, which can result in road accidents and casualties.

Keywords: cycling, public transport, health

1. INTRODUCTION

Promotion and facilitation of bicycle use in public transport of the secondary school pupil and student's population, i.e. stress free and healthy cycling, is the innovative way aimed to attracting young people to use bicycles, as a means of transport, which will in turn help their physical and health culture. Young people from the target groups, i.e. students and pupils of secondary schools, will have to be informed in the first place on the key risk factors which lead to mistakes that bicyclists, as road users, usually make, and which may result in road accidents and casualties, such as:

- Inadequate and improper movement on the roadway surface intended for the movement of vehicles,
- Movement on the roadway surface intended for the movement of vehicles, in cases when there are bicycle facilities along the roadway,
- Staying long on the roadway surface intended for the movement of vehicles,
- Crossing the road at dangerous and poorly visible locations on the roadway,
- Disobeying light signals (traffic lights) when crossing the road,
- Careless and irresponsible road crossing without paying attention to vehicle movement,
- Using pedestrian facilities in cases when there are bicycle facilities provided,
- Careless and irresponsible use of pedestrian facilities.

Activities aimed at promoting and facilitating bicycle use as a means of public transport of the pupil and student's population – stress free and healthy cycling, will be implemented in all schools and faculties in the Canton of Sarajevo. The number of direct beneficiaries to be included in the activities is around 10.000 secondary school pupils and students. Framework activities to be implemented will include the following:

- Lectures – presentations, with the following titles:

- Bicycle, sport and health of the pupil and student's population;
- Bicycle infrastructure in the City and Canton of Sarajevo;
- Regulations and rules for safe cycling;
- Bicycle as a means of transport and sustainable mobility in the City and Canton of Sarajevo.

- Competition – tests for a proper participation in public transport.

- Tests have been made to check the knowledge of traffic rules for bicyclists. They make the integral part of the tests intended for passing driving examination for drivers of motor vehicles. Additions include adequate situations in traffic involving bicycles and motor vehicles, bicycles and pedestrians, bicycles and bicycles, etc.

- Competition – making innovations in bicycle design for use in public traffic.

- Competition for an innovative bicycle design will be organized among the secondary school pupils and students, with the intention of involving in and thinking about this form of „healthy“ transport.

- Competition – making innovations in infrastructure.

- Competition for the bicycle parking lot design will be organized among the secondary school pupils and students.

- Questionnaire – the use and importance of bicycles for transport, sport and health.

- The questionnaire will be offered in majority of schools and faculties with the aim of surveying how many bicycles are available to this population, how many of them know how to cycle, how many of them have bicycles, how many of them use their bicycles and how many of them would use bicycles, etc.

- Promotional cycling – promotional cycling will include a huge number of secondary school pupils and students.

- Promotional cycling with the participation of secondary school pupils and students will be organized using adequate cycling facilities, i.e. bicycle lanes and safe bicycle paths, leading from schools to eligible destinations.

- Making the elaborates on upgrading bicycle infrastructure (parking lots and bicycle garages) which will be provided for and installed in all secondary schools and faculties [2].

- A modern parking lot of a type will be made to serve as a model to all institutions showing the interest in investing appropriate funds to allow for a secure disposal of bicycles.

2. DESCRIPTION OF THE PROBLEM, TARGET GROUPS, OBJECTIVES, ACTIVITIES

The following are the issues that may help with the decision making process related to transport by bicycle in cities or in any local community:

- Increase in the motor vehicle traffic.
- Traffic jams and air pollution caused by motor vehicle traffic.
- Road accidents.
- Poor sports activities of secondary school pupils and students.

- Low level of traffic culture of the secondary school pupils and students.

The following are the issues restricting bigger use of bicycles in transport and recreation, in cities or in any local community:

- Bicycle paths are provided only partially.
- Conflict points of bicyclists and other road users at locations where bicycle paths are missing are not resolved.

Activities and needs of cities or local communities aimed at promoting bicycles as a means of transport for better health should be reflected in the following:

- Need for constructing additional bicycle paths.
- Need for constructing parking lots and garages for bicyclists.
- Need for developing environmentally friendly end clean transport and a city of comfortable living.

Around 5.000 pupils in schools and students of the Sarajevo University, aged 15 to 25 years, of both genders, are direct beneficiaries of the abovementioned activities.

Indirect beneficiaries include the following: Young people who will benefit from experiences and attitudes of direct beneficiaries, through peer education – 5.000 beneficiaries. Young people who will receive information by public media, internet and social networks – 10.000 beneficiaries. Professors and assistants included in the project – 300 beneficiaries. Individuals to whom the message from the project will be conveyed, through media will include – 100.000 beneficiaries.

Specific objectives of the project:

- Developing traffic culture of young people through lectures, competition, questionnaires, video footage and simulations aimed at observing traffic culture, and safe and responsible behavior of bicyclists in traffic.
- Raising young people's awareness on bad habits and risky behaviors contributing to devastation of traffic culture and occurrence of road accidents and injuries.

3. ACTIVITIES AIMED AT IMPROVING BICYCLE USE IN PUBLIC TRANSPORT

Activities aimed at promoting and facilitating the use of bicycles in public transport of secondary school pupil and student's population are made up of preparatory activities, main activities and concluding activities. Preparatory activities include the following:

- Providing educational tools;

- Establishing cooperation with the University and faculties and also with schools;
- Establishing cooperation with media;
- Promoting the project through social networks;
- Preparation of lecturers;
- Preparation of presentations, practical exercices, video materials and simulations;
- Preparation of materials for competition, questionnaires and tests;
- Preparation of materials for questionnaires and examination of opinions for the purpose of making a register and database on bicyclists and bicycles;
- Preparations of promotional cycling;
- Preparation and data collection related to the volume and size of improvement of bicycle facilities, bicycle parking lots and garages; [3]
- Preparation of prizes, awards, acknowledgments and certificates;

Main activities comprise the following:

- Implementation of lectures, display of video materials and simulations;
- Implementation of competitions and tests;
- Implementation of questionnaires and surveys to examine attitudes;
- Proposal for the register and database on bicycles and bicyclists;
- Making of elaborates and project documentation for improvement of bicycle infrastructure, parking lots and garages for bicycles in secondary schools and faculties in the area of the Sarajevo Canton;[4]
- Promotional cycling;
- TV production;
- Sending press releases;
- Promotion of the project on Internet;

Concluding activities include the following:

- Analysis of results;
- Building and improving bicycle facilities;
- Making of the concluding materials – Final project report (brochure);
- Promoting and sending results to the interested stakeholders.

4. SUSTAINABILITY OF ACTIVITY

Implementation of the aforementioned activities will permanently provide adequate material (presentations, practical exercices, tests, questionnaires, simulations, video recordings, brochure, etc) and infrastructure that will be used in the forthcoming period for the purpose of the same and similar activities aimed at improving the culture of bicycle riding, and adequate enhancement of traffic culture and road safety. Also, implementation of the project will enable the promotion of the importance of bicycle use in the public transport and affirmation of bicycle traffic. The population of secondary school pupils and university students will go through the stages of education, testing, questionnaires. A wide cooperation will be established among media, local communities, ministries, universities, faculties, schools and all other actively involved institutions and their representatives. All the aforementioned will represent a solid basis and a well built system for a successful implementation and sustainability of this project in the future [5].

Well designed lectures, tests, questionnaires and simulation exercices, and the beginning of construction works of adequate parking lots for bicycles, guarantee that the young people will remember for a long time what they have learned. They will preserve the acquired knowledge and use it when participating in traffic. They will also benefit from the adequate infrastructure on their mission of transferring and developing knowledge in the institutions, throughout their school or working engagement. By accepting bicycles as an integral part of movement, along with pedestrian flows, young people (secondary school pupils and students) do so in the context of developing the awareness on the necessity of this kind of sport, recreation and transport, as a response to the growing demands for cities with comfortable and environmentally clean living.

5. CONCLUSION

The implementation of the activity "Promotion and facilitation of bicycle use in the public transport of pupil and student’s population – stress free and healthy on bicycles“ will familiarize young people from target groups – students and secondary school pupils, with the key risk factors that lead to mistakes made by bicyclists when participating in road traffic, which all may lead to road accidents and injuries. Through implementation and application of certain activities (presentations, practical exercices, video materials, simulations, competitions, questionnaires, tests and promotional rides), the awareness of students and secondary school pupils will be influenced in particular, with the aim to indicate the necessity to accept and use bicycles as the integral part of movement and transport. At the same time, this would represent a significant step towards a healthier, better and more comfortable life of this population also in their late age, as they would keep the same attitudes in the old age, once they acquired the habits and knowledge at their young age. In addition, with the construction and improvement of cycling infrastructure, parking lots and garage for bicycles, in secondary schools and faculties in the area of the Canton of Sarajevo, this project will certainly become sustainable.

6. LITERATURE

[1] Alikadić, A. 2007., Planiranje razvoja nemotorizovanog prometa na području Kantona Sarajevo, Diplomski rad, Fakultet za saobraćaj i komunikacije Univerziteta u Sarajevu, Sarajevo;

[2] ES Hydrotechnicsd.o.o. Sarajevo, 2009. Elaborat mreže biciklističkih staza na području Kantona Sarajevo, Ministarstvo saobraćaja – Direkcija za puteve Kantona Sarajevo;

[3] Institut za saobraćaj i komunikacije Sarajevo, 2014. Izvedbeni projekt obilježavanja biciklističke staze u ulici HamdijeČemerlića horizontalnom i vertikalnom saobraćajnom signalizacijom, Ministarstvo saobraćaja – Direkcija za puteve Kantona Sarajevo;

[4] Institut za arhitekturu, urbanizam i prostorno planiranje Arhitektonskog fakulteta Sarajevo, 2014. Izvedbeni projekat biciklističke staze "Nedžarići – Ilidža – Hrasnica – granica Entiteta", Ministarstvo saobraćaja – Direkcija za puteve Kantona Sarajevo;

[5] Lindov, O.; Alikadić, A; Pejić, M. 2012, Mogućnosti za afirmaciju biciklističkog saobraćaja na užem gradskom području, Ekspertni tim Federalnog ministarstva unutrašnjih poslova, Sarajevo.

11th International Conference
"Road Safety in Local Community"
Serbia, Vrnjacka Banja, Hotel Zvezda,
April 13 – 16, 2016

INVITED PAPER

UPGRADING THE ROAD ACCIDENTS DATABASE ACCORDING TO THE CADaS RECOMMENDATIONS OF THE EUROPEAN COMMISSION - IMPORTANCE FOR LOCAL COMMUNITIES

Dragoslav Kukic[1], Jelena Milosevic[2], Boban Milinkovic[3], Rade Cvijovic[4]

Abstract: At the European level, road accident data are sent to the CARE road accident database. The European Commission has defined a road accident dataset – CADaS. This set of data should be collected by all the states which deliver data to the CARE database. In 2014, the Road Traffic Safety Agency implemented the project called "Monitoring basic characteristics of road accidents in Serbia, in accordance with the CADaS recommendations of the European Commission". The project aimed at harmonizing data sets on road accident recorded in Serbia with the recommendations of the European Commission. Project implementation helped make the basis for the work on upgrading road safety in Serbia by improving the quality of road accident data collection process when making road accident investigations. After the completion of the project, the training for 413 traffic police officers was conducted in the first half of 2015, in order to raise the quality of road accident database which constitutes one of the most important elements for the analysis, monitoring and improvement of the road safety system. In order to increase the number of people who will be involved in the data collection system according to CADaS, the Agency carried out an additional training of police officers, per police administration units, at the end of 2015. Final harmonization with the EC recommendations was made during the mentioned training, and conditions were provided

[1] Ph.D., Kukic Dragoslav, Road Safety Sector of AMSS-Motor Vehicles Center LLC, kukicdragoslav@cmv.rs
[2] Milosevic Jelena, M.Sc., Associate, Road Traffic Safety Agency, 2, Bulevar Mihajla Pupina, Belgrade, Serbia, jelena.milosevic@abs.gov.rs
[3] Milinkovic Boban, B.Sc., Head of Department, Ministry of Interior-Traffic Police Administration, 2, Bulevar Mihajla Pupina, Belgrade, Serbia, boban.milinkovic@mup.gov.rs
[4] Cvijovic Rade, Head of Department, Ministry of Interior- Traffic Police Administration, 2, Bulevar Mihajla Pupina, Belgrade, Serbia, rade.cvijovic@mup.gov.rs

for the beginning of recording road accident data in accordance with the CADaS protocol, as from 1st January 2016. During the work with police officers, planned changes of the road accident data set have been tested and upgraded accordingly. This paper presents the most important innovations and improvements of the road accident data set within the road accident database.

Keywords: CADaS, road accidents, database, contributory factors, data set

1. INTRODUCTION

Good understanding of a road safety situation is the basis for the selection of measures intended for road safety improvement. Selected measures yield best results when they are targeted at specific problems on the observed territory. Databases holding road safety characteristics are the most important tool for understanding the current state and identifying road safety issues (WHO, 2010). The significance of databases for road safety management has been highlighted many times, both globally and at the European level, while the quality of road safety data is significant for understanding the nature and specific features of the problems that lead to the occurrence of road crashes (Kukic et al., 2015).

The concept of developing and improving road accident databases has been largely accepted worldwide. However, certain problems have been observed when using collected data, which appear in the form of uneven definitions of terms and insufficient level of data details. In order to sort out the problem in question at the European level, the European Commission proposed the basic set of standardized road accident data - CADaS[5] (EC, 2013). Standardization of road accident data aims at increasing the potential of databases, as practical tools that are used for road safety improvement (Kukic et al., 2015).

Quality road safety management is not possible without developed road accident databases (Kukic et al., 2014). One of the activities of the Agency, defined by the Road Safety Law (Article 9, paragraph 2, item 1) is making analyses, monitoring and improving the road safety system, and consequently, development and use of the unique database of significance for road safety (RSL, 2009). The national database has been established, and since the mid 2015, it has become publicly available through the web-gis application enabling the representatives of local communities and all other stakeholders to use this very important tool. The set of road accident data and their consequences may be the most significant segment of the unique database of importance to road safety. One of the first steps made by the Agency on the path of improving the road accident data set was the implementation of the project called “Monitoring basic characteristics of road accidents in Serbia, in accordance with the CADaS recommendations of the European Commission”, in 2014. The implemented project helped review the possibilities for introducing CADaS in the Republic of

5 CADaS – Common Accident Data Set

Serbia, which will provide a basis for modifying the way in which road accident data are collected and stored. After that, in the first half of 2015, in cooperation with the Traffic Police Administration of the Ministry of Interior, the training was carried out and included 413 police officers working on investigations on road accident data collection according to the CADaS recommendations of the European Commission. In October and November of 2015, additional training of police officers was carried out, after which they had to organize trainings in their stations in order to train as many police officers as possible for the initial data collection following CADaS recommendations, starting from 1 January, 2016. During the additional training, modifications of the road accident data set were tested in parallel and certain corrections and upgrading made accordingly. The paper will present some of the novelties foreseen by CADaS and certain corrections that were the result of the tests, with the special highlight on their significance for local communities.

2. THE IMPORTANCE OF DATABASES FOR LOCAL COMMUNITIES

Databases on road safety features are one of the most important managing tools of a traffic policeman. This tool is a must for decision makers at all levels of road safety management, and at the local level in particular. Practically, it turned out that the problem of inadequate allocation of funds incurring from collected fines for traffic offences happened to be a big issue at the level of local communities. This is due to the fact that data containing road safety characteristics are not sufficiently or not at all recognized and used when taking managerial decisions.

Databases are of great importance for local communities in terms of improvement of work of local road safety coordination bodies, but also of other important stakeholders involved individually in road safety at the local level. The significance of databases is in the fact that they allow for identification and more accurate definition of road safety issues. Accordingly, facts and conclusions resulting from the use of databases on road safety features are very important input parameters for defining road safety policies and strategies, as well as for action plans and programs of local communities. Selected road safety improvement measures must importantly be focused on recognized problems in the territories of local communities, because greatest effects and the most significant improvements of road safety will be achieved in that way. Therefore, data from databases can be used for the quantification of effects of implemented measures and for identification of the most effective measures for elimination or reduction of road safety related problems.

Local communities are encouraged to develop their own databases with road safety characteristics at the local level which will contribute even more to upgrading road safety management, identifying problems and making best decisions for efficient reduction or complete elimination of road safety related problems in local communities (Petrovic and Kukic, 2014).

Apart from road accident data and their consequences, which belong to the so called absolute road safety indicators, local databases on road safety characteristics should also have data on relative indicators (risk of casualties of certain road user groups, for the territory of a municipality, i.e. size of risk of casualties on roads and road sections), then data on road and traffic, including also data on the type and quality of road network, cadastre of traffic signs and markings, the riskiest road sections, hazardous locations and alike, data on road safety performance indicators and data on road user’s attitudes concerning risky behavior and penalty policy for sanctioning illegal traffic behaviors.

3. DATA SET IMPROVEMENTS

Since road accidents and their consequences are one of the most important sets of data in the database on road safety characteristics, this paper focuses on novelties in the road accident data collection. Collection of “new data” on road crashes started on 1 January, 2016. Certain novelties are the result of the changes based on CADaS recommendations, while the others emerged from the joint work of the Road Traffic Safety Agency and police officers who tested the proposed data set. Certain CADaS related novelties have been already described in the paper “Monitoring basic characteristics of road accidents in accordance with the CADaS recommendations of the European Commission” (Kukic et al., 2015).

3.1. Improving data on scenes of road accidents

3.1.1. Coordinates of road accident scenes

A very important novelty foreseen by CADaS is collecting data on road accident site coordinates. The insight into the spatial distribution of road crashes is provided by reading the coordinates of road accident sites. Compared to the previous aggregated analysis of all road accidents that happened in a specific local community, it will be possible to have an accurate picture of road accident distribution, by means of data on their coordinates, i.e. to see if road accidents are aggregated on certain locations, road directions or intersections. This has helped make a necessary step towards the quality spatial analysis of road crashes which is largely becoming a standard in EU states.

3.1.2. Road sections of the state road network

Another new capacity of the database is the analysis of road accidents according to the road sections on which they occurred. In fact, the nomenclature of state road sections has been entered into the database, which has been made possible by adopting the “new” reference system of state roads, meaning that, apart from other data, the data on the exact road section on which a road accident has occurred is also available. When it comes to funds allocation in road safety, it is not always easy to define the priority list. Therefore, calculation, analysis and comparison of road sections per risk values may be of great importance for setting priority actions, i.e. selection of those sections that are marked as highly risky.

3.1.3. Position of a road accident in the intersection

Road accidents that happened in an intersection will be recorded in the part of intersection where the road accident occurred, as defined by CADaS.

Table 1. *Parts of an at-grade intersection and a grade separated intersection (loop)*

Position in the intersection
Merging (center of intersection)
Access to intersection (up to 20m)
Part of the road between two merging areas (distance between areas of 10m and 20m)
Part of intersection where the median has been interrupted
Merging (in the loop)
Access to intersection in the loop (up to 20m)
Part of the road between two merging areas (in the loop)
Entry/exit ramps (in the loop)
Acceleration/deceleration lanes (in the loop)
Unknown

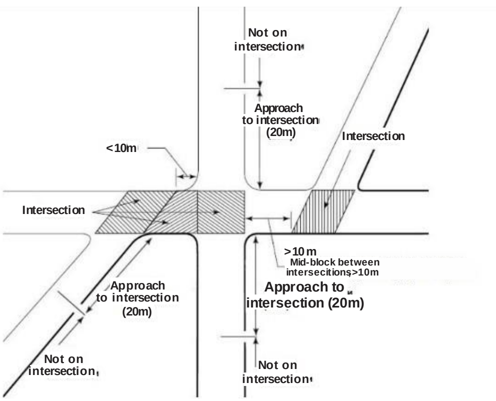


Figure 1. *At-grade intersection (source: CADaS Glossary, EC, 2013*)*

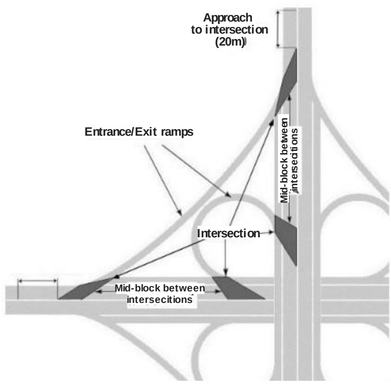


Figure 2. *Grade-separated intersection (source: CADaS Glossary, EC, 2013*)*

*The text of the original figure has been translated into Serbian within the process of introducing CADaS in Serbia

The elements of the at-grade and grade separated intersection (loop) have been defined, and parts of intersection where road accidents happened are recorded for each road accident in an intersection. Mentioned type of data offers the possibility to make more detailed analyses of road accidents in intersections. Table 1 shows parts of an intersection which make the nomenclature of the variable *Position in intersection* in the database, while Figures 1 and 2 give a graphical display of marked intersection elements.

3.1.4. Specific locations of road accidents

Database changes were tested during the work with policemen. It was found out that there are certain specific features related to the scene of road acccident which should be recorded as important in order to be available in the database, later on. The CADaS protocol has foreseen recording the specific features, such as the occurence of a road accident in a tunnel or on a bridge. However, it was revealed that in practice, there is a whole range of specific locations where road accidents occur, whose recording will be of great importance, but which is not in line with the CADaS protocol.

Table 2. *Variable – Specific location of a road accident*

Specific location of a road accident
Curve
Saddle
Narrow road
Bridge
Tunnel
Railway crossing without boom gates or half-boom gates
Railway crossing with boom gates or half-boom gates
Work zone
School zone
Zone "30"
Slow traffic zone
Pedestrian zone
Emergency stopping lane (of a highway or main road)
RA in the traffic lane for public enterprises – “yellow lane”
RA in the tram garden
Part between physically separated carriageways used for U-turn (excludes intersections)
Pavement
Bicycle lane or track
Unknown
Not a specific location
Remark

Having that in mind, a variable was created representing the improvement of the mentioned CADaS variables and providing for the recording of specific information such as: occurrence of RA[6] on the saddle, railway crossing, school zone, pedestrian zone, yellow lane, tram garden, etc. Values defined for the *Specific location of a road accident* variable are shown in Table 2.

3.2. Improvement of maneuvers data

When testing the proposed data set according to CADaS recommendations of the European Commission, it was found that the information on the manner in which road users (vehicles and pedestrians) were moving before a road accident was described in detail in the Minutes filled out by the police officers in the Republic of Serbia for each road accident, during the investigation. Having that in mind, a need occurred for a more detailed nomenclature than the one proposed by CADaS. Therefore, a correction and extension of the nomenclature has been made. CADaS proposed 26 values for vehicle maneuver and 12 values for pedestrian movement, while the corrected version of nomenclature relating to vehicle maneuver contains 30 values, and 13 values for pedestrian movement.

3.3. Improvement of data on contributory factors

Recording of contributory factors began in January 2016, but before that, the so called “causes” of road accidents – primary and secondary, had been recorded in the Republic of Serbia. The main shortcomings in the then system of recording of “causes” was that police officers assigned to each road accident one (primary) or two (primary and secondary) causes, which were after that “assigned” to drivers, vehicles or pedestrians. One of the disadvantages of this system was that all other factors were neglected, even if they existed in the situation in question and had an impact on the occurrence of the road accident in question, but could not have been recorded.

By introducing the model of contributory factors, police officers became able to collect all those factors relevant for a road crash, but which could have not been recorded by the previous system of recording the “causes” of road accidents. Contributory factors actually show why road accidents happen, and more importantly, imply how road accidents can be prevented (Kukic et al., 2013). More information on contributory factors have been presented in the paper “Monitoring basic characteristics of road accidents in accordance with the CADaS recommendations of the European Commission” (Kukic et al., 2015). Before it was finally adopted, the proposed model of contributory factors had been tested, and following corrections were made to include the conclusions from the conducted tests of the model. It can be said that the structure of the model has

[6]RA – Road accident

been preserved, but it was found that it was necessary to add certain factors (Annex 1).

Therefore, the following contributory factors have been amended in the group of contributory factors relating to **ROAD**:

- 104: Inadequate/nonexistent or masked signs, road markings **or road facilities**,
- 110: **Missing pavement in an urban area**,
- 111: M**issing bicycle path or lane in an urban area.**

The following contributory factor was added in the group of contributory factors relating to **VEHICLE**:

- 209: **Other vehicle defects.**

The following contributory factors have been amended or added in the group of contributory factors relating to **DRIVERS**:

- 302: Disobeyed “Give way” or “Stop” sign or markings as **defined by the sign of the police officer in charge**, road signs or **traffic rules**,
- 308: Unsafe length **or distance** between vehicles,
- 401: Junction overshoot (Failing to stop at the junction in front of the marked stop line **or a stationary vehicle)**,
- 707: Rain, sleet, snow, fog, **smoke**, etc.

The following contributory factors have been amended or added in the group of contributory factors relating the **SPECIAL CODES**:

- 904: Vehicle door **opened or** closed negligently (including public transportation vehicles),
- 906: **Unsecured scene of the road accident that contributed to the occurrence of a secondary road accident.**

4. CONCLUSION

Having in mind the great significance of road safety databases, it will be necessary to make improvements and upgrades of the mentioned tools, if the need be. Also, given the need for adjusting road accident data sets with the recommendations of the European Commission, the Road Traffic Safety Agency and the Traffic Police Administration of the Ministry of Interior have put efforts in raising the level of quality of road accident data to the level existing in the most developed European countries. The road to improvement did not see only the adjustments with the recommendations of the European Commission, but took into account the experiences obtained when testing the proposed data set by traffic police officers.

Benefits that local communities may expect from the improved road accident data sets include in the first place a more accurate and higher quality identification of road safety issues. More accurate data on road accident scenes offer information which concrete locations should have certain road safety improvement measures implemented. The fact that hazardous locations and road sections could not have been identified in a reliable manner, only on the basis of data from the road accident database, posed a great restriction in the past. By recording a larger number of data on the scenes of road accidents, this restriction should be overcome completely. In addition, recording contributory factors of road crashes gives a wider picture of various factors that had an impact on the occurrence of road accidents or more serious consequences of these road accidents. Contributory factors data offer information on why a concrete road crash occurred and imply the ways in which road accidents can be prevented.

Apart from the initial definition of the data set that need to be collected, it is very important to continually monitor how data collection process is unfolding in the field, primarily by the Traffic Police Administration of the Ministry of Interior. By monitoring how data are entered into a database, the quality of data can be enhanced and additional possibility provided for the correction and improvement of road accident data sets.

Local communities are expected to start to use the potential which is at their disposal, in order to improve road safety. To that end, local communities should be more focused on using the existing national databases on road safety characteristics, and also on establishing their local databases. It is of particular importance for them to use the advantages of the new method of road accident data collection. With new data, the analyses will be more effective, and problems will be identified in a more reliable manner, which is a necessary condition for the making of road safety strategies and action plans, as well as for the implementation of all other activities that are undertaken with the aim to reduce or completely eliminate road safety problems in each local community.

5. LITERATURE

[1] European Commission (EC). (2013). CARE Database. CADaS Common Accident Data
Set – Reference Guide.

[2] European Commission (EC), (1993). Directive No. 93/704/EU, Brussels.

[3] IRTAD – International Traffic Safety Data and Analysis Group (2014).

[4] Кукић, Д., Пешић, Д., Антић, Б., Милошевић, Ј. (2015). Праћење основних обележја саобраћајних незгода у Србији у складу са CADaS препорукама Европске комисије. X међународна конференција: Безбедност саобраћаја у локалној заједници. Крагујевац.

[5] Кукић, Д., Малешић, С., Милетић, Б., Лакићевић, С., (2014). Интегрисана база података од значаја за безбедност саобраћаја. IX међународна конференција: Безбедност саобраћаја у локалној заједници. Зајечар.

[6] Кукић, Д., Милетић, Б., Малешић, С., Милинковић, Б., (2013). Прилог дефинисању појма и поделе узрока настанка саобраћајних незгода у Републици Србији. VIII међународна конференција „Безбедност саобраћаја у локалној заједници“, Зборник радова, стр. 191-196.

[7] Петровић, Д. и Кукић, Д., (2014). Формирање базе података о саобраћајним незгодама на територији локалне самоуправе, значај и потенцијал. IX међународна конференција: Безбедност саобраћаја у локалној заједници. Зајечар.

[8] Tomas et al., (2008). European Commission, SafetyNet, Deliverable D1.12: Harmonizing national road accident data: Development of transformation rules for 15 European countries.

[9] World Health Organization (WHO). (2010). Data systems – A Road Safety Manual For Decision-Makers And Practitioners. France.

[10] Закон о безбедности саобраћаја на путевима (2009), Службени гласник Републике Србије бр. 41/09, 53/10, 101/11.

Improved table of contributory factors

Group I	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**
Contributory factors attributed to road and road environment	Poor or defective road surface	Deposit on road (eg. oil, mud, etc.)	Slippery road surface (due to weather conditions)	Inadequate/nonexistent or masked signs, road markings or road facilities	Defective traffic signals	Traffic calming measures implemented (eg. road humps, chicanes)	Temporary road layout (eg. contra-flow, change in traffic regime)	Road layout (eg. bend, hill, narrow road)	Animals or object in carriageway	Missing pavement in an urban area	Missing bicycle path or lane in an urban area
Group II	**201**	**202**	**203**	**204**	**205**	**206**	**207**	**208**	**209**		
Vehicle defects	Tyres illegal, defective or under inflated	Defective lights or indicators	Defective breaks	Defective steering or suspension	Defective or missing mirrors	Overload or poorly loaded vehicle or trailer	Defective trailer or articulated vehicle	Poorly marked trailer or articulate vehicle	Other vehicle defects		
Codes relating to all drivers (including bicyclists and riders) — **Group III**	**301**	**302**	**303**	**304**	**305**	**306**	**307**	**308**	**309**	**310**	
Driver/Rider undertaking injudicious actions	Disobeyed automatic traffic signal	Disobeyed "Give way" or "Stop" sign or markings as defined by the sign of the police officer in charge, road signs or traffic rules	Disobeyed double white lines	Disobeyed a marked crossing pedestrian facility	Illegal turn or direction of travel	Exceeding speed limit	Travelling too fast for the existing conditions	Unsafe length or distance between vehicles (following too close)	Vehicle travelling along pavement	Bicyclist entering road from pavement	
Group IV	**401**	**402**	**403**	**404**	**405**	**406**	**407**	**408**	**409**	**410**	
Driver/Rider error or reaction	Junction overshoot (Failing to stop at the junction in front of the marked stop line or a stationary vehicle)	Junction restart (moving off at junction, after having stopped successfully in front of the junction)	Poor turn or maneuver	Failed to signal or misleading signal given to other road user before maneuvering	Driver/Rider failed to look properly	Driver/Rider failed to judge other road user's path or speed	Too close overtaking/passing of bicyclists, horse riders or pedestrians	Sudden braking	Swerve (sudden change in vehicle direction)	Loss of control	
Group V	**501**	**502**	**503**	**504**	**505**	**506**	**507**	**508**	**509**	**510**	
Failures of drivers due to bad psychophysical condition, impairment or distraction	Driver/Rider impaired by alcohol	Driver/Rider impaired by drugs (illicit or medicinal)	Fatigue	Uncorrected, defective eyesight (lack of appropriate glasses, lenses)	Driver/Rider illness or disability, mental or physical	Not displaying lights at night or in poor visibility	Rider wearing dark clothing	Driver using mobile phone	Distraction in vehicle	Distraction outside vehicle	
Group VI	**601**	**602**	**603**	**604**	**605**	**606**	**607**				
Failures of drivers due to inexperience, inappropriate and illegal behavior	Aggressive driving	Driver/Rider careless, reckless or in a hurry	Driver/Rider nervous, uncertain or panic	Driving too slow for conditions or slow vehicle	Learner or inexperienced driver	Inexperience of driving on the right lane	Unfamiliar with vehicle model				
Group VII	**701**	**702**	**703**	**704**	**705**	**706**	**707**	**708**	**709**	**710**	
Failures of drivers due to vision affected by external factors	Stationary or parked vehicle	Vegetation (trees, hedge or any other type of vegetation)	Road layout (bend, winding road, hill crest, etc.)	Buildings, road signs, street furniture, etc. on driver's vision	Dazzling headlights of the oncoming vehicle (dazzled driver)	Dazzling sun (dazzled driver)	Rain, sleet, snow, fog, smoke, etc.	Spray from other vehicles (the "spray" effect) on driver's vision	Visor or windscreen dirty, scratched or frosted	Vehicle blind spot (due to vehicle design)	
Group VIII	**801**	**802**	**803**	**804**	**805**	**806**	**807**	**808**	**809**	**810**	
Contributory factors attributed to pedestrians	Crossing road masked by stationary or parked vehicles	Pedestrian failed to look properly, not being convinced that it is safe to step on the road	Pedestrian failed to judge vehicle's path or speed	Pedestrian wrong use of pedestrian crossing facility – crossing at the red pedestrian	Dangerous action in carriageway (eg. playing, running in front of a vehicle, etc.)	Pedestrian impaired by alcohol, behaving in the manner that contributed to the occurrence of a road accident	Pedestrian impaired by drugs (illicit or medicinal), behaving in the manner that contributed to the occurrence of a road accident	Pedestrian careless, reckless or in a hurry, behaving in the manner that contributed to the occurrence of a road accident	Pedestrian wearing dark clothing at night, contributing to the occurrence of a road accident	Pedestrian disability or illness, mental or physical, contributing to the occurrence of a road accident	
Group IX	**901**	**902**	**903**	**904**	**905**	**906**				***999**	
Special codes	Driving a stolen vehicle that contributed to driver's behavior and occurrence of a road accident	Road accident occurred while driving a vehicle in course of crime (excluding stolen vehicle) and police chase	Road accidents involving emergency vehicles on a call	Vehicle door opened or closed negligently (including public transport vehicles)	Falling out of or from the car that is moving, including injuring public transport passengers	Unsecured scene of the road accident that contributed to the occurrence of a secondary road accident				Other factors that cannot be attributed to the previously mentioned factors, but have an influence on the occurrence of a road accident	

ROAD SAFETY
IN LOCAL COMMUNITIES

WE INVITE YOU TO

XII International
Conference
ROAD SAFETY IN LOCAL COMMUNITY

APRIL, 2017

www.bslz.org

INVITED PAPER

METHODOLOGY FOR BLACK SPOTS IDENTIFICATION ON ROADS - CASE STUDY FOR THE CITY OF SKOPJE

Zoran Davidoski[1], Zoran Joshevski[2], Daniel Pavleski[3], Stoimko Zlatkovski[4]

Abstract: The basis for qualitative management with the dangerous spots of the traffic network represent existence of data about the characteristics of the street network, data about the traffic load and data about the number of accidents. The existence of functional data base about the traffic accidents represents basic precondition about management with the dangerous spots, in other words „black spots". In Macedonia there is no this kind of approach. The intention of this research is determining and implementation the method of identifying the hazardous locations on the roads to be created basis for better proactive approach for traffic safety on the roads. In this particular research it is made a spatial and temporal distribution of the traffic accidents on the Boulevard "Partizanski Odredi" in Skopje. The part of the research that refers to the identification and classification of the dangerous spots „black spots" on the Boulevar "Partizanski Odredi" in Skopje, should help to establish contemporary system in management with the dangerous spots, as one essential procedure for reduction of the risk of accidents on the existing traffic network in the city of Skopje.

Keywords: traffic accident, black spots, identification, road network.

[1] Davidoski Zoran, B.Sc., Grad Skopje, R.Macedonia, davidov_zoran@yahoo.com
[2] Ph.D., Joshevski Zoran, Professor, Faculty of tehnical sciences – Bitola, R.Macedona., zjosevski@yahoo.com
[3] Pavleski Daniel, B.Sc., Grad Skopje, R.Macedonia, daniel.pavleski@skopje.gov.mk
[4] Ph.D., Zlatkovski Stoimko, Faculty of tehnical sciences – Bitola, R.Macedona., stoimkoz@live.co.uk

1. INTRODUCTION

Road safety is a key component for operation of transport function. Generally speaking there is an everyday risk in traffic for safety of life and people. Never the less there are fraction of the traffic network (parts of roads, cross roads, curves and so on) that are important at less safety spots. Continuous safety can be obtained with permanent analysis of actions at parts of traffic labeled as „black spots“. In order to successfully manage unwanted effects at black spots it is necessary to: 1. have a precise legislative regulation which will enable marking of black spots of the roads and 2. unified measures and activities in the direction of reduction and may be a total elimination of black spots of the roads.

To establish the location of black spots its highly necessary to have analyzed data, in RM we use data from the Ministry for Internal Affairs, the official penalty records (reports form accident sites) request for penalty procedures, fines, bulletins and plans of situations (diagrams of accidents). This leads to the conclusion that the problem that we have in Republic of Macedonia is the lack of a defined and established methodology for identification of black spots as a tool in safety enlargement on the roads.

2. METHODOLOGY FOR IDENTIFICATION OF BLACK SPOTS IN RESIDENTIAL AREAS

There isn’t a definition of what a black spot is, in different countries, members of the EU there is a different criteria for regulation of such black spots, for example in Denmark, a black spot is considered a spot at which in a period of five years there have been at least four accidents, in Germany, a black spots its considered a section of the road in the length of 300 meters where at least five accident occurred, in Portugal such a place is a place of 200 meters where at least four accidents took place. In Spain a black spot is a road with length of 1000 meters on which during the period of one year five accidents took place with casualties.

To establish black spots for the purposes of this study software was used. The methodology approach for identification of black spots is based on three criteria.

- a one year map of places where at least five accidents from the same type,
- a three year map of places where at least five accidents happened and there have been hurt people involved and
- a three year map of places where at least three accidents happened and there have been hurt people involved and casualties as well.

3. A SAFETY CONDITION ANALYSIS

An observation subject in this study was the boulevard “Partizanski Odredi” in Skopje. The boulevard is part of a primary traffic network and is very important to the city. It is mostly used for trips from the city center to the west exit and vice versa. The boulevard crosses three municipalities: Center, Karposh and Gjorche Petrov. Its primary function is to connect the west entrance of the city with the central city area and also to connect other municipalities and residential areas through the surrounding streets. From a traffic burdening point of view, through the boulevard on daily basis 6000 vehicles circulate. According to the general urban plan for the City of Skopje the boulevard “Partizanski Odredi” is part of the primary traffic network of the city and it is in the category of a city main road with a total length of 5737 meters. The boulevard profile consists of two lanes, 10.5 meters wide, physically divided by a green area wide 5 meters. Each lane consists of three traffic lanes, 3.5 meter wide. There are total of 11 crossroads along the boulevard, one of which is a roundabout, two of them have no traffic lights, 7 others are with traffic lights.

The boulevard has 13 enter – exit points for vehicles regulated with vertical signalization and 12 pedestrian crossings, three of which have no traffic lights and nine have traffic lights.

This analysis used data about accidents which occurred on the boulevard in the period of 2012 – 2014. 225 accidents happened at this bulevard with two casulties, 22 participants were seriously injured and a total of 160 people were with minor injuries, the rest is material damage. The statistical analysis was made according:

- **Technique for consequences in traffic accidents** (for the period of 2012 until 2014, 22 accidents happened in total with casualties or seriously injured people which in percents is 9% from the total number of accidents, 118 accidents are with minor injuries of 46%, in 115 accidents there is only material damage or 45%)
- **The type of accidents** (9 out of total happened while one vehicle in motion hit an object or 4%, 88 accidents happened during turning on crossroads or 35%, 36 accidents happened while passing a crossroad or 14%, 10 accidents happened with stopped or parked vehicles or 4%, 109 accidents from the total number happened driving in the same direction or 43%, and 3 accidents happened from various reasons or 1%.
- **According the type of reasons and participants in the accidents** (38 accidents are with pedestrians or 15%, 18 accidents are with bikers or 7%, 27 accidents are of drivers driving while under the influence or 11%, 11 accidents are because of passing another vehicle or 4% and 2 accidents because of collision with an animal or 1%)

- **According the type of participants in traffic** (236 accidents with cars or 93%, 38 pedestrians are participants in the accidents or 15%, 18 are with bicycles or 7%, 18 are with motorcycles or 7%, 10 are with trucks or 4% and 30 are with busses of 12%)

4. DISCUSSION

According the criteria “a one year map of black spots where at least five accidents took place from the same type” in the period of 2011 – 2014 on the boulevard “Partizanski Odredi” in Skopje there are 7 spots that meet the criteria.

According this analysis and the second criteria “a three year map of black spots where at least five accidents took place with people hurt in the radius of 25 meters” in the period of 2011 – 2014 on the boulevard “Partizanski Odredi” in Skopje there are 11 spots that meet the criteria.

If there is an analysis according the third criteria “a three year map of black spots where at least five accidents took place with people seriously hurt or dead in the radius of 25 meters” in the period of 2011 – 2014 on the boulevard “Partizanski Odredi” in Skopje was identified one black spot, in the radius of 25 meters 7 accidents happened there .

According this analysis and the established method for black spots at the boulevard “Partizanski Odredi” a total of 12 black spots identified. One black spot is identified according all three criteria and that is the crossroad at the boulevard with boulevard 8th September.

In table 1 there is a graphic picture of the identified fractions on the boulevard “Partizanski odredi” in Skopje.

Table 1. *Identified black spots at boulevard Partizanski Odredi Skopje*

year	Black spot	Number of traffic accidents
Criteria 1: Five accidents from the same type		
2012	Crossroad between boul. “P. Odredi” – st.„Bledski dogovor“ and st.„Pariska“	7 traffic accidents
2012	Enter point with st.„Aminta Treti“	5 traffic accidents
2012	Crossroad between boul.“Partizanski Odredi” and boul„Kliment Ohridski“	7 traffic accidents
2012	Crossroad between boul. “Partizanski Odredi” and st. „Franklin Ruzvelt“	5 traffic accidents
2012	Crossroad between boul. “Partizanski Odredi” –st.„A.Dinev“ and st.„I.Cankar“	5 traffic accidents
2013	Crossroad between boul. “Partizanski Odredi” -st.„G. Petrov“ and st.„A.Shopov“	6 traffic accidents

year	Black spot	Number of traffic accidents
Criteria 1: Five accidents from the same type		
2014	Crossroad between boul. “Partizanski Odredi” and boul.„8 Septemvri“	5 traffic accidents
Criteria 2: Five accidents where have been hurt people involved		
2012-2014	Crossroad between boul. “Partizanski Odredi” and boul.„8 Septemvri“	17 traffic accidents
2012-2014	Crossroad between boul.“Partizanski Odredi” and boul„Kliment Ohridski“	10 traffic accidents
2012-2014	Crossroad between boul. “Partizanski Odredi” and st. „Franklin Ruzvelt“	8 traffic accidents
2012-2014	Crossroad between boul. “Partizanski Odredi” -st.„G.Petrov“ and st.„A. Shopov“	8 traffic accidents
2012-2014	Enter point with st. „29 Noemvri“ and st.„Kosturski Heroi“	7 traffic accidents
2012-2014	Crossroad between boul. “P.Odredi” and service road at market G. Petrov	7 traffic accidents
2012-2014	Enter point with st.„Aminta Treti“	6 traffic accidents
2012-2014	Crossroad between boul. “P. Odredi” -st.„Ljubljanska“ and st.„Moskovska“	5 traffic accidents
2012-2014	Crossroad between boul. “Partizanski Odredi” –st.„A.Dinev“ and st.„I.Cankar“	5 traffic accidents
2012-2014	Enter point with st.„Shekspirova“	5 traffic accidents
2012-2014	Pedestrian crossing „Bunjakovec“	5 traffic accidents
Criteria 3: three accidents where have been hurt people involved and casualties		
2012-2014	Crossroad between boul. “Partizanski Odredi” and boul.„8 Septemvri“	7 traffic accidents

5. CONCLUSION

The problem because of lack of methodological approach for identification of black spots in traffic points to the fact that, Republic of Macedonia has to define the term “black spot”. This has one purpose only - timely identification of black spots, the reasons why these spots are dangerous, and measures and activities which need to be taken to resolve these issues in the direction of a safer traffic.

This analysis and according to the established method for identification the boulevard “Partizanski Odredi” has a total of 12 places identified as black spots. A dangerous road fraction which meets all three criteria is the crossroad with the boulevard 8th September. To eliminate this black spot, analysis from the aspect of traffic conditions is needed, the amount of traffic, building possibilities (a roundabout, or out of level crossroad) this identification of the boulevard enables city authorities to think about and find ways to reduce and eliminate these black spots.

6. LITERATURE

[1] Elvik, R. (2008). State – of – the – Art Approaches to Road Accident Black Spot Management and Safety Analysis of Road Networks, 6th Framework Programme,
[2] K. Agent (2002). Development of Procedures for Identifying High – crash Locations and Prioritizing Safety Improvements, College of Engineering, Kentucky Transport Centre, University of Kentucky, USA,
[3] S. Cafiso, G. La Cava, A. Montella (2007). Identification of Hazard Location and Ranking of Measures to Improve Safety on Local Rural Roads, Department of Civil and Environmental Engineering University of Catania, July,
[4] http://vision-traffic.ptvgroup.com/en-uk/products/ptv-visum-safety.

11th International Conference
"Road Safety in Local Community"
Serbia, Vrnjacka Banja, Hotel Zvezda,
April 13 – 16, 2016

INVITED PAPER

TRAINING OF PROFESSIONALS IN LOCAL COMMUNITIES - ANALYSIS OF THE CURRENT ROAD SAFETY SITUATION

Krsto Lipovac[1], Miladin Nesic[2], Filip Filipovic[3]

Abstract: Raising awareness and developing attitudes of the professional, political and general public about the scope and type of road safety issues, and about the possibilities for road safety management, cannot be improved without profession and professionalism in road safety. The aim of the project is strengthening road safety capacities at the local level, through appropriate training of professionals in local communities. The project includes training of professional comprehension of attitudes and perception of trends in road safety, creation and use of local databases that are holding data on attitudes, behaviour, capacity and integrity of institutions, i.e. road accidents and other direct road safety indicators, as well as training on the scope and type of road safety problems, global trends and the importance of a strategic approach to the road safety management.

Keywords: professional training, local communities, road safety

1. INTRODUCTION

Improving and encouraging road safety profession and professionalism in local communities represents the crucial element for the development of awareness and attitudes of the professional, political and general public on the scope and type of road safety issues and possibilities for road safety management. The structure of local road safety councils is made of members of various professions and levels

[1] Ph.D., Lipovac Krsto, Regular Professor, Faculty of Transport and Traffic Engineering, 305, Vojvode Stepe, 11000 Belgrade, Serbia, k.lipovac@gmail.com
[2] Ph.D., Nesic Miladin, Assistant Professor, Academy of Criminal and Police Studies, 196, Cara Dusana, 11080 Zemun, Serbia, miladin.nesic@kpa.edu.rs
[3] Filipovic Filip, M.Sc., Project Engineer – Associate, Faculty of Transport and Traffic Engineering, 305, Vojvode Stepe, 11000 Belgrade, Serbia, filip.filipovic@bslz.org

of education, with insufficient number of transport and traffic engineers among them or no such engineers at all. On the other hand, transport and traffic engineers are in need of refreshing and advancing the knowledge they acquired during the university studies, by means of various courses organized within the programs of professional training.

In addition to great efforts put in reducing the number of road accidents at the global level, local institutional road safety capacities play the key role. Their role is particularly significant in low- and middle income countries (Pedenetal, 2004). The weaknesses of institutional capacities pose a great obstacle for the functioning and progress of the whole system, and clear focus on the implementation of concrete results is very often missing (WHO, 2009). Having in mind that insufficient attention has been paid so far to the strengthening of institutional capacities in road safety in Serbia, it can be concluded that there is a quite obvious need for strengthening these institutional capacities, primarily in relation to trainings of road safety professionals and decision makers. According to the recommendations of the World Health Organization (WHO, 2009), external support plays a key role in the process of strengthening institutional capacities. In fact, the accent should be put on providing a process oriented style of technical assistance where external, out-sourced professionals would work together with local professionals. Thus the professionals would primarily help with the transfer of necessary knowledge and encourage strengthening of institutional capacities in a sustainable way.

In order to completely understand and design the complex and dangerous nature of the road traffic system, and finally manage to overcome the issue of road accidents, it will be necessary to recognize accountability and share it in an adequate way. Apart from the activities undertaken by the Government, health sector, private sector, industry, agencies, academics, the Global Report of the World Health Organization highlights the significance of involving non-governmental organizations-associations (NGO). Projects should be planned so as to use the available elements of the protective system in order to achieve the utmost effectiveness and efficiency of implemented measures (WHO, 2009). Non-governmental organizations as free associations can engage in intensifying significantly the jurisdiction of communities within important projects, critically and impartially comprehending the problems and encouraging activities whose aim is road safety prevention (Lipovac et al., 2014). On the other hand, NGOs can implement these activities in an effective way, with relatively small budgets, which is a very important issue for the Government in the process of decision making, given the low availability of funds. The effectiveness of projects, due to specific objectives and structure of the process, largely depends on the adequate integration of groups from the non-governmental sector (WHO, 2009).

The importance of implementation of NGO projects in the Republic of Serbia has been recognized, and programs for funding their projects are carried out at different levels. One of these programs was implemented by the Ministry of

Construction, Transport and Infrastructure of the Republic of Serbia. The Ministry announced an invitation to tender for co-financing the project of associations and other civil society organizations in the area of construction, transport and infrastructure, in 2015. It offered an opportunity for the implementation of NGO projects in the Republic of Serbia aimed at strengthening institutional capacities in road safety. One of these projects is the professional training in local communities called “The analysis of the current road safety situation and road safety management at the local level”, implemented by the association “Road Safety in Local Community” (RSLC).

The paper shows the mentioned training Project implemented by the RSLC in 2015, in 4 local communities in the Republic of Serbia.

2. PROGRAM OF TRAINING

The project called “The analysis of the current road safety situation and road safety management at the local level” is the result of the recognized need for professional training of road safety professionals in local communities. It has been supported and partially financed by the Ministry of Construction, Transport and Infrastructure of the Republic of Serbia, with the participation of the RSLC, which was the project leader.

The goal of the project was strengthening institutional capacities in road safety, at the local level, through the education of professionals. The target group of the project was made of members of the local road safety bodies, employed in road traffic inspection and other similar professional departments in local communities, senior traffic police officers, employed in public enterprises, professional secondary schools, elementary schools, etc.

Table 1. *Themes of implemented workshops*

Workshop 01	Road safety management Global Plan for the Decade of Action for Road Safety
Workshop 02	WHO Road Safety Training Manual
Workshop 03	Monitoring attitudes on risks in road safety
Workshop 04	Monitoring road safety indicators at the local level
Workshop 05	Local databases on road accidents and other features of importance to road safety

Expected results of the project included the following:

- Better understanding of global and national road safety trends,
- Improved attitudes and raised awareness on the importance of road safety and significance of specific institutions and individuals at the local level,
- Improved attitudes on the importance of local databases and monitoring of attitudes on risks, traffic behavior and road accidents.

The project included the program of training consisting of five (5) thematic workshops (***Table 1).***

Training program was implemented in four local communities: Belgrade, Nis, Novi Sad and Kragujevac.

2.1. Workshop 1 – Road safety management Global Plan for the Decade of Action for Road Safety

Workshop 1 indicates the importance of road accidents, as a societal problem, and of detrimental consequence of road traffic in general. The Tylösand Declaration has been presented and described as the beginning of development of the thought on global road safety as a human right and the beginning of making strategic road safety documents at the global level. Road safety management has been presented through a cybernetic management approach, where particular importance is given to the permanent monitoring of the current situation, as a starting management phase. Within the phase of defining the target state, the ambition, mission and vision of the Road Safety Strategy of the Republic of Serbia has been also presented. Using various examples, road safety management levels and their role in the system have been shown to the workshop participants.

In terms of the Global Plan for the Decade of Action for Road Safety 2011-2020, the participants got familiar with the history of the Decade, the ten reasons for launching the Decade of Action for Road Safety 2011-2020. The objectives of the Decade of Action, its principles and directions of action, as well as five pillars on which the Decade of Action is relying, have been also discussed.

Workshop 1 also included discussion which concerned the implemented activities in the area of road safety management in the given local community, as well as the problems that occurred during the implementation of activities in question.

2.2. Workshop 2 – WHO Road Safety Training Manual

The Manual of the World Health Organization has been presented to the participants of the Workshop 2. The Manual provides the following necessary information to the participants: importance and impact of road traffic injuries; key risk factors; necessity for a scientific approach to road traffic injury prevention; ways in which to improve the database on evidences for the purpose of prevention; how to include promising interventions; how to provide post crash care; necessity for multisectoral cooperation; and how to formulate and implement road safety policies. The Manual is designed for the needs of multi-disciplinary public including doctors, medical nurses, transport and traffic engineers, vehicles safety professionals, law enforcers, policy makers and sociologists, in order to reinforce capabilities for implementation of measures for road traffic injury prevention, in various frameworks.

The Workshop included the following subjects:

1. Importance and impact of road traffic injuries;
2. Risk factors contributing to road traffic injuries;
3. Implementation of specific interventions in road accident prevention;
4. Providing post crash care;
5. Multisectoral cooperation;
6. Formulating and implementing road safety policies.

Group work has been also done during the Workshop and concerned relevant road safety data and multisectoral cooperation.

2.3. Monitoring attitudes on risks in road safety

Workshop 3 included the presentation of results of the survey of road user's attitudes on risks in road traffic in Serbia. The survey was conducted by the Road Traffic Safety Agency in 2014 (Backalic et al., 2014), and was based on the concept applied in the SARTRE 4 (Social attitudes according to the risks in road traffic in Europe)[4] research (IFSTTAR&ENER, 2012). SARTRE is a European research project on road user's attitudes on road traffic risks that was carried out 4 times, in the period from 1991 to 2012.

Concrete examples have been used to reflect the conditions in Serbia and show the link between the attitudes and absolute road safety indicators. The role of road safety management system professionals has been highlighted, stating that their role is not only organization and technical regulation of traffic, maintenance and control of the state of traffic system, but also active undertaking of activities for monitoring and analysis of road safety, with the aim of undertaking effective and efficient measures, along with the successful cooperation with other (higher) levels of road safety management.

2.4. Monitoring road safety indicators

Workshop 4 was dedicated to the importance of indicators in the road safety system. Practical use of indicators has been presented through four basic stages: monitoring, reporting, usage and accountability examples.

The overall process of data collection and assigning values to road safety indicators have been presented, starting from the preparation and implementation of a field survey, data processing and creation of final reports in the form of tables, charts and maps, using the example of seat belts.

Activity related to road safety indicators has been also dealt with.

[4]SARTRE - Social Attitudes to Road Traffic Risk in Europe

2.5. Local databases on road accidents and other features of importance to road safety

The subject of the last Workshop 5 was "Local databases on road accidents and other features of importance to road safety". The aim of this workshop was training of professionals in local communities for the purposes of making road accident databases for their own needs. The review of global and national databases was presented, and the binding role of the Road Traffic Safety Agency of the Republic of Serbia in monitoring the state of road safety, in terms of databases, was highlighted in particular. After that part, several examples have been presented to show how to use an online application to take the data from the Agency's database. During the interactive part of the workshop, participants were able to use the online application and generate a database for their municipalities, according to their needs.

3. RESULTS

The results of the evaluation have shown that implemented workshops had positive effects on participants. In 75% of cases, participants of Workshop 1 said that the workshop helped them reinforce the attitude that "road safety management should be science based", while 25% think that the workshop helped them only partially (Figure 1).

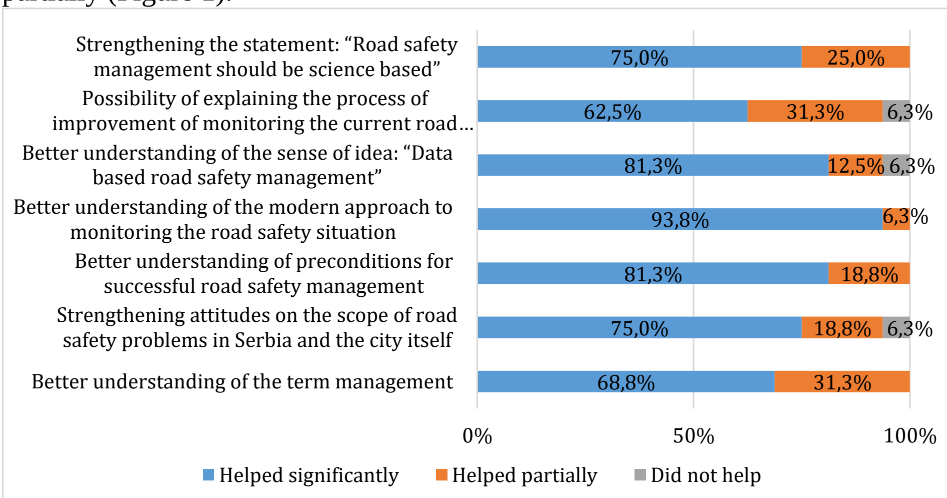


Figure 1. *Percentage of workshop participants'statements relating to help offered by the workshop for the improvement of specific ability*

As for the contribution of the workshop to the improved possibility to more easily explain how the current state of road safety should be improved at the local level, 63% of participants said that the workshop helped them completely, 31%

think that it helped them only partially, while 6% is of opinion that the workshop did not help them (Figure 1). Equal percentage of respondents (81%) thinks that the workshop helped them to a great extent to understand the idea of road safety management on the basis of data and to better understand the preconditions for successful road safety management (Figure 1).

Even 94% of respondents stated that the workshop will help them significantly to better understand the modern approach, while 6% stated that it will help them only partially (Figure 1). Three quarters of participants of Workshop 1 think that the workshop helped them significantly to reinforce their attitude on the scope of road safety problems in Serbia and in the city, while 6% of participants think that the workshop did not help them in that sense (Figure 1).

After the workshop has been finished, 69% of participants stated that the workshop will help them significantly to understand the concept of road safety management, while 31% of respondents think that it will help them only partially (Figure 1).

Participants of the workshop think that the presence during the workshop largely contributed to more easily allocate key areas related to road traffic injury prevention (even 87,5% of workshop participants think that the workshop will help them significantly – Figure 2). As for the question of understanding the multisectoral cooperation, 12,5% of respondents think that the workshop did not help them only in that case (Figure 2). All participants of Workshop 2 think that the workshop will help them describe various forms of cooperation in road traffic injury prevention, at the local level, as well as describe interventions for road accident prevention, out of which 75% think that the workshop will help them considerably (Figure 2). As in the previous statement, the distribution is the same when it comes to the question of stating at least three reasons why data are important in road traffic injury prevention. As for the question of analysis of quality of post crash care, half of participants think that the workshop will help them significantly in this analysis, while the other half is of opinion that it will help them only partially (Figure 2). When describing the main sources of data of importance to road safety in our conditions, 57% of workshop participants think that the workshop will help them considerably, while the rest of respondents think that it will help them only partially (Figure 2). When it comes to the question of defining the necessity of multisectoral cooperation for the road accident prevention, 63% of respondents think that Workshop 2 will help them significantly, while 25% of respondents are of opinion that it will help them only partially.

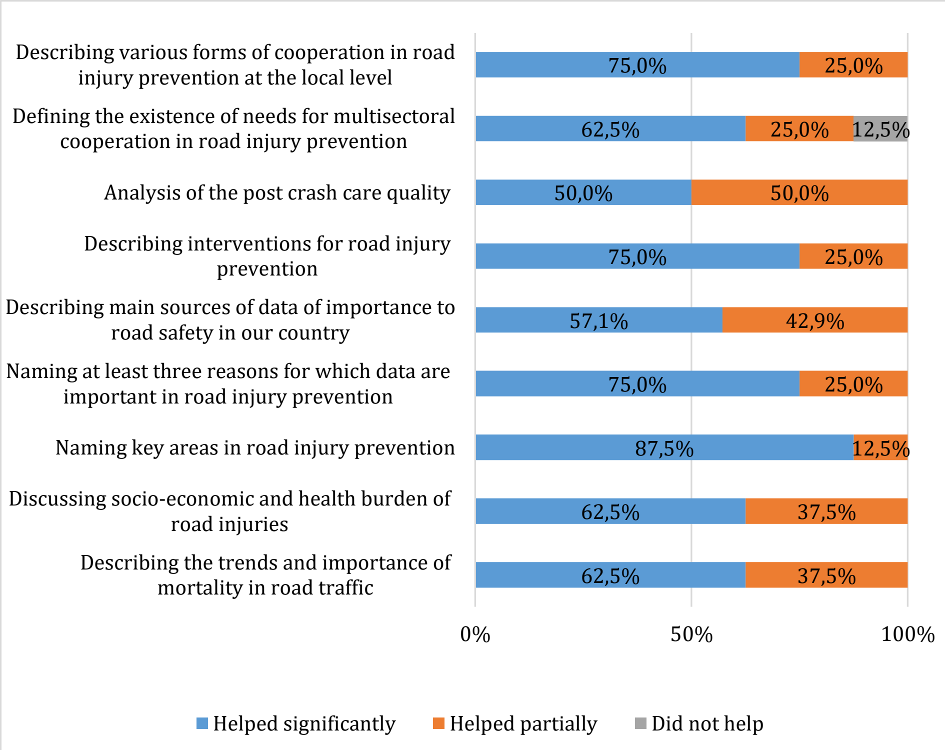


Figure 2. *Percentage of help offered by the workshop*

When discussing the socio-economic and health problems in road safety, and the possibility to describe the trends and importance of mortality in road safety, 62,5% of respondents say that the workshop will help them considerably, while 37,5% of respondents thinks that it will help them only partially.

More than half of participants of Workshop 3 and 4 (61%) are of opinion that the presented contents of workshop is excellent, 23% think that it is satisfying, 8% of participants think that the contents was better than expected, while 8% of respondents is of opinion that it is below average. As for the ratio of theory and practical contents, 85% of participants of Workshop 3 and 4 think that it is well balanced, while all participants of Workshop 3 and 4 agreed that the activities presented in the workshop are useful.

Workshop participants came from various institutions, with a considerable number of them being members of local road safety councils. Participants also included representatives of municipalities, members of city road traffic secretariats, public communal enterprises, parking services, Ministry of Interior, secondary traffic education schools, health institutions, faculties and high schools, pre-school institutions, etc.

4. CONCLUSION

Without a well established protective road safety system and implementation of appropriate measures, it will not be possible to improve the system of road safety. On the other hand, effective road safety management requires the existence of developed institutional capacity, with established procedures and relations among the authorities in charge. With this in mind, it is of great importance to permanently improve the attitudes and awareness of local road safety professionals on global and national trends in road safety, to emphasize the importance of individual institutions in road safety, as well as the significant role of local databases and monitoring of attitudes on risk, behavior in road traffic and road accidents.

Based on results from the evaluations made, it can be concluded that the members of local road safety institutions are largely interested in professional development through the improvement of attitudes and awareness of the importance of road safety. Therefore, five workshops organized for road safety professionals, employees of local institutions, identified a great potential for better understanding of modern approaches to solving road safety problems. Also, the workshops helped identify the possibility of upgrading the methods and contents of work, as well as the possibilities of applying such a concept in other municipalities and cities across Serbia.

Bearing in mind that professional organizations are thus gathering stakeholders that are very interested in road safety or its individual segments, they can largely contribute to improving the road safety system through this and similar projects. In terms of road safety, they gather professional public and have one of the leading roles in creating measures and requirements that are put before individual, accountable road safety entities. Professional organizations act independently, in accordance with their articles of association, but also offer technical support to other entities within their scope of work. They observe with criticism and communicate to the public their unbiased and critical views of the current state of road safety (often different from the official position), of certain activities carried out by the State, which oppose the fundamental principles of road safety management, as well as of failures, specific problems and their possible solutions.

The general conclusion concerning the implemented project is that the training in question contributed to the professional development of participants – road safety professionals. Related attitudes and awareness of the importance of road safety and significant role of individual institutions and individuals at the local level have been improved, and so have the attitudes on the importance of local databases and monitoring of attitudes related to risks, road user’s behavior and road accidents.

The concept of training has been successfully implemented in the largest local communities in Serbia. With certain adjustments made to the concept, it will be possible to implement such trainings in other local communities throughout Serbia.

Following the results of the evaluation and support of leading managerial structures, it will be possible to continue with the project on the territory of the same local self-governments, and also to extend it to other cities and municipalities, following the programs of local communities which provide funds for financing projects of related associations. Given that trainings were well accepted by road safety professionals in local self-governments, the proposal is to continue with the similar projects in the future.

5. LITERATURE

[1] Липовац, К. et al. (2011). Превенција повреда у друмском саобраћају – Модификовани приручник за обуку. Криминалистичко-полицијска академија, Земун.
[2] Peden M et al. (2004). World report on road traffic injury prevention. Geneva, World Health Organization.
[3] World Health Organization (2009).Country Guidelines for the Conduct of Road Safety Management Capacity Reviews and the Specification of Lead Agency Reforms, Investment Strategies and Safe System Projects. Implementing the Recommendations of the World Report on Road Traffic Injury Prevention
[4] World Health Organization (2013). Global Status Report on Road Safety 2013 – Supporting a decade of action for road safety 2011-2020.
[5] Липовац, К. et. al (2014). Основе безбедности саобраћаја. Криминалистичко-полицијска академија.
[6] IFSTTAR & ENER (2012). European road users' risk perception and mobility: SARTRE 4 final report.

CIP – Каталогизација у публикацији
Народна библиотека Србије, Београд

656.08(082)
352.07(082)

INTERNATIONAL Conference Road Safety in Local Community (11th ; 2016 ; Vrnjačka Banja)
Conference Proceedings / XI International Conference Road Safety in Local Community, Vrnjačka Banja, April 13-16, 2016. ; [organized by] Academy of Criminalistic and Police Studies ... [et al.] ; [editors Krsto Lipovac, Miladin Nešić]. - Belgrade : Academy of Criminalistic and Police Studies ; Wuppertal : Bergische Universität ; Zagreb : Faculty of Transport and Traffic Sciences, University ; Novi Sad : Serbian Road Safety Association, 2016 (Čačak : Univerzal) . - IX, 190 str. : ilustr. ; 24 cm

Tiraž 100. - Str. VII: Foreword / Miladin Nešić, Krsto Lipovac. - Napomene i bibliografske reference uz tekst. - Bibliografija uz svaki rad.

ISBN 978-86-7020-371-6 (KPA)

1. Academy of Criminalistic and Police Studies (Belgrade)
a) Саобраћај - Безбедност - Зборници b) Локалне заједнице - Зборници

COBISS.SR-ID 228384780

ROAD SAFETY
IN LOCAL COMMUNITIES

ПОЗИВАМО ВАС НА

XII Међународну Конференцију
БЕЗБЕДНОСТ САОБРАЋАЈА У ЛОКАЛНОЈ ЗАЈЕДНИЦИ

АПРИЛ, 2017.

www.bslz.org

WE INVITE YOU TO

XII International Conference
ROAD SAFETY IN LOCAL COMMUNITY

APRIL, 2017


3M
Više od tri decenije doprinosimo bezbednosti na putevima Srbije
Stamark aplikativne trake
Scotchlite retroreflektujuci materijali
Engineer Grade, High Intensity i Diamond Grade
Predstavništvo 3M (East) AG
Milutina Milankovica 23, 11070 Beograd, Srbija
Tel.: +381 11 2209 400; Fax: +381 11 2209 444
www.3M.com/rs
Нови Сад
Novi Sad
Бешка
Beška

REDFLEX TRAFFIC SYSTEMS

Dual radar tehnologija

Dual radar tehnologija omogućava snimanje saobraćajnih prekršaja na mestima gde tradicionalni radarski sistemi ne mogu, na taj način što eliminiše uobičajene probleme radara kao što su fantomski signali, refleksije i drugi problemi povezani sa smetnjama.

Tehnologija se zasniva na primeni dva radarska senzora. Prvi radar meri brzinu vozila, dok drugi radar uz merenje brzine određuje i tačnu poziciju vozila. Time je obezbeđena maksimalna pouzdanost rezultata merenja (sistem obavlja dva nezavisna merenja koja upoređuje), kao i identifikacija saobraćajne trake kojom se vozilo kreće i pozicije snimljenog vozila.

Uz sistem dolazi industrijska foto kamera u boji, visoke rezolucije 11 MPx. U kombinaciji sa klasičnim ili IC blicem, obezbeđuje Redflex dual radar sistemu snimanje fotografija savršenog kvaliteta.

Osnovne prednosti dual radar tehnologije:

- ✓ Pouzdani rezultati merenja (dvostruka provera)
- ✓ Sertifikovan za merenje brzine vozila do 320 km/h
- ✓ Jedan uređaj pokriva 6 saobraćajnih traka
- ✓ Istovremeno merenje brzine vozila u oba smera
- ✓ Istovremena detekcija više vozila u prekršaju
- ✓ Bolja detekcija vozila, naročito motorcikala i vozila koja se kreću zaustavnom trakom ili van kolovoza

Distributer u regionu

MRG
EXPORT - IMPORT D.O.O.

Sedište u Beogradu:
Ustanička 25/V
11000 Beograd
Tel: +381 11 2433-705
Fax: +381 11 2433-792
Email: office@mrg.rs
Web: www.mrg.rs

Predstavništvo u BiH:
Milana Radmana 23
78000 Banja Luka
Tel: +387 51 316-586
Fax: +387 51 316-601
Email: office@mrg-bl.com
Web: www.mrg-bl.com

Modularnost dual radara

Kao stacionanrni sistem (na potralu ili stubu) i kao mobilni sistem (na stalku ili u vozilu)

ISBN 978-86-7020-371-6
9 788670 203716