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The aim and scope of the Traffic and Transport Theory and Practice (TTTP) Journal is:

- Provide international dissemination of knowledge and contributions to the science and practice in the field of traffic and transportation
- Promote and exchange information and knowledge in the transportation research arena and its application
- Explore the new trends in development and invention related to the efficiency, reliability, safety and economically and ecologically sustainable transportation.

TTTP provides conditions and positive environment for the new idea promotion, exchange research results and achievements accomplished by the scientific community from academia and transportation industry.

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Contents

EDITOR'S WORD

Dear readers, you have before you the fourth issue of the international scientific magazine "Traffic and Transport Theory and Practice - TTTP". This magazine is published in electronic and printed edition in English. We publish papers from all scientific fields that gravitate towards traffic and transport.

Traffic is a heritage of civilisation and without it we cannot imagine social and economic development. A citizen of a large European city on average loses one year of life waiting due to traffic jams and for not having updated information on situation in traffic. Unfortunately, traffic also has harmful effect of people. High death rates, pollution of the environment are just few issues that require preventive activities, not only by traffic experts, but other parties also. We live in a time of fast development of information technologies that change ambiance processes in traffic and transport every day. Intelligent transport systems in the area of intelligent vehicles, intelligent roads, satellite and navigation systems, passive safety systems, require a multidisciplinary approach to solving problems.

This issue had eight papers written by nineteen authors from Bosnia and Herzegovina, Serbia, Montenegro, Belgium and the USA. I expect that the contents of this issue of our magazine are going to incite to cooperate and encourage you to take activities as authors in some of the future issues.

I would like especially thank the former Editor-in-Chief and the founder of our magazine, Professor Mirsad Kulović, PhD, for his contribution in founding and running this magazine.

Kind regards,

Editor-in Chief
Danislav Drašković

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ORIGINAL SCIENTIFIC PAPER

Application of a new Model for Fatigue Identification of Commercial Vehicles Drivers

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Abstract: For decades, around the world is developing a fatigue detection system to alert drivers when they reach the state of fatigue that threatens them in traffic. Most of the research on the impact of fatigue on drivers based on driving simulators mainly because it is a controlled environment, cheap and safe approach. Since the nineties of the last century, many surveys were conducted in which the survey method was applied, while examining the subjective attitudes of drivers about the impact of fatigue on traffic safety. The beginning of the 21st century is characterized by the development of a fatigue detection system based on modern technologies, and a number of experiments were conducted. However, it not yet in use tools that can be easily detected drivers fatigue, in order to respond quickly and prevent them from operating the vehicle in such condition.

The aim of this paper is to demonstrate the importance and implementation of a new fatigue identification model for commercial vehicle drivers in selected transport companies. Based on the results of this research, it is possible to determine which company is the safest from the aspect of fatigue, which is least safe. Also, the analysis of the results can determine which influencing factor is “the weakest link” among the drivers in the transport company, or where to direct measures in order to improve the road safety of the company, and therefore the local community.

The study included five transport companies in Serbia, three of which are engaged in the carriage of passengers, and two transport goods. The survey used the survey method, the face face model, and 265 drivers of commercial vehicles participated, 16.6% of whom were found fatigued before the start of the shift.

Keywords: road safety, fatigue, model for fatigue identification, commercial vehicle drivers.

INTRODUCTION

In order to identify driver fatigue, several methodologies are applied depending on whether a preventive approach is used - identification of fatigue prior to the occurrence of a traffic accident or analysis of traffic accidents, or determining the factors that led to sleep during driving. Analyzing a number of world experiences (for example see 1-19), fatigue can be identified using the following methods:

1) analysis of a database of traffic accidents;
2) a system for the detection of fatigue;
3) driving simulator (tests of psychomotor alertness, consumption of energy drinks, coffee, etc.);
4) analysis of attitudes and self-reported behavior of drivers.

Identification of fatigue by analyzing the database of traffic accidents is not an acceptable method because the analysis starts only after a traffic accident occurs. This method can be used to analyze impact factors and define measures for improving traffic safety.

Driver Detection Systems, which have been developed so far, are based on a variety of principles, such as fatigue detection based on the speed and frequency of closing eyelids, based on tracking the position of the vehicle in the traffic lane, based on headlining and movement, in relation to the dividing line, on the basis of the face line, etc.

Gupta and Garima (20) indicated that methods for fatigue detention based on modern technologies are divided into intrusive and non-intrusive. Intelligent methods include methods in which electrodes that must be in direct contact with the driver’s body are used to determine its physiological state and according to him, detected drowsiness. The disadvantage of this technique is that it requires physical contact with the driver.

Other methods, which fall into unobtrusive, include a system that does not interfere with the driver during his driving. The system measures the level of alertness of the driver following the movements of the steering wheel, braking patterns, the view of the traffic lane in which the vehicle is located, facial movements. Accordingly, the driver will be alerted via video or audio signals, without any physical contact. An unobtrusive system based on visual data collection has been developed to locate eye and mouth positions, and to detect drowsiness with the driver. During the driver's supervision, the system is able to detect when the eyes are closed and the mouth is open simultaneously, for a long time interval, and then alert the driver to the danger with the help of sound and text signals. Also, the system will warn the driver if the driver closes his eyes for a long period of time, which may mean that he has fallen asleep while driving. Namely, the human face is dynamic and has a high degree of variability. Face Detection is the first step in the analysis of facial movements. Today, a large number of different methods of face detection using computer software are in use. One of the essential facial features for identifying and analyzing facial movements is the eyes. When the eyes are detected, using their location can be determined the position of other characteristic facial features, such as the mouth and nose. Therefore, the main objective of this technique represents an analysis of the above mentioned features.

With the help of a variety of driving simulators, numerous laboratory studies have been carried out over the past decades, which have shown that due to limited sleeping, there is accumulation of daily performance deficits that affect the ability to monitor traffic, reaction time and alertness (21) for the occurrence of a traffic accident is increasing.

An analysis of attitudes and self-reported behaviors is a method that has been used for many years to collect data from a large number of respondents in various fields, as well as to determine fatigue and its influence factors. Tools have been developed to help determine the tendency to tired, the level of daily drowsiness, and the like. This method is suitable for rapid data collection, only issues need to be carefully selected in order to avoid giving socially desirable answers.

The aim of this paper is to demonstrate the importance and the possibility of applying a new model for identifying fatigue in the drivers of commercial vehicles in selected transport companies based on the analysis of attitudes and self-reported behavior. The model is formed on the basis of weight factors of influence factors and as an output gives information whether the driver is tired or not.

Based on the results of this research, it is possible to determine which company is the safest from the aspect of fatigue, which is least safe. By analyzing the results, one can determine which of the influencing factors is "the weakest link" among drivers in the transport company, or where to direct measures in order to improve the safety of the company's traffic, and hence the local communities.

METHODOLOGY

The application of a new model for identifying fatigue in commercial vehicle drivers consists of collecting new data set by a face-to-face model, entering data in a specially formed database based on the programmed code for the application of such models, and processing and analyzing the data collected.

The research was conducted in the period from April to July 2018, in five transport companies in the Republic of Serbia, two dealing with transport of goods and three for transporting passengers (Table 1). A total of 265 drivers were surveyed, 84 of them were truck drivers. Prior to taking the driving order, or before the start of the shift, drivers were asked to select the subcategory for the 11 relevant indicators that best describes them. The application of a new model for identifying fatigue in commercial vehicle drivers consists of collecting data by a face-to-face model, entering data in a specially formed database based on the programmed code for the application of such models, and processing and analyzing the data collected. Drivers did not have an insight into the weight coefficients of the subcategories they chose. They did not know the value of their responses used for the model, so they did not have an overview of what the outcome depends most on. The survey was carried out by a person employed in a transport company that did not have a slight insight into the value of the weight coefficients of the offered responses, nor information on the layout of the model.

Table 1. Overview of the respondents to the company and the type of transport engaged

Company	Type of transport engaged	number of drivers
TC1	passengers	59
TC2	passengers	56
TC3	passengers	66
TC4	goods	42
TC5	goods	42

Table 2. The ranking of indicators related to the fatigue of commercial vehicle drivers (22)

Group	Influential factor	Value
1	Sleep quality	14.909
	The amount of sleep	14.455
2	Daily driving time	10.545
	Driving time (by visibility)	10.455
	Daily rest of the driver	9.364
3	Weekly driving time	7.909
	Age	7.727
	The measures used to eliminate sleepiness	7.364
	Two-week driving time	6.545
4	Monthly mileage	5.636
	The type of vehicle it manages	5.091

The drivers responded to 11 questions, which are defined according to the most important factors influencing the onset of fatigue in the driver of commercial vehicles, which were previously defined by Davidović and Antić (22), are shown in Table 2. Davidović and Antić (22) have shown that using the method of expert judgment, it was found that the most influential indicator of fatigue is the quality of sleep, which has a 2.92 times greater impact than the least influential indicator, that is, the type of vehicle that the driver manages.

RESULTS

In order to identify the fatigue due to commercial vehicle drivers, the five observed transport companies analysed all 11 influential factors: the amount of sleep, sleep quality, daily, weekly and two-week driving time, daily rest, driving time (by visibility), as well as the types of vehicles that drives, the driver's age and distance traveled.

In the continuation of the analysis type of vehicles, not particularly analyzed, given that the companies, TK1-TK3 passenger transportation by bus, and in TK4 and TK5 goods, heavy cargo vehicles. Also, not really analyzed monthly distance travelled because it is approximately equal in all transportation companies where more than 80% of drivers travel more than 1600 km monthly. In addition, the age of the driver as an influential factor is something included in the model, but not particularly analysed according to the transport companies, because the sample was not stratified by this criterion. As a result of the analysis of the four observed age categories it was found that 23.5% of the drivers aged 36-45 years identified fatigue, then 17.5% of the drivers 26-35 years, at 9.1% of drivers over 45 years of age and 4.5% among drivers up to 25 years.

The analysis of the eight road safety indicators, which, due to the commercial vehicle drivers' fatigue, can determine which company has the most driver fatigue, at the time of testing, and that these are " weakest link" for any company in terms of these indicators.

Table 3. Values of analysed fatigue indicators for transport companies

TC	% of drivers who drive more than 1.600 km a month	% of drivers who slept less than 6 hours last night	% of drivers who have poor sleep quality	% of drivers who drive over 70% at night	% of drivers who exceeded the daily driving time	% of drivers who exceeded the weekly driving time	% of drivers who have exceeded the two-week driving time	% of drivers who had at least 11 hours of daily rest	% of tired drivers
TC1	98	25	1,7	5,1	1,7	52,5	59,0	42	5
TC2	93	71	3,6	3,6	19,6	16,1	25,0	29	7
TC3	86	45	25,7	15,1	19,7	25,7	35,0	42	35
TC4	81	69	16,7	7,1	16,7	1,6	1,6	33	17
TC5	86	69	16,7	7,1	11,9	7,1	12,0	36	17

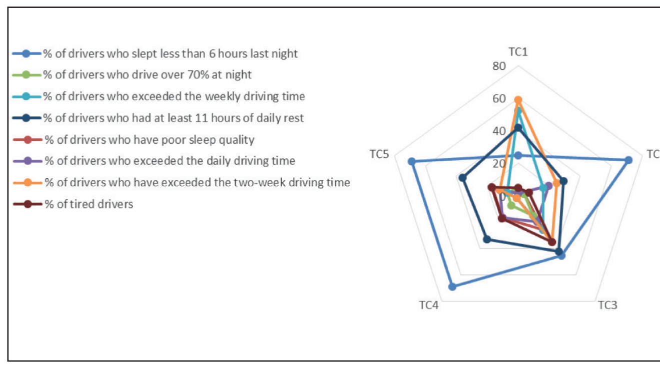

Figure 1. Values of analysed indicators for transport companies

In the company, which is designated as TK1 the worst value has indicator "% of drivers who have exceeded the law defined driving time for two consecutive weeks", which is 90 hours, even 59% of drivers. In the other four analyzed transport companies indicator with the worst results is "% of drivers who slept less than 6 hours of the night." On the basis of the presented results, it can be concluded that on the issue of fatigue due to drivers of commercial vehicles in TK1, the most important indicator is from the group of indicators related to the transport company, while in other companies the biggest problem is the amount of sleep, i.e. the indicator that is in connection with the driver. The second place is the indicator related to the transport company, that is, the daily rest of the driver is shorter than 11 hours.

The application of a new model for the identification of fatigue, which is based on the weighting of influential factors has been found that the most tired drivers in a company is engaged in the transport of passengers marked with TK3, even 35%, then 17% in companies that are engaged in the transport of goods (Fig. 2-left).

According to Davidović and Antić (22), the most influential factors are the quality and quantity of sleep. A comparative analysis of the results of the models and indicators «% of drivers who have poor sleep quality» and» % of drivers who have slept less than 6 hours of the night « observed that companies with a high value of drivers who have poor sleep quality, have a higher driver fatigue index. On the other hand, the amount of sleep has a different distribution, that is, at least sleep have the drivers in the company of TK2, after which the truck drivers (Fig. 2-right).

A comparative analysis of the percentage of drivers whose last day›s rest was less than 11 hours and the percentage of driver fatigue observed that a larger percentage of driver fatigue in companies in which more drivers have been reduced daily rest (Fig. 3-left). Similarly, a study shows that companies where drivers are more likely to drive at night have a higher percentage of driver fatigue (Fig. 3-right).

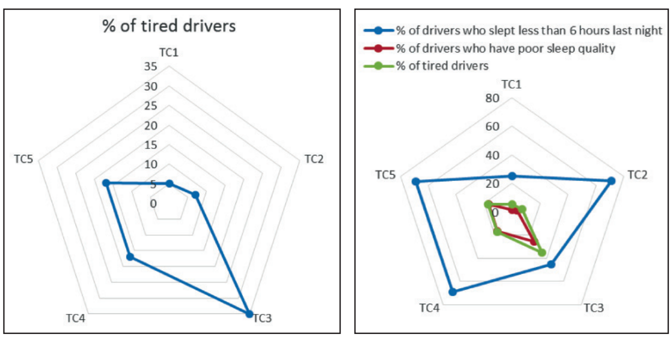

Figure 2. Percentage of tired drivers (left) and comparative analysis of indicators related to sleep and determined fatigue by transport companies (right)

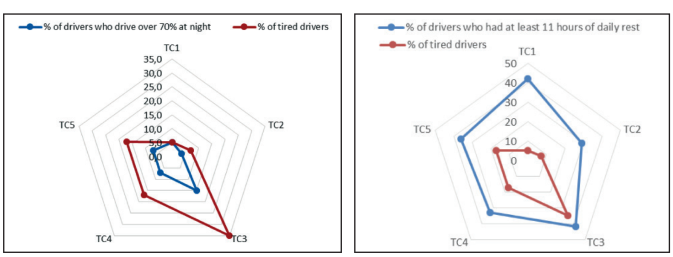

Figure 3. Comparative analysis of daily rest and % of tired drivers (left); % of drivers driving more than 70% at night and % of tired drivers (right)

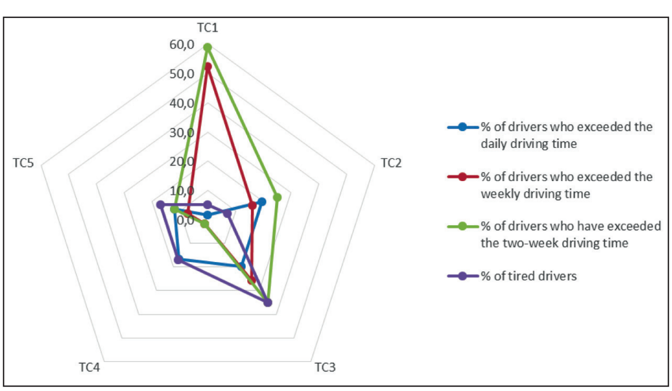

Figure 4. Comparative analysis of driving time and % of tired drivers

As a result of the analysis of road safety indicators in relation to driver fatigue of commercial vehicles become destructive data, so that in the analyzed transport companies, the percentage of drivers who were in the previous day exceeded by law limited driving time ranges from 1.7% to 19.7%. During the week, driving time and driving time for two consecutive weeks exceed 1.6% of drivers in TK4 to 52.5%, i.e. 59% of drivers in TK1 (table 3, figure 4).

A comprehensive analysis of the studies concludes that the largest excess of the legal limit of driving time in TK1, and the smallest in TK4, the largest percentage of drivers who had a reduced daily rest in TK1 and TK3. On the other hand, drivers in TK1 have better values of indicators that relate to the amount and quality of sleep. Bus drivers have significantly better performance values that relate to the quality and amount of sleep than a truck driver, but have more common exceeding legal driving time limits.

DISCUSSION

Model for the identification of fatigue due to commercial vehicle drivers, in which the application is shown in this paper, provide detailed and comprehensive analysis of the state of road safety on the issue of drivers fatigue, regardless of whether it is the transport of goods or the transport of passengers.

The model allows:

- to prevent driving under the influence of fatigue
- identify the main indicators of road safety, related to fatigue due to the drivers of commercial vehicles
- rank transport companies according to the level of road safety in terms of fatigue
- identify the "weakest link" within the transport company when it comes to indicators that relate to driver fatigue
- highlight the best companies at the local community level that will be subsidized and rewarded.

The advantages of this model compared to the still developed models are:

- apply quickly-the driver needs no more than 3 minutes
- easy to apply-the driver answers 3 questions and the responsible person reads the information for another 8 items from the valid documents
- reliable-out of 11 questions, 8 are obtained by reading documents, only 3 questions are based on self-reported behavior (quantity and quality of sleep, application of measures to eliminate drowsiness)
- does not require additional material resources (cameras, electrodes, devices for monitoring brain waves, sensors, etc.)
- does not require drivers to be connected to any

devices that distract them while driving
- it acts proactively-the driver does not put in motion, if it is found that tired, ie without endangering any passengers or cargo, or the driver
- not spatially limited – does not bind to one vehicle, which is installed, can be applied anywhere
- not timed-previous fatigue detection systems usually have trouble identifying in the event of darkness or if the driver is using sunglasses, so at night and on hot summer days is not suitable.

The main disadventage of this model is that it does not include all the influential factors, for example. Can not determine whether the driver during the day rest rested or had some extra work, can not control himself, whether the driver was 6 hours of sleep, and even if he had frequent sleep breaks, or sleep was quality. These deficiencies can be addressed by further research, i.e. identification of factors that can be controlled and are directly related to these deficiencies.

CONCLUSION

This paper shows the procedure for applying new, simple and reliable models to identify fatigue in commercial vehicle drivers. The model shown takes a step further compared to the models that have been used so far because it does not require additional resources in the form of a camera, a device for recording brain waves, electrodes, sensors, etc.., does not require special training, is applied simply, not spatially limited application and gives an overall picture of the status of important road safety indicators that are based on fatigue in commercial vehicle drivers.

The importance of applying a new model for identifying fatigue in the drivers of commercial vehicles for the local community is that local communities and transport companies within local communities can be monitored and ranked in terms of fatigue. As shown in the paper, the model shows in which company the most tired drivers are, whether the company is a problem of safety indicators of traffic related to fatigue related to drivers or related to the transport company. The significance of the local community is also reflected in the possibility of ranking transport companies in this aspect of traffic safety and easier choice of carriers, for example, for organized transportation of pupils, for organized excursions, etc.

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ORIGINAL SCIENTIFIC PAPER

Model of Information Integration of Management in Road Transport Companies

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Abstract: In modern business conditions, the management of work by road transport companies is becoming more and more complex, and it is challenging to manage the companies' management and business continuously before the management of these companies.

The expansive development of information and communication technologies, technique and technology, the globalization of the world economy, the ever more diverse requirements of transport service users require efficient adaptation of the business of road transport companies. The application of modern information and communication technologies facilitates the business and operation of road transport companies, and management information systems create the preconditions for efficient decision-making by all decision makers in road transport companies.

In order to improve the process of managing the work of a road transport company it is necessary to explore the possibility of information integration of the management of a road transport company, which will integrate all the managers regardless of the level of management they belong to. Infrastructure integration is necessary in the horizontal line of management, especially operative and medium, and in the vertical line all levels of management (top, middle and operational).

In this paper, a new model of information integration of management will be proposed, which can be applied in medium-sized and bigger transport companies.

Keywords: road transport companies; road transport; information systems; management.

INTRODUCTION

Road transport is an open and dynamic system within which car transport companies operate which carry out public transport of goods and / or passengers.

In modern business conditions, the management of road transport companies is becoming more and more complex due to increased competition in both the domestic and international transport market, globalization of the market, technical and technological development, and so on.

The complexity of the business of road transport companies imposes the need for adequate information to managers at all hierarchical levels of governance.

As a prerequisite for a successful and efficient management of the operation of a road transport company, the availability of management is timely, useful and accurate information that will be used in the decision-making process.

The expansive development of information and communication technologies has a strong impact on road transport. Road transport companies that perform public road transport of goods and / or passengers must use modern information and communication technologies in their work to ensure survival, achieve an adequate level of competitiveness and development.

Decision makers in road transport companies have at their disposal modern information systems that enable them to make decisions efficiently.

In order to more efficiently manage road transporting companies it is necessary to provide information integration of management at all hierarchical levels.

In this paper, in order to improve the management process in road transport companies, the possibility of horizontal and vertical information integration of management in road transport companies will be explored and a new model of information integration proposed.

REVIEW OF THE PROBLEMS IN THE LITERATURE

Road transport companies are open and dynamically complex systems operating in a changing and turbulent environment.

Thus, according to Peter Drucker [1] "the future development of the global environment can be observed in the following way:

- The world economy will continue to be highly competitive and turbulent,
- There will be an urgent need for information from the external environment of the organization,
- Knowledge as a resource will increasingly be accepted in the heads of employees in the organization,
- Management will significantly change the attitude towards employees, as the organization of the future will be composed of highly skilled staff,
- Organizations will have to show their employees how important they are,
- The notion of "management" will have to change its meaning and content and focus on knowledge and learning as the basic elements of organizational success."

"Management is the process of planning and deciding, organizing, managing and controlling human, material, financial and information resources of an organization in order to achieve its goals in an efficient and effective manner."

The author of the previous definition Peter Drucker gave a simplified definition: "management is an effective and efficient use of resources to achieve the desired goals".

A well-known theoretician in the field of information technology for management Efraim Turban defines the information as follows [2]: "Information is data that is organized so that it has the meaning for the recipient".

Turban and his associates further define the information system management as follows: "systems that support management in functional areas are called information systems management".

Speaking about the importance of information technology, Turban states [2] that "for real success it is necessary to know how to use information technology to improve their performance (quality, speed and efficiency in doing business) and how to improve their products and services so that they get a greater usable value with consumer aspects".

Famous theorist James O'Brien states [4] that it is important "that managers and IT experts realized that data and information are an important organizational resource."

Road transporting companies through the development of information systems create the preconditions for gaining competitive advantage in the transport market.

It is necessary to know that the competitive advantage in practice does not last long and that the competition quickly responds to changes, harmonizes its business with them and thus improves its development.

From the foregoing, it can be concluded that road transport companies must constantly identify models for improving the management of the company's operations in order to maintain an adequate level of competitiveness in the transport market.

Thus, on the management of road transport companies, the permanent task is to improve the process of managing the operation of road transport companies through the founding of new models.

ORGANIZATION OF ROAD TRANSPORT COMPANIES

One of the most important conditions of a rational organization of a road transport company is its size. Road transport companies determine their internal organization autonomously, and in terms of structure, it is projected in a vertical and horizontal line, vertically from top to every single workplace, and divisions, departments and / or sectors are formed in the horizontal. The structure of the internal organization of the road transport company has no limitations, but it depends on the processes and scope of transport and the complexity of the work that the company carries out in that process. Every modern road transport company has its own organizational scheme that is designed based on the established organization and business policy, and in accordance with the personnel resources and the degree of development achieved by the road transport company.

In modern business conditions, carriers must adapt their organization in line with changes that occur in the environment and in line with changes in the company itself (a significant increase in the number of means of transport, the expansion of the transport market, etc.). Only in this way road transporting companies will be able to keep up with competition in an increasingly demanding transport market and provide effective adaptation and adequate level of competitiveness.

Organizational structure of a road transport company

Despite the differences that are reflected in the size, purpose or specialization of transport capacities, an organizational structure can be designed, in practice, with most road transport companies that are larger or average in size.

In an average size or larger car carrier, it is common to organize functions across sectors, and the most common ones are:

- transport sector,
- technical maintenance sector,
- the financial and accounting sector,
- the commercial sector,
- general affairs sector.

The diversity of road transport companies by size, purpose, means of transportation, territorial coverage, etc. shows that it is not possible to design a universal organizational scheme for a road transport company[3].

Therefore, it can be concluded that the functional model of the organizational structure is applied in larger road transport companies.

The basic characteristic of the functional model of the organizational structure is that it is a centralized organizational structure that is based on a functional grouping of tasks, and functions in an enterprise are organized on the optimal number of sectors and services.

STRUCTURE OF MANAGEMENT IN ROAD TRANSPORT COMPANIES

Given that the most commonly used medium-sized and larger carriers are the functional model of the organizational structure with the projected sectors and services, hierarchical levels of management are designed accordingly, and the number of managers is determined.

Accordingly, three levels of management in road transport companies can be formed[6]:

- top management,
- middle management,
- operational (lower) management

Figure 1 shows the levels of management of the road transport company by vertical line

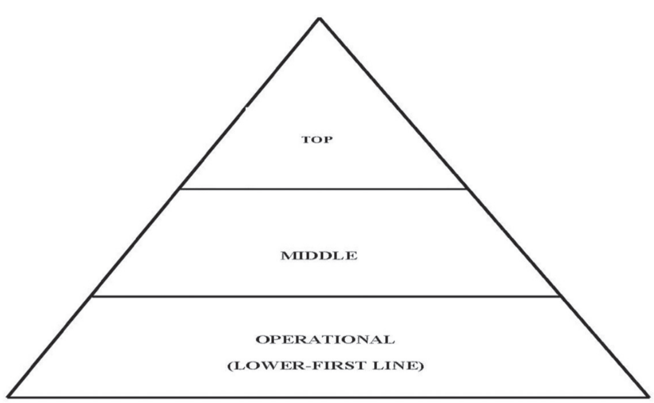

Figure 1. Levels of the management of the road transport company by vertical line

The top managers define business policy, ie goals and strategies for their realization. They also make the strategic plans for the development of a road transport company and are responsible for the functioning and performance of the company's operations.

The structure of top management in road transport companies is most often comprised of: board members, executive directors, executive assistants, etc.

The middle management of a road transport company is positioned between the top and operational management and it is tasked to elaborate the strategy and transfer the plans and goals from the top to the operational management.

Middle managers are responsible for the implementation of policies and plans brought by top managers and they coordinate and control the operation of operational managers.

Also, middle managers are authorized to manage organizational units or sectors and are responsible for the results of these organizational units.

Middle management consists mostly of sector directors, managers, etc.

Operational managers are managers at the lowest level through the hierarchy of the management of a road transport company and their task is to coordinate and monitor the work of direct executors. They are responsible for the daily activities of the company.

In road transport companies, operational management must provide the necessary resources for the production of transport services such as:

- motor fuel, lubricants, tires, spare parts for transport means,
- necessary personnel (drivers, car mechanics, workers of other specialties),
- necessary professional staff (dispatchers, operators, controllers, etc.),
- necessary staff for procurement, sales, accounting, administration, etc.

The operational management of a road transport company includes all managers who manage services, units or drives, that is, those in the first line from the execution of jobs.

MANAGERS' NEEDS FOR INFORMATION IN ROAD TRANSPORT COMPANIES

In order to efficiently and effectively manage the road transport companies, it is necessary that managers, as decision-makers in the decision-making process, have timely, accurate and useful information [5].

According to the hierarchical levels of management, the management information systems in the road transport company should provide information for[6]:

- top management,
- middle management.
- operational (lower) management.

Top management in road transport companies needs information that relates to the whole enterprise.

Based on this information, the top management determines the business policy and goals of the road transport company, as well as adopts the company development strategy.

Middle management in road transport companies has a need for information related to the work of organizational units (sectors) they manage. This information refers to the needs for transport services, then the information necessary for the planning of the volume of transport, the accomplished transport work, the personnel necessary for fulfilling the tasks of the organizational units, the realized revenues, expenses, etc.

Operational management in road transport companies has the need for information related to the execution of certain tasks such as information on the engagement of transport vehicles and rolling stock, the transport process, the cancellations of means of transport, the results achieved, the revenues and expenses, the working conditions, protection at work, etc.

MODEL OF INFORMATION INTEGRATION OF MANAGEMENT IN ROAD TRANSPORT COMPANIES

The intensive development of information and communication technologies, the improvement of transport means, the growing and diversified requirements of the users of transport services, and the increasingly pronounced competition in the domestic and international transport market condition the necessity of the modern operation of road transport companies.

The modern business of road transport companies can not be imagined if the company does not use modern information and communication technologies both in the operational part and in strategic planning and decision-making [5].

Application of information systems in road transport companies raises the level of quality of transport services, enables efficient operation and safe transport process, facilitates the decision-making process of all decision-makers, etc.

Modern road transport companies increasingly depend on computer information systems in terms of processing operational data, financial reports, human resources management, business transactions, management of individual organizational processes, etc.

Timely and efficient decision-making by the management of a road transport company provides a high level of transport services, and thus directly influences the level of competitiveness of the road transport company.

In order for an road transport company to operate efficiently on the transport market, it is necessary to integrate the information management system, that is management.

The information integration of the management of the road transport company is a new model that will ensure the functioning of the company on modern principles and will contribute to a significant competitive advantage in the transport market.

The new model of information integration of the management of the road transport company implies a dual integration:

- horizontal information integration of operational and middle management and
- vertical information management integration.

Horizontal information integration of the operational management of a road transport company

Horizontal information integration implies information flows at the same decision-making level and represents a modern form of integration, as it provides mutual exchange of information and data between all operational managers in the road transport company.

Operational managers in the road transport company are in charge of planning and executing operational tasks and tasks that they perform within regular business activities. They perform these tasks within all sectors, or services in the road transport company.

In modern business conditions, road transport companies are extremely important for operational management to be horizontally integrated in information, that is, that they have all the necessary information that they can use from a single database.

Figure 2 shows an example of horizontal information integration of the entire operational management of a road transport company.

Figure 2. An example of horizontal information integration of the operational management of a road transport company

It is very important to note here that when designing horizontal information integration of operational management, operational managers must not be overloaded with redundant and unnecessary information or reports, for example, the same information is not required to the manager of the traffic operator and the manager of legal affairs.

Horizontal information integration of operational management enables operational managers to easily plan business operations, simplify communication and organization, and more effectively monitor and control all processes in the road transport company.

Horizontal information integration of middle management in road transport companies

Middle management in road transport companies in the governance process plays a very important role because the hierarchy is between top management and operational management and represents the level of management entrusted with the tasks of realizing plans and goals and achieving results.

In road transport companies, middle management, most often, consists of sector managers (transport manager, technical maintenance manager, commercial manager, financial manager, etc.).

Mid level managers manage organizational units (sectors) and propose to the top management the organization of these sectors, determine the work plans of the sector (annual, quarterly and monthly) and control the operations of the operational managers or the services they manage.

In order for the management of road transport companies to be efficient and functional, it is necessary to perform horizontal information integration of middle management.

The integration of information and reports exchanged by middle managers among themselves, depending on business activities, has multiple benefits for the whole process of managing the operation and operation of a road transport company.

In modern conditions of business of road transport companies, a large number of information and reports are available to middle managers, so it is of the utmost importance that these managers do not get overloaded with redundant and unnecessary information and reports.

Figure 3 shows an example of horizontal information integration of middle management in road transport companies.

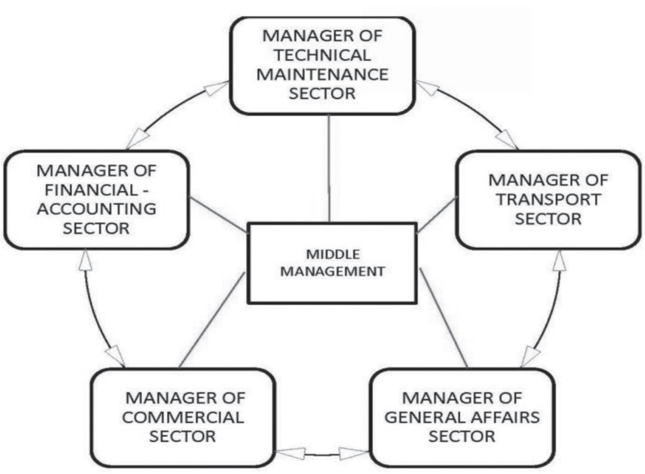

Figure 3. An example of horizontal information integration of middle management in road transport companies

Vertical information integration of management in road transport companies

Vertical information integration involves information flows between different levels of management, from top management to middle to operational management (from top to bottom) and vice versa from operational management through middle to top management (from bottom to top).

The information that goes from top management to middle and operational management is management decisions, and the information that goes from operational management to middle and top management is input information.

From this it can be concluded that vertical information integration of management represents an important segment in improving the management of the management in road transport companies.

In this way much more efficient work of all levels of management is achieved and they achieve significantly better results of work and better organization of all managing structures of the road transport company. Figure 4 shows an example of the flow of information in the system of vertical information integration of management in road transport companies.

Figure 4 shows an example of the flow of information in the system of virtual information integration of management in road transport companies.

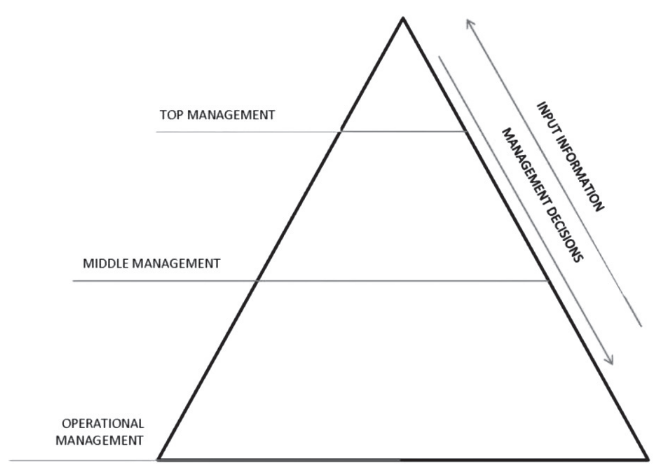

Figure 4. An example of the flow of information in the system of vertical information integration of management in road transport companies

Expected effects of the proposed model of information management integration

By applying a new (proposed) model of information integration of management in road transport companies, the management process would be significantly improved and in this way would create the preconditions for more efficient and effective operation of the road transport company.

At all stages of the management from the planning process to the control process, better communication would be achieved and considerably facilitated the decision making process.

As a result of the information integration of the management, the organization of the entire transport process will be significantly improved, which will result in the improvement of the quality of the transport service and the level of competitiveness of the transport company in the transport market.

CONCLUSION

Road transport, as an open and dynamic system, is very subject to change, especially those that come from the environment, so road transport companies need to permanently adjust their organization and business exactly to these changes.

Road transport companies, as complex systems by their organization, operate on an increasingly demanding domestic and international transport market.

In modern conditions, road transport companies must use modern information and communication technologies in their work in order to ensure more efficient operation, increase the level of quality of transport services and maintain an adequate level of competitiveness in the transport market.

Managing the operation of road transport companies is a complex process that is becoming more and more complex with the expansive development of information and communication technologies, increased competition in the transport market, globalization of the economy, growing demands of users of transport services, requirements for environmental protection and so on.

In this paper, the possibilities of improving the management of the operation of road transport companies have been explored through the proposed model of information integration of management, which is necessary to be implemented through horizontal information integration, especially operational management and middle management, as well as vertical information integration.

Improving the management of the operation of road transport companies through this model is reflected in the more efficient work of the overall management of the road transport company, significantly faster flow of information between decision-makers in the decision-making process and certainly better communication in the company, resulting in a more competitive appearance in the transport market.

Horizontal and vertical information integration of management in road transport companies will provide for a more efficient management process in all phases from planning tocontrol.

In further research of this model, it will be necessary to explore the possibilities of information integration of the sales function, especially from the aspect of road transport companies that are territorially dislocated or road transport companies that operate as dependent companies (eg more road transport companies with the same owner). Thus, it is possible to supplement the proposed model of information integration of management especially with larger road transport companies.

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PROFESSIONAL PAPER

The Influence of the Weather Conditions on Traffic Accidents With the Most Severe Consequences in the Republic of Srpska

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Abstract: Traffic accidents with the most severe consequences, i.e. killed in traffic accidents and great material damage, are the result of numerous complex impact factors. Among these important factors, there are different time parameters, that is, meteorological parameters. Research on the impact of weather parameters on the occurrence of traffic accidents was the subject of research in the early 70s of the twentieth century. Weather conditions usually have a double impact on the occurrence of traffic accidents such as: the impact on the risk of a traffic accident and the impact on the exposure to the risk of an accident. In other words, it can be said that the time parameters influence directly and indirectly on the safety of traffic, or the occurrence of traffic accidents. Namely, it has been proven that the weather conditions influence the change in the structure of the traffic flow (change of mode of transport), as well as the total number of realized trips. Although the impression is that the impact of weather conditions on the occurrence of traffic accidents is unambiguous and clear, concrete research on the impact of weather conditions is quite rare and the results sometimes differ from the expected ones. Through a review report, a special aspect of the analysis will focus on identifying concrete changes in the characteristics of time, with the aim of recognizing their impact on the number of traffic accidents with the most severe consequences in the Republic of Srpska.

Keywords: тraffic accidents, weather conditions, safety on traffic.

INTRODUCTION

Every day more than 3700 die in traffic accidents, which leads an annual 1,35 milion killed in traffic accidents, of this number, almost half are made by vulnerable road users. According to a report from the World Health Organization it is estimated that on the roads in Europe of the total number of dead 27 % dead pedestrians (WHO 2018). Due to this fact traffic accidents have become the main cause of the death and of the bad physical injuries in the countries of the European Union. When it comes to material losses, they amount to 160 milliard of convertible marks even more not counting immaterial losses which include costs of hospital treatment, insurance, sick leave and similarly. For these reasons a certain analysis of traffic accidents with the most severe consequences should contain a detailed analysis of all factors that cause such traffic accidents. The main aim of this analysis is to find out influence factors and to prevent the same in order to reduce the number of traffic accidents and the consequences of these traffic accidents.

LITERARY EXAMINATION

Traffic problems were recognized by scientists from experts of state institutions and many other. Malenje et al. 2018. in their work, they investigate unsafe pedestrian crossings and the risks that arise on that occasion. Pedestian overpasses crossing in unprotectected places are very unpredictable with vehicles, in addition to generally hindering the normal flow of vehicles. Drivers must not only anticipate but also react to unpredictable pedestrian procedures to avoid potential pedestrian conflicts. The aim of this paper is to describe the behavior of the driver in the circumstances of an unsafe pedestran crossing. Results show that pedestrian that cross over to unsafe areas have a negative impact on traffic flows because they are unpredictable congestion and lead to vehicle traffic disruption. Unpredictable crossings can cause traffic accidents when either side misjudges the actions of the other party (whether it is a wrong estimate of the driver or pedestrian). Therefore the work recommends the adoption of additional provisions for pedestrians or the taking of measures to prevent improper pedestrian behavior of non- compliance with legal provisions.

In their work Uttley et al. 2017. show that ambient light has a significant impact on the risk of injuries to pedestrians at a pedestrian crossing. In the paper itself concluded that the increase in risk is not solely due to the lack of street lighting at the crossings. However, this raises the question of whether the transit lighting is adequate and sufficient to improver the visibility of pedestrians while waiting or crossing the pedestrian crossing. Another factor that can be associated with an increased risk at pedestrian crossings for the dark is trust,which pedestrian can have when deciding to across and the expected behavior of the driver who is then in the vehicle. The decision to cross the road relies on accurate speed estimation, distance and to the extent of any approaching vehicle. Estimates of pedestrians and drivers will probabley be wrong if the low level of illumination at pedestrian crossings. The conclsion of this paper refers to the illumination of pedestrian crossings in particular whether the exising lighting is adequate and whether it could be improved so that the passage would be more visible and the estimates of pedestrians and drivers more precisely.

METHODOLOGY

According to needs of research and analysis of traffic accidents with the most severe consequences, it is obsereved the entire number of such traffic accidents in the Republic of Srpska at different police departments for the years 2015, 2016 and 2017. The Agency of the Road Safety in the Republic of Srpska provided the detailed information about traffic accidents with the most severe consequences (the number of killed and badly injured people). These traffic accidents are related to weather conditions which are divided into two categories:

- „BAD“, bad weather conditions such as rainy, snowy, icy and cloudy weather
- „GOOD“, good weather conditions such as sunny and clear weather

One of the related factors also was visibility which has an important influence on these traffic accidents and which is also divided into two categories:

- „POOR“, poor visibility during the night , dusk and foggy weather
- „GOOD“, good visibility during the day and clear weather

Traffic accidents are divided into several groups according to the type of accident:

Going off the road, side impact, hitting the pedestrian, driving in the opposite direction4. The most frequent accidents that happened are presented in the table.Beside these facts, the most frequent months, during which happened the most traffic accidents with severe consequences, are examined in some police departments. In the charts below we presented some facts which are gathered from the base of traffic accidents of the Ministry of Interior of the Republic of Srpska, by the Agency of the Road Safety in the Republic of Srpska.

Table 1. Trafic Accidents in Dependence of Weather Conditins During 2017.

POLICE DEPARTMENT	WEATHER CONDITIONS		VISIBILITY		TYPE OF ACCIDENT	
	BAD	GOOD	POOR	GOOD	BAD WEATHER CONDITONS	GOOD WEATHER CONDITONS
BANJA LUKA	40	94	26	28	Going off the road	Driving in the opposite direction
GRADIŠKA	11	14	9	9	Going off the road	Going off the road
PRIJEDOR	13	55	13	15	Hitting the pedestrian	Going off the road
MRKONJIĆ GRAD	12	6	5	2	Driving in the opposite direction	Hitting the pedestrian
BIJELJINA	37	54	16	17	Going off the road	Side impact
ZVORNIK	40	21	18	17	Driving in the opposite direction	Going off the road
ISTOČNO SARAJEVO	36	16	23	7	Driving in the opposite direction	Side impact
DOBOJ	65	74	30	34	Driving in the opposite direction	Going off the road
FOČA	18	21	7	2	Going off the road	Going off the road
TREBINJE	18	29	6	5	Going off the road	Going off the road

From the previous chart it is visible that the highest number of traffic accidents occurs in police departments of Doboj and Banja Luka but it must be emphasized that in both police departments the number of traffic accidents is lower during the bad weather conditions and it is especially expressed in the police department of Banja Luka. Other police departments of Gradiška, Prijedor, Bijeljina, which are placed at lower elevation (flat areas), also have the lower number of traffic accidents during the bad weather conditions than during the good weather conditions. It is also noticed that the number of traffic accidents in all police departments placed at higher elevation (hilly and mountainous areas of Mrkonjić Grad, Zvornik and Istočno Sarajevo) is higher during the bad weather conditions.

It can be stated that during the year 2016 the number of traffic accidents with the most severe consequences is the highest on the territory of Banja Luka and Doboj police departments and that the number of traffic accidents with the most severe consequences is approximately the same during the bad and good weather conditions on the territory of all police departments. It can also be stated that the number of traffic accidents is approximately the same on the territory of Gradiška, Prijedor and Bijeljina police departments. During the years 2017 and 2016 the number of traffic accidents, in the areas at higher elevation, is higher during the bad weather conditions in comparison to periods of good weather conditions (Zvornik, Istočno Sarajevo and Foča).

Table 2. Traffic Accidents in Dependance of Weather Conditions During 2016.

POLICE DEPARTMENT	WEATHER CONDITONS		VISIBILITY		TYPE OF ACCIDENT	
	BAD	GOOD	POOR	GOOD	BAD WEATHER CONDIONTS	GOOD WEATHER CONDITINS
BANJA LUKA	94	95	50	33	Going off the road	Driving in the opposite direction
GRADIŠKA	26	29	19	6	Going off the road	Going off the road
PRIJEDOR	33	40	19	13	Going off the road	Going off the road
MRKONJIĆ GRAD	19	20	5	16	Going off the road	Going off the road
BIJELJINA	29	63	12	21	Side impact	Going off the road
ZVORNIK	43	31	18	9	Driving in the opposite direction	Side impact
ISTOČNO SARAJEVO	46	31	19	12	Driving in the opposite direction	Side impact
DOBOJ	61	77	32	34	Driving in the opposite direction	Going off the road
FOČA	33	11	11	4	Driving in the opposite direction	Hitting the pedestrian
TREBINJE	26	24	6	8	Going off the road	Going off the road

Table 3. Traffic Accidents in Dependance of Weather Conditons During 2015.

POLICE DEPARTMENT	WEATHER CONDITIONS		VISIBILITY		TYPE OF ACCIDENTS	
	BAD	GOOD	POOR	GOOD	BAD WEATHER CONDITIONS	GOOD WEATHER CONDITIONS
BANJA LUKA	105	122	58	49	Going off the road	Driving in the opposite direction
GRADIŠKA	28	29	22	8	Going off the road	Going off the road
PRIJEDOR	36	56	15	22	Hitting the pedestrian	Going off the road
MRKONJIĆ GRAD	8	15	5	7	Going off the road	Going off the road
BIJELJINA	23	64	13	23	Side impact	Side impact
ZVORNIK	44	31	15	9	Side impact	Side impact
ISTOČNO SARAJEVO	64	45	16	12	Driving in the opposite directin	Going off the road
DOBOJ	78	82	42	23	Going off the road	Going off the road
FOČA	20	4	9	0	Going off the road	Going off the road
TREBINJE	14	39	7	13	Going of the road	Going off the road
BANJA LUKA	105	122	58	49	Going off the road	Driving in the opposite direction

From the previous chart it is visible that in all police departments which are placed at higher elevation (Zvornik, Istočno Sarajevo, Foča), the number of traffic accidents is higher during the bad weather conditions but according to the type of accident facts are not matching with the previous two years. More precisely during the year 2015 according to the type of accident in Zvornik and Foča police departments, the most dominant traffic accidents are going off the road and side impact whereas in Istočno Sarajevo according to the type of accident, facts are matching with previous two years and the most dominant type is driving in the opposite direction.

In the next chart the most dominant months, during which traffic accidents with the most severe consequences occur, are shown and assigned to police departments for the years 2015, 2016 and 2017.

Table 4. Traffic Accidents in Dependance of Weather Conditions During 2015, 2016 and 2017.

POLICE DEPARTMENT	MONTH
BANJA LUKA	JUNE, DECEMBER
GRADIŠKA	MAY, JULY
PRIJEDOR	AUGUST
MRKONJIĆ GRAD	AUGUST, APRIL, MAY
BIJELJINA	SEPTEMBER, NOVEMBER
ZVORNIK	JULY, MAY
ISTOČNO SARAJEVO	MAY, NOVEMBER, JUNE
DOBOJ	OCTOBER, DECEMBER
FOČA	MAY, JUNE, AUGUST, DECEMBER, JANUARY
TREBINJE	MAY, AUGUST, JULY

In chart 4 it is presented the review of the most dominant months during which traffic accidents with the most severe consequences occured, divided according to three observed years and according to certain police departments. It is obviously that in the highest number of police departments, during all three observed years, the number of traffic accidents with the most severe consequences occured during one or two months (Prijedor, Banja Luka, Gradiška, Bijeljina, Zvornik and Doboj).

The main distractions which can occur during the research are distractions which refer to accidents with light injuries and material damage which are not included by this research. There are also restrictions in database which refer to insufficient possibilities to filter the data and to include other factors which refer to traffic accidents.

RESULTS

Analysis of facts about the most serious traffic accidents for the last three years has shown that in flat areas i.e. areas at lower elevation, there are more traffic accidents with more severe consequences during the good weather conditions i.e. when it is sunny, clear weather etc. Whereas in mountainous areas i.e. areas at higher elevation, there are more traffic accidents with the most severe consequences during the bad weather conditions which is shown on diagrams (diagram 1; diagram2; diagram 3).

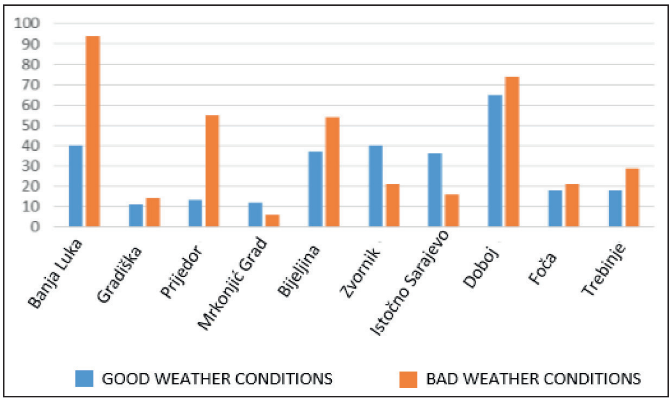

Figure 1. Trrafic Accidents With Killed and Badly Injured People During 2017.

On previous diagram we can see that during the good weather conditions the most dominant police departments are Banja Luka and Doboj police departments and during the bad weather conditions the most dominant is Doboj police department.

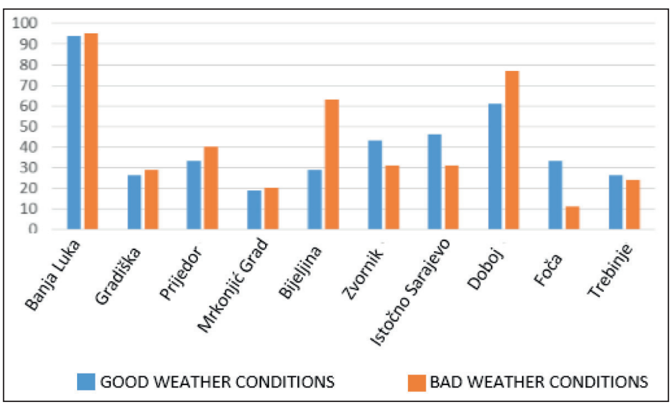

Figure 2. Trrafic Accidents With Killed and Badly Injured People During 2016.

On diagram 2 we can see that during the good weather conditions the most dominant are Banja Luka, Doboj and Bijeljina police departments, whereas during the bad weather conditions the most dominant are Banja Luka, Doboj, Zvornik and Istočno Sarajevo police departments.

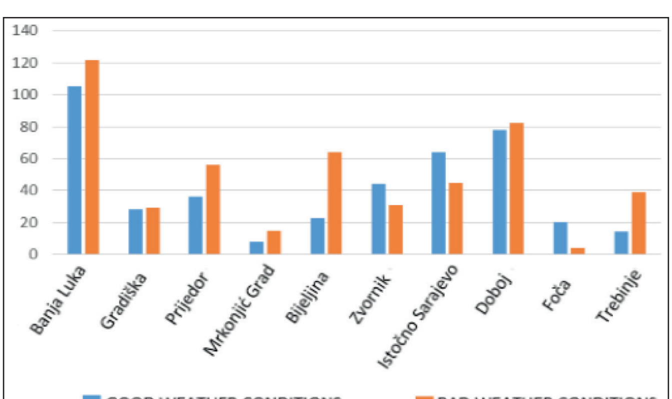

Figure 3. Traffic Accidents With Killed and Badly Injured People During 2015.

On diagram 3 we can see that during the good weather conditions the most dominant are Banja Luka, Doboj and Bijeljina police departments and during the bad weather conditions the most dominant are Banja Luka, Doboj and Istočno Sarajevo police departments.

The highest number of traffic accidents, according to the shown diagrams, occurs in Banja Luka police department. This number can be seen as something which is in accordance with the number of population because Banja Luka police department, in comparison with other police departments, has the considerably higher number of population and therefore the number of traffic accidents can be higher.

From the analysis of the most dominant months during which occurred the highest number of traffic accidents with the most severe accidents, for all three years, it can be seen that the highest number of these accidents occurred during the period of good weather conditions, that is during the period of strong weather changes that is when winter driving conditions change to summer driving conditions (May) and when summer driving conditions change to winter driving conditions (October).

DISCUSSION

Climate conditions are very important factor for a safe traffic. These factors influence the elements of a safe traffic on roads. Climate conditions have two kinds of the influence which are connected to the traffic accidents.

- They influence the human health and mood: Besides many researches into the influence of the climate conditions on humans, it is not still explained completely how the weather conditions influence the human body and mood. Although there is a connection between the climates conditions, human health, human mood and traffic accidents.
- They influence the change of the outside conditions of the traffic: Climate conditions can cause the change of the outside conditions of the traffic which can cause problems for traffic participants. Connection between climate conditions which influence the change of the outside conditions of the traffic and between the traffic accidents is obvious but it is not still completely examined how much the climate conditions influence the number of traffic accidents and the consequences of the traffic accidents. To get a more complete answer it is necessary to do systematic researches on different roads during different climate conditions. When we establish how the climate conditions cause the traffic accidents, we must keep in mind that these conditions are different in certain areas because of the

geographical position.

Both bad weather conditions (snow, ice, rain etc.) and good weather conditions (sunny, clear weather etc.) can have the negative influence on the traffic accidents. If we observe all traffic accidents (material damage, light physical injuries, bad physical injuries and killed people), we can conclude that bad weather conditions considerably contribute to higher number of traffic accidents. However if we observe the most severe consequences of traffic accidents (bad physical injuries and killed people), good weather conditions are more dominant than bad weather conditions i.e. the higher number of traffic accidents with the most severe consequences occurs during the good weather conditions and it is mostly connected to areas at lower elevation i.e. to flat areas. When it is about geographical regions, the bad weather conditions are more dominant than the good weather conditions in the areas at high elevation i. e. more traffic accidents with the most severe consequences occur during the bad weather conditions.

The good weather conditions and higher number of traffic accidents with the most severe consequences can be connected to the vehicle speed and to the carelessness of drivers because the most dominant type of accidents during the good weather conditions is going off the road of the vehicle because of the maladjusted vehicle speed to road conditions. During the good weather conditions, drivers are usually less careful and they are also full of self-confidence and they move faster thus they have a tendency to behave risky and therefore they provoke the traffic accidents with the most severe accidents.

Thus the bad weather conditions connected to elevation also influence the higher number of the traffic accidents with the most severe consequences. According to the type of accident during the bad weather conditions, the most dominant ones are accidents during the driving in the opposite direction and they are followed by poor visibility. These accidents can be connected to the action of passing of a moving vehicle during which drivers start passing another vehicle but because of poor visibility they are not able to estimate whether they have enough space or time to finish the started action. Also these accidents can be connected to bad conditions on roads (ice, snow, rain etc.) which can cause the loss of the vehicle control and passing on the opposite side of the road.

CONCLUSION

This work draws attention to the particularly vulnerable in the category of participants in traffic (pedestrian). Data anaalysis defines indicators indicating who makes mistakes that are most commonly mistakes in what area under what conditions and for which such types of traffic accidents arise. On the basis of this, certain conclusions and measures have to be taken to minimize the number of such traffic accidents and increase the safety of traffic primarilay vulnerable participants in traffic or pedestrians.The inclusion of all institutions of the Republic of Srpska primarily by the institutions dealing with traffic plays a key role in solving this problem. The Traffic safety agency Republic of Srpska as a key factor in coordination with all interested institutions to local government units for governmental and nongovermental organizations and all other entities that are interested in participating and work on improving traffic safety should animate these institutions. Initation of the Republic of Srpska Ministry of internal affairs for the harmonization of repression measure with a joint preventive action plan is the first stepm that in the months that are marked as critical for vulnerable road users, they have increased control of pedestrains, especially in segments of light reflective vests and pedestrian movement. Also the institute for Adult education of Republic of Srpska suggest that the problem of vulnerable participants in pedestrian traffic and the way in which they can contribute to solving this problem or what measures can they take in the driver's training so that drivers are ready for situations that thez can encounter in traffic and thez are tied to pedestrians. When implementing preventive activities, other institutions that can have a significant impact on the population of pedestrians should be animated. To carry out education in the framework of preventive activities how youngest participants in traffic are students from the first to the fifth grade as well as students from the fifth to ninth grade of the elementary school with suggestions on dangerous situations arising from the analysis of the data (suggesting the adapted age of the students).

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REVIEW

Methodology of Calculating Heavy Vehicle Equivalents

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Abstract: Passenger car equivalents (PCE) present a very important parameter for capacity calculation and road service level as well as a planning segment of road capacity. There are many ways of calculating PCE and most of them are based on Greenshield's basic method. This paper studies the PCE calculation methodology and conditions under which it is applied. The first part of the paper is about role of PCE in analyzing traffic flow, and the rest of the paper is presenting methodologies for computation of PCE. Example of the latest method for determining PCE according to HCM-2010 is given in this paper. The goal of the research is presented by structural, parameter and functional analysis of methods. Further research directions of PCE are shown as well.

Key words: passenger car equivalents (PCE), analysis, heavy vehicle, flow.

INTRODUCTION

Many studies have been made in order to understand the effect of different categories of vehicles on traffic flow. PCE is used to evaluate the effect of different categories of vehicles on traffic flow. As traffic flow is made of more than one type of vehicle, PCE values are used to translate a real traffic flow through an equivalent of homogenous traffic. PCE is first mentioned in 1965, and since then many researchers have tried to determine a quantity effect of heavy vehicles in traffic flow during the development of HCM (*Highway Capacity Manual*) using different methodologies and equality criteria. According to the HCM-2000 [1] PCE is a number of passenger cars distributed according to a single category of units of vehicles depending on traffic conditions, i.e. an average number of passenger cars that would use the same percentage of capacity of the road as any other vehicle (HV, BUS, RV) in given road and traffic conditions. This also creates a unit of measurement of capacity as passenger car/hour (PC/h). Presence of heavy vehicles in traffic flow results in decreased capacity of traffic lanes in intersections, which is shown in [2]. Influence of heavy vehicles on traffic flow is also seen in the fact that heavy vehicles are larger than passenger cars and therefore occupy more space in traffic flow. Also, heavy vehicles are inferior comparing to passenger cars in terms of technical and usage abilities (acceleration and deceleration) and therefore require larger distances between vehicles. In [3] it is presumed that drivers of other types of vehicles are maintaining larger safe following distances comparing to heavy vehicles during driving.

HISTORICAL DEVELOPMENT OF EQUIVALENTS

Papers that have examined PCE were mostly trying to estimate PCE regarding different categories of vehicles under different conditions of traffic flow and roads ([4], [5], [6], [7]). There are different chronological methods in establishing PCE. For example, HCM-1965 uses *speed reduction method* to determine PCE for highways, also known as Walker's method. According to Huber [8] there are three performance measures of PCE: *speed, density and passenger car's speed in both lanes*. In 1980, Ramanayya [9] used the title „*equivalent of a car's design*" instead of unit of a passenger car for traffic model observed in urban roads in India. This kind of study is the first that measures flow in metric values instead of PCE values. The study shows that PCE values are not constant due to heterogenous road conditions. This Indian model is trying to translate all vehicles to a unit of „*equivalent of a car's design*". Raghava Chari and Badarinath [10] considered heavy vehicle equivalents through density, which they were calling „*areal density*" (density observed in an area). This is the first study that was observing vehicle's area (the area that vehicle occupies) to measure density. This density is defined as a vehicle on the road per unit of the road section. Determining area density is done with a camera in time interval of one second. Cunagin and Messer [11] are using *delay* relations as a performance measure to evaluate PCE of heavy vehicles at highways with several lanes. Sumner and Shapiro [12] are using *a number of vehicles per hour* to present density equivalent because veh/h is in a function of vehicle's speed and its length. Kumar [13] is using characteristics of traffic flow to study traffic on national roads in India. Al-Kaisy et al. [14] is using *a factor of queue discharge flow* as a measure to evaluate PCE during traffic congestion.

METHODOLOGY FOR DETERMINING PCE

In practice, many types of research were focused on defining the influence of different categories of vehicles on the capacity of roads. Basic method of establishment of this influence is based on the concept of determining PCE. Similarly, the method of relative relations of time headway in process of queue discharge flow is the most common and the most frequently used to determine PCE value. This method was developed by Greenshields in 1947 and it is known as "*basic method of determining the time headway*". The method is very simple and uses the following relation:

$$PCE_i = \frac{H_i}{H_{pc}}, \text{ where}$$

PCE_i – passenger car equivalent for ith vehicle category
H_i – average value of time headway for ith vehicle category
H_{pc} – average value of time headway for passenger car

Method recommended by HCM-1965

PCE values for basic sections of highways with several lanes are based on relative delay and are calculated as:

$$E_T = \frac{\left(D_{ij} - D_B\right)}{D_B}, \text{ where}$$

D_{ij} – delay of passenger car depending on type *i* under condition *j* ;
D_B – basic delay of standard passenger car due to passenger cars with lower speeds.

Besides this method based on delay, Cunagin and Messer [11] used the extended version of HCM-1965 to determine PCE of roads with several lanes based on relative delay. In their approach combination of Walker's method of relative number of passings and method of relative delay has been used. In their research, they recognized that at roads with several lanes passing or overtaking of vehicles is prevented only by traffic flow of other traffic lanes. PCE, in this case, is thus calculated as:

$$E_T = \frac{\left(OT_i / VOL_i\right)\cdot\left[\left(1/SP_M\right)-\left(1/SP_B\right)\right]}{\left(OT_{LPC} / VOL_{LPC}\right)\cdot\left[\left(1/SP_{PC}\right)-\left(1/SP_B\right)\right]}, \text{ where}$$

OT_i – number of overtaking of vehicles type *i* by passenger cars,
VOL_i – number of type *i* vehicles,
OT_{LPC} – number of overtaking of passenger vehicles with lower technical and exploitation characteristics by standard passenger cars,
VOL_{LPC} – number of passenger cars with lower technical and exploitation characteristics,
SP_M – average speed of mixed traffic in the lane,
SP_B – average speed of basic traffic flow made of passenger cars with higher technical and exploitation characteristics and
SP_{PC} – average speed of traffic flow in the lane only with passenger cars.

Linzer et al. [15] bring the utility of designers diagrams which are resulting in microsimulation which is done in MRI – Midwest Research Institute. Here, design connects the grade, mixed flow and percentage of heavy vehicles in capacity percentage (equivalent of V/C relation). Here, PCE, e.i. E_T is thus calculated as:

$$E_T = \frac{q_B - q_M\left(1-P_T\right)}{q_M \cdot P_T}, \text{ where}$$

q_B – equivalent of flow of passenger cars for given relation V/C,
q_M – mixed traffic flow and
P_T – percentage of heavy vehicles in mixed traffic flow.

Huber [8] has developed an equation in a different functional form to show PCE for passenger car lane in relation to mixed flow lane. Heavy vehicle effect is expressed by a number, i.e. through connecting flow for the same level of service. Every equivalent of the level of service can be used for determining values. For example, if density would be used to define equal criteria of level of service, the relation flow-density could be used to connect flow with same density values. Huber's basic equation is:

$$E_T = \frac{1}{P_T}\left(\frac{q_B}{q_M} - 1\right) + 1, \text{ where}$$

P_T – percentage of heavy vehicles in a mixed flow,
q_B – basic flow (passenger cars only),
q_M - mixed flow.

In 1984, Sumner et al. [6] have expanded Huber's equation to calculate PCE value for a single heavy vehicle in a mixed traffic flow, which includes different types of heavy vehicles. This calculation demands observation of basic flow, mixed flow and flow with appropriate vehicles. Equal level of service should be shown for all three flow curves. The relation which Sumner describes is thus presented as:

$$E_T = \frac{1}{\Delta P}\left(\frac{q_B}{q_S} - \frac{q_B}{q_M}\right) + 1, \text{ where}$$

ΔP – proportion of required vehicles added to mixed flow and deducted from proportions of passenger cars,
q_B – basic flow (passenger cars only),
q_M – mixed flow and
q_S – flow which includes added required vehicles.

PCE in HCM - 1985

According to Roess and Messer [16] PCE in HCM-1985 is calculated for heavy vehicles in category weight/power for 60,9 kg/kW, 121,8 kg/kW and 182,7 kg/kW, and 121,8 kg/kW is considered as an average heavy vehicle. Movement of a typical heavy vehicle of 182,7 kg/kW to 121,8 kg/kW is inspired by an indication that average heavy vehicle fleet on roads was between 76,1 and 103,5 kg/kW. Besides this change, the method of PCE calculation in V/C relation in TRB circular 212 stayed the same in HCM-1985. Same as in TRB circular 212, PCE was the biggest at long downgrades, but it was decreasing with the increase in the percentage of heavy vehicles.

Method of spatial distance is discussed as a replacement for density unit. Both methods affect the maneuver capabilities in traffic flow. With a change of equation in PCE chapter based on traffic velocity, designed by Huber, for calculation of PCE values is used equation based on distance. The quation uses keeping distance, as the perception of a driver of the following vehicle about maneuver capabilities influences on PCE value. Opposing these findings by Cunagin and Chang [17], the distance for heavy vehicles following other heavy vehicles is significantly smaller than distance for passenger car following heavy vehicle. Therefore, opposite to recommended equation of Seguin et al. [18], Krammes and Crowley [19] suggest PCE calculation as:

$$E_T = \frac{\left(1 - P_T\right) \cdot H_{TP} + p \cdot H_{TT}}{H_P}, \text{ where}$$

P_T – percentage of heavy vehicles,
H_{TP} – distance of heavy vehicle following passenger car in mixed traffic flow,
H_{TT} – distance of passenger car following heavy vehicle in mixed traffic flow and
H_P – distance of passenger car following any type of vehicle in mixed traffic flow.

Webster and Elefteriadou [7] have published a study to determine the influence of traffic flow on PCE for basic level road sections using FRESIM simulation model. They completed the calculation of PCE for five types of heavy vehicles, which are different in relation to weight/power, as well as in overall length of vehicles. Their study evaluated five types of heavy vehicles:

1. Truck with semi-trailer with five axles,
2. Truck without trailer with two axles,
3. Truck with semi-trailer with four axles,
4. Truck with two trailers and five axles and
5. Truck with three trailers.

Tested traffic flow was expressed in flows of 500, 1,000, 1,500 and 2,000 vehicles/h/lane. This classification determines PCE values for five controlled types of heavy vehicles. As previously mentioned, in 2002 Al-Kaisy et al. [14] have published a report describing the calculation of PCE values with usage a factor of queue discharge flow (*QDF-Queue Discharge Flow)*, as well as terrain sum of traffic flow of vehicles separated in their categories. Their hypothesis is based on an attitude that the effect of the influence of heavy vehicles is higher during traffic congestion rather than saturated conditions. The primary hypothesis of their research is that the capacity of discharging traffic flow is constant, except when it comes to influencing of heavy vehicles on traffic flow. Al-Kaisy used observation scope and linear programming for determining PCE.

Table 1. Effect of traffic flow on level road sections in ratio to PCE [7]

Traffic flow (veh/h/lane)	PCE				
	Truck with semi-trailer with five axles	Truck without trailer with two axles	Truck with semi-trailer with four axles	Truck with two trailers and five axles	Truck with three trailers
500	1.02	1.03	1.09	1.02	1.02
1,000	1.05	1.05	1.04	1.06	1.07
1,500	1.14	1.07	1.06	1.12	1.16
2,000	1.42	1.04	1.15	1.42	1.62

Huber [8] assumed that traffic flow q_B of basic flow (passenger cars only) and traffic flow q_M of mixed flow have a proportion *p* of heavy vehicles and proportion *1-p* of cars that have same measure performances, and thus the following calculation can be made:

$q_B = (1 - p) \cdot q_M + e \cdot p \cdot q_M$, where

e – PCE value for heavy vehicles.

However, the formula of Huber's followers Sumner and Shapiro [12] allows calculation of PCE value for a single heavy vehicle in a lane mixed with other vehicles. Applied to roads, the density is the most often equal to the level of service, so Webster and Elefteriadou [7] used this method to determine PCE for heavy vehicles. Their approach was using a simulation model for calculating relations between density and flow. Again researchers were examining the influence of prevailing traffic flow, truck dimensions (length and power/weight ratio), length and grade and a number of lanes on the road. The result of the analysis of Webster and Elefteraidu indicate an increase of PCE with the increase of flow on the road section and decrease of PCE with the increase of the percentage of heavy vehicles and traffic lanes. The most important conclusion is that the type of heavy vehicle toward length and power/weight ratio is a priority for determining PCE values.

Demarchi and Setti [20] have published a paper describing limitations in determining PCE values for traffic lanes for multiple vehicle types. In their algebra analysis, they have shown that PCE value is developed for one type of heavy vehicle. However, in a mixed traffic flow made of several types of heavy vehicles, there is not enough attention dedicated to the interaction between heavy vehicles themselves. Their consideration they justified with next statement: „*With an increase of the percentage of heavy vehicles in a lane, increase (decrease) of PCE value is neglected due to marginal effect of vehicles in the lane*“. To the contrary, the influence of heavy vehicles in mixed traffic flow is overrated, as their proportions should be smaller than they are when adding a given vehicle. Demarchi and Setti also indicate the possibility of preventing this problem in order to avoid mistakes when calculating PCE values for each heavy vehicle individually by calculating mutual PCE formulated in this way:

$$E_T = \frac{1}{\sum_i^n P_i} \cdot \left[\frac{q_B}{q_M} - 1 \right] + 1 \text{, where}$$

P_i – proportion of trucks going from origin leg i to destination leg j in a mixed stream,
q_B – base stream (passenger cars only),
q_M – mixed stream.

This equation is basically made by Huber and it is modified for several types of heavy vehicles in a mixed lane. This approach of usage mutual PCE seems that is adopted in HCM-1994. and HCM-2000. PCE values in HCM-2000 and HCM-2010 are presented for *the percentage of grade, length of grade and percentage of heavy vehicles.* PCE decreases with the decrease in the percentage of heavy vehicles. There are many other worldwide researchers who worked on PCE methodology. Further, in this paper, it will be analyzed PCE methodology according to HCM-2010 for two-lane roads because of accommodation to conditions in the Republic of Srpska.

PCE IN HCM-2010 ON TWO-LANE HIGHWAYS IN TIPYCAL ROAD CONDITIONS

As the methodology of calculating capacity and level of service in HCM-2010 is consisted of 8 steps which determine values, the focus will be on PCE values only. Also, there are two cases related to one-way and two-way two-lane highways. Furthermore, it is necessary to determine the specific terms which are referred to road sections with grade of 3 percent or more and road sections at least 0.97 km (0.6 mi) long. Same as in HCM-2000, in order to convert volume for the full peak hour to passenger car equivalent flow rate (pc/h) there are necessary three correction factors: grade adjustment factor, heavy vehicle adjustment factor and peak-hour factor.

$$v_{i,ATS} = \frac{V_i}{PHF \cdot f_{g,ATS} \cdot f_{HV,ATS}}$$

According to HCM-2010 a heavy vehicle is defined as any vehicle (trailer) with more than four wheels. All commercial vehicles are categorized as heavy and recreational vehicles. Heavy vehicles consider small pickup and panel trucks with more than four wheels to double and triple tractor-trailer units. Small pickup and panel trucks with only four wheels are classified as passenger cars. Heavy vehicles also include all types of buses and recreational vehicles consider motorized campers, motor homes etc. In this case, PCE values are given for two-way two-lane highways.

Table 2. PCE for trucks and recreational vehicles for level terrain and specific downgrades and rolling terrain for two-way two-lane highways [21]

VEHICLE TYPE	FLOW RATE (vehicle/hour)	Terrain	
		Level terrain and specific downgrades	Rolling terrain
TRUCKS E_T	≤ 100	1.9	2.7
	200	1.5	2.3
	300	1.4	2.1
	400	1.3	2.0
	500	1.2	1.8
	600	1.1	1.7
	700	1.1	1.6
	800	1.1	1.4
	≥ 900	1.0	1.3
RECREATIONAL VEHICLES E_R	All flows	1.0	1.1

Heavy vehicle adjustment factor is calculated with following equation:

$$f_{HV,ATS} = \frac{1}{1 + P_T \cdot (E_T - 1) + P_R \cdot (E_R - 1)} \text{, where}$$

P_T – percentage of trucks in traffic flow (decimal),
P_R – percentage of recreational vehicles in traffic flow (decimal),
E_T – passenger car equivalent for trucks from the previous figure,
E_R – passenger car equivalent for recreational vehicles from the previous figure.

PCE values according to HCM-2010 [21] are defined for:

- Level terrain,
- Specific upgrades, and
- Specific downgrades

At one-way two-lane highways, it is a common occurrence of inability to overtake slow moving vehicles, due to the inability of entering the other lane. The methodology is the same as in the case of two-way two-lane highways in HCM-2000, only that HCM-2010 suggests equivalent values as given in the figure below.

Table 3. PCE for trucks and recreational vehicles for level terrain and specific downgrades and rolling terrain for one-way two-lane highways [21]

VEHICLE TYPE	FLOW RATE (vehicle/hour)	Terrain	
		Level terrain and specific downgrades	Rolling terrain
TRUCKS E_T	≤ 100	1.1	1.9
	200	1.1	1.8
	300	1.1	1.7
	400	1.1	1.6
	500	1.0	1.4
	600	1.0	1.2
	700	1.0	1.0
	800	1.0	1.0
	≥ 900	1.0	1.0
RECREATIONAL VEHICLES E_R	All	1.0	1.0

CONCLUSION

In order to make the comparison useful, important parameters are selected which determine the method for establishing PCE values. In the interest of more detail observation of method of determining PCE, the methodology for determining PCE at two-lane highways according to HCM-2010 is highlighted, as road network of the Republic of Srpska is mostly covered with two-lane highways. Some of the segments of two-lane highway cannot be realistically compared for the reason that classified values are given in different criteria, but from a global point of view it is possible to make the selection using a unified criterion.

If equivalent values for computation of heavy vehicles into passenger car equivalents (PCE) were compared using HCM-1965 to HCM-2010 chronologically, it will be noticeable a great reduction in equivalent values. It is evident that the development of automobile industry, heavy vehicle industry and traffic economy have made an influence in traffic flow, specifically to dynamic and technical and exploitation characteristics of vehicles which resulted in a consequence, among others, of change of distance and time headway, and thus automatically to change of values of PCE equivalents. Phenomenon of decreasing of equivalent values for heavy vehicles is still actual. However, method for calculating these equivalents is still attached to the standard Greenshield's method, regardless of all the research papers and results presented in this paper. Further research should be much more focused on monitoring equivalents values on roads, than to advancement of methods for calculating equivalents, as PCE values have major oscillations as they are highly influenced by traffic dynamics.

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PRELIMINARY COMMUNICATIONS

Identifying the Most Significant Indicators of the Total Road Safety Performance Index- Case Study: European Union

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Abstract: The review of the national and international literature dealing with the assessment of the road safety level has shown great efforts of the authors who aimed to define the methodology for calculating the composite road safety index on a territory (region, state, etc.). The procedure for obtaining a road safety composite index of an area has been largely harmonized. The question that has not been fully resolved yet concerns the selection of indicators. There is a wide range of road safety indicators used to show the road safety situation in a territory. The road safety performance index (RSPI) obtained on the basis of a larger number of safety performance indicators (SPIs) enables decision makers to more precisely define earlier goal- oriented actions. Recording a broader comprehensive set of SPIs helps identify the strengths and weaknesses of an area's road safety system. Therefore, there is a need for calculating a road safety performance index with a limited number of indicators ($RSPI_{In}^{n}$) which will provide a comparison of sufficient quality, of as many countries as possible. The application of the Data Envelopment Analysis (DEA) method and correlation analysis has helped to check if the $RSPI_{In}^{n}$ is likely to be of sufficient quality. A strong correlation between the $RSPI_{In}^{n}$ and the RSPI based on all indicators has been identified using the proposed methodology. This will help achieve the standardization of indicators including data collection procedures and selection of the key list of indicators that need to be monitored.

Keywords: road safety level, road safety performance index, most significant indicators.

INTRODUCTION

Due to the multidisciplinary nature of road safety, policy makers must consider numerous contributory factors when making decisions affecting road safety. A wide range of such contributory factors can be combined by applying the composite index approach which has been used increasingly in international cross-country comparisons. No final methodology for road safety composite index design has yet been adopted globally. The accuracy of a composite index does not depend only on selected indicators, weight allocation and data aggregation methods, but also on the strength of correlation between indicators and road crashes and their consequences (Hermans et al., 2009b).

This paper deals with the comparison of countries at the international level. It contains information on the territories (countries) that have been subject to research, the period to which available data on safety performance indicators belong and the software used for the optimization method of selecting safety performance indicators (**Section 2**). The international cross- country comparison of territories takes into account 21 European countries. In order to compare the results, data for the international comparison have been taken over from Hermans, 2009a and represent the snapshot in terms of six chosen safety performance indicators belonging to the period from 2002 to 2008. This manuscript also offers greater details on all seven steps of the methodology for the calculation of the road safety performance index (**Section 3**), with focus on the fourth step concerning the "allocation of weights" and the fifth step that is dealing with the "aggregation method", as the most contributing steps in the process of calculating a road safety performance index. **Section 4** shows the results of the methodology applied for the selected countries. The results thereof have been analyzed from the following two aspects (**Section 5**): 1) correlation analysis of the value of a road safety performance index with a limited number of indicators and the road safety performance index obtained on the basis of all indicators concerned and 2) comparison of countries' ranks on the basis of values of a road safety performance index with a limited number of indicators and the road safety performance index obtained on the basis of all indicators concerned.

STUDY DESIGN

Study objectives

The main objective of this paper is to develop a scientifically sound and appropriate methodology for the creation of a road safety performance index with a limited number of indicators ($RSPI_{ln}^{n}$) that can be used for the monitoring and comparison of road safety performance among countries. This methodology should offer relevant, reliable, and comparable values of the $RSPI_{ln}^{n}$ having the strongest correlation with the RSPI obtained on the basis of the six selected SPIs. Depending of the $RSPI_{ln}^{n}$ a comparable analysis of countries' rankings has been made, highlighting the strength of the correlation with the mortality rate and the human development index, two important indexes which have been linked to the RSPI before (Al- Haji, 2007; Hermans 2009a; Chen et al., 2016). The application of the above methodology will help identify the most significant indicators in the total road safety performance index, on the basis of data measured as a snapshot in time. Also, it allows for a comparison of the largest number of countries possible and provides an adequate, simple and efficient way of road safety monitoring, which, on the other hand, generates actions for the development of a sustainable system for periodical measuring of indicators in low-ranked territories. From a practical point of view, we aim to make credible comparisons of countries in conditions when the availability of data concerning the values of same indicators for a larger number of countries, in a defined time period, is rather limited.

The subject of this study is the continuation of the research conducted so far, by taking into account practical issues of scarce data. The methodology for calculating a road safety performance index with a limited number of indicators used in this paper is of universal and open nature, and is able to allow extension of data to be analyzed in three directions: 1) spatial: it is able to include a larger number of countries, regions, etc. (territories) by adding appropriate data; 2) temporal: it is possible to span more years (time series), and 3) quantitative: involvement of a larger number of indicators or different indicators. Having this in mind, this concept is valuable for the development of a road safety performance index. This reinforces the credibility, acceptability and future development of the road safety performance index with a limited number of indicators for this set of European countries.

Collection and selection of indicators

Attention should be paid to the collection of reliable data because the validity, interpretability and explanatory power of the constructed index depends on data quality and their completeness. The focus of this study is put on European countries with the aim of evaluating the road safety performance of countries with a comparable level of mobility development (i.e. countries characterized by a similar transport system and motorization rate). Nonetheless, a broader analysis on a worldwide scale may be interesting but availability of data concerning the values of the same indicators for a larger number of countries, in a defined time period, constitutes a significant limitation. In addition to data availability, comparability of available data from the point of view of definitions and the manner of measuring them in the field is also disputable. In the present study, data collection starts from the seven risk domains considered in the SafetyNet project (Vis, 2005) as it is a key source with respect to the following road safety performance indicators: alcohol and drugs, speed, protective systems, daytime running lights, vehicle, roads and trauma management. Each indicator used for the calculation of a road safety performance index represents one risk domain. The performance of countries with respect to daytime running lights is not captured by this indicator, as the nature of this indicator distinguishes only three possible values (countries with the mandatory use of DRL on all roads during the entire year; countries with the mandatory use of DRL on some roads and/or during some periods of the year; and countries enacting no DRL law) and the classification is characterized by some level of uncertainty. Therefore, it is decided not to incorporate the indicator for the daytime running lights domain in the index construction process.

The subject of analysis includes the following 6 road safety performance indicators that have been collected on the basis of a selection process: (SPI_1) % of surveyed car drivers < BAC (Blood Alcohol Concentration limit); (SPI_2) % of surveyed car drivers < speed limit in urban areas; (SPI_3) seat belt wearing rate at front seats of cars and vans; (SPI_4) % of cars < 6 years; (SPI_5) density of motorways and (SPI_6) total health expenditure as a % of GDP. The available data relating to the SPIs were collected and compiled from some international databases and several publications. Data collected for each indicator belong to the period [2002; 2008]. The data set of the core set of basic road safety performance indicators (SPIs) was available for only 21 European countries (20 EU Member States plus Switzerland). Data unavailability is a common limitation for all studies dealing with country comparisons from the road safety point of view. This limitation is particularly highlighted in case of data on the road safety performance index. The fact is that "safety performance indicators" were introduced for the first time only in 2001 (European Transport Safety Council, 2001).

From a theoretical point of view, a larger number of indicators provides a road safety performance index of higher quality by means of which decision makers are able to more precisely define the earlier goal- oriented actions. Or, it is possible to more precisely identify the strengths and weaknesses of a country's road safety system by recording a broader comprehensive set of SPIs. However, from the point of view of practical use, a road safety performance index with a limited number of indicators is valuable to calculate.

METHODOLOGY

The calculation in this paper has been made using the methodology for developing a composite road safety performance index for cross-country comparisons, developed by Hermans, 2009a. This methodology consists of several steps: 1) Selecting the appropriate indicators to combine in an index; 2) Collecting the data on indicators; 3) Making data analyses/ normalization of data; 4) Assigning weights to each indicator; 5) Aggregating the weighted values of indicators; 6) Testing the robustness of the index and 7) Computing, evaluating and visualizing the scores of the final index. This methodology has been applied to create a composite road safety performance index relating to the intermediate outcome layer. The text below presents two important steps for the calculation of a composite index with a limited number of indicators: the weighting method and the aggregating of indicators.

One of the most significant steps in the process of composite index calculation is "**Assigning the weights to each indicator**". The Data Envelopment Analysis (DEA), originally developed by Charnes, Cooper and Rhodes (1978), is a non- parametric mathematical optimization technique used to assess the relative efficiency of a homogeneous set of decision- making units (DMUs), on the basis of multiple inputs and multiple outputs. The degree of other DMUs' inefficiency can be measured on the basis of their distance from the frontier. For each country, there can be obtained a composite index score between zero and one, with higher values indicating a better relative performance.

Step 5 of the methodology deals with the "**Selection of a data aggregation method"** according to recommendations of Hermans 2009a.

General Concepts of Ordered Weighted Averaging (OWA)

The Ordered Weighted Averaging (OWA) operators are used as an expert method for data aggregation. OWA functions are the second type of common averaging aggregation functions. They have been introduced by Yager (1988). As far as this method is concerned, it is important to mention that weights differ in the case of the "weight allocation method" and the case of the "OWA function". In case of OWA, a weight is no longer associated with the meaning of a particular criterion (or indicator)– such as the alcohol weight– but with its magnitude. Very common aggregation operators include maximum, minimum and arithmetic mean. The weighting vector $\vec{w}$ of these operators is given as: 1) max: $\vec{w} = (1,0,..,0)$, considering only the best performance; 2) min: $\vec{w} = (0,..,0,1)$, considering only the worst performance, and 3) arithmetic mean: $\vec{w} = (1/n, 1/n..,1/n)$, considering each performance equally. One of the methods for obtaining relevant OWA weights is the "orness" concept. The degree of orness corresponds to the degree of optimism of a decision maker (Yager, 1997). For an OWA weighting vector, the degree of orness is defined as shown in Eq. 4.1.

$$orness\ (\vec{w}) = \frac{1}{l-1}\sum_{i=1}^{l}(l-i)\vec{w_i} = \frac{1}{l-1}\sum_{i=1}^{l-1}(l/i)^{\alpha} \qquad (4.1)$$

$$\vec{w_i} = Q\left(\frac{i}{l}\right) - Q\left(\frac{i-1}{l}\right) \text{ for } i = 1, \dots, l$$

$$Q(r) = r^{\alpha} \text{ with } \alpha \geq 0$$

In case of six indicators, the above formulas result in:

$$\vec{w_1} = [\tfrac{1}{6}]^{\alpha}; \vec{w_2} = [\tfrac{2}{6}]^{\alpha} - [\tfrac{1}{6}]^{\alpha}; \vec{w_3} = [\tfrac{3}{6}]^{\alpha} - [\tfrac{2}{6}]^{\alpha};$$

$$\vec{w_4} = [\tfrac{4}{6}]^{\alpha} - [\tfrac{3}{6}]^{\alpha}; \vec{w_5} = [\tfrac{5}{6}]^{\alpha} - [\tfrac{4}{6}]^{\alpha}; \vec{w_6} = [\tfrac{6}{6}]^{\alpha} - [\tfrac{5}{6}]^{\alpha} \qquad (4.2)$$

In terms of road safety, α represents the degree to which the occurrence of road fatalities depends on the magnitude of the six performances. For α equal to one, the number of road fatalities per million inhabitants is considered to result equally from good and bad performances. The value of α that is higher (lower) than one implies that the worst (best) performances affect the number of road fatalities more and therefore low (high) indicator values are emphasized in that case.

Linguistic formulations of Ordered Weighted Averaging (OWA)

In order to incorporate the aggregation idea that is deduced by means of linguistic formulations, i.e. in order to punish bad performances, by a panel discussion, the following principles regarding the aggregation were put together:

- In case a country scores badly on more than a few indicators, its final road safety index score should be small.
- In case a country scores badly on a few indicators, its final road safety index score should be between small and average.

The first step in transforming the guidelines into restrictions for α is to give a specific meaning to the concepts 'badly' (with respect to indicator performance), 'a few' (with respect to the number of indicators), 'small' and 'average' (with respect to the index score). As for the performance, it will be classified as 'good', 'average' or 'bad', depending on specific indicators. Here, score 1 is assigned to good; score 0.5 to average and score 0 to bad performances. On a total of six indicators, 'a few' corresponds to two; 'most' to four and 'almost all' to five. A 'small' index score is 0.25 at the most, an 'average' index score corresponds to 0.5 whereas a 'large' index score is at least 0.75. By using the (Eq. 4.2.), restrictions for α can be deduced.

$f_\alpha(1,1,1,0,0,0) \le 0.25$ (Small index score) (4.3)

$\Leftrightarrow \overrightarrow{w_1} + \overrightarrow{w_2} + \overrightarrow{w_3} \le 0.25$ (More than two indicators are bad = three indicators are good)

$$\Leftrightarrow \left[\frac{1}{6}\right]^\alpha + \left[\frac{2}{6}\right]^\alpha - \left[\frac{1}{6}\right]^\alpha + \left[\frac{3}{6}\right]^\alpha - \left[\frac{2}{6}\right]^\alpha < 0.25$$

$$\Leftrightarrow \left[\frac{1}{2}\right]^\alpha \le 0.25$$

$$\Leftrightarrow \alpha \ge 2$$

$0.25 < f_\alpha(1,1,1,0.5,0,0) < 0.5$ (Index score lying between small (0.25) and average (0.5)) (4.4)

$\Leftrightarrow 0.25 < \overrightarrow{w_1} + \overrightarrow{w_2} + \overrightarrow{w_3} + 0.5 \times \overrightarrow{w_4} < 0.5$ (Two indicators are bad = three indicators are good and one indicator has an average score)

$$\Leftrightarrow 0.25 < \left[\frac{1}{6}\right]^\alpha + \left[\frac{2}{6}\right]^\alpha - \left[\frac{1}{6}\right]^\alpha + \left[\frac{3}{6}\right]^\alpha - \left[\frac{2}{6}\right]^\alpha$$

$$+ 0.5 \times [\left(\frac{4}{6}\right)^\alpha - \left(\frac{3}{6}\right)^\alpha] < 0.5$$

$$\Leftrightarrow 0.25 < 0.5 \times \left(\frac{3}{6}\right)^\alpha + 0.5 \times \left(\frac{4}{6}\right)^\alpha < 0.5$$

$$\Leftrightarrow 1.2946 < \alpha < 2.6526$$

Based on (Eq. 4.3.) and (Eq. 4.4.) we can conclude that α should range in the interval [2;2.65] to aggregate the six indicators in a way that is acceptable for the experts. The orness value in the interval [0.236; 0.306] is obtained by inserting the limit values of α in Eq. 4.1. The selected value of α producing the strongest relation with the ranking is based on the number of road fatalities per million inhabitants. The result is the value of α equal to 2.0 and an OWA vector of (0.03; 0.08; 0.17; 0.27; 0.42; 0.58). Reflecting on the experts and decision makers' attitudes is very useful in this respect. However, if one wants to avoid compensation between good and bad scores, this method is the most useful aggregation operator for the road safety index case because it enables the experts/ decision makers/ stakeholders at the national level to agree on the linguistic formulation for the purpose of this aggregation method. This also provides a higher degree of acceptability of the results obtained, which opens the door to the definition of earlier goal- oriented actions.

Index methodology

Obtaining the final road safety performance index scores requires making a decision that concerns indicator selection, weighting and aggregation. These steps have been dealt with in the previous sub- headings. (Eq. 4.5.) represents the algebraic model used to compute the final road safety performance index score (RSPI) for a country j (j = 1,…, n):

$$RSPI_j = \frac{max}{\overline{w_{ij}}} \sum_{i=1}^{l} \overline{r_{ij}}\,\overline{w_{ij}} \quad (4.5)$$

$$\sum^{l} \overline{w_{ij}} = 1$$

$$0.236 \le \frac{1}{l-1} \sum_{i=1}^{l} (l-1)\overline{w_{ij}} \le 0.306$$

$$L_m \le \frac{r_{mj} w_{mj}}{\sum_{i=1}^{l} \overline{r_{ij}}\,\overline{w_{ij}}} \le U_m$$

$$\overline{w_{ij}} \ge 0$$

With:
l = number of indicators
‾ = ordered value; r = rescaled value; w = weight
m = {alcohol; speed; protective system; vehicle; road; trauma management}
L = lower limit; U = upper limit

As shown in (Eq. 4.5.), the road safety performance index score of a country consists of the ordered rescaled indicator values (i.e. values between zero and one, in decreasing order) and ordered weights (i.e. the first weight is corresponding to the best performance). More specifically, the share of each of the six indicators in the total index score was restricted by a lower and upper limit, using the budget allocation weights from a panel of experts.

The weights obtained by calculating the RSPI served for the calculation of $RSPI_{ln}^{3}$, $RSPI_{ln}^{4}$ and $RSPI_{ln}^{5}$ that are used in this study, since the programme could not find a feasible solution. The reason for that is the reduction in the space for searching an optimum solution based on three or four indicators. The additive aggregation method has been used in these cases, which helps obtain the value of the product of the allocated weight and the normalized value of the indicator (defined by Eq. 4.5.) without the software retrieval of the possible solution. The mentioned aggregation method has been used following the recommendations of Nardo et al., 2005 and those of Pešić, 2012, who made a test in which the linear aggregation method, based on pre- defined criteria, scored the best result.

Depending on the value of their road safety performance index, the countries have been assigned a specific level of $RSPI_{ln}^{n*}$ in the following way: 1) High RSPI- countries with a value over 0.500; 2) Average RSPI- countries with a value from 0.307 to 0.499; and 3) Low RSPI- countries with a value under 0.306. The index score is bounded by the highest and lowest indicator's value and has been made using the ordered weighted averaging (OWA) operators.

A system of "indicator combinations" with three, four and five indicators has been designed for the calculation of the $RSPI_{ln}^{n}$. The formula (Eq. 4.6.) has served to determine the total number of indicator combinations for the calculation of values of a road safety performance index, i.e. total number of combinations $\binom{6}{3}$, the value of $RSPI_{ln}^3$ is calculated for 20 combinations:

$$C_k^n = \binom{n}{k} = \frac{n!}{k!(n-k)!} = \frac{n\cdot(n-1)\cdots(n-k+1)}{k\cdot(k-1)\cdots 1}, n \geq k \geq 0, (n,k) \in N \quad (4.6)$$

RESULTS OF THE INTERNATIONAL CROSS-COUNTRY COMPARISONS

The results obtained in this study will be discussed in two parts. Based on the correlation strength between the $RSPI_{ln}^n$ and RSPI, the most significant indicators for 21 countries have been identified first. In addition, the change in the country ranking depending on the most significant three, four and five indicators based on OWA operators has been also analyzed. The values of $RSPI_{ln}^{n*}$ have been compared using the mortality rate and the human development index, as relevant references.

Correlation analysis between the $RSPI_{ln}^n$ and RSPI

The application of Spearman's correlation analysis of the results obtained by calculating the road safety performance index for various combinations of three, four and five indicators and the composite index obtained on the basis of all six indicators has helped obtain the results shown in Table 1. Column 1 contains the combination of indicators marked by SPI codes and sorted by correlation coefficient values from Column 2. Cohen, 1988 (taken over from Pallant, 2011) ranked the correlation values in the following way: 1) small correlation (r = .100 - .299); medium correlation (r = .300 - .499), and large correlation (r = .500 - 1.000).

Based on these guidelines for the correlation interpretation, it is possible to conclude that among the road safety performance index values ($RSPI_{ln}^3$), only the combination of "protective system, vehicle and trauma management" (: 3_4_6) has a medium correlation (r = .471, p= .01), while all other values of $RSPI_{ln}^3$ have a large correlation with the value of RSPI (r ≥ .50, p= .01). The most significant indicators are "speed, roads and trauma management" (: 2_5_6), giving the highest value for the correlation coefficient (r = .906, p= .01) amongst the values of composite index $RSPI_{ln}^3$ and the value of RSPI for 21 countries.

Table 1. The most significant indicators based on Spearman's rho (rank correlation coefficient) with RSPIs

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
$RSPI_{ln}^3$ (SPI code)	Rank based on r values	$RSPI_{ln}^4$ (SPI code)	Rank based on r values	$RSPI_{ln}^5$ (SPI code)	Rank based on r values
2_5_6	0.906	**1_2_5_6**	0.958	**1_2_3_5_6**	0.994
2_3_5	0.905	**1_2_3_6**	0.936	**1_2_3_4_5**	0.957
2_3_6	0.878	**2_3_5_6**	0.931	**1_2_4_5_6**	0.957
1_2_5	0.871	**1_2_3_5**	0.927	**1_2_3_4_6**	0.948
1_5_6	0.866	**2_3_4_5**	0.912	**2_3_4_5_6**	0.927
2_4_5	0.856	**1_2_4_5**	0.895	**1_3_4_5_6**	0.821
2_3_4	0.848	**1_4_5_6**	0.891		
1_2_3	0.842	**2_4_5_6**	0.866		
1_2_6	0.803	**2_3_4_6**	0.852		
1_4_5	0.801	**1_2_4_6**	0.848		
2_4_6	0.792	**1_2_3_4**	0.829		
1_3_6	0.751	**1_3_5_6**	0.825		
1_3_5	0.726	**1_3_4_5**	0.777		
4_5_6	0.710	**1_3_4_6**	0.749		
1_4_6	0.694	**3_4_5_6**	0.669		
1_2_4	0.681				
3_5_6	0.666				
3_4_5	0.626				
1_3_4	0.536				
3_4_6	0.471				

SPI codes:	1	Alcohol: % of surveyed car drivers < BAC limit
	2	Speed: % of surveyed car drivers < speed limit in urban areas
	3	Protective system: seat belt wearing rate at front seats of cars and vans
	4	Vehicle: % of cars <6 years
	5	Roads: density of motorways
	6	Trauma management: total health expenditure as GDP%

When looking at Columns 3 and 4 in Table 1. it can be noticed that all the combinations of indicators of $RSPI_{ln}^4$ offer a large correlation (r ≥ .500, p= .01 for all combinations) with the RSPI. The most significant four indicators are "alcohol, speed, roads and trauma management" (1_2_5_6), having a correlation coefficient of r = .958. Finally, Columns 5 and 6 show the ranking of values for $RSPI_{ln}^5$ with the RSPI. The correlation coefficient of the combination containing five indicators is extremely large (r > .900). The most significant five indicator combination is the one with "alcohol, speed, protective system, roads and trauma management" where r =.994 (almost complete congruence of values of the composite index $RSPI_{ln}^5$ with the RSPI). Regardless of which indicator combination is in question, the strength of the correlation with the RSPI is extremely large, with the exception of the combination 3_4_6 which is ranked as a medium correlation.

Rank variations depending on $RSPI_{ln}^{n*}$ based on OWA operators and correlation analysis with final outcomes

The value of a road safety performance index has been calculated for the most significant three, four and five indicators, on the basis of which the countries have been ranked. The countries are grouped within obtained classes (three colours) and the standard deviation of country rankings on the basis of different $RSPI_{ln}^{n*}$ has been also calculated. The analysis of changes in country ranking in relation to the final ranking of the countries based on the value of RSPI leads to the following results given in Figure 1.. The similarity in country ranking on the basis of values of $RSPI_{ln}^{n*}$ and the ranking on the basis of RSPI values is considerable. The matching rate of these values is higher if the calculation of a road safety performance index is made on the basis of a larger number of indicators.

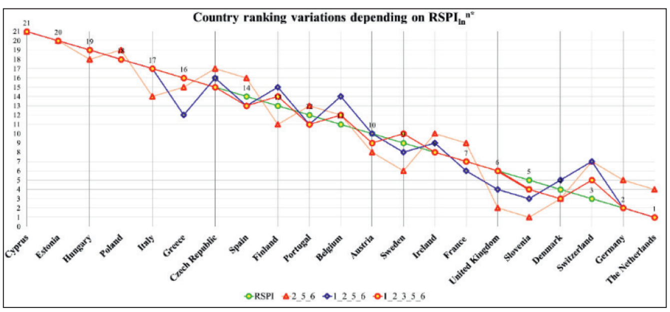

Figure 1. Final country ranking variations depending on $RSPI_{ln}^{n*}$

Two countries whose ranking is consistent across different combinations have been singled out. They are: Estonia and Cyprus, while some countries sustained changes in their positions, for one place only (Poland and Hungary), by adding certain indicators into the calculation. The remaining countries largely deviate in ranks, having therefore the most unstable standing (change in two or more positions), for example Slovenia (5 positions), Switzerland (4 positions), Belgium (4 positions), etc. The most essential differences amongst the rankings are observed for Finland (between 11th and 15th place),

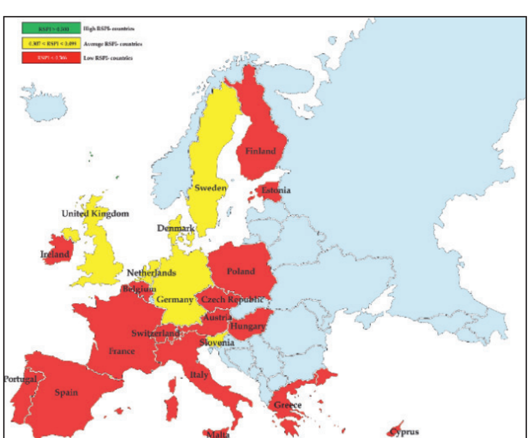

Figure 2. Coloured map on road safety performance index based on RSPIln3*: 2_5_6

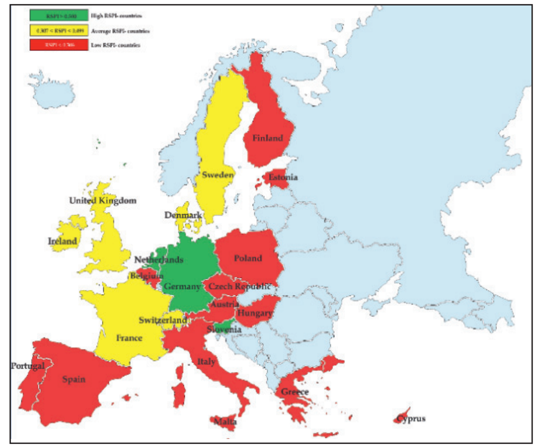

Figure 3. Coloured map on road safety performance index based on

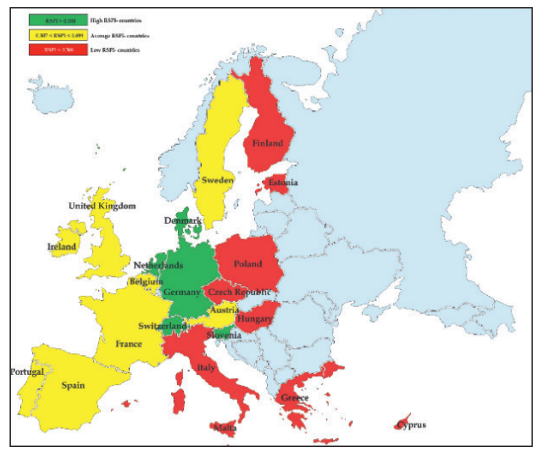

Figure 4. Coloured map on road safety performance index based on $RSPI_{ln}^{5*}$: 1_2_3_5_6 $RSPI_{ln}^{4*}$: 1_2_5_6

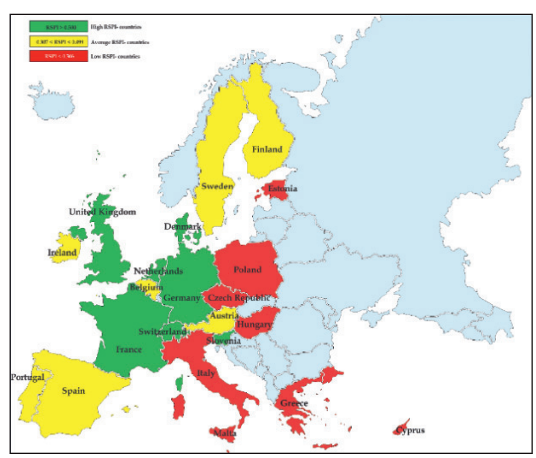

Figure 5. Coloured map on road safety performance index based on RSPI (all six indicators)

Sweden (between 6th and 10th place) and Slovenia (between 1st and 5th place). The text below shows the mapping of the analyzed countries per value of the RSPI obtained on the basis of various combinations of indicators (three, four, five) that are having the highest correlation with the RSPI obtained on the basis of all six indicators concerned (Figure 2., 3. and 4.). Figure 5. shows the map of countries ranked on the basis of values of a RSPI obtained using all the indicators involved.

Matching of country rankings on the basis of RSPI values and values of $RSPI_{ln}^{3*}$, $RSPI_{ln}^{4*}$ and $RSPI_{ln}^{5*}$ is expressed in the correlation coefficient value (Table 2.). The strength of correlation among country rankings depending on the indicator combination is extremely large and ranges from r= .926 to r= .992. The value of a road safety performance index with a limited number of indicators is reliable for cross- country comparisons and for defining earlier goal- oriented actions.

Table 2. Spearman's correlations of the rankings

			Ranking $RSPI_{ln}^{3*}$: 2_5_6	Ranking $RSPI_{ln}^{4*}$: 1_2_5_6	Ranking $RSPI_{ln}^{5*}$: 1_2_3_5_6
Spearman's rho	RSPI Ranking	Corr. Coefficient	.926**	.961**	.992**
		Sig. (1-tailed)	.000	.000	.000
		N	21	21	21

** Correlation is significant at the 0.01 level (1-tailed).

As the country ranking matching rate is very high, regardless of the selected combination of most significant indicators, the correlation strength has been calculated between the mortality rate and the Human Development Index (HDI), and the road safety performance indicators (RSPI) and $RSPI_{ln}^{3*}$, $RSPI_{ln}^{4*}$ and $RSPI_{ln}^{5*}$. A high value of correlation coefficient is shown in Table 3. Looking at the values of correlation coefficients among certain factors, it can be noticed that $RSPI_{ln}^{3*}$: 2_5_6 correlates more strongly with the mortality rate when compared to the RSPI. The remaining values of the composite index $RSPI_{ln}^{4*}$: 1_2_5_6 and $RSPI_{ln}^{5*}$: 1_2_3_5_6 have a somewhat lower correlation rate.

Table 3. Spearman's correlation of a road safety performance index with a limited number of indicators with the mortality rate and the Human Development Index

			RSPI	$RSPI_{ln}^{3*}$: 2_5_6	$RSPI_{ln}^{4*}$: 1_2_5_6	$RSPI_{ln}^{5*}$: 1_2_3_5_6
Spearman's rho	Mortality rate	Correlation Coefficient	-.685**	-.727**	-.615**	-.643**
	HDI		.714**	.633**	.651**	.689**
		Sig. (1-tailed)	.000	.000	.000	.000
		N	21	21	21	21

Regardless of the selected combination for the calculation of the composite index, the strength of the correlation with the final outcomes (in this case: mortality rate) and the RSPI is significant. Spearman's correlation coefficient is used to evaluate the degree of consistency between the RSPI and $RSPI_{ln}^{n*}$ ranking with the HDI ranking. The results show that a road safety performance index and a road safety performance index with a limited number of indicators, irrespective of indicator combination (the number of indicators (3, 4 or 5), have a very strong positive correlation with the HDI (RSPI, r= .714, p<.01; $RSPI_{ln}^{3*}$, r= .633, p<.01; $RSPI_{ln}^{4*}$, r= .651, p<.01, $RSPI_{ln}^{5*}$, r= .689, p<001).

DISCUSSION AND CONCLUSIONS

As shown in Table 1., the correlation analysis has revealed that all the combinations have a large correlation (Spearman's coefficient rho is over .536) with the RSPI, with the exception of the indicator's combination of "protective system, vehicle and trauma management" that has medium correlation strength. Overall, there exists a high degree of matching (congruence) of indicator's combinations (three, four or five). Based on this, the most significant indicators having the largest correlation with the RSPI values have been identified. To further capture the graphical insight into the specific relationship between the rankings, the comparison of country rankings, based on the $RSPI_{ln}^{n*}$, is illustrated in Figure 1., where the basic ranking is built on the basis of the RSPI. It can be seen that:

- Overall, the four rankings (RSPI, $RSPI_{ln}^{3*}$, $RSPI_{ln}^{4*}$and $RSPI_{ln}^{5*}$) are relatively consistent, with slight deviations across the different combinations of indicators. The ranks of Estonia and Cyprus are consistent across different combinations. At the same time, the rankings of Finland, Sweden and Slovenia are associated with relatively large deviations. Countries whose rankings fluctuate by at least one to mostly three positions, depending on indicator combination, are ranked in-between.
- The rankings derived from different combinations of indicators are almost identical to the RSPI rankings. The matching is strongest with the values of $RSPI_{ln}^{5*}$, and weakest with the values of $RSPI_{ln}^{3*}$ which is expected as the value of a road safety performance index is more accurate when a larger number of indicators is involved in the calculation. However, the value of a road safety performance index with a limited number of indicators is reliable and robust enough for international cross- country comparisons as it provides an adequate, simple and efficient way of road safety monitoring, which, on the other hand, generates actions for the development of a sustainable system of periodical measuring of indicators in (low- ranked) territories.

Validity of a road safety performance index with a limited number of indicators can be compared to the country ranking which is made according to the values of the mortality rate and the Human Development Index (HDI). In general, it can be concluded that the developed road safety performance index and road safety performance index with a limited number of indicators are linked with the mortality rate and the human development index. A strong correlation between the $RSPI_{ln}^{3*}$ and the mortality rate (r = - .727, p = .01), confirms the significance of indicators (2_5_6) in cases of scarce or missing data. These three indicators allow for comparisons of a larger number of countries and are sufficient for defining the earlier goal- oriented actions in those three risk domains that will serve for road safety improvement. This reinforces the credibility, acceptability and future development of the road safety performance index with a limited number of indicators for this set of European countries. Previous results have been confirmed by the strength of correlation among the rankings of a road safety performance index and road safety performance index with a limited number of indicators. The correlation strength in this case is extremely high and the value of the correlation coefficient is above r > .926, (Table 2.), regardless of which indicator combination is considered. However, the following are the most significant indicators for the 21 countries set (Table 1.):

- Three most significant indicators are "speed, roads and trauma management" (abbr.: 2_5_6), (r = .906, p= .01);
- Four most significant indicators are "alcohol, speed, roads and trauma management" (abbr.: 1_2_5_6), (r= .958, p=.01), and
- Five most significant indicators are "alcohol, speed, protective system, roads and trauma management" (abbr.: 1_2_3_5_6), (r = .994, p= .01).

Therefore, the most significant indicators ensure the optimum selection of indicators and reliable comparison of the safety performance indicators of countries in conditions of unavailable and scarce indicator data. Since there is a strong correlation between the RSPI and $RSPI_{ln}^{n}$, it will be possible to identify a common list of indicators for all analyzed countries on the basis of the most contributing indicators per country. This ensures a simpler monitoring of indicators, simple understanding of road safety situation as well as the international comparisons and benchmarking process. Also, the most significant indicators provide the selection of right actions for the improvement of weak points within the road safety system, whose accuracy is increasing with the number of indicators included in an analysis. A road safety performance index is a quality tool for country comparisons, identification of successful practices and definition of timely measures for improving the road safety situation. Also, the RSPI serves decision makers to recognize and understand road safety issues. Selection of indicators is the most demanding part of the RSPI calculation methodology, having the strongest impact on its value. Also, the proposed methodology for the calculation of the road safety performance index with a limited number of safety performance indicators offers the possibility of monitoring and comparing territories (both at international and national level), on the basis of several combinations of the most significant safety performance indicators and indicator standardization.

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PRELIMINARY COMMUNICATIONS

Detecting Drug Abuse and Misuse in Road Traffic

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Abstract: Every road user understands what driving under the influence (DUI) of alcohol means. Equally, many of those who use psychoactive substances and who are drivers know what driving under the influence of psychoactive substances implies. A small number of drivers across all categories who daily use drugs based on prescribed medication know what drug abuse means in traffic. The danger of drug misuse while driving is significantly higher when there is a traffic accident due to driving under the influence of drugs. In this paper, we have pointed out the importance of investigating a road traffic accident, primarily from the criminal aspect, when one of the parties involved in a traffic accident has driven a vehicle under the influence of drugs. The regulations from the Law on Traffic Safety from the Republic of Serbia can be of use to the officials of the police and judiciary of the Republic of Srpska, as well as Bosnia and Herzegovina. These regulations are very relevant for each local community or its relevant authorities.

Keywords: Law on Traffic Safety, Traffic Accident, Drugs, Medications, Criminal Procedure, Investigation.

INTRODUCTION

Traffic accidents happen on roads around the world on a daily basis with various, even the most severe consequences. It is the same in the Republic of Serbia, and in all parts of Bosnia and Herzegovina. Officials who are aware of these traffic accidents - most often members of the police, sometimes public prosecutors - after conducting an investigation into these traffic accidents as one of the mandatory steps, determine whether the drivers or certain categories of traffic accident participants were psychologically and physically capable of driving a vehicle. The human factor is the most important aspect in traffic safety [1] that can to a large extent be influenced to achieve better results, but at the same time this factor poses the greatest danger unless granted greater regulation.

Most often, police officials check the drivers of the vehicles after a traffic accident that have remained at the scene of the accident to eliminate whether they were driving a vehicle under the influence of alcohol. At the same time, it is rare to carry out a spot check if certain drivers were driving under the influence of psychoactive substances - narcotic drugs (hereinafter: PS) because most often they lack the necessary equipment to undertake this test at the scene. Officials, primarily police officers, but also public prosecutors lack knowledge of the possibilities of checking for the presence of PS through appropriate procedures and whether the individual drivers involved in a traffic accident were operating a vehicle under the influence of drugs. Thus, this issue should be given greater attention given the fact that almost every person in Serbia but also in all parts of the Republic of Srpska and Bosnia and Herzegovina - regardless of age, gender, or any other feature – at some time or another has used prescribed medication after a health examination and sometimes has self-medicated when feeling unwell. In addition, few people think about this or even know - except for medical or pharmaceutical professionals - that certain types of medication can impair the psychological and physical abilities when driving.

In this paper, we will limit ourselves to presenting how psychological and physical conditions for driving in the Republic of Serbia and the Republic of Srpska are determined in accordance with the legal regulations. Special attention is given to the road users who have participated in traffic accidents under the influence of drugs as this is still very much a gray area. This is relevant for all local communities and police officers who, when dealing with road users, can recognize prohibited modes of driving and qualify them properly in case they are involved in a road traffic accident.

REGULATIONS CONCERNING PSYCHOLOGICAL AND PHYSICAL CONDITIONS FOR DRIVING

The Law on Traffic Safety on the Roads of the Republic of Serbia (hereinafter: ZBS) [3], which is applicable from December 11, 2009, contains, among other things, provisions related to the psychological and physical conditions for driving a vehicle.

Art. 187 of the ZBS which stipulates the psychological and physical conditions for driving a vehicle, states that a driver must not drive a vehicle or start driving the vehicle if they are under the influence of alcohol and/or psychoactive substances. Unlike the former Law on Basic Safety of Road Traffic (hereinafter: ZOBSP) [2], which did not contain the meaning of the term "narcotic drugs" referred to in Art. 163 in the provisions relating to the meaning of certain expressions, the valid ZBS contains a precise definition of the term psychoactive substance.

Art. 7, para. 99 of the ZBS defines that a "**psychoactive substance**" is a type of drug or medication that has been prescribed but states that it should not be used before and during driving, and it also includes other chemical substances that may affect the psychological and physical ability of drivers (except alcohol).

Art. 187, para. 6 of the ZBS explicitly stipulates when a driver is considered to be under the influence of psychoactive substances – when an investigation using the appropriate means and methods (tests for determining the presence of psychoactive substances, etc.) establishes the presence of these substances in the organism. This is important for establishing a more severe form of offense - intent on the part of the driver, road user or the perpetrator of a traffic accident.

Art. 187, para. 7 of the ZBS stipulates that a driver is incapable of driving the vehicle safely when a specific test has established that they are tired, **ill** or in such a psychological and physical state that they are unable to drive the vehicle safely.

The **2018 Law on Amendments and Supplements to the ZBS** [4] stipulates a change in the provisions relating to psychological and physical conditions in Art. 187 in the part referring to the presence of alcohol in the blood across certain categories of road users. It establishes a set limit of 0.20 mg/ml of alcohol in the blood for road users, while it was 0.30 mg/ml according to the 2009 Law. There were no changes or amendments in the rest of this provision relating to psychoactive substances or medications.

Regulations related to psychological and physical conditions for road users in the **Law on Basic Safety of Road Traffic in Bosnia and Herzegovina** (hereinafter: ZOBSP of B-H) [5], applied on the territory of this country in all its constituent parts, are very similar. The only difference that can be seen at first sight is that the provisions relating to psychological and physical conditions are set out in two articles of this law.

Art. 173 of the ZOBSP of B-H stipulates the following: "A driver who is so tired or ill or is in such a state of physical condition that they are incapable of driving the vehicle safely, as well as a driver under the influence of narcotic drugs or other illicit drugs or **prescribed medications that state they must not be used before and during driving**, must not drive a vehicle on the road."

Art. 174 of the ZOBSP of B-H stipulates the following: "The driver must not drive a vehicle on the road or start to drive if they are under the influence of alcohol or when it is considered that they are under the influence of alcohol." However, Art. 9 of the ZOBSP B-H that refers to the meaning of the term fails to define a psychoactive substance, as does the **Criminal Code of the Republic of Srpska** [6].

When making a comparison between these two laws - the ZBS and ZOBSP B-H in the part relating to the provisions regarding the psychological and physical conditions for driving and in the part related to the issues of this paper, we can consider that the provisions of the ZOBSP B-H are clearer about the type of medicines only insofar as the provision is separated into a separate article of the law in relation to the ZBS where all the circumstances of importance for the psychological and physical conditions for driving are stated in an objectively large - bulky article.

THE RELEVANCE OF AN INVESTIGATION FOR COURT PROCEDURES (FROM THE ASPECT OF PSYCHOLOGICAL AND PHYSICAL CONDITIONS)

Investigations of traffic accidents are not only relevant for criminal proceedings (criminal and misdemeanor), they also have a great significance for the procedures that are not being considered at the moment of conducting the investigation in regard to some criminal proceedings, these being the procedures in which the investigation after the accident cannot be performed objectively. In fact, these are out-of-court or civil proceedings for damages [7].

It is important for extra-judicial proceedings that the quality of the investigation carried out has an impact on the decision whether the agreement on the compensation of damage will be performed out of court between the insurer and the insured or if there needs to be a lawsuit for compensation regarding damages. The procedure to award compensation for damages caused which, as a rule, follows after the termination of the criminal procedure, can depend on the quality of the investigation carried out, and in other cases, the same is valid for establishing the existence or lack of fault of the drivers involved in a traffic accident - now parties in the civil proceedings – and the supposed shared responsibility to define damage compensation in litigation. In addition, when it comes to litigation procedures for damage compensation, the quality of the investigation carried out has an impact on the decision even when there is a legally binding conviction in criminal proceedings, and also when establishing the person responsible for the traffic accident in a damage compensation case, as well as the fault of one of the parties for the traffic accident and the percentage of the contribution.

During the investigation of a traffic accident, the traffic police, in addition to other undertakings, and depending on the type of traffic accident and the resulting consequences – the material damage, injuries or fatalities, also control the psychological and physical conditions across certain categories of persons or drivers participating at the time of the traffic accident.

Evidently, this is most commonly done by way of appropriate devices used by traffic police to check whether drivers or certain categories of participants were under the influence of alcohol, and depending on the established level of alcohol on the spot, the police officers have the power to decide on their own or in consultation with the competent public prosecutor whether it is necessary to carry out a blood test on the drivers to analyze the alcohol level content in the blood, and define the number of tests to establish the alcohol level of the driver in a traffic accident.

Significantly rarer are the cases of checking at the scene by means of appropriate devices if one of the drivers in a traffic accident was driving the vehicle or as a participant was under the influence of psychoactive controlled substances (narcotics). The main reason for this is that both the Republic of Serbia and Bosnia and Herzegovina lack the resources for its traffic police officers to be equipped with the appropriate devices to determine the presence of PS in the body, although this is necessary as some official data indicates that a large number of drivers are driving vehicles under the influence of PS. European traffic safety studies conducted in 2006 have shown that the proportion of drivers under the influence of alcohol and marijuana is approximately equal and ranges between four and five percent [8]. According to various studies, the proportion of allowed drug use (mainly benzodiazepam) among drivers is greater than the amount of illicit drug use - mainly marijuana and opiates [9].

It is uncommon for traffic police officers in the Republic of Serbia to consider that any of the drivers involved in a traffic accident has been driving a vehicle under the influence of drugs and that such driving was or could have been the cause for the traffic accident and in addition, to take the appropriate measures to check and possibly establish this fact. We believe that in this respect, the situation is similar or identical in all parts of Bosnia and Herzegovina regarding traffic police officers.

Therefore, the issue of drug misuse while driving and its impact on the road traffic accidents is a great unknown in criminal or misdemeanor procedures.

The issue of proving the presence of drugs containing psychoactive substances in the organism of the driver is relevant for discerning between intent and negligence in a criminal sense, which is of importance to the type of criminal offense perpetrated. Also, this is of importance in the appropriate procedure for damage compensation in order to establish an obligation for the driver to recompense the insurance company in the recourse action that has already made full or partial payment to those injured.

For this reason, the importance of a thorough investigation of a traffic accident in criminal offenses is of utmost importance, as only at this stage can the presence of certain types of drugs used in driving be detected by finding the packaging of the medication in the vehicles that have participated in a traffic accident.

THE ISSUE OF DRUG MISUSE AND THEIR IMPACT ON INVESTIGATIONS ACROSS THE WORLD

A number of studies have been carried out by experts or teams of experts in the world regarding the impact of drugs on those driving in the last two decades. Most of the studies concerned the research of the effects of specific medications on the ability to drive a vehicle. These are medications used for pain relief, insomnia and anxiety (bromazepam, diazepam, lorazepam), which can cause drowsiness, confusion and motor coordination difficulties [10], [11], [12].

More significant research was carried out at the European Union level through the DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines) project [13]. This was a significantly more comprehensive study aimed at examining the effects of medication, drugs and alcohol on the ability to drive a vehicle. A total of 3,054 medications were examined and, on that basis, medications were classified into 4 categories.

The greatest number of drugs was classified as category 0 - about 57% of all drugs. These are medications that have none or have a very negligible effect on driving, and therefore no special warning is required for these medications. Category 1 includes about 26% of drugs, while 17% of the drugs analyzed were included in category 2 and 3. According to this study, category 1 drugs have very little impact on the ability to drive a vehicle, which is why caution is recommended and the need to read the instructions from the package before starting to drive. Category 2 drugs have an average impact on the ability to drive a vehicle, which is why special care is recommended and not driving before consulting the doctor or pharmacist. Category 3 drugs have a major impact on the ability to drive a vehicle and contain the warning of "Attention: dangerous! Do not drive! Seek medical advice before you drive again."

All medications from category 1, 2, 3 must have appropriate pictograms on the packaging that warn drivers about the effect of the medication on the ability to drive.

THE ISSUE OF DRUG MISUSE IN REGULATIONS OF THE REPUBLIC OF SERBIA

The Republic of Serbia has also taken appropriate steps in the area of labeling certain types of drugs and their effect on driving motor vehicles. This was necessary given the meaning of the concept of psychoactive substances, which is more comprehensive than the notion of narcotic drugs, which includes medications that indicate they are not to be used before and while driving.

In the Republic of Serbia, the labeling of certain types of medicines is regulated by the Ordinance on the content and manner of marking the outer and inner packaging of the medicinal product, additional labeling, as well as the content of the instructions for the medicinal product (hereinafter: the Regulations) [14]. This by-law includes provisions on psychoactive substances that can be equally dangerous to other road users as alcohol. Art. 83 of the Ordinance stipulates the following: "The packaging of the medicinal product and the instructions for a medicinal product containing psychoactive controlled substances must contain the following precautionary measures and warnings:

- a warning triangle: a relative prohibition on driving motor vehicles or machinery;
- a solid red triangle: an absolute prohibition on driving motor vehicles or machinery and
- the symbol of the paragraph (§) for psychoactive controlled substances.

Although it is not fully in line with the labeling as defined at EU level, we consider this to be effective labeling of certain types of drugs that can effect safe driving in a sufficiently clear and recognizable way. Of course, this applies to the drivers who read the instructions for use of the medication before driving and consult their chosen doctor or pharmacist when they obtain the medications regarding the effect of this medication on driving.

However, the issue of misuse of medications containing psychoactive controlled substances and driving under the influence of these drugs by drivers who are ill, although referred to in Art. 187 of the ZBS, is almost completely unknown in case-law. This question is also of importance for determining the psychological correlation between the intent and the cause of the traffic accident.

In addition, the question arises of the effects of drugs that contain no psychoactive substances and can be dangerous for drivers. These are medications that are bought over the counter and which are recognizable throughout the territory of the former SFRY, as well as on the territory of Serbia. One of these medicines is the well-known Fervex, which is especially purchased during the flu and cold season. The same applies to Coldrex in powder form, in a sachet. The above medications have none of the three signs mentioned in the aforementioned Rulebook, but the instructions for use state that caution should be advised when driving due to possible drowsiness. This also applies to another well-known medicine that we often self-medicate with - the cough medicine Sinecod. These problems are being increasingly reported in Serbia via media coverage [15], [16].

In addition, the problems of misuse of certain types of drugs in combination with alcohol and DUI are also mentioned more in the Serbian media [17].

This further entails a greater level of responsibility - the sale of only prescribed medications that affect psychophysical abilities, but this is not the subject of this paper.

THE PROPER PROCEDURE USED BY POLICE OFFICERS DURING INVESTIGATION OF DRUG MISUSE BY ROAD USERS

Traffic police officers who in most cases perform an on-site investigation at a traffic accident also have the greatest responsibility for checking the psychological and physical conditions of individual drivers or participants in a traffic accident. During an investigation, attention is rarely given to other features of drivers or certain participants in a traffic accident other than alcohol abuse. This also applies to driving under PS. As a rule, traffic police officers in general pay little attention to the behavior of the road users whose driving is influenced by the effects of the medications that they used before or during driving, and which contain PS. In regard to drugs containing psychoactive substances and their effect, or in other words, how they affect the speed of reaction and concentration, is not observed by traffic police officers mainly because they have no training for it. Therefore, for them, but also for the relevant public prosecutors when carrying out an investigation in the most severe traffic accidents, this is a new and still insufficiently understood occurrence.

Therefore, after conducting an on-site investigation with completion of the relevant measurement data, diagrams and photos of the accident, police officers should pay attention to empty medication packaging with or without instructions when examining the vehicle. If in addition to other objects of interest found inside the vehicle for example, a cell phone, shoes under the driver's seat, etc., officers also notice packaging of medication especially around the driver's seat or around the front passenger's seat in the front right-hand seat, it is first necessary to photograph the items before they are removed from the vehicle. It is then necessary to determine whether this involves medication that is marked on the packaging as not to be used before or during driving, provisionally confiscating them with the correct procedure to establish the users of the drugs. Depending on the location of the packaging of these particularly marked types of drugs, whether around the driver's or the passenger seat, traffic police officers can order a blood test from the driver as well as from any passengers in the vehicle in order to determine the effect of the medications on their psychological and physical abilities. This is especially necessary in situations where the driver died and medication packaging with these warnings was found around the passenger's seat. The reason for this is that due to a lack of witnesses, a traffic accident which is a result of a deliberate act can be excluded.

When the public prosecutor is carrying out an investigation, traffic police officers are obliged to look for any medication packaging marked with warnings at the scene or immediately after the investigation, at the same time as certain procedures are still being taken, for example, an inspection of the vehicles of the road users involved in a traffic accident, and inform the public prosecutor who in this situation should call for a blood test for the driver involved in the accident in whose vehicle such medication packaging was found, thereby verifying the potential effect on the driver's ability to drive.

If an officer makes an oversight and fails to inspect the vehicle during the investigation or immediately after its completion, but the filled or empty medication packaging is subsequently found when the vehicle is still under police supervision, which has occurred in practice, it is realistic that such a driver will manage to circumvent criminal responsibility for driving a vehicle under the influence of medication that should not be used before or during driving and causing a traffic accident. This continues to have significance in the procedure for compensation, as this driver may claim that he needed such medication due to the nature of his illness but failed to take it before or during driving. In this situation, it is difficult to prove the presence of such prohibited medication in the driver's blood if a test was not carried out to establish the presence of such drugs in the blood at the time of the accident.

CONCLUSION

Traffic accidents are a worldwide problem which cannot be resolved totally, but proactive action can reduce the number of traffic accidents and their consequences in all countries.

The issues of detecting and proving drug misuse while driving and its impact on the occurrence of road traffic accidents are still widely unknown in most criminal proceedings in Serbia and in the Republic of Srpska, in either criminal or misdemeanor proceedings. We also pointed out the importance of detecting and proving the misuse of certain medications while driving in the procedures that follow the criminal proceedings - in extrajudicial proceedings or civil litigation.

The data in this paper is intended to increase traffic safety not only in the Republic of Serbia, but also in the Republic of Srpska and all parts of Bosnia and Herzegovina. By correctly training traffic police officers regarding the detecting of drug misuse in driving and the proper qualification of criminal offenses and their perpetrators by the relevant public prosecutors can serve to increase traffic safety at the level of local government.

Therefore, it is necessary to constantly strengthen the capacities of the relevant police and judicial authorities in the Republic of Serbia as well as in the Republic of Srpska and all the parts of Bosnia and Herzegovina, in order to improve the safety of road traffic within the area of these authorities.

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PRELIMINARY COMMUNICATIONS

Safety of railway transport of dangerous cargo

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Abstract: By railway, according to its technological characteristics, the respective amounts of dangerous cargo are being transported. Numerous hazards for people, assets and environment during the dangerous railway cargo transport processes, are expressed in the case of an extraordinary case or any other mismanagement, where the transport becomes risky, but the same risk is an opportunity for improvements if it's recognized on the way and measures are defined and established for its management. For achieving safety goals within transport of dangerous cargo, it means minimizing the number of extraordinary circumstances and overall consequences with undisturbed transport process support, it's necessary to manage and to work constantly on the safety improvements. In the safety management process, the whole railroad staff must take part according to the work duties, responsibilities and competences.

Keywords: dangerous cargo, railway, transport, safety, management.

INTRODUCTION

The transport, or, dangerous cargo transport by railway, from one place to another, which takes action through continuous realization of actions, is usually linked, using mutual transport means (truck and tow vehicles and overhaul mechanics)people and railway communication – track and following infrastructure elements. The transport process takes action in three phases: dangerous cargo preparation for sender, dangerous cargo transport and dangerous cargo dispatch for recipient. In the process of dangerous cargo preparation by sender, packer, loader, filler and containers tank user/ portable tanks, the person who takes part in this process is entitled as lighterman. The role of other participants in the process of transport is, also significant, but their role is less complex.

The dangerous cargo transport should be observed with its input (dangerous cargo intended for transporting, transport means, equipment, information, people and other and with its output (dangerous cargo transport service realization) [1].

Also, transport of dangerous cargo by railway can be observed like a service, or, like an aspect of logistics service. The transport process itself is, both according to the International classification of goods and services[1] and United Nations methodology[2], separated as an individual type of service.

Dangerous cargo can be transported by railway only under the conditions that are defined by Annex A and B, RID [7], respecting the requirements of the dangerous goods transport law [8] and laws brought by this law. All dangerous goods transport activities process by railway are planned and realized; to be able to ensure that transport service is realized with all of its value elements and needed safety level.

In the railway traffic, about 16% of dangerous goods are being transported. According to statistic data, most part of the dangerous cargo consists of flammable liquid substances, about 70% of the total dangerous cargo transport volume. It is expected from railway and other subjects also, to transport dangerous cargo with secured maximum safety level for people, infrastructure, environment and the dangerous cargo itself as well. The fulfillment is possible with qualitative and consistent dangerous cargo safety management. In overall management, processes should include all members according to their competences and roles [4].

[1] (Alphabetic list) in which is given the classifying of each good or service. Following that way, transport services are classified into **Class 39: The Transport services,** packing and storage of goods, route organization.

[2] World organization for intelectual property protection designed the International classification of goods and services, in which list of unique goods and services

THE DANGEROUS CARGO TRANSPORT BY RAILWAY THE PROCESS WITH INCREASED RISK

It is needed to define criteria of classification, to be able to define conditions for safe transport of dangerous cargo, and, also to determine potential hazards of dangerous substance. Those criteria are in Recommendations of the United Nations for the Dangerous Goods Transport (UN RTDG)[3].

In general, (the term) risk can be defined as certain exposure to functioning of factors whose activity can cause unexpected consequence. The main definition of the OH & S risk is that OH & S risk is a probability of occurrence of a dangerous event' combination, or exposure, and serious injuries(health vulnerability), which can be caused by a dangerous act or exposure (quotation: standard SRPS BS OHSAS 18001:2008). There is a clear need for different technical or organizational solutions, to enable its reduction, to a level where it can be controlled and managed with ease.

Essentially, risk is defined as a product of probability of a future event, and the consequence weight of that event. The probability and consequences can be qualitatively and quantitative evaluated by using proper methods. So, the Law on safety and health on work defines risk as „*a probability of injury emerging, disease and health damage of employees due to danger...*", but the SRPS OHS standard defines it as „a *probability measure and potentially dangerous event consequence...*".

The risk included with dangerous cargo transport by railway represents the combination of extraordinary event emerging probability, or, accident with damaging consequences for human lives and general health, economic assets (mobile – transport railway capacity and infrastructure) and the environment. During the dangerous railway cargo transport, the possibility of emerging of an extraordinary event, with large consequences impose the need of professional and ecological risk management.

In the dangerous cargo transport, observed from the aspect of jeopardizing members of transport process, reflects in injuries or death of people, directly linked with the dangerous cargo transport and where such injury requires immediate intensive medical intervention, longer stay in hospital and incompetence for future work. Observed by the aspect of assets and life environment, jeopardizing reflects in damaging of transport capacities, infrastructure and life environment, directly linked with the dangerous cargo transport, where such kind of damage requires larger material investments and longer halt in the unfolding of dangerous cargo transport.

Figure 1. Disaster events during transport of hazardous materials [12]

During the transport of dangerous cargo by railway, extraordinary events with all aforementioned threats, are followed by numerous costs such as: the cost of damaged or lost dangerous cargo or costs linked with damage compensation- to the mismanaged environment, or eventually with injured persons, and all of those involved in transport process. Eventual damage for transport capacity, infrastructure and life environment is also the linked to extraordinary events by dangerous cargo transporting by railway, picture number 1.

The risk in the dangerous cargo transport simply exists and its very appearance does not mean something bad – it is real, but in the most cases, it can be avoided. The risk as well means the opportunity for improving if it is discovered on time, determined and defined with ways of measuring and being able to manage it. Instead, it is needed to take into account the fact that full risk elimination is not possible, or even necessary.

The professional risk evaluation and risk from the extraordinary event by dangerous cargo transporting, enables the establishment of preventive measures and action lines for minimization the probability of accident occurrence and its eventual consequences.

The numerous potential dangers per people, assets and environment are especially expressed in the case of an extraordinary event or any other omission during the process of unfolding the dangerous cargo transport by railway. The omissions are possible due to every single disrespect which arises from avoiding international and national regulations, where safe transport of dangerous cargo by railway is defined. All of this makes the dangerous cargo transport process too risky.

The tendency itself for the risk minimization of the extraordinary event and the dangerous cargo safety transport by railway, impose a large number of limitations to all transport process members that is determined by rules and conditional procedure.

[3] United Nations Recommendations on Transport of Dangerous Goods, Model Regulations

For the correct defining the dangerous cargo safety by railway, it must begin from the dangerous cargo safety transport basics of the railway traffic. Having in mind the general aim of traffic safety, the dangerous cargo transport specifics and possible safety risks during its unfolding, it can be said that the general goal of the dangerous cargo transport by railway is minimization of bad effects and ensuring security of undisturbed unfolding of dangerous cargo transport. If the dangerous cargo transport subject is narrowed, then the goal also can be narrowed on minimum effects of consequences of extraordinary events. The dangerous cargo safety transport by railway, defined like this, can be achieved by: extraordinary events number minimization and reduction of consequences, and also the professional training of all transport process members for the dangerous cargo treatment.

The transport and dangerous cargo manipulation, significantly, is different from the procedures with other types of cargo. The consequences of the extraordinary events point out that there is a need to do risk evaluation in the case of some dangerous cargo transport. The main rule is that the dangerous cargo transport is forbidden, unless it does not unfold under conditions which are correctly determined by national legal regulation or confirmed international agreements. It can be concluded that dangerous cargo transport process cannot be unfolded without knowing the conditions according to which it is possible.

From these reasons, it can be concluded that there is a clear need for all transport process members to be trained for jobs carried on a daily basis, which is predicted by the legislative prescription.

SAFETY MANAGEMENT OF DANGEROUS TRANSPORT BY RAILWAY

Transport safety of dangerous cargo by railway, means the dangerous cargo transport service performance. The dangerous cargo safety transport can be and must be managed. Under dangerous cargo safety management by railway it implies the process of planning, organization and controlling and safety transport activities improvement and using the available (secured) activities.

In regard that the safety transport process is conditioned by way of individual activities from all members of the transport process, mismanagement parameters can be avoided by following its required procedure.

Those are the parameters-elements, in its basis, otherwise, safety factors. Having in mind the nature and specificity of the dangerous cargo transport process, defined parameters in such a way can serve as the main lever for transport management safety.

The requirement fulfillment for the realization of main and elemental dangerous cargo transport process activities, which are relevant for the dangerous cargo transport area given in sources [7,8], it can be used for the dangerous cargo safety transport parameters management. So it can be singled out separately:

- classification, entrance and dangerous cargo transport according to RID,
- security of necessary documents,
- usage of allowed and suitable packaging for the dangerous cargo transport,
- correct packaging marking with dangerous cargo,
- requirement adherence about the shipping method and limitations by dangerous cargo shipping,
- correct marking of loaded driving and transport means by the danger leaflets, orange boards and necessary markings, picture number 2.
- visual checking of obvious driving deficiencies, transport means or dangerous cargo,
- fulfillment requirement checking refers to packaging, loading, discharge and manipulation,
- conditions respect of joint loading ban,
- checking of the permissible car load,
- prescribed equipment existing in the cab engineer,
- driving staff notice checking about loaded dangerous cargo and its position in train,
- entrance goods no delay without forced reasons,
- do not start loading until the suitable measures are undertaken to eradicate shortcomings and irregularities,
- checking, before or during discharge, if packaging, tanks, vehicle or containers are damaged in a way that could jeopardize the discharge procedure,
- accordance checking of unloaded dangerous cargo with quotes in the transport documents,
- discharge checking of eventual damaged packaging, cargo and rolling stock,
- dangerous substance displacement that arrive, during discharge, on the exterior side of vehicle or container,
- valve checking for closing after the tank discharge, hatch control, closing seal of empty and uncleaned tanks,
- prescribed cleaning safety and decontamination wagon and container,
- removal safety or leaflets danger covering, orange tables and necessary markings by empty and cleaned wagon and container.

Disturbance of above mentioned parameters that is not fulfilling of prescribed and determined necessary requirements jeopardize the dangerous cargo transport safety by railway, but also the need for proper safety management.

Railroad management has to plan and manage processes and goals, which are needed for the **constant improvement** of safety in dangerous cargo transport. It must constantly be improved, in terms of system efficiency, by using goals for safety, checking all results of conducting transport activities and processes, data analysis, corrective and preventive measures and reconsideration of responsible persons.

Constant dangerous safety transport improvement lies in gradual conducting process of improving and determination of it's effectively. The dangerous cargo safety transport improvements by railway are often random and unplanned, the result are urgent measures for problem removal during the transport, as a reaction on the appearance of danger, which should be prevented to ensure safety storage. Those are not real and essential dangerous cargo safety transport improvements, just only performance safety returns, in the expected-needed stain. It would be desirable to do plans of preventive and corrective measures.

The dangerous cargo safety transport management starts by projection and use of necessary **preventive measures** that should be result of adequate safety risk management, picture number 3. [5].

The preventive measures must take action because of potential deviation risk removing that jeopardizes safety in order to prevent its appearance. It must suit to the consequences of potential problems. The possible jeopardizing of dangerous cargo safety transport by railway, which can arise because of danger substance nature, as a subject of transport or because of the very transport process characteristics.

The reporting probability, character effect and exquisiteness regarding the risk prevention of dangerous cargo transport safety can be taking into account during the process of planning and preventive measures design.

The potential for jeopardizing of transport safety are all those actions which did not occur. The potential determination for endangering is embedded in the search for transport process characteristics.

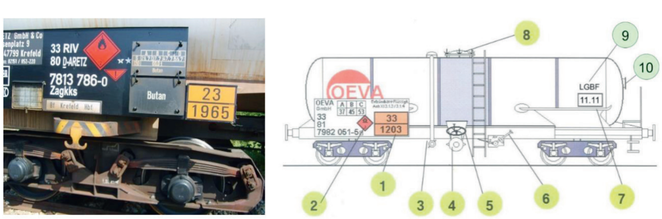

Figure 2. Marking of vehicles with dangerous cargo in the function of safe transport

The potential jeopardizing determination includes analysis and risk evaluation. During the need for determination of possible preventive measures, one should evaluate existing mechanisms for realization of transport process. And, on these basics, its evaluation should determine the requirements for certain measure of prevention all threats to safe transport.

The preventive measure for the control of potential jeopardizing dangerous cargo transport safety can be insight of transport planning or certain activities, warnings (alarms) – distracting attention on the possible jeopardizing, changing of persons behavior included in transport realization and similar. The railway infrastructure characteristics and other elements of environment can be the cause of endangered transport activities, and there is a need for change and intervention.

The efficiency of the conducted preventive measures must be examined, by determining its efficiency, in order to prevent all threats to safety of dangerous cargo transport. The reconsideration of conducted preventive measures should be realized through the following next steps:

- determine reconsideration of measures that are undertaken,
- evaluation as a result of determination, if the preventive measures are conducted in the most suitable way,
- to determine if the threat of dangerous cargo safety transport has appeared after applied preventive measures.

The persons responsible for the transport realization process must manage **corrective measures** because of the root of dangerous cargo safety transport disturbance, to be able to prevent its repetition. The corrective measures must respond to be applied to the base threat of safe transport of dangerous cargo.

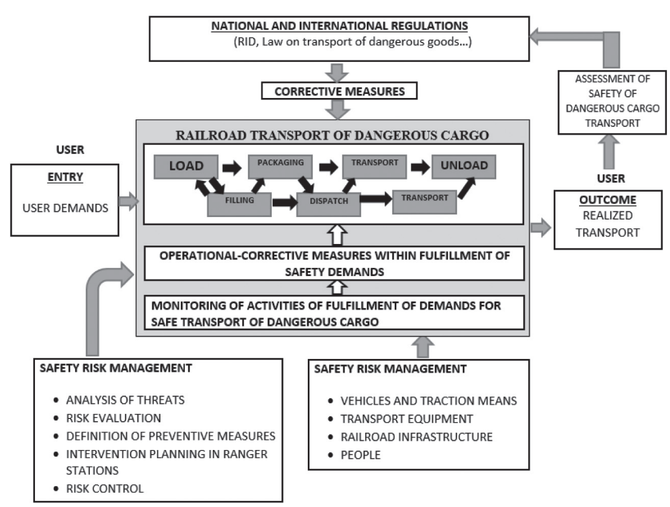

Figure 3. Safety management of railway transport of dangerous cargo [5]

The corrective measures should be followed by symptoms of jeopardized dangerous cargo transport safety problems until its cause, to give solutions for prevention of repeated menace appearance. The corrective measure provides reverse connection in the transport management cycle.

If the transport threats to safety do appear, it also often guides directly to the system problem. In that case, the problem should be stopped by added or repeated training and education, by changing the realization path of transport activities and similar.

The data about factors which threaten transport can be collected and analyzed in terms of transport safety process revelation. Each threat to safety has its causes and reasons of emerging. The cause detection and its operation within dangerous cargo safety transport are very important for the removal of existing and potential prevention of threats.

The dangerous cargo safety transport threat is identified – uncovered during monitoring and transport control process. When the root problem for transport safety is determined, solution can be proposed – enforced corrective measures for consequences removal, and prevention of it reoccurring.

When a large number of cases threatening dangerous cargo transport appear, or the safety is end angered within significant number of transport process activities, such potential dangers should be ranked along the way, for example, according to its causes, so they can be revealed and explained, and eventually that they can be solved.

The endanger transport cause revelation is of vital interest for the selection and management of corrective measures. In principle, two types of separated corrective measures should be undertaken:

- measures for safety removal of threats and
- measures for prevention of the repeated appearance of threats to safety.

After revelation that threats to safety can occur during the transport process realization, it indicates to omissions of members –process decision makers, as well as indirect executors. It also proposes corrective measures which should be applied, in regard of transport process specifics and potential dangers and possible risks against safety.

In the end, one should examine the effects of all corrective measures conducted with the goal of eradicating all threats, and determine if the desired results are achieved at the end. The corrective measures are effective when, after a period of time, whether they are not recorded again.

The reconsideration of effectiveness of measures should be realized through several steps:

- reconsideration because of redetermining which corrective measures should be undertaken,
- evaluation in terms of determining if corrective measures are conducted in the best way and
- determination if threats to dangerous cargo transport occur again after applied corrective measures.

The state of safety conditions is analyzed and evaluated, with observation in which measure requirements are respected that reveal from national and international regulation. Based on the conducted analysis results, the eventual weakness is determined and the necessary corrective managerial measures are defined, that should bring to stain dangerous cargo safety improvement.

In the dangerous cargo safety system management by railway, special attention should be dedicated to prevention with the goal of avoiding danger and possible consequences. So observed preventive means that management risk is not completely avoidable and inevitably exist like a constant follower of all activities. The dangerous cargo process transport by railway are followed by risks connected with the source of dangers per health and workers life on the railway (professional risks) and dangers from the extraordinary event in the traffic, chemical accident, fire and explosions (ecological risks).

The danger existence means that real risks are existing from human jeopardizing, material goods and life environment, during the dangerous cargo transport. Before the process of transport, it should evaluate risks and determine protective preventive measures, and the measures of readiness also, respond to the extraordinary event and recovery of its consequences, from the aspect of all determined dangers. These activities mean essential management risks principles. In principle, the management risk is consisted of the analysis and risk control, where analysis should involve the danger analysis, risk evaluation, decision making process about risk acceptance and preventive measures prescription [9].

The risk control, should involve use of: preventive measures, readiness measures and response to extraordinary events and measures for the removal of extraordinary events, circumstances (recoveries), during the dangerous cargo transport by railway. It requires design of the proper protection plans, before initialization of transport activities, which should involve the use of all necessary measures for risk suppression or its reduction to minimum acceptable level.

The readiness can be defined as reached preparation stain of all transport process members, from sender to receiver, because of proper answer undertaking on the extraordinary events by minimal consequences.

The extraordinary event answer formed during the dangerous cargo transport by railway, should include a certain assemblage of measures and procedures, which should be further elaborated by proper protection plans.

In formation of a response to the extraordinary event, the following must be done: the extraordinary event volume evaluation and its consequences, constant jeopardized space observation establishment and conducting necessary measurements, precise and complete notification about extraordinary event by giving concrete instructions about next treatment, giving elements for the decision making process about necessary treatment, proper professional service work coordination and competent authorities informing on the higher level.

Measures and procedures arise from the conducted analysis basics, and risk evaluation is deducted from extraordinary event and its circumstances. The proposed measures and procedures, according to the protection plan, should stop and isolate the emerging of a dangerous process during an extraordinary event, or limit its effects, minimize consequences and create conditions for contained post accident situation following recovery of the environment.

THE TRAIN IN DANGEROUS CARGO SAFETY TRANSPORT IMPROVING BY RAILWAY

The goal of organization of railway transport of dangerous cargo is directed at constant improvement of transport safety. It includes work capacity of workers on the railway, and it can be under influence of external and internal factors. Also, it involves changes on the transport market service, transport technologies, international regulations and requirement of transport users. These changes can be requested by railroad officials, to analyze their needs connected with training process.

The dangerous cargo safety transport by railroad can be achieved, with minimization of number of extraordinary events and its consequences, or by increasing the professional training member's level in transport process for treatment of dangerous cargo.

During the dangerous cargo transport by railway, certain irregularities are possible to occur, and in a certain way, these fall to the responsibility of the staff – persons employed on the railway such as:

- staff in the exploitation process who are directly involved in the dangerous cargo transport (engineers, maneuvers and similar),
- staff responsible for control of technical safety of cars, which are using the dangerous cargo transport,
- staff responsible for management and conducting of cars and maneuvers service, such as railway infrastructure staff management (carriages, trainees, operational service officers, telecommunications officers and similar).

The aforementioned staff must be capable to answer to requirements for transport of dangerous cargo is imposing within its work duties, responsibilities and competences. The staff should strive to possess necessary skills, habits, but also the knowledge, which should be reached in the first place. The knowledge and skills are directed to concrete tasks and by basic (and supplementary) training for safe transport of dangerous cargo. It means that the staff must be trained, on a proper manner, for all regulations requirements to be fulfilled, and by regulating the transport of dangerous cargo, by railway, where on that base, safety parameters are defined.

The proper training is one of the possible preventive measures in line. The SRPS ISO 10015:2002 standard gives the frame for choosing appropriate training as an effective way of giving answer to the needs for improvement of transport safety, as in figure4.

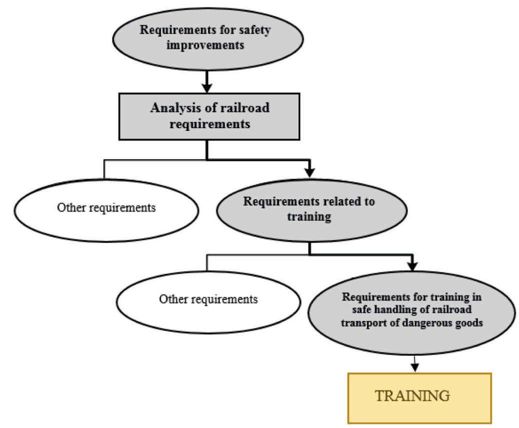

Figure 4. Improvement of safety by education

Through the education system, personnel employed on the railroad acquires general knowledge about transport of dangerous cargo, but only through training system skills necessary for dangerous cargo transport concrete tasks implementation. The training should provide increasing of individual knowledge, skills and problem understanding of dangerous cargo transport to the individuals and its safety.

The training process must be planned and systematically thought, to be able to give proper contribution to the railway. For improving its abilities and to achieve its goals in the sphere of dangerous cargo transport, and for the needs of conduction of such training, a general training model can be used, as displayed in figure 5.

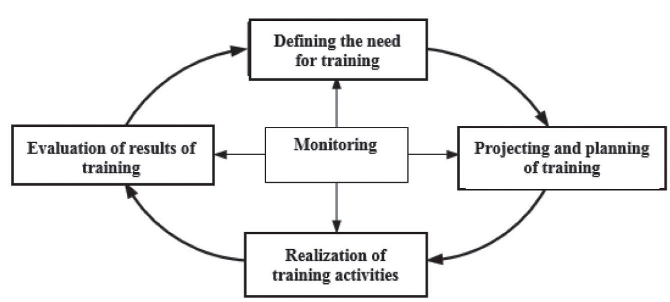

Figure 5. Basic training phases

The railway organization must, according to specifics and dangerous cargo transport requirements to define needs for training, projects and plans training, be conducted on the proper way and evaluate the results of its training at the end.

In the appropriate chapter of RID, basic and supplementary themes are defined, which include elements linked with knowledge of dangerous cargo transport, depending on workplace specificities[4]. Besides that, personnel must be trained to recognize risks and a danger which lies within dangerous cargo transport, in case of an extraordinary event during the transport process realization, for it can bring lots of bad things to human safety, assets and life environment.

The persons like sender and the railway infrastructure manager must be trained additionally, through basic and supplementary training, according to the railway traffic characteristics.

Amendments in regulations inevitably require revilement and refreshment of knowledge through certain courses. In the process of training, special attention must be directed to the case when dangerous cargo is being transported with high potential danger[5]. Persons, who participate in the dangerous cargo transport with high potential danger, must be capable for conducting and usage of safety plans, whose content is defined in point 1.10.3.2.2 of RID.

Certain persons, who work on the railroad station must be trained with urgent interventions planning, coordinated work, so the consequences for human lives and the environment are reduced to the minimum possible measure.

CONCLUSION

In railroad traffic, a respective quantity of dangerous cargo is transported every day. Transport of dangerous cargo is a very complex process and it is significantly different from other types of cargo transport. It follows the possibility of an extraordinary event to occur, with inconspicuous consequences for human lives and the environment, which can put a lot of risk on the transport process.

The primary goal of safe transport of dangerous cargo must be to achieve orderly conduct with maximum level of safety for human beings, assets and the environment. To accomplish such a goal within transport management establishment, safety imposes as a vital transport service performance.

For dangerous cargo, basic parameters of safety in transport management should be prescribed, foreseen and required for all members of the process, and at the same time, they represent vital safety factors.

The large number of missions, which threaten transport safety, as a consequence of hierarchy failure within management structure, they are tightly connected to the disrespect of requirements defined in relevant international and national regulation documents, which imposes conclusion about proper need for training of all transport process members. The training should be projected to ensure proper training, where the outcome disconnected to the requirements of dangerous cargo transport imposes in the frame of some work obligations, responsibilities and competence transport process member's competence.

The safe transport of dangerous cargo requires that all railroad personnel possess knowledge and skills, acquired by basic and supplementary training, and that they are directed at concrete tasks to ensure dangerous cargo transport. The training is realized in such a way that railroad personnel acquire abilities for correct and safe conduct, during the dangerous cargo transport realization.

With maximum engagement of all dangerous cargo transport members by railway, railroad professional staff and railroad infrastructure manager staff- on tracking, application and prescribed requirements fulfillment, all in the mentioned chain can expect satisfactory results when questioning transport safety.

[4] Depending on possible dangers that might bring to injuries and damages, as an extraordinary event with consequences for dangerous cargo transport, employees must be trained about the risks and dangers that come with dangerous cargo, with the goal of dangerous cargo safety manipulation and measures in any case of escalation.

[5] Under the term „dangerous cargo", with high potential of hazard,are all goods which are used in terroristic actions that might bring to the serious consequences sucha as the loss of human lives or massive destructions, or especially in the case of radioactive substances- massive social-economic destructions (subchapter 1.10.3 RID)

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[12] Figure 1. was downloaded from the following internet source: https://www.google.com/search?q=%C5%BEelezni%C4%8Dki+prevoz+opasne+robe&oq=%C5%BEelezni%C4%8Dki+prevoz+opasne+robe&aqs=chrome..69i57.11414j0j9&sourceid=chrome&ie=UTF-8, (assessed on 27.2.2019)

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PRELIMINARY COMMUNICATIONS

Probability Analysis of Traffic Accident Occurrence Based on Incomplete and Unreliable Evidence

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Abstract: The paper presents a methodology for analyzing a traffic accident and evaluating the existence of a traffic accident in the conditions of incomplete and unreliable evidence. Namely, the examination of the causes of a traffic accident is the usual activity of traffic experts who, with their knowledge, experience and skills, help the court and parties in the court proceedings to find out from the qualified, experienced and impartial person the reasons for the occurrence of a traffic accident, and in relation to that, mistakes and responsibilities participants in a traffic accident. In contrast, lately there are phenomena of traffic accidents in which individuals and/or groups try to improvise traffic accidents in order to achieve their various benefits and interests. This paper provides a methodological approach to such an expert evaluation of probability of traffic accident evaluation with examples in the cases of vehicle-vehicle and vehicle-pedestrian collision.

Keywords: Traffic Accident, Probability, Evidence.

INTRODUCTION

Traffic accident reconsruction is the effort to determine, from whatever evidence is avilable, how an accident occurred. Accordingly, the reconstruction of a traffic accident is in a certain sense "intellectual reconstruction" of a traffic accident event presented and explained by a simple and comprehensible vocabulary with explanations of all the details of the particular phases - sequences of that event. Traffic accident reconstruction can be treated as a problem in uncertain reasoning about particular event, and developments in modeling uncertain reasoning for artificial inteligence can be applied to this problem. Physical principles can usually be used to develop a structural model of the accident and this model, together with an expert assessment of prior uncertainity regarding the accident's initial conditions, can be represent as Bayesian network. At the First international Conference on Forensic Statistics Lindley (1991) argued that the probability should be applied to forensic inference more generally [1]. Lindley focused on problems for which the hypothesis of interet were the guilt or inosence of defendant, and the task was to weight the plausability of these alternatives in light of evidence. His proposed solution was Bayesian, where one first determines prior assignment of probability to the alternative hypotesis, along with the probability of the evidence given each alterantive, and than uses Bayes's theorem to compute posterior probabilities for the hypothesis. This approach has since been applied to increasingly more problems in forensic identification (Balding, 2000; Dawid Mortera, 1998)

The subject matter of the expert examination, in the case of a traffic accident, is to determine the cause of the accident, i.e. the faults of all participants in the accident and their possible liability for these failures. Thus, when the course and dynamics of a traffic accident are presented, it gives the answer to the question of how the accident occurred. And the assessment of the technical capability, or the inability to avoid an accident, is given. In the some cases, the subject matter of the expert examination may be only the existence of a traffic accident, or giving an answer to the question: did a traffic accident really happen? The answer to this question is becoming more important in recent times when there is a "fake traffic accident" phenomenon in which individuals and/or groups try to improvise the occurrence of traffic accidents trying to achieve their different benefits and interests. This paper gives an example of a methodological approach to such an expert assessment.

PROBABILITY AS A MEASURE OF UNCERTAINTY

Probability is a branch of mathematics that aims to conceptualize uncertainty and makes it suited for decision making. So probability can be considered a significant branch of wider theme of "reasoning under uncertainty". The probability estimation is dependent on two factors: event D whose probability is considered and information I available in relation to event D. The result of this assessment is the probability that event D occurs if it is I known. All probabilities are conditional because they depend on certain information. Concept of probability and statistics are based on randomly variable, probability distribution and descriptive statistics. When facing the phenomenon of uncertainty, it is necessary to describe this uncertainty in some form. Knowledge of probability and statistics is used to articulate the amount of uncertainty. In the analysis of traffic accidents, uncertainties appear in each executed calculation. There are many reasons for this, and two most obvious are: (a) simplifying real physics into manageable mathematical expressions that cause insecurity, and (b) evidence is never perfect. It is necessary to distinguish the terms "population" and "sample". The population is a set of all possible values and its total number can be a discrete amount, and the sample is a selected part of the population. However, in numerous examples of application in the assessment of traffic accidents there is an infinite number of values that can be assigned to each variable in a given diapason. Values that are defined as mean values and standard deviations are considered "unbiased" because with increasing data they are approaching the parameters of the population: $\overrightarrow{x} \rightarrow \mu; \delta^2 \rightarrow \sigma$, where μ is the mean, and σ variance (Figure 1.)

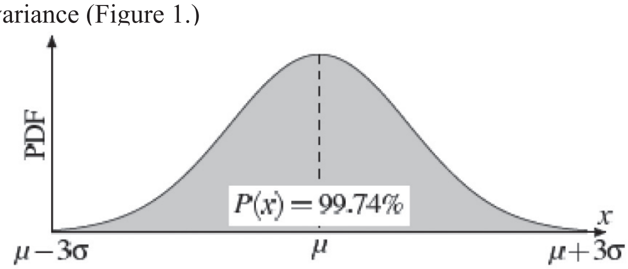


Figure 1. Typical probability density function

PROBABILITY ANALYSIS OF VEHICLE-VEHICLE COLLISION

The variable v_{ij} denotes the speed of vehicle *i* or vehicle *j* and takes value 0 if the speed was not grater then the speed limit, and takes value 1 if it is. The variable x_{ij} indicates the vehicle's initial distance from the contact point and takes value 0 if this distance is „short" and the value 1 if this distance is not short. The problem of more precisely defining of the term „short" will, for now, be ignored. The variable Y_{ij} indicates whether a collision occurred and takes value of 0 if it is not, and the value is 1 if it is. It is assumed that the value Y_{ij} correlates with the values v_{ij} and x_{ij} according to the following equation [1]:

$$Y_{ij} = \left(1 - x_{ij}\right) - x_{ij}v_{ij}$$

Expressed by the words this equation means that the vehicles collision occurred in the case if the initial distance $\left(1 - x_{ij}\right)$ was short, or in case this distance was not short, but the speed was greater than the limited speed$(x_{ij}v_{ij} = 1)$. Since all the variables belong to Boolean algebras, the dependence betweenY_{ij}, , and v_{ij} can be represented by a simple Boolean collision model (Table 1.) In Table 1., each given value for v_{ij} and x_{ij} determines the possible state of the event between the vehicles. In the literature, the different column names in the table are used, such as "state", "possible scenario" or "system state". Also, in practice of philosophical logic, which becomes more and more common in the research of artificial intelligence, the term "possible worlds" is used. Here, in the following text, we will use the term "possible scenario". Uncertainties in traffic accident reconstruction can occur when available evidence is not sufficient to determine which scenario is real.

Table 1. Possible scenarios and probability distribution for Boolean collision model

Possible Scenario	Vehicle "i"					Vehicle "i"					P_{ij}
	v_i	x_i	Y_i	$Y_{vi=0}$	P_i	v_j	x_j	Y_j	$Y_{vj=0}$	P_j	
1	0	0	1	1	1/4	1	0	1	1	1/4	1/16
2	1	0	1	1	1/4	0	1	1	0	1/4	1/16
3	0	1	0	0	1/4	1	0	0	1	1/4	1/16
4	1	1	1	0	1/4	0	1	1	1	1/4	1/16

For example, suppose we want to know if the speed of vehicle *i* was greater than allowed, and the only reliable evidence we have is that the collision occurred
$(Y_i = 1)$

Table 1. indicates that this condition eliminates scenarios number 3 and 4 as an option, but from the remaining two scenarios two have the value $v_i = 0$ and two have the value $v_i = 1$, so it can be said that is possible, but not necessarily, that the speed of this vehicle was above limited value. On the other hand, let's assume that, according to a reliable witness the initial vehicle distance from the contact point was long $(x_i = 1)$ when the vehicle *j* entered the path of vehicle *i*. Only scenario 4 has $(x_i = 1)$ and$(Y_i = 1)$. In this scenario$(v_i = 1)$, so we can conclude that the speed of vehicle *i* was higher than allowed. Therefore, conditional probability that the speed of the vehicle was higher than allowed and the collision occurred:

$$P_{ij}\left(v_{ij} = 1 \middle| Y_{ij} = 1\right) = \frac{P\left(v_{ij} = 1 \middle| Y_{ij} = 1\right)}{P(Y_{ij} = 1)} = \frac{\left(\frac{1}{16} + \frac{1}{16}\right)}{\left(\frac{1}{16} + \frac{1}{16} + \frac{1}{16}\right)} = \frac{2}{3} = 0.67$$

PROBABILITY ANALYSIS OF VEHICLE-PEDESTRIAN COLLISION

In order to provide the findings on the circumstances and the probability of a traffic accident occurrence, all elements that are important for determining the course, dynamics and causes of traffic accident in case of a collision accident type "vehicle-pedestrian collision" are analyzed. The mentioned essential elements, their description and their significance for analyzing the probability of the subject event are given in Table 1. In order to determine the significance of a particular element for the probability analysis of the subject event, an analytical procedure is defined that determines the significance of an individual element, depending on the objective evaluation of importance of that element for the adoption the final conclusion about a particular event. Objective evaluations of the importance of elements are classified into four categories, which are defined by linguistic expressions: exceptional, great, medium and low significance. The main objective of the analysis of the above elements is to obtain an answer to the question of whether the factual state and probability of a particular element *supports* or *does not support* the thesis that the event is "vehicle-pedestrian collision" type. An analysis of each of the above elements is based on the data from the court file and presented in the following text.

I. Location of vehicle-pedestrian collision (Collision Point-CP)

In the subject case on the spot no evidence on which to reliably able to determine the place where possibly there were contacts of vehicles and pedestrian. In most traffic accident cases with pedestrian place of vehicle impact on pedestrian can be determined if direction of the vehicle (skid marks) and the direction of movement of pedestrian are known, or if the location of lighter objects that belonged to the pedestrian at the time of flight time (hat, footwear, telephone, newspapers and the like) is determined. Given that in the present case there are no signs indicating the location of contact to state that it is not possible to reliably determine the location of possible collisions of vehicles and pedestrians. Probable location of this place can be estimated on the basis of other available elements such as: possible crash pedestrians after the collision, position marking glass and blood in the area of a possible fall of pedestrians, the most likely mode of movement of pedestrians, damage to the vehicle and the estimated most probable speed of the vehicle at the time it encounters pedestrians. If we accept the estimated speed of the vehicle at the time of collision with a pedestrian, which is 50 km / h (see paragraph VI of findings) and place indicated on the sketch of the scene as the resume body pedestrians after the crash then the distance dismissal pedestrians could amount to about 17, 0 m, including the distance that the vehicle and pedestrians crossed at a combined speed of 50 km / h after the body was loaded onto the vehicle. However, this version of events is unlikely since it is evident that there are no indications that the vehicle is braked, which would cause a separation of pedestrian body from the vehicle.

This element "Location of vehicle-pedestrian collision" is of extraordinary importance for analyzing the subject event and for determining the likelihood of its occurrence. The absence of any material tracks on the carriageway that would determine the location of the collision or associate with the location of the vehicle and pedestrian contact does not support the thesis that the incident in question is a traffic accident of vehicle-pedestrian collision type.

Table 1. Elements relevant to the analysis of a traffic accident type "vehicle- pedestrian collision" and their significance for analyzing the likelihood of the subject event

No.	Element	Description	Significance for analyzing the likelihood of a given event
I	Location of vehicle-pedestrian collision – Collision point (CP)	It represents the place where the vehicle-pedestrian collision occurred	Extraordinary Significance
II	Location of damages and traces on the vehicle (VD)	It represents the type and location of damages found on the vehicle that were created in the collision with a pedestrian, as well as all other traces of the contact and the mutual relationship of these damages with injuries to the pedestrians.	Extraordinary Significance
III	Pedestrian injuries (PI)	The injuries sustained by the pedestrian during contact (collision) with the vehicle and the mutual relationship of these injuries to the damages on the vehicle.	Extraordinary Significance
IV	Way of movement and behavior of pedestrian before collision with a vehicle (PB)	Defines the way and direction of pedestrian movement in relation to the carriageway immediately before contact with the vehicle and the pedestrian behavior in relation to the way of the vehicle movement.	Great Significance
V	Way of vehicle movement and behavior of the driver before a vehicle-pedestrian contact (DB)	It represents direction and the way of vehicle movement before contact with the pedestrian and the behavior of the driver in relation to the way of pedestrian movement	Great Significance
VI	Technical capability or inability to avoid collision of vehicles and pedestrian –Collision avoid ability (CA)	It represents an analysis of the ratio of available space and time for the driver in relation to the position of pedestrian. It also represents the basis for the conclusion on the cause(s) of the accident	Great Significance
VII	Speed of the vehicle at the time of the collision with a pedestrian (VS)	It represents the speed of the vehicle at the moment of contact with pedestrian.	Medium Significance
VIII	Place and distance of pedestrian body rejection after collision (PR)	It represents the distance from the place of vehicle-pedestrian collision and the place of pedestrian fall after the collision and relationship of this place with the way of pedestrian and vehicle movement.	Low Significance
IX	Position of the vehicle after a collision with a pedestrian (VP)	It represents the place of stopping the vehicle after a collision with a pedestrian	Low Significance

II. Location of damages and traces on the vehicle (Vehicle Damage-VD)

The following damages to the subject vehicle has been identified: the headlamp, the bonnet (hood), the front left mudguard on the side in the front panel, the front windshield rack frame on the left side at a height of about 1.90 m. The intensity of the damage and the precise location of these damage are not listed and are not described in detail. In traffic accidents like "vehicle-pedestrian collision", besides damage to vehicles, remain traces such as traces of swabs on the vehicle, traces of tissue, traces of hair and traces of blood. However, in the concrete case, these tracks were not found. The front bumper is the most extreme point on the vehicle and is located at a height of 0.65 m from the ground. In case of a frontal collision, the first contact of the vehicle with the body of pedestrians is achieved by a bumper. Since the height of the bumper is considerably lower than the center of the body of the pedestrian then there is a horizontal rotation of the body around the point of the center of gravity and the body leakage on the hood, and then on the windscreen, depending on the speed of the vehicle.

This element of "Location of damages and traces on the vehicle" is of extraordinary importance for analyzing the subject event and for determining the likelihood of its occurrence. The results of the analysis of this element and the absence of correlation between this element and the element "Pedestrian injuries" does not support the thesis that the incident in question is a traffic accident of vehicle-pedestrian collision type.

III. Pedestrian injuries (PI)

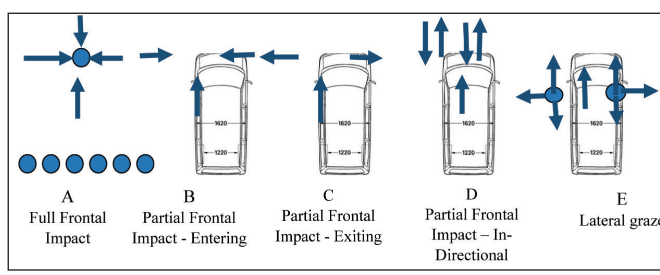
In traffic accidents like "vehicle-pedestrian collision", parts of the pedestrian body with the highest percentage of injuries are legs (32.6%) and head (31.4%), followed by breast (10.3%), arms (8.2%), pelvis (6.3%), etc.

In the frontal vehicle/pedestrian crash, the primary contact is achieved by striking the front bumper of the vehicle into one or both legs of the foot pedestrian. Already at relatively low speeds, the impact of a bumper force often results in the breakdown of the lower legs. Due to this primary contact, the pedestrian feet are pulled in the direction of the vehicle movement, whereby the body of the pedestrian receives a rotational acceleration around its center of gravity with the direction of rotation which is opposite to the direction of movement of the vehicle. Immediately after this primary kick of the front bumper in the foot of a pedestrian, a vehicle of a pontoon type or a combination of a pontoon-box type, an adult's pelvis and pelvis strikes in the front of the bonnet (hood). In this way, the body of the pedestrian receives a very powerful translational acceleration, which often results in severe injuries to the hip and hip hips, due to very large impact forces. Although the front of the vehicle in question has a distinctive transition shape from a pontoon to a box, this shape, however dominant, has features of a pontoon shape. However, no injuries were found on the pedestrian to match the injuries resulting from the collision of the above-mentioned vehicle body shapes.

This element of "Pedestrian injuries" is of extraordinary importance for analyzing the subject event and for determining the likelihood of its occurrence. The results of the analysis of this element and the absence of correlation between this element and the element "Location of damages and traces on the vehicle" does not support the thesis that the incident in question is a traffic accident of vehicle-pedestrian collision type.

IV. Way of movement and behavior of pedestrian before collision with a vehicle (Pedestrian Behavior-PB)

According to the records, two pedestrians were walking next to the each other, along the right side of road in the same direction as motor vehicle. According to the standard size of the carriageway surface when walking pedestrians could occupy a space of about 1.5 m along the width of the carriageway. The probability of the type of vehicle-pedestrian collision in the concrete case is analyzed (Figure 2.). Based on the evidence from the court-case file variants A, B, C and E are excluded as possible alternatives. It was concluded that there might be a likelihood that the case D (Partial Frontal In-directional Impact) occurred, but only if only one pedestrian were present. However, this variant was unsustainable because, in reality, two pedestrians were present and injuries of pedestrians and damages of vehicle do not support this alternate.



There are no elements in the content of the file that would indicate the lateral movement of any of the above-mentioned pedestrians. Also, there is no element in the content of the case file that would indicate any reaction of the pedestrians to the presence of the vehicle, including the "reflex reaction". Based on the above, it can be concluded that for pedestrians in the concrete situation, there was no indication of presence of any sudden of danger factor. The lack of a sudden hazard situation and non-action of pedestrian to avoid contact with the vehicle is totally atypical for traffic accidents like "vehicle-pedestrian collision".

This element of "Way of movement and behavior of pedestrian before collision with a vehicle" is of great importance for analyzing the subject event and for determining the likelihood of its occurrence. The results of the analysis of this element and the absence of correlation between this element and the element "Way of movement and behavior of the driver before a vehicle-pedestrian collision" does not support the thesis that the incident in question is a traffic accident of vehicle-pedestrian collision type.

V. Way of vehicle movement and behavior of the driver before a vehicle-pedestrian collision (Driver Behavior-DB)

According to data from the content of the court file, it can be concluded that the road is straight, without curves in the zone of the accident site, that pavement is 3.90 m wide, was dry at the time of the accident, that the weather was clear and that the place was illuminated by street lighting. It can also be noted that, at the time of the accident, there were no other vehicles and other pedestrians. Since there are no traces of braking on the spot or any other traces indicating a slowdown of the vehicle or some other maneuver, it can be concluded that the speed of the vehicle at the time of the collision with pedestrians was equal to the speed of that vehicle before the collision. Also, there are no indications of a change in how the vehicle moves after a collision with pedestrians, and it can be concluded that the speed of the vehicle has remained the same, that the speed after the collision is identical to the speed of the vehicle before the collision and that the vehicle continued to move without stopping

This element of "Way of movement and behavior of pedestrian before collision with a vehicle" is of great importance for analyzing the subject event and for determining the likelihood of its occurrence. The results of the analysis of this element and the absence of correlation between this element and the element "Way of movement and behavior of pedestrian before a vehicle-pedestrian collision" does not support the thesis that the incident in question is a traffic accident of vehicle-pedestrian collision type.

VI. Technical possibility or inability to avoid collision of vehicles and pedestrian (Collision Avoid-ability)

There was an objective possibility for the driver of the vehicle to see pedestrian on the road. Also, there was a technical possibility for the driver to avoid a collision with pedestrian because the minimal available visibility distance (40 m) was much longer than required stopping distance (28 m). The technical ability to avoid collision with pedestrian would also exist at speeds greater than 50 km/ h, that is, the technical ability to avoid an accident would be at all speeds less than 64 km/h. Also, for pedestrian there was an objective possibility to see the lights of the vehicle and to hear the approaching vehicle, and there was more than a sufficient time interval to avoid contact with the vehicle.

This element of "Technical possibility or inability to avoid collision of vehicles and pedestrian" is of great importance for analyzing the subject event and for determining the likelihood of its occurrence. The results of the analysis of this element does not support the thesis that the event is a traffic accident of the type vehicle-pedestrian collision because the existence of conditions for the technical ability to avoid an accident, both for the driver and pedestrians, and the absence of any reaction of any participant in the accident question is the real cause of this accident.

VII. Speed of the vehicle at the time of the collision with a pedestrian (Vehicle Speed-VS)

According to this length of glass scattering and interdependence, and the length and speed of the vehicle's impact on pedestrians, the speed of the vehicle at the time of the flight could range from 50-55 km / h. The reality of this speed of the collision is confirmed by the results of scientific-expert survey of the sample of 374 actual cases of vehicle impact on pedestrians with fatal consequences and consequences of bodily injuries to pedestrians. Namely, the results of these studies show that almost seventy percent (69.4%) of cases of speeds ranged from 30-59 km / h (speed from 30 to 39 km / h, 23.4%, speeds of 40 to 49 km / h in 23.4% and speeds of 50 to 59 km / h in 22.5% of cases). The vehicle speed at the moment of a pedestrian run is significant from the point of view of the accident and from the aspect of time-spatial analysis of the event, or analysis of the possibility or inability to avoid an accident. However, the exact amount of speed in a particular case is not decisive for determining the likelihood of a traffic accident occurrence

This element of "Speed of the vehicle at the time of the collision with a pedestrian" has a secondary importance for analyzing the event in question and determining the likelihood of its occurrence. The results of the analysis of this element can partially support the thesis that the event is a traffic accident of vehicle-pedestrian collision type.

VIII. Place and distance of pedestrian body rejection after collision (Pedestrian Rejection-PR)

The blood traces found on the spot on the left side of road may associate with the place of the pedestrian fall after a collision with the vehicle. However, these tracks are not described in detail so that they cannot be a reliable basis for the claim that this is the real place of the fall of pedestrians after the vehicle's collision. These tracks cannot be reliably linked to the probable location of the crash site and the position of the vehicle and pedestrians as previously described.

This element "Place and distance of pedestrian body rejection after collision" has less significance for analyzing the event in question and determining the likelihood of its occurrence. The results of the analysis of this element do not support the thesis that the event is a traffic accident of a type of vehicle-pedestrian collision type since the position of the traces, which could possibly indicate and represent the place of the pedestrian fall after the collision with the vehicle, is incompatible with the relationship between the direction, speed and direction movement of vehicles and pedestrians

IX. Position of the vehicle after a collision with a pedestrian (Vehicle Position-VP)

The vehicle did not stop after an eventual collision with pedestrian, so that there is no data on the position of the vehicle after the collision. The absence of vehicles on the spot after a possible collision with pedestrian partially does not support the thesis that the event is a traffic accident. However, this element can also partially support this thesis because it can be assumed and accepted the fact that it was about to be removed from the scene of the accident for reasons known to the driver. These reasons cannot be reliably established.

This element "Position of the vehicle after a collision with a pedestrian" is of low importance for analyzing the event and determining the likelihood of its occurrence. The results of the analysis of this element can partially support the thesis that the event is a traffic accident of a type vehicle-pedestrian collision.

PROBABILITY CALCULATION SUMMARY

Probability can be calculated after weight is assign for each analyzed element. Analysts can develop weights that reflect their experience and knowledge in a natural and intuitive manner. The following methods can be used to set the weights:

- Uniform weighting
- Direct weighting
- Delphi technique
- Gambling method
- Mutual consultations or opinion pools (observers)
- Comparison of criteria pairs (Pair-wise comparison between criteria)
- Establishing a hierarchy of priorities and using AHP (Analytic Hierarchy Process)

In our example weghting is based on mutual consultations and opinions applying analytical method that reflects analysts' experince and professional judgement. For each analyzed element the weight values are determined depending on the degree of element importance (Table 2.)

Total values of weight for all elements that *do not fully support* the hypothesis that the subject event is the vehicle-pedestrian collision:

$$H^{-} = \sum_{i=1}^{m} q_i = 9.0 + 9.0 + 9.0 + 7.0 + 7.0 + 7.0 + 3.0 = 51$$

Total values of weight for all elements that *do not partially support* the hypothesis that the subject event is the vehicle-pedestrian collision:

$$H^{\mp} = \sum_{i=1}^{m} q_i = 5.0 + 3.0 = 8$$

On the basis of the above values, the minimal, mean and maximal probabilities are calculated:

- Minimal probability that the subject event (A) is not vehicle-pedestrian collision and maximal probability that event (B) is vehicle-pedestrian collision:

$$P(A)_{min} = \frac{48}{59} = 0.81, P(B)_{max} = 1 - 0.81 = 0.19$$

- Mean probability that the subject event (A) is not vehicle-pedestrian collision and mean probability that event (B) is vehicle-pedestrian collision:

$$P(A)_{mean} = \frac{51}{59} = 0.86, P(B)_{mean} = 1 - 0.86 = 0.14$$

- Maximal probability that the subject event is not vehicle-pedestrian collision and minimal probability that event (B) is vehicle-pedestrian collision:

$$P(A)_{max} = \frac{51 + 0.5x5.0 + 0.5x3.0}{59} = \frac{55}{59} = 0.93, P(B)_{min} = 1 - 0.93 = 0.07$$

CONCLUSION

The results of the analysis of the relevant factors for assessing the likelihood of a traffic accident do not support the thesis that the incident in question is a traffic accident of the type vehicle-pedestrian collision.

Out of a total of nine analyzed important elements, the results for the seven elements, of which three (3) elements have extraordinary significance, three (3) elements are of great importance and one (1) element has low significance, do not fully support the thesis it's a traffic accident. The results of the analysis for the remaining three analyzed elements, whose significance is defined as medium or low, partially support the thesis that it is a traffic accident. It is possible, furthermore, to provide appropriate numerical weight characteristics to the relevant elements (factors) and to indicate the numerical values of the above probabilities.

The presented examples indicates that there are

Table 2. Weight of analyzed elements

Element (x)	CP	VD	PI	PB	DB	CA	VS	PR	VP
Weight (q_i)	9.0	9.0	9.0	7.0	7.0	7.0	5.0	3.0	3.0
Significance	Extra	Extra	Extra	Great	Great	Great	Medium	Low	Low

similarities and differences in the analysis of the flow and dynamics of the accident and the assessment of the probability of a car accident. It is necessary for a traffic expert to analyze thoroughly and critically all the essential elements - the parameters of the accident that would otherwise be analyzed in case of an accident actually happened and to say whether the results of the analysis of these elements support or do not support a well-founded hypothesis.

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(initial capitals, boldface, on separate line)
Third-Level Subhead
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Indent first line 12.7 mm (0.5 in.); do not indent for text runovers.

Table Titles and *Figure* Captions

TABLE 5 Effects of All Factors
(Insert title above the table; "Table" is all capitals; title is initial capitals; all type is boldface; extra space but no punctuation after number; no punctuation at end of title.)

FIGURE 3 Example of results.
(Insert caption below the figure; "Figure" is all capitals; caption is sentence case; all type is boldface; extra space but no punctuation after number; period at end of caption.)

Body of paper

The **Introduction** should provide a clear statement of the problem, the relevant literature on the subject, and the proposed approach or solution. It should be understandable to colleagues from a broad range of disciplines.

The **Materials and methods** should be complete enough to allow possible replication of the research. However, only truly new research methods should be described in detail; previously published methods should be cited, and important modifications of published methods should be mentioned briefly. Capitalize trade names and include the manufacturer's name and address. Subheadings should be used. Methods in general use need not be described in detail.

The **Results** should be presented with clarity and precision. The results should be written in the past tense when describing author's findings. Previously published findings should be written in the present tense. Results should be explained, but largely without referring to the literature. Discussion, speculation and detailed interpretation of data should not be included in the Results but should be put into the Discussion section.

The **Discussion** should interpret the findings in view of the results obtained in this and in past studies on the topic. State the conclusions in a few sentences at the end of the paper. The Results and Discussion sections can include subheadings, and when appropriate, both sections can be combined.

References

The reference list should contain only references that are cited in the text, numbered in the order in which they are first cited. Bibliographic lists will not be published.

Denote a reference at the appropriate place in the text with an **italicized Arabic numeral in parentheses**, e.g., [2].

Do not include in the reference list any unpublished material, personal communications, telephone conversations, or similar material that would not be available to readers electronically or in printed form in a library or from the originating agency. Instead, cite the unpublished work in the text and enclose the author's name along with the term "unpublished data" in parentheses.

The following examples illustrate the basic TTTP style for references.

EXAMPLES OF ACM PUBLICATION REFERENCES

Journal article [1]
[1] Zahavi Y. and Ryan, M. James. Stability of Travel Components Over Time. *Transportation Research Record*, 750 (1980), 70-75.
Book [2]
[2] Shinar, D. *Psychology on the Road: The Human Factor in Traffic Safety*. John Wiley & Sons, Inc., New York, 1978.
Article in a Periodical [3]
[3] Jolliffe, J.K. and Hutchinson, T.P. A Behavioural Explanation of the Association Between Bus and Passenger Arrivals at a Bus Stop. *Transportation Science*, 9, 3 (August 1, 1975), 248-282.
Government Report [4]
[4] Dempsey, J. Barry. *Climatic Effects of Airport Pavement Systems: State of the Art.* Report DOT2DRD-75-196. FHWA, U.S. Department of Transportation, 1976.

Web Page [5]

[5] Stevens, R.C. Testimony Before United States Senate Special Committee on the Year 2000 Technology Problem. Sept. 10, 1998. http://www.senate.gov/~y2k/statements/091098stevens.html. Accessed Oct. 5, 1998.

CD-ROM [6]

[6] Martinelli, D.R. A Systematic Review of Busways. *Journal of Transportation Engineering* (CD-ROM), Vol. 122, No. 3, May–June 1996.

Metrication

Measurements in papers must be provided either in SI system units (preferred style). The TTTP Editorial Services Office follows Standard Practice for Use of the International System of Units (SI), published by ASTM as E380-91.

Pay particular attention to determining whether weight is to be expressed in mass (kilograms) or in force (newtons), and express poundforce per square meter (N/m^2) of pressure or stress in pascals Pa).

Use prefixes instead of powers for SI units. -In figures and tables, provide only the units in which the original research was conducted.

Mathematical dependences, their notations in the text and other symbols should be written using Equation Editor 3 Italic in 10 pt type, indexes -in 7 pt and sub indexes -in 6 pt type. Matrices are written in square brackets and vectors in Bold-Regular 10 pt type. All numerals, including index numbers, are presented in Regular type. Formulas are centred, aligned right and numbered using Arabic numerals in round brackets. An interval of one line between a formula and text should be left.

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Do not use footnotes to the text. Incorporate the information into the text or delete the notes.

Abbreviations, Acronyms, and Symbols

Abbreviations, acronyms, and symbols must be fully defined the first time they are used in the paper; the definition should be given first, followed by the abbreviated term in parentheses.

Acknowledgments

Authors of papers that report results of research sponsored directly or indirectly by Goverment programs should indicate this sponsorship in an Acknowledgment section at the end of the text, before the References.

Appendices

Do not use appendices. Include pertinent material in the paper itself or, where necessary, include a note that background material, such as derivation of formulas, specifications, or survey forms, is available from the author or in another report, which should be cited in the reference list.

Tables and Figures

For peer review of papers, tables and figures should be embedded in the text, as close as possible to the related text. Color is permissible.

If the paper is accepted for publication in the *Journal for Traffic and Transport Research and Application*,

all tables and figures should be inserted at the end of the manuscript after the list of tables and figures. Use a separate page for each table or figure. Each table and figure must be cited by number in the text.

Authors should bear in mind that the original tables they submit will be reset and that the figures may be reduced for publication. Therefore, authors should ensure that the type in any table or figure submitted with their paper is **at least 10-point font** (typeface). Keep type sizes and fonts uniform and consistent.

Tables should be kept to a minimum and be designed to be as simple as possible. Tables are to be typed double-spaced throughout, including headings and footnotes. Each table should be numbered consecutively in Arabic numerals and supplied with a heading and a legend. Tables should be self-explanatory without reference to the text. The details of the research methods should preferably be described in the legend instead of in the text. The same data should not be presented in both table and graph form or repeated in the text.

Figure legends should be typed in numerical order. Graphics should be prepared using applications capable of generating high resolution GIF, TIFF, JPEG or PowerPoint before pasting in the Microsoft Word manuscript file. Tables should be prepared in Microsoft Word. Use Arabic numerals to designate figures and upper case letters for their parts (Fig. 1). Begin each legend with a title and include sufficient description so that the figure is understandable without reading the text of the manuscript. Information given in legends should not be repeated in the text.

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