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- Promote and exchange information and knowledge in the transportation research arena and its application
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EDITOR'S WORD

Dear reader,

You have before you the sixth issue of the "Traffic and transport theory and practice – TTTP" Magazine available online and in printed version.

This sixth issued of the magazine contains seven titles, carefully selected according to strict requirements of renowned editors, for which I am thankful, first to the authors, editors and members of the editorial staff.

We invite our colleagues, experts and researchers to share their knowledge and research in publication of the "Traffic and transport theory and practice - TTTP" Magazine.

Editor-in-Chief
Prof. Danislav Drašković, PhD

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ORIGINAL SCIENTIFIC PAPER

Establishment of a System for the Transport of Goods by Unmanned Aircraft

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Abstract: Delivery of goods by air using unmanned aerial vehicles is one of the many potential applications of unmanned aerial vehicles.

The problem in the operationalization of this type of use of unmanned aircraft is, on the one hand, the limitation in the legal regulations and, on the other hand, the lack of a unified system of control, management and servicing of unmanned aircraft.

The paper describes a model of a unique, integrated system of control, management and servicing of unmanned aircraft that can be logistically supported by an extensive network of small airports in the Republic of Serbia.

The economic profitability of this way of delivering goods is correlated with the real needs of the market with the efficiency and effectiveness of delivery on the principle of "today for today".

Keywords: unmanned aerial vehicle, airport, control, management and service system.

INTRODUCTION

The imperative of the time in which we live is the fast, safe and efficient delivery of goods, this is especially relevant during the pandemic caused by the virus "COVID-19" where people's lives depend on the timely delivery of medicines.

The problem that the aviation authorities of almost all countries of the world are facing today is the safe integration of unmanned aircraft into regular air traffic.

The integration of unmanned aerial vehicles into scheduled air traffic and their potential market success depends on a complex set of technical, economic, political and legal factors. Unlike previous years of aviation, drones do not fly in "empty" airspace [1].

One of the possible methods of safe integration of unmanned aircraft into air traffic is the technical solution that applies it - an air tunnel designed to protect the boundaries of the air corridor intended for the flight of unmanned aircraft [2].

In addition to the above, the flight safety of drones can be improved by applying the system to the drone itself, which is known in the literature as the "Flight Awareness System". This system is designed to semi-automatically (under human supervision) avoid hazards and accidents due to internal or external causal factors [3].

Deliveries of goods to drones and their further distribution using commercial airports are not adequate due to the size of commercial aircraft and the airport infrastructure itself, which would be very difficult to adapt to the needs and requirements for servicing drones and significantly condition time constraints for other air traffic.

The development of a network of small sports airports that would be in the function of a single system of control, management and servicing of unmanned aircraft would enable more efficient, economical and effective integration of unmanned aircraft into air traffic.

In a single integrated system of control, management and servicing of unmanned aircraft, in addition to human and material resources, processes that enable the safe integration of unmanned aircraft into a single air traffic system play a significant role.

In the further work, the process performance in a unique integrated system of control, management and servicing of unmanned aircraft will be discussed.

METHOD

In order to better understand the performance of the process, we will briefly look at the very definition of the process. There are several definitions of the term "process", some of which are:

The process can be defined as "a set of interconnected activities, which convert inputs into outputs" [4].

A process is a set of interconnected or interacting activities that converts input elements into output [5].

An activity or group of activities that use resources and have a management that enables the transformation of input elements into output elements can be considered a process [6].

Each process has a performance that allows the establishment of an efficient system, and is reflected through the categories of performance [7].

Quality in the delivery of products / services is ensured by certification of human and material resources, one of the possibilities for transporting goods is the use of unmanned aircraft "Black Swan" which can transport payloads up to 350 kg and can fly 2500 km in one flight [8].

Speed in the delivery of goods on the principle of "today for today" is achieved by establishing a single information system that would have the function of collecting and processing requests and distribution of goods with continuous control of mission execution.

Reliability is achieved by linking all elements of the system into a single information system.

The flexibility of the system is reflected in the possibility of flight derailment due to the meteorological situation or other extraordinary circumstances.

The price / cost in relation to other types of air transport is significantly reduced due to the flight in the free flight layer.

For the successful implementation of a unified system of control, management and servicing of unmanned aircraft, it is necessary to develop an information system whose purpose would be to use it in the airport operations center and to facilitate access to information relevant to traffic. This information system considers five main processes:

1. Airport certification process;
2. Airport monitoring process;
3. Information forwarding process;
4. The process of legal and financial operations and
5. The process of flight monitoring and dispatch / acceptance of goods.

In the further work, the system will be decomposed by describing the hierarchy of data flow diagrams. A diagram at the highest level of the hierarchy is called a context diagram, and it actually represents the entire information system [9].

The context diagram contains:

One process (information system for control, management and servicing of drones)

Five external facilities (airports, civil aviation directorate, Ministry of Civil Engineering, Transport and Infrastructure, air traffic control service and drone operators)

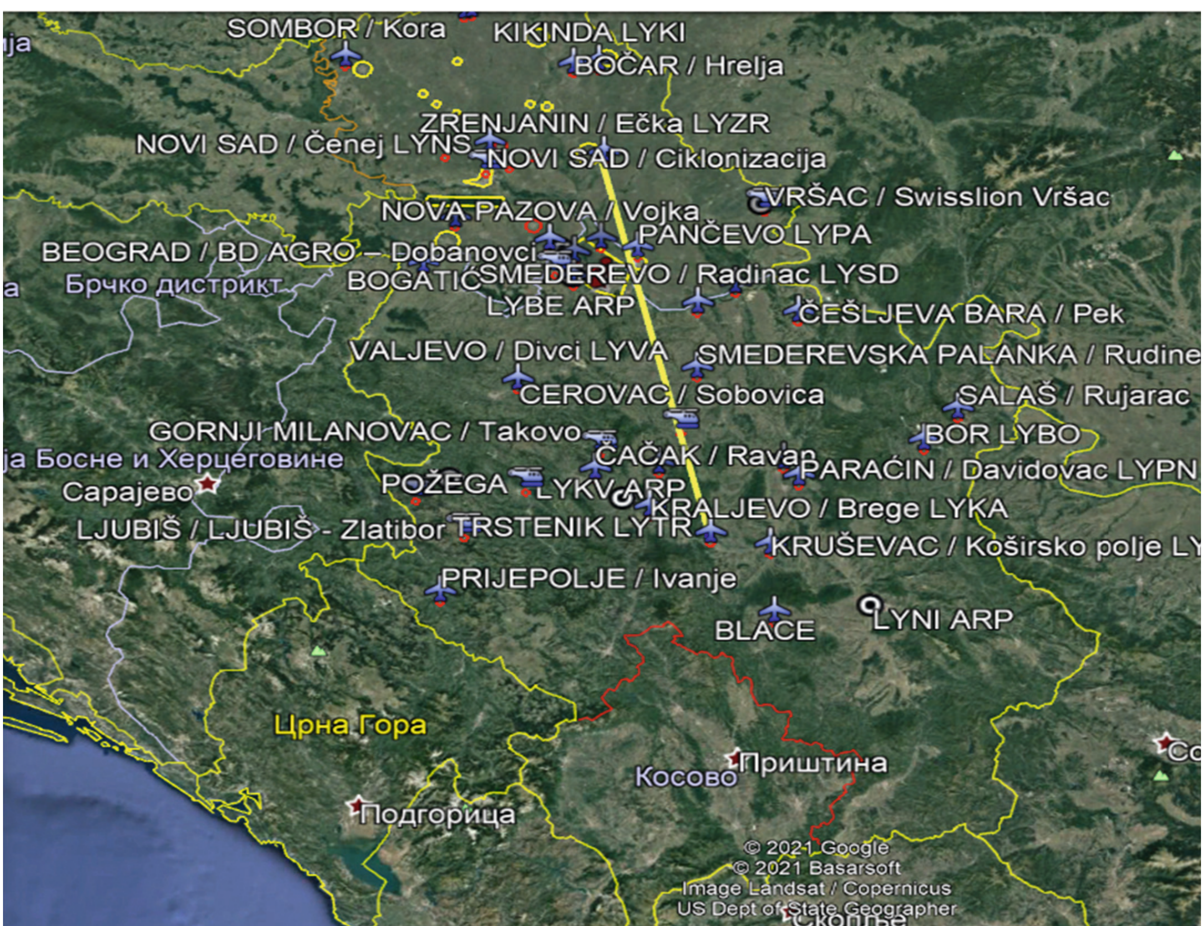

Figure 1. Overview of airport networks in the Republic of Serbia

Data flows (between these five external objects and processes)

The first level diagram contains:

Five processes (1. request for information on traffic conditions at the airport, 2. request for information on the condition of the airport, 3. request of drone operators for the use of the airport, 4. legal business and 5. legal business)

Five external facilities (airports, civil aviation directorate, Ministry of Civil Engineering, Transport and Infrastructure, air traffic control service and airline)

Data flows (between external objects and processes)

In the further work, the network of airports in the Republic of Serbia and the possibility of transporting goods by unmanned aircraft from the airport "Ečka" near Zrenjanin to the airport "Odžaci" near Trstenik will be presented.

ANALYSIS OF TRANSPORT OF GOODS

Figure 1 shows the airport network in the Republic of Serbia. The distance from the airport "Ečka" near Zrenjanin to the airport "Odžaci" near Trstenik by air is 196 km, taking into account the characteristics of the unmanned aircraft "Black Swan" flight time would be about 30 minutes, and the maximum weight of the goods would be 350 kg.

If the goods were transported by land, the duration of transportation would be about 2 hours and 30 minutes. The operating costs of transporting goods by land would be around 250€, while the operating costs of transporting goods by air would be around 150€.

CONCLUSION

The performed analysis indicates that the use of unmanned aircraft in a single, integrated system of control, management and servicing of unmanned aircraft can achieve higher profits, faster delivery of goods and at the same time ensure safe flight with minimal risk to other air traffic.

This paper should provide the basis for the development of regulations in the field of drone flight management, on the one hand and on the other hand to provide the basis for the development of a system of safe, efficient and efficient transport of goods by air.

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PROFESSIONAL PAPER

Analysis of the Impact of no Passing Zones on Fuel Costs

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Abstract: The primary task of traffic and transportation planning is to improve the conditions of traffic and level of service on the entire road network. On three sections, which were analyzed in this paper, the possibility of reducing the precentage of no passing zones was noticed, by changing the horizontal signalization on the segments of road section where the clear visibility for overtaking was determined for one direction of the two-way highway. In the first part of the paper, the analysis of traffic conditions on the existing and on the newly designed variants of all three observed road sections was performed. Analysis of the level of service on the intersections that are part of this research are done in chapter 2. Increasing the speed on the newly designed section results in a reduced travel time and this leads to savings in fuel costs as shown in chapter 3. Traffic forecast for the planning 2029 is done in chapter 4, the forecasted traffic load implies future traffic volumes for which adequate capacities of the road network need to be provided. Chapter 5 is based on determination of the relationship between the benefits brought by the newly designed variant and the costs that are realized during its construction. The results of this analysis were used as input data for the economic evaluation of the project solutions, where the savings in fuel costs were analyzed.

Keywords: no passing zone, horizontal signalization, fuel costs.

INTRODUCTION

The roads that are the most common elements of the road network of every country, including Serbia are the roads that consist of two lanes, which are also traffic lanes, which are not physically separated and are intended for the movement of vehicles from opposite directions. Due to the role and character standard categories of vehicles are represented in the traffic flow, where, in addition to passenger cars, trucks, buses and recreational vehicles are also represented, whose technical characteristics differ from each other. The consequence of this is the need to overtake a slower vehicle, which is one of the most dangerous and demanding actions while driving. The main difference between the overtaking maneuver relation to other roads (freeway and multi-lane highway) is that the vehicles cross the traffic lane when overtaking, which is intended for the movement of vehicles from the opposite direction. Therefore, the basic parameter for the analysis of traffic conditions and service levels on this kind of roads is the possibility of overtaking and reducing the driving time in the column behind slower vehicles. [1]

The subject of research in this paper is to examine the impact of no passing zones on the basic indicators of the level of service of roads Ruma - Irig, Aljinovići - Sjenica and Krst - Zavlaka. After calculating the passing visibility in individual curves, the engineers determined that there are segments of these sections, which are marked as no passing zones, and on which there is optimal passing visibility for safe execution of passing maneuvers in one direction of the observed road. The traffic solution for this problem is to change the horizontal signalization on those segments.

The main goal of this part of the paper is to check whether the newly designed variant solutions will lead to the improvement of traffic conditions on the observed sections, and at the same time the results of this analysis served as input data for the second part of the paper. In the first part of the paper, a capacitive analysis and analysis of the service level of the observed stock variants were performed. Third chapter gives fuel cost analysis, while fourth chapter analyses traffic volume in 2029. Fifth chapter analyses costs of implementation of simple solution. Results showed what could brings savings in fuel costs, which bring with them newly designed solutions.

ANALYSIS OF LEVEL OF SERVICE THE OBSERVED SECTION

Existing and newly designed variant of the section of road Ruma – Irig

Determination of key parameters for the analysis of the level of service was done according to the HCM 2000 methodology (Highway Capacity Manual) using HCS software (Highway Capacity Software) which was developed according to the HCM 2000 methodology. [2] Due to the specifics issues in this paper, the method of analysis of each direction was separately used.

The paper used data on average annual daily traffic (AADT) on the observed sections of roads Ruma - Irig, Aljinovići - Sjenica and Krst - Zavlaka, which were taken from the website of the Public Enterprise “Roads of Serbia” These data represent the basis for determining the relevant traffic load.

Due to the impossibility of field measurements of certain parameters required for the analysis of the service level, their recommended values were adopted:

- Base free flow speed BFFS = 80 km / h
- Peak hour factor PHF = 0.88
- Flow distribution in directions d = 60/40
- Percentage of recreational vehicles RV = 0%
- Qm = 12% AADT

Figure 1. Separate segment of the existing variant of the section Ruma- Irig, where it is possible to change the horizontal signalization

From this road route, 1 km of the section Ruma - Irig was singled out, which is specific for the analysis of the issues in this paper (Figure 1). The width of the road on the section Ruma - Irig is 6.5 m. The width of the traffic lane is 3.25 m and the width of the free side space is 1.5 m. On the analyzed section of the section, there are two access points per kilometer, through which vehicles from other roads are connected to the analyzed road. The road stretches across the plain terrain. [4]

On the existing variant of the observed part of the section of the road Ruma - Irig, there is a large representation of no passing zones. The length of the unbroken line, which separates the directions of the observed section and marks no passing zone, is 731 m, which is 73% of the length of the road.

Based on the obtained results gained with the help of HCS software , it is concluded that the level of service on the existing variant of the observed road section is LOS = E. The ratio of flow rate and capacity is V / C = 0.5 in direction A and V / C = 0.33 in direction B.

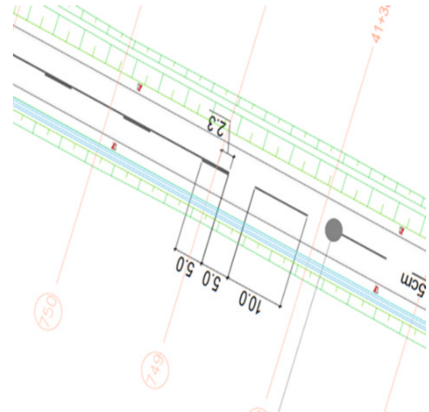

Figure 2. Expert proposal for modification of the horizontal signalization on the selected segment of the section from the previous figure

Based on the graphic documentation of the newly designed variant of the section Ruma - Irig (drawing from AutoCad), with the changed horizontal signalization, a new calculation of the percentage of no passing zones was performed. The length of the uninterrupted line marking no passing zones, for direction A is 471 m, which is 47% of the length of the observed section, while for the opposite direction B is 546 m, or 55% of the length of the observed section.

After obtained results gained with the help of HCS software it is concluded that the level of service on the newly designed road variant remains LOS = E (in both directions). The percentage of time spent following the slower vehicle decreased by 4.1% in direction A and in direction B it decreased by 1.5%.

Existing and newly designed variant of the section of the road Aljinovići - Sjenica

Figure 3. Segment of the existing variant of the section Aljinovići – Sjenica

The observed section extends over hilly terrain. The width of the traffic lane is 3.25 m and the width of the free side space is 1.5 m. One access point per kilometer appears on the analyzed section of the section. In the structure of traffic flow on the observed section, the share of trucks is 12%. The average annual daily traffic is only 878 vehicles per day. The relevant traffic load is 106 pa/ h in both directions. It was adopted that the distribution of traffic flow in the directions is 60/40, so the traffic load in the A direction is 64 pc/ h, and in the less loaded direction 42 pa/ h.

On the existing variant of this section, the length of the continuous line marking of no passing zone is 1638 m, which is 91% of the length of the observed section.

After obtained results gained with the help of HCS software it is concluded that the level of service on the existing variant of the observed road section is LOS = C. The ratio of flow rate and capacity is V / C = 0.04 in direction A, and V / C = 0.05 in direction B .

In the continuation of the chapter, the results of the parameters ATS and PTSF on the modified variant of the section Aljinovići - Sjenica are presented, where the percentage of zones with overtaking is reduced, by designing a double combined dividing line shown in Figure 4. marked in red.

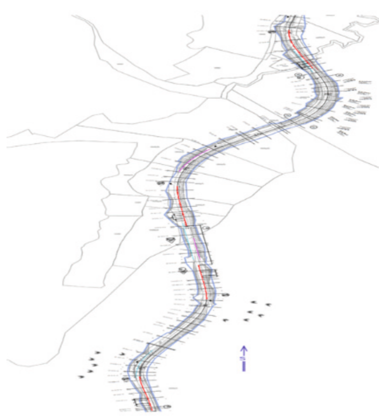

Figure 4. Modified horizontal signalization on the newly designed variant of the section Aljinović – Sjenica

In Figure 4 is shown newly designed variant of the section where the percentage of no passing zones is reduced, by designing a double combined dividing line shown in Figure 4. marked in red.

The new values of no passing zone percentage for individual directions are:

- np A = 78%
- np B = 73%

After obtained results gained with the help of HCS software, it is concluded that the service level on the newly designed road variant remains LOS = C (in both directions). The percentage of time spent following the slower vehicle decreased by 6.5% in direction A and in direction B it decreased by 7.6%.

Analysis of the section Krst – Zavlaka

The last section analyzed in this paper is the section of Krst – Zavlaka. From this road route, 1 km of section was also allocated, which is specific for the analysis of the issues addressed in this paper.

The observed section extends over hilly terrain. The width of the traffic lane is 3.25 m and the width of the free side space is 1 m. One access point per kilometer appears on the analyzed section of the section. In the total structure of traffic flow on the observed section, the share of trucks is 7%. The average annual daily traffic on the section Krst - Zavlaka is 3774 vehicles per day. The relevant traffic load is 453 pc / h in both directions. It was adopted that the distribution of traffic flow in the directions is 60/40, so that the traffic load in one direction is 272 pc/ h, and in the opposite, less loaded direction is 181 pc/ h.

On the existing variant of the observed section of Krst - Zavlaka, the length of the uninterrupted line, which marks the zone of prohibition of overtaking vehicles, is 760 m, which is 76% of the length of the observed section.

Figure 5. Road direction Krst-Zavlaka

Based on the obtained results in HC software, it is concluded that the level of service on the existing variant of the observed road section is LOS = E. The ratio of flow and capacity is V / C = 0.22 in direction A, and V / C = 0.14 in direction B.

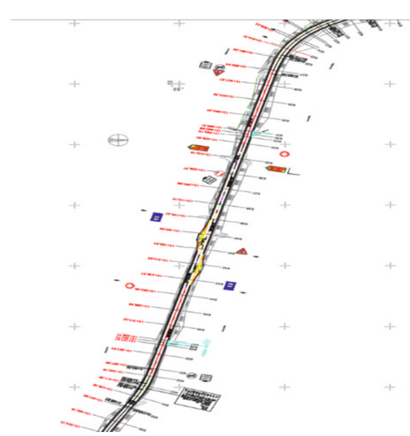

Figure 6. Modified horizontal signalization on the newly designed variant of the section

The new values of the overtaking prohibition zone percentage for individual directions are:

- np A = 63%
- np B = 63%

Based on the obtained results, it is concluded that the service level of the newly designed variant of the observed road section was improved to LOS = D in direction B, while in direction A it remained at level E. The percentage of time spent following a slower vehicle was reduced by direction A by 2, 8%, and for direction B it was reduced by 2.4%.

FUEL COST ANALYSIS IN 2019

Based on the results of the capacitive analysis, changes in the average vehicle speeds on existing and newly designed variants road sections were observed. Increasing the speed of vehicles on newly designed variants of sections results in a reduction in travel time, which entails savings in fuel costs. The length of the section adopted for the calculation of fuel cost savings on the newly designed variant variants in relation to the existing ones is 10 km. For each section, the vehicle travel time was calculated on the existing and newly designed variants of the section, in order to determine the time losses expressed in seconds per vehicle. The form used to calculate fuel cost savings is as follows:

$$\Delta Ti=(\Delta t/3600*AADTi*365)*Pgi*Cg$$

ΔTi - vehicle category fuel cost savings expressed in € / year
Δt - time losses
Pgi - average fuel consumption of a certain category of vehicle expressed in l / h
Cg - unit price of fuel expressed in € / l

For the calculation of the total fuel costs in 2019, the fuel consumption for individual categories of vehicles that appear on the observed section was analyzed. In the calculation of fuel costs, the fuel consumption values of individual vehicle categories were used, converted into values expressed in liters per hour.

The results of the capacitive analysis of the section of the road Ruma - Irig showed that the average driving speed on the existing variant of the section in direction A VPA = 56.1 km / h, while on the newly designed variant the speed was increased to VNA = 56.9 km / h. In direction B the speed was also increased from VPB = 54.8 km / h to VNB = 55.5 km / h. By including these speeds in the calculation of vehicle travel time on both section variants (length 10 km), savings (Δt) of 9 seconds per vehicle in direction A and 8 seconds per vehicle in direction B on the newly designed variant were achieved. How are these time savings the travel of individual vehicles affected the savings in total fuel costs.

Based on the results it can be noticed that on the newly designed variant of the section Ruma- Irig, savings in fuel consumption of 61,138 l / year were achieved. Multiplying by an average unit fuel price of € 0.97 / l), results in fuel cost savings of approximately **€ 60,000 / year.**

According to the same methodology, the calculation of fuel costs on the section Aljinovići - Sjenica was performed. Based on the results of the capacitive analysis (Chapter 3), small changes in vehicle speeds were observed on the existing and newly designed variant of the section Aljinovići - Sjenica. The average travel speed on the existing variant of the section in direction A is VPA = 70.1 km / h, while on the newly designed variant the speed is increased to VNA = 70.2 km / h. In direction B, the speed is increased from VPB = 70.1 km / h to VNB = 70.4 km / h. This change in the average speed of the vehicle results in savings in travel time of 1 second per vehicle in direction A, and 3 seconds per vehicle in direction B.

Based on the results it can be noticed that on the newly designed variant of the section Aljinovići-Sjenica, savings in fuel consumption in the amount of 909.6 l / year were achieved. Multiplying by the average unit price of fuel of 0.97 € / l, you get savings of about **1,000 € / year.**

Also, the calculation, according to the same methodology, obtained the total savings in fuel costs, on the newly designed variant of the section Krst - Zavlaka, in 2019. The average travel speed on the existing variant of the section Krst - Zavlaka in direction A is VPA = 61.5 km / h, while on the newly designed variant the speed has been increased to VNA = 62 km / h. In direction B, the speed is increased from VPB = 60.6 km / h to VNB = 61.2 km / h. The reduction of the average speed of the vehicle on the newly designed variant of the observed section also conditioned the reduction of the travel time of the vehicle, namely 4 seconds per vehicle in direction A and 6 seconds per vehicle in direction B.

Results shows that on the newly designed variant of the section Krst - Zavlaka, savings in fuel consumption in the amount of 10,296 l / year were achieved. Multiplying by the average unit price of fuel of € 0.97 / l, you get savings in fuel costs, worth **€ 10,000 in 2019.**

Based on the results of the analysis of fuel costs on all three sections, it can be seen that the reduction of the percentage of overtaking zones on the newly designed variants of shares would affect the reduction of fuel costs in the base year 2019. The next task is to determine the amount of money that would be saved on the newly designed variants of shares in relation to the existing variants of shares, in the next ten-year period of exploitation, more precisely in the period from 2019 to 2029. To analyze the costs of vehicle operation in the future, it is necessary to first forecast future traffic loads on the observed sections.

TRAFFIC FORECAST FOR THE PLANNING 2029

Traffic load is the number of vehicles that pass or are expected to pass through a certain road section in a certain time interval. From the aspect of analysis and evaluation of traffic projects, data on the existing traffic load on the observed road sections are necessary, as well as data on the future condition of the road network. Existing traffic loads on the road network are easily obtained by counting the traffic on the field. Data on the average annual daily traffic and categorization of traffic on the roads of the first and second order in the Republic of Serbia are obtained with the help of automatic meters that are distributed on the road network throughout Serbia. The forecasted traffic load implies future traffic volumes for which adequate capacities of the road network need to be provided. The main problem of forecasting the future situation is that there are a large number of factors that affect the forecast (demography, country development policy, spatial planning, construction, increase production and consumption, transport policy of the state and so on), which makes traffic forecasting complex and risky procedures. The representation of trucks on the road network is, for example, directly related to production and consumption in a given area. Public transport vehicles for passenger transport mostly depend on the number of inhabitants, the purpose of land areas, the purpose of travel and the level of income of the population [5].

General form for traffic forecast.

AADTi = AADTBAZ * FRi

AADTi- average annual daily traffic in the planning year
AADTBAZ- average annual daily traffic in the base year
FRi- traffic growth factor in the observed time period

There are various methods for forecasting the future state of traffic. One of them is the growth rate method, which is a relatively simple forecasting method, and which was applied in this paper to forecast traffic load in the next 10 years, on the observed sections. The growth rate is calculated according to

$$i = \left[\sqrt[n]{\frac{AADT_n}{AADT_{BAZ}}} - 1 \right] * 100$$

Where n is the number of years for which the degree of traffic growth is determined.

The traffic growth factor in the observed time period was obtained on the basis of next equation

$$F_R = [1 + \frac{i}{100}]^n$$

Based on the obtained values of average traffic growth factors on the observed sections in the period from 2015 to 2019, and assuming that such traffic growth trend will continue in the next ten years AADT values were predicted based on a pattern based on the formula above.

The forecasted values of AADT on the observed sections, in 2029, are given in Table 1

Table 1. Average annual daily vehicle traffic on the observed sections, in the planned 2029

Sections	Ruma – Irig	Aljinovići – Sjenica	Krst – Zavlaka
AADT2019 [veh/day]	10.130	878	3.774
AADT2029 [veh/day]	12.504	1.386	5.021

Based on the data from Table 1. it is concluded that in the planned year 2029, there was an increase in the load on all observed sections, which also affects the change in the conditions of vehicle movement on those sections. In order to obtain the most representative results of the analysis of fuel costs on the observed sections in the planned ten-year exploitation period of the sections, a new analysis of the parameters (with the help of HCS software) was performed, with data for 2029. The paper presents only data on new average vehicle speeds on existing and newly designed variants of the observed sections, because these data are necessary for further calculation of vehicle operating costs in 2029.

Based on the results it can be noticed that on the newly designed variant of the Ruma - Irig section, savings in fuel consumption in the amount of 61,938 l / year were achieved. Multiplying by a unit fuel price of € 0.97 / l results in fuel cost savings of € 60,100 in 2029. Comparing these results with the results of the cost analysis in the base year 2019, it is concluded that on average, € 60,000 can be saved annually on the Ruma - Irig section. For the planned exploitation period of ten years, **€ 600,000** would be saved on the Ruma - Irig section by implementing the newly designed solution of the section.

Variant of the section Aljinovići - Sjenica, savings in fuel consumption in the amount of 1,748 l / year were achieved. Multiplying by a unit fuel price of € 0.97 / l results in fuel cost savings of € 1,700 in 2029. Comparing these results with the results of cost analysis in the base year 2019, it is concluded that an average of € 1,400 can be saved per year on the observed share. For the planned period of exploitation of ten years, on the section Aljinovići - Sjenica, **€ 14,000** would be saved, by implementing the newly designed solution of the section.

Based on the results. it can be noticed that on the newly designed variant of the section Krst - Zavlaka, savings in fuel consumption in the amount of 16,546 l / year were achieved. Multiplying by a unit price of fuel of € 0.97 / l will result in savings in fuel costs of € 16,100 in 2029. Comparing these results with the results of the cost analysis in the base year 2019, it is concluded that an average of € 13,100 can be saved annually on the section Krst - Zavlaka. For the planned exploitation period of ten years, **€ 131,000** would be saved on the Krst - Zavlaka section, by implementing the newly designed solution of the section.

COSTS OF REALIZATION OF NEWLY DESIGNED VARIANTS

When designing new variants of road network sections, it is necessary to determine the relationship between the benefits brought by the newly designed variant and the costs that are realized during its construction. Practice has shown that in order to improve the quality of traffic conditions on the road network, it is often necessary to build new or reconstruct existing parts of the road network, carrying out construction works that require high costs (replacement of road construction, change of road geometry, reconstruction of intersections, construction of bridges and tunnels). similar to).

The newly designed variant solutions of the observed sections of Ruma - Irig, Aljinovići - Sjenica and Krst - Zavlaka provide the possibility of improving the quality of traffic conditions with the performance of small-scale works. The new stock variants only involve changing the horizontal signaling on certain segments of the stock. The existing geometry of the road sections remains unchanged thus avoiding high construction costs. Modification of the horizontal signalization implies the construction of a dashed dividing line 5 + 10 m (width 0.15 m) along an unbroken line, which gives a combined double dividing line, as shown in Figure 7.

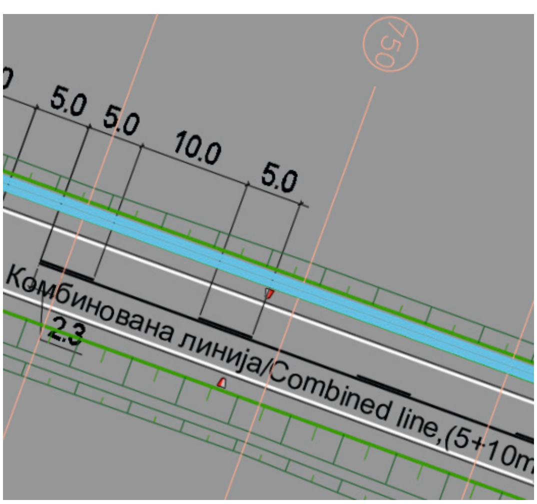

Figure 6. Combined double dividing line

Works on the change of horizontal signalization are performed as part of regular maintenance and protection of roads. The method of calculating the costs of making horizontal signalization, which was used in this paper, is based on the unit price of works and the unit price of materials per meter of road. According to the "Price list of works on regular road maintenance" issued by the PE "Roads of Serbia", the price of construction of central and edge lines on the road is 7.31 dinars per meter. This price includes the transport of paint, thinner and laundry, then the machine for marking the horizontal signalization as well as the price of transporting workers from the point to the marking, paint preparation and marking the line itself [2]. The unit price of the material used to make road markings depends on the type of material used. Markings can be made with paint, hot and cold plastic, application tapes, wedges and markers. For a broken line (5 + 10m) 0.15m wide, a unit price of 22.24 dinars per meter was adopted.

The length of the dashed line (5 + 10m) that needs to be marked on the section Ruma - Irig 10km long, according to the project solution, is 4,350 m. The costs of changing the horizontal signalization on this section are:

T = 4,350m * 7.31 dinars / m + 4,350m * 22.24 dinars / m ≈ **130,000 dinars**

On the section Aljinović - Sjenica it is necessary to mark 1,650m with a dashed line 5 + 10m. The costs of changing the horizontal signalization on the newly designed variant of this section are:

T = 1,650m * 7.31 dinars / m + 1,650m * 22.24 dinars / m ≈ **50,000 dinars**

On the section Krst - Zavlaka, it is necessary to change the horizontal signalization by marking the dashed line 5 + 10m on the length of 2,650m. The costs incurred due to the change of the horizontal line on the newly designed variant of the section Krst-Zavlaka are:

T = 2,650m * 7.31 din / m + 2,650m * 22.24 din / m ≈ **80,000 dinars**

The total cost of changing the horizontal signalization, which occurs on all three sections that are analyzed in this paper, is about € 2,200.

CONCLUSION

In the first part of the paper, a capacitive analysis and analysis of the service level of the observed stock variants were performed. The task of this part of the paper was to check whether the newly designed variant solutions will lead to the improvement of traffic conditions on the observed sections, and at the same time the results of this analysis served as input data for the second part of the work stock.

The section Ruma - Irig is part of the state road IB order, number 21, which connects Novi Sad and Belgrade with tourist destinations in Western Serbia, so it is very busy. The relevant traffic load in 2019 was 1216 pc/ h. On the existing variant of the section, the percentage no passing zone is 73%, while on the newly designed variant this percentage is reduced to 47% in the direction of Ruma-Irig and to 55% in the opposite direction. The results of the capacitive analysis showed that on the newly designed variant of the section, the percentage of time that vehicles spend in convoy driving was reduced by 4.1% in the Ruma-Irig direction and 1.5% in the opposite direction.

Section Aljinovići - Sjenica is lightly loaded, the average annual daily traffic in 2019 was 878 pc / day, or 106 pc/ h. In the observed section of the section, the percentage of no passing zones is prohibited is 91% of the section. With the proposal to change the horizontal signalization, this percentage of zones was reduced to 78% in the direction Aljinović-Sjenica, and 73% in the direction Sjenica-Aljinović. This measure resulted in a decrease in PTSD by 6.5% in one direction and 7.6% in the other.

One kilometer was also set aside from the section Krst - Zavlaka for the analysis of traffic conditions. On this section, an average of 453 pc/ h pass. Overtaking slower vehicles is prohibited at 76% of the length of the analyzed section of the section. With the newly designed variant solution, this percentage would be reduced by 2.8% in the direction of Krst-Zavlaka and 2.4% in the opposite direction.

On the Ruma - Irig section, the average travel speed was increased from 56.1 km/h on the existing variant to 56.9 km / h in the Ruma-Irig direction, and from 54.8 km/h to 55.5 km/h in the opposite direction. The savings in fuel costs that would result from increasing the speed of the vehicle amount to € 60,000 / year on the section Ruma - Irig. Fuel costs of all vehicle categories on the section Aljinovići -Sjenica are significantly lower than the costs on the section Irig - Ruma, which is a consequence of lower traffic load. The savings that would be made on this section, by increasing the possibility of overtaking vehicles, amount to about 1000 €/year. On the last section analyzed in this paper, an increase in speed from 61.5 km/h to 62 km/h in the direction Krst- Zavlaka and from 60.6 km/h to 61.2 km/h in the direction Zavlaka ka Krst was observed. These changes in speeds resulted in savings in total fuel costs of € 10,000/year.

The degree of motorization in Serbia is growing from year to year, which causes the appearance of a larger number of vehicles on roads across the country. Increasing the flow requirement negatively affects the speed of the vehicle, and thus the travel time of the vehicle. In the planned 2029, the traffic load on all three observed sections will be higher compared to the base year 2019, which would affect the change of conditions prevailing on the observed sections, which is why a new capacitive analysis was performed with data for 2029 and determined are the new values of vehicle speeds.

The results showed that due to the increased load on the roads, the speed of vehicles decreased compared to the base year 2019. Savings in fuel costs, which would occur on the section Ruma-Irig, in 2029, amount to 60,100 € / year, on the section Aljinovići - Sjenica 1,700 € / year and on the section Krst-Zavlaka 16,100e.

Finally, by adopting the average annual savings in fuel costs on the newly designed share variants, a savings of around € 745,000 in the ten-year exploitation period on all three observed shares are obtained. The obtained results are relative, but essentially prove that on all three observed sections there would be savings in fuel costs that are incomparably higher than the costs of project solutions. Newly designed variant solutions of observed sections Ruma - Irig, Aljinovići - Sjenica and Krst -Zavlaka offer the possibility of saving in fuel costs, and their implementation is possible with the performance of small-scale works and with small financial investments.

The results of this research can serve as an initiative for further, more detailed research on this issue on the road network of Serbia. The road network of Serbia consists of 16,844,287 km of state roads of the first and second order.. The paper analyzes only 3 sections on the territory of Serbia, and it was determined that in the next ten-year period, savings in fuel costs of € 754,000 could be brought about by the implementation of newly designed solutions. On the entire road network of Serbia, there are certainly other sections with the same problem described in this paper, so the savings in fuel costs, which bring with them the newly designed solutions, would be many times greater for society as a whole.

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PROFESSIONAL PAPER

The Impact on Mobile Phone use on Pedestrian Road Crossing Behaviour

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Abstract: Mobile phone use at pedestrian crossings has been recognized as a growing problem in the field of traffic safety. The objective of the paper is to analyze the impact of mobile phone use at pedestrian crossings considering specific territory. Signalized and unsignalized intersections are observed in the study. Several factors having the impact on unsafe pedestrian crossing behaviour are identified such as: age, location and the type of mobile phone using. The model of unsafe pedestrian behaviour based on displayed mobile phone use while crossing the intersection is constructed. It has been shown in this research that talking and texting on mobile phone distract pedestrians. Listening to music does not affect pedestrians to behave unsafely because it requires less cognitive activity than talking or texting. Also, location affects the pedestrian crossing behavior. The results of this research can serve the purpose of preventing the mobile phones use and reduce the negative impact on pedestrian crossing behavior.

Keywords: mobile phone use, pedestrian crossing, unsafe behaviour.

INTRODUCTION

The number of mobile phones is increasing, both in everyday use and in traffic, therefore it is unsurprising that the prevalence of pedestrian distraction by handheld technologies devices appears to be increasing. Nowadays, more than half of drivers use mobile phone as one of the most ubiquitous devices while driving. Besides motorists and cyclists, cell phones are increasingly used by pedestrians, which poses a significant traffic risk. At the same time, public concern is growing about their potential negative impact on traffic safety. At some point in the day, everyone is a pedestrian, and unfortunately pedestrian fatalities remain high. Pedestrian distraction is becoming a growing road safety concern worldwide and a great deal of research has been addressed to the impact of mobile phone use while driving or crossing the street.

Pedestrians' mobile phone use behaviour while crossing is a multi-tasking activity because it requires them to complete two tasks simultaneously resulting in walking errors. First, to observe the surrounding traffic environment carefully such as vehicles, traffic signs and signals. Second, pedestrians are compelled to pay visual, auditory and cognitive attention to check and operate their mobile phones to keep in touch with their social circle.

The aim of this study is to determine the percentage of pedestrian's mobile phone use at signalized and unsignalized intersections and to determine the impact of mobile phone use on pedestrian crossing behavior aiming to prevent its negative impact. The independent variables are defined in order to determine the output model of unsafe pedestrian behaviour. The rest of the paper is organized as follows. A brief review on related work is presented in second section. Third section provides the methodology used for obtaining the results. Results are presented and discussed in fourth section while fifth section concludes the paper.

RELATED WORK

So far, there is a significant number of studies considering mobile phone use and crashes among pedestrians. Crossing or walking along roads makes a minor part or total walking but presents the highest risk because of the potential interaction with motor vehicles. Mobile phone use among pedestrians leads to increased cognitive, physical, visual and auditory distraction, reduced situation awareness and increased unsafe traffic behaviour (Hatfield and Murphy, 2007; Neider et al., 2010; Lamberg and Muratori, 2012; Schwebel et al., 2012). The study in Russo et al., 2018 showed that talking or texting on a smartphone may not be significantly associated with walking speed, but pedestrians who were texting were more likely to commit crosswalk violations. Compared to the pedestrians that were not using mobile phones while crossing, pedestrians distracted by mobile phones are shown to walk more slowly (Schabrun et al., 2014), change directions more often (Hyman et al., 2010), take longer and miss safe opportunities to cross (Byington and Schwebel, 2013) and usually make more errors (Pešić et al., 2016).

The study conducted by Lennon et al., 2017 demonstrated that attitudes and norms strongly influence pedestrian intentions to use a smart phone while crossing, particularly for younger pedestrians. Compared to non-smartphone users, the pattern of critical events was different for smartphone users as shown in Horberry et al., 2019. In order to suggest solutions for pedestrian distraction, Larue et al., 2020 analysed whether distracted pedestrians were able to detect the activation of lights as a warning. It has been shown that pedestrians are able to detect the activation of LED lights while performing a distraction task on their smartphone and that lights can be detected without the need to look directly at them. It should be included in the future studies and research.

Therefore, as pedestrians make the largest group of road users, their distraction due to mobile phone use is getting more attention and requires solving the problem. It is not possible to simply expect pedestrian to never become distracted. The results of this work will offer a profile and attitudes of pedestrians who use mobile phone and to better understand the incidence and severity of pedestrian mobile phone distraction. It will be one step toward and input to develop strategies and other countermeasures that minimize the impact of distraction on road safety, rather than attempt to eliminate it al together.

METHODOLOGY

Procedure

In order to obtain the model of unsafe pedestrian behaviour the observation method was used in this research. Four observers participated, each of them with defined task. The observers were so located that they could determine and enter into the survey form all those basic features of significance for the research. They noted the pedestrian crossing behaviour in both directions and recorded the total number of pedestrians and those who used mobile phones. The manner of using mobile phone was related to texting, talking or listening to the music and if any of these was used by pedestrian while crossing, the behaviour was assumed to be unsafe. The behaviour of pedestrians who used mobile phones was classified into two categories: those who pay attention at traffic or traffic lights before crossing (traffic environment) and those who did not. Crossing types were treated separately for most analyses because behaviours have differential relevance at signalized versus unsignalized crossings. A logistic regression was used to define the model of unsafe behaviour as the outcome. Logistic regression allows testing the models to predict categorical outcomes with two or more categories.

Participants

The research was conducted in Republic of Srpska (entity of Bosnia and Herzegovina). Data were collected in six locations in the city of Doboj, Republic of Srpska. Three signalized and three unsignalized intersections were selected based on their most common type (four-leg intersections with one traffic lane in each direction) and reasonably heavy pedestrian traffic (see Figure 1). During the period of research, the behaviour of 10280 pedestrians was recorded. 753 pedestrians used mobile phones. Speed limit at these locations is general speed limit in urban areas in Republic of Srpska, 50 km/h (Law on Road Safety).

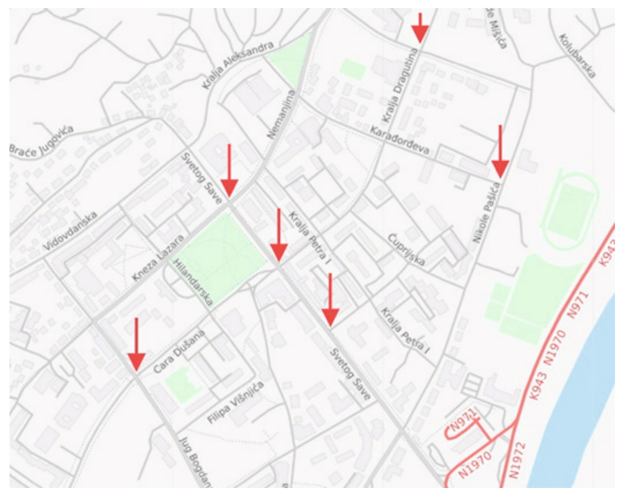

Figure 1. The considered research locations

According to this law, both drivers and pedestrians have some obligations related to crossings and there is a predicted penalty for using mobile phones while crossing. The observation was carried out on a daily basis, on workdays (Tuesday and Thursday) in December, during one-hour period of the day- morning and afternoon. The pedestrians' age was estimated and classified into several different age groups (< 20, 21-30, 31–50, > 50). The structure of the sample is given in Table 1. The variables chosen to be independent are: age, gender, the location of intersection and the manner of using mobile phone.

Table 1. The structure of the sample

	Signalized	Unsignalized
Total number using mobile phone	375	368
Gender	Male- 148 Female- 227	Male- 149 Female- 219
Age	< 20- 164 21-30 - 117 31-50 - 77 > 50 - 17	< 20- 95 21-30 - 112 31-50 - 122 > 50 - 39
Total number of pedestrians observed	5587	4693

Coding and statistical analysis

After the field research was completed, obtained results were entered in the Excel table and processed. Methods of comparative statistical analysis, binary logistic regression using the SPSS 17.0 software, were used for a detailed analysis of results obtained in the field survey. The binary logistic regression was used in order to estimate the influence of several factors on the dependent variable and to predict the outcome variables (unsafe type of behaviour). All independent variables are classified as dichotomous (coded with 0 or 1 in SPSS) except the age variable which has been treated as ordinal. The threshold of the statistical significance has been set up at 5%.

RESULTS AND DISCUSSION

We constructed the model of unsafe pedestrian behaviour based on displayed mobile phone use while crossing the intersection. The model included the following predictor variables: gender, age, the manner of using mobile phone and location of intersection. At the signalized intersections 6.71 % of total pedestrians used mobile phone, while at the unsignalized intersections 7.84 % used mobile phone. At the signalized intersections 64.3 % of pedestrians were texting, 18.4 % were talking and 17.3 % were listening to music. At the unsignalized intersections 48.6 % were texting, 36.1 % were talking and 15.2 % were listening to music (see Figure 2).

The whole model with all the predictors was statistically significant: $\chi 2$ (9, N = 753) = 223.118 (Chi-square), $p < 0.001$. As shown in Table 2, three independent variables made a statistically significant contribution to the model: age, the manner of using mobile phone and the location of intersection.

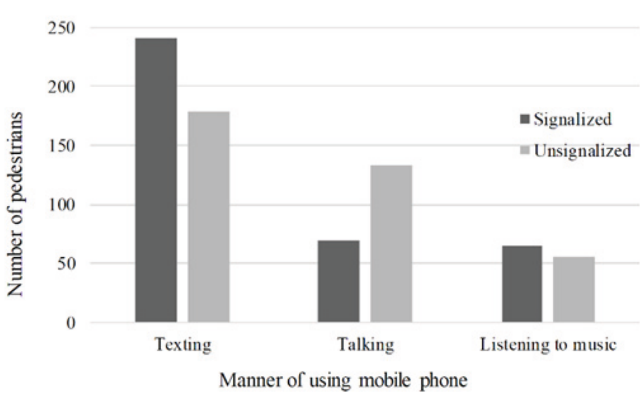

Figure 2. Mobile phone use

The results have shown that gender does not affect pedestrians to behave unsafely (p = 0.167). Pedestrians younger than 20 years have 2.7 times bigger chances to behave unsafely while crossing compared to software reference group (> 50 years) while pedestrians aged 21-30 have 1.7 times bigger changes to behave unsafely. Pedestrians from the age group 31-50 do not have statistically significant greater chances to behave unsafely when compared to the reference age group (p = 0.106). The pedestrians talking on mobile phones while crossing have 2.8 times bigger chances to behave unsafely than those who do not use mobile phones while for pedestrians texting on mobile phones the chance to behave unsafely rise by 2 times. So, it has been shown in this research that talking and texting on mobile phone distract pedestrians. Listening to music does not affect pedestrians to behave unsafely because it requires less cognitive activity than talking or texting. Also, it could be seen from Table 2 that location affects the pedestrian crossing behavior ($p < 0.001$).

Considering location, two types of intersections were investigated in the paper: signalized and unsignalized. The percentage of pedestrians paying or not the attention to the traffic environment depending of the intersection type is given in Table 3. It could be seen that the number of pedestrians not paying attention at traffic environment is higher on signalized intersections (55.5 %) while the number of pedestrians paying attention at traffic environment when using mobile phone is higher on unsignalized intersections (62.2 %). This can be attributed to the fact that pedestrians feel safer and have more freedom to use mobile phones when there are traffic lights while at unsignalized intersections they have to pay more attention at the coming traffic.

Table 2. Odds ratios for predictors of unsafe pedestrian crossing behaviour

	The model of unsafe behaviour
Gender	0.905 (1.795-2.399) p = 0.167
Age	2.733 (2.016- 3.707) p < 0.001
< 20 21-30 31-50	1.718 (1.273- 2.319) p < 0.001 1.276 (0.950- 1.713) p = 0.106
The manner of using mobile phone Texting Talking	2.037 (1.610- 2.579) p < 0.001 2.801 (2.127- 3.688) p < 0.001
Location	2.075 (1.795- 2.399) p < 0.001

Table 3. The percentage of pedestrians paying/not paying attention at the traffic environment

	Signalized	Unsignalized
Total number using mobile phone	375	368
Gender	Male- 148 Female- 227	Male- 149 Female- 219
Age	< 20- 164 21-30 - 117 31-50 - 77 > 50 - 17	< 20- 95 21-30 - 112 31-50 - 122 > 50 - 39
Total number of pedestrians observed	5587	4693

It should be noted that some of the limitations of this research are the number of observers (there were not two observers noting the same data), the number of intersections and the time of research. In some future work more intersections and higher number of observers should be included. Also, the percentage of pedestrians who used mobile phones is recorded in December (cold time) and some future work should include the summertime because this number would be probably higher.

This research gives the answers on factors distracting pedestrians in the city of Doboj as well as the locations where pedestrians behave less or more safely while crossing (pay attention or not to traffic environment). This could be the input data for local government to apply some measures such as LED lighting of pedestrian crossing because conflict zones such as pedestrian crossings require greater attention from traffic participants and therefore better lighting than with traffic routes without the danger of collisions. Also, road safety campaigns could be implemented with target aged groups according to the results (< 20, 21- 30 years). The campaigns should make pedestrians to recognize the risk of using mobile phones while crossing.

At the territory of Republic of Srpska (entity of B&H) a national methodology for measurement and monitoring road safety performance indicators at the territory has been defined. According to this methodology there are 4.4 % of drivers who use mobile phones. However, the methodology does not provide the measurement of pedestrians using mobile phones or other mobile devices. We think these data should be included because drivers and pedestrians are two different categories and the behaviour of both differs when using mobile phones.

CONCLUSION

The decrease in prices and the development of technologies brought a widespread use of mobile phones and its significant impact on pedestrian traffic safety. The negative impact of using mobile phones must be considered and researched separately for drivers and pedestrians because of two different tasks that require visual and cognitive perception. The results of this research can serve the purpose of preventing the mobile phones use and reduce the negative impact on pedestrian crossing behavior.

It has been shown that many pedestrians in the city of Doboj use mobile phones while crossing (about 7 %) and it is intuitively expected that this number should be even higher in the summertime. Texting and talking, pedestrians up to 20 years old as well as 21-30 years are the main factors that are identified to have the impact on unsafe pedestrian behaviour. Also, the type of intersection influences different the pedestrians' attention while crossing and that is why signalized and unsignalized intersections are treated separately.

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PROFESSIONAL PAPER

Comprehensive Approach to Achieving Business Continuity and Sustainable Success of the Transport Organization

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Abstract: Achieving business continuity and sustainable success of the transport organization requires a comprehensive approach that involves the consideration and resolution of a large number of factors that affect its business and arise from the specifics of its activities. Based on the author's experiences, in this paper discusses issues of importance for achieving sustainable success and business continuity of the transport organization in a modern, very complex and dynamic business environment. Coordinated consideration and resolution of all these issues is the essence of an approach that enables the achievement of expected results. As a the most important factors for achieving the organization's ability to achieve sustainable success and business continuity the following factors are highlighted: understanding the context of the organization, the organization's resilience to environmental influences, application of approaches "Risk-based thinking" and "Risk-based management", integration of management systems, continuous improvement and application of international standards for management systems. The application of the described approach is possible, except in transport, in other organizations, taking into account its specifics

Key words: transport, transport organization, sustained success, business continuity, management, resilience, risk.

JEL Klasifikacija: M14 Corporate Culture; Diversity; Social Responsibility; R4 Transportation Economics.

INTRODUCTION

The business of a transport organization in a modern, dynamic and very demanding business environment is exposed to frequent, often unexpected, changes in business conditions as well as the risks and opportunities that arise from it. The impacts of these changes, risks and opportunities can be fateful for an organization, including changes in its status ranging from achieving high results measured by financial and non-financial indicators, to complete disappearance from the market. In order to survive and operate successfully in such conditions, the organization needs to be ***resistant*** to the negative influences of the environment and ***able*** to respond effectively and efficiently to all (negative and positive) factors of its business environment. This is especially important in situations such as the current pandemic, natural and other disasters (floods, earthquakes, fires, etc.), global and regional social, political and economic changes and crises, market changes, climate change, etc.

The basic goals of any serious and, especially, ***socially responsible***, transport organization are to achieve ***sustainable success*** and ***continuous business*** over a long period of time. This means that, according to the definitions of these terms,[1,2] given in the international standards ISO 9000: 2015 [1] and ISO 22301: 2019 [2], the organization should ***be able to operate successfully in some (read: longer) period of time***, ie. ***to anticipate and meet the needs, requirements and expectations of all relevant stakeholders and strive to continuously increase their satisfaction***. Also, the organization ***should be able to, in case of disturbances that affect or may affect its business, continue to provide transportation services in, for the user and other relevant stakeholders, in acceptable time frames and predefined parameters such as quantities, dynamics, quality, etc***.

Achieving these goals must be the ***"goal of all goals"*** of the transport organization: the realization of all other goals must be focused on the realization of these

[1] Sustainable success: Success over a period of time. [1]

[2] Busines continuitey: Capability of an organization to continue delivery of products and services within acceptable time frames at predefined capacity relating to a disruption. [2]

two basic goals. At the same time, the ability of the organization to achieve continuous business and achieve sustainable success is a very significant support to achieve other business goals.

How can an organization achieve these goals?

The answer to this question is very simple and, at the same time, very complex!

The simplicity of the answer lies in the fact that in order to achieve these goals, an ***effective and efficient management system capable of enabling the achievement of these goals is needed***! And that's the end of simplicity! What follows is the question of the ***structure of that and such a management system***.

A management system that will be able to ensure the achievement of sustainable success and business continuity of the organization must provide effective and efficient management of all factors that affect or may affect the achievement of sustainable success and business continuity of the organization. This implies the adoption and application of an approach to considering and resolving these issues, which includes a comprehensive consideration of all factors that affect or may affect the business of the organization, their interrelationships and mutual influences, forms and intensity of influence on the organization, etc. This also implies a certain type of ***redesign of the existing management system*** of the organization, and the basic elements and success factors of this process are:

- ***completely knowledge and understanding of the factors of the business environment*** (context) of the organization and their impact on its business, as well as monitoring changes in these factors,
- ***achieving the required degree of resilience*** to negative environmental influences and business disruptions,
- ***application of the approaches "Risk-based thinking"*** and ***"Risk-based management"***,
- ***integration of management systems***, which means merging and harmonizing all subsystems of the organization's management system into a highly functional, effective and efficient whole,
- ***continuous improvement*** of transport and, if necessary, other services,[3] processes and systems,
- ***effective (substantial, not formal) application of international standards for business continuity management systems*** and achieving sustainable success of the organization EN ISO 22301: 2019 Security and resilience - Business continuity management systems - Requirements and ISO 9004: 2018 Quality management - Organization quality - Guidance for achieving sustainable success, as well as other international standards for management systems important for achieving sustainable success and business continuity of the organization (ISO 9001: 2015, ISO 14001: 2015, ISO 45001: 2018, ISO 27001, etc.).

In the following text, the importance, potential benefits and the manner of application of the mentioned factors will be pointed out in the basic outlines.

UNDERSTANDING THE CONTEXT OF THE MODERN TRANSPORT ORGANIZATION

Organization context - general considerations

The context of a modern organization or *the environment* (external and internal) in which it operates can be ***briefly described as complex, demanding, changeable, full of risks (but also opportunities)***. Managing an organization in such conditions is often, one might say, a nightmare for managers, but at the same time, it is also a great challenge! The main task of managers in such conditions is ***to seek and find answers to the impacts of the business environment on the organization, its business, success and survival in the market***.

It is generally known (from the literature, experience, ...), factors that exist or may exist in the environment of the organization and affect or may affect, negatively or positively, various aspects of its business. However, it is not very often known ***which factors, in what way and with what intensity*** affect or can affect ***a specific organization***, as well as what are, or can be, ***the consequences of these impacts***! This is something that must be fully known to every manager. It should be borne in mind that environmental factors and their potential and actual impact on the organization are changing and that these changes can be very dynamic, sometimes dramatic! This, of course, means that the manager, in addition to knowing the factors of the business environment of the organization must ***constantly monitor all events in that environment that have or may have an impact on changes in these factors***!

The forms of impact of the context factors of the organization, according to the consequences on its business, can be ***negative*** and ***positive***. Negative impacts or ***risks*** (***hazards***) are manifested by various adverse events, occurrences and results related to the business of the organization. Positive impacts or ***opportunities*** are reflected in the possibility of achieving certain benefits for the organization. It is obvious that the organization must make an effort to eliminate the risks and their consequences or reduce them to an acceptable level, and to use the opportunities as much as possible.

Why is it necessary to know the factors of the context of the organization, the manner and intensity of their actions, the type and intensity of their consequences and their changes?

[3] It should be borne in mind here that some transport organizations are also engaged in providing other services, e.g. tourism, catering, logistics, as wel as the some organizations, in addition to their core business, are also engaged in providing transport services.

Given the fact that the context factors of the organization contain various ***risks*** and ***opportunities***, it is obvious that their impact on the organization's business, primarily on business continuity and long-term business success, can be very large and even crucial! It follows that the organization, in the first place the top management, must systematically manage the influences of the factors of its business environment (context) to ensure business continuity and achieve sustainable success ***by providing an effective response*** to factors that affect or may affect, negatively or positively, to busines of the organization and its survival in the market. For that, it is necessary that an effective ***process of monitoring and analysis of the context of the organization*** to be established and applied in the organization, which should include the identification, analysis and understanding of:

- ***factors of the business environment*** (internal and external) that affect or may affect the business of the organization,
- ***type and intensity of actual and possible impacts*** of business environment factors on the organization's business (risks and opportunities),
- ***entities in the organization*** (products / services, processes, systems, ...) ***that are or may be affected*** by business environment factors, including the types and intensity of these impacts for each identified site of influence,
- ***changes in the business environment*** and their impact on the organization's business.

The process should be documented, defining:

- process activities, their order and mutual connections,
- competencies, responsibilities and authorities for the implementation of the process as a whole and activities within the process,
- methodology of data collection and analysis,
- methodology of processing and presenting the results of the analysis,
- dynamics of process realization and activities within the process,
- other that, depending on the specifics of the organization, is necessary for the effective implementation of the process.

For the realization of this process, it is necessary for the organization to provide appropriate resources (human, material, intangible).

The result (output elements) of this process should be actual, accurate and precise information and data on the state and trends in the business environment of the organization. Their usability depends on:

- ***characteristics and methods of process implementation***, which may include the structure of the process, consistency in the implementation of the process and its activities, competencies and awareness of participants in the implementation of the process on the importance of the process for the organization (including all levels of management), etc.
- ***availability of data and information*** on context factors and their actuality, accuracy and precision,
- ***adequacy of the applied methodology*** of data collection, processing and analysis.

The establishment and implementation of this process is one of the mandatory requirements of several international standards for management systems. However, the authors' experiences indicate to, often, inappropriate application and satisfaction of this requirement and, in connection with that, small, it can be said, insignificant benefits from that. This is, most often, a consequence of insufficient understanding of the essence of this request, the way of satisfaction and the benefits that the organization can have from it. In practice, the satisfaction of this requirement is often reduced to a formality that needs to be met because "it is required by the assessors"! Also, when "describing" the context of the organization, several factors listed in the literature are mentioned, but without essential consideration of their real influences in a specific situation. Unfortunately, some assessors accept and support and, it can be said, promote such approach!

What are the benefits of this approach? Of course, we can't talk about any benefits here - on the contrary! In addition to no benefit, certain negative consequences are possible in case, due to insufficient and inadequate knowledge and understanding of the context of the organization or changes in it, decisions are made whose results will be unfavorable for the organization and, perhaps, ***some of its stakeholders***. ***Is that acceptable? Does this lead to sustainable business success and continuity?***

It follows from the above that monitoring and understanding the context of the organization and changes in it must be permanent, it can be said daily, ***the task and activity of top management***. Having up-to-date, accurate and precise data and information about events in the business environment of the organization enables decision-making based on verified facts, which reduces the degree of uncertainty that accompanies decision-making. Also, it is possible to effectively respond to changes in the environment that may affect the implementation of decisions.

The context of the transport organization

The context of a modern transport organization contains, to a certain extent, all the above characteristics, with smaller or larger differences in relation to organizations engaged in other activities.

A number of factors are of special importance, so their consideration must be approached with special care. Some of these factors are:

- New technologies in the field of means of transport,
- Changes in the characteristics of the object of transport which result in specific and stricter requirements regarding the mode of transport and handling during transport.
- Social, demographic, cultural and other characteristics of passengers as users of transport services.
- Changes in national and international legislation in the field of transport.
- Administrative and physical barriers (eg still unfavorable visa regime for professional drivers, unacceptably long stays at border crossings, etc.), negatively affect the competitiveness of our carriers in the international market of transport services.
- Performing international transport activities, for the most part, in the quota regime of bilateral and multilateral CEMT licenses.

In addition to the above, depending on the specifics of the organization and its business environment, the existence of other environmental factors and their impact on the organization's business should be considered. It should be borne in mind that certain factors of the business environment, starting from the fact that the transport organization performs some of its activities in environments whose characteristics (geographical, climatic, political, legislative, ethnic, ...), can be very different. This primarily refers to organizations dealing with international transport and requires effective and efficient analysis of these factors as well as adaptation to specific conditions.

RESILIENCE OF THE TRANSPORT ORGANIZATION TO THE IMPACTS OF THE BUSINESS ENVIRONMENT

In the modern business environment, the transport organization, as stated above, is exposed to the action (negative and positive) of numerous and various factors, the consequences of which can be very important for the functioning of the organization and its survival.

What does the organization have to do?

The first step is ***to know and understand own context***, ie. environmental factors of the organization that affect or may affect the business of the organization. This is, in outline, discussed in the previous chapter of this paper. That, of course, is not enough on its own!

The next step is to prepare (make capable) the organization to respond to the identified (actual and potential) influencing factors in accordance with the identified or assessed form and intensity of their actions and possible consequences for the organization. In other words, the organization must achieve an appropriate degree of ***resilience to the influences of its environment and be able to manage the risks that may lead to disruption of its business***. The definition of the term ***resilience***[4] is given in the international standard ISO 22300: 2018 Safety and resilience - Terminology. [3]

The resilience of the transport organization to the influences of the environment and its ability to manage the risks arising from the action of factors of its business environment are the basis for ***ensuring the business continuity*** of the organization, ie. for ***achieving the ability of the organization to, in case of any adverse event*** (incident, change in the environment, etc.), ***in the shortest possible time, continue the implementation of its business activities at the same level and scope as before the incident or at a predefined level and scope, with a tendency to quickly return to pre-incident conditions***. An effective way to achieve this organizational capability is to establish, operate, maintain, and continually improve an effective ***business continuity management system***. This system must:

- be designed and implemented in accordance with:
  - characteristics and specifics of the transport organization, its organizational structure, systems and processes, which arises from the characteristics of its activity,
  - the needs of the transport organization arising from the characteristics of its environment,
  - the amount, types and intensity the impacts of factors of context that the organization can (or cannot) withstand in the event of a business interruption caused by an incident
  - needs, requirements and expectations of relevant stakeholders in case of disturbances,
- enable the realization of the policy and goals of business continuity and, thus, other goals of the organization,
- enable the organization to achieve the required level of ability to respond effectively in the event of a disturbance and continue to operate in a previously defined manner,
- enable sufficiently fast recovery of the organization and elimination of the causes and consequences of the disorder,
- providing learning and gaining experience from incidents and disorders, as well as responding to them.

Business continuity management system, as well as other management systems, contains the following elements:

- policy and goals of the business continuity management system (BCMS),

[4] Resilience: ***the ability to adapt to a changing environment.***

- competent people at all levels,
- unambiguously defined responsibilities and authorities,
- documented management processes, which include:
  - analysis and understanding of the context of the organization,
  - defining and implementing the policy and goals of BCMS,
  - planning of the BCMS (strategic and operational),
  - realization of operational activities of BCMS,
  - support processes (resources, communication, documented information, ...),
  - monitoring and evaluating the effectiveness and efficiency of the BCMS,
  - inspections and review of BCMS,
  - continuous improvement of BCMS.

The system must be documented to the extent and in a manner that provides operational management of the system and the processes within it, as well as an assessment of the effects achieved. Its structure must be in accordance with the structure of the management system of a particular transport organization, and a good, but not mandatory, basis for this is provided by the international standard EN ISO 22301: 2019 Safety and resilience - Business continuity management systems - Requirements. Guidance on the use of this standard is given in EN ISO 22313: 2020 Safety and resilience - Business continuity management systems - Guidance on ISO 22301. [4]

The benefits that a transport organization can have from the business continuity management system are multiple, and can be observed from several aspects:

- From the aspect of business, BCMS contributes to the resilience of the organization and enables the achievement of strategic goals, creation and maintenance of competitive advantage, preservation and strengthening of the image, reputation and credibility of the organization in the conditions of business disturbance.
- From the aspect of process implementation in the organization, BCMS enables maintenance of the required level of capabilities of key processes in conditions of disturbances or business interruption, proactive management of risks and opportunities, as well as potential "vulnerabilities", ie. elements of processes and systems which are sensitive to the action of factors that cause disturbances.
- From the aspect of spending financial resources, the BCMS enables the reduction of direct and indirect costs that occur or may occur due to disturbances or business disruptions.
- From the aspect of relations with interested parties, the BCMS enables, in the conditions of disturbances or disruptions of business, the satisfaction of their needs, requirements and expectations within the envisaged framework. It also enables the protection of human life and health, property and the environment. It thus demonstrates its ability to achieve sustainable success, while giving relevant stakeholders confidence in its capabilities. It also shows a high degree of social responsibility.
- From the aspect of the impact on individual mobility and accessibility of near and far areas, as well as due to its significant impact on the rational use of time, BCMS enables transport organizations to influence the quality of life of people in a broader sense.
- From the aspect of long-term goal - membership in the European Union, which the Republic of Serbia has set as its strategic and national interest, BCMS enables transport organizations to define their European position; they create and implement a transport policy that will use their own opportunities and concentrate on their own advantages.

APPLICATION OF THE "RISK-BASED THINKING" AND "RISK-BASED MANAGEMENT" APPROACHES IN THE TRANSPORT ORGANIZATION

The two most common questions of every manager are:

- What ***hinders*** us from achieving sustainable success and business continuity?
- What ***can help us*** achieve sustainable success and business continuity?

The greatest threat to successful and continuous business lies in the risks that are an integral part of a large number of activities directly or indirectly related to the business of the organization. The term ***risk***, according to ISO 9000: 2015 [1] is defined as ***"the effect of uncertainty"***, where ***uncertainty*** is defined as ***„a condition that occurs due to complete or partial lack of information and knowledge about an event, which affects the understanding of the event, especially its causes"***, and ***„effect"*** as ***"deviation from the expected - positive or negative"***.

In practice, the term ***"risk"*** is most often used when only negative consequences are expected. However, in accordance with the above definition, we can also talk about ***"positive risks"***, ie. ***events that may occur and, if they occur, have or may have a positive impact on the achievement of the objectives***. In practice, the term ***"opportunities"*** (or possibilities, chances, ...) is used for such events. ***Opportunities*** are contained in a large number of factors that affect or may affect the business of the organization and can, if recognized and used, have a significant positive impact on achieving sustainable success and business continuity.

Given the above, it is obvious that, due to the lack of reliable data and information on all key (but also other) factors that affect or may affect (***positively or negatively***) the business of the organization, its sustainable success and business continuity can be brought to question. It should be borne in mind ***that both***

risk and opportunity that are not recognized and to which an adequate response is not provided can have equally negative consequences!

What risks and opportunities can affect the organization's sustainable success?

Each ***identified risk*** and each ***identified opportunity***, in a certain way and in certain conditions, can have some impact on achieving sustainable success and business continuity of the transport organization through the impact on:

- quality of its services,
- satisfaction the needs, requirements and expectations of stakeholders and relations with them,
- impact on the environment and the working environment,
- level of safety and health protection at work,
- security of data and information,
- energy efficiency,
- business continuity of the organization,
- fair pricing in transport,
- strengthening the internal market and strengthening the external dimension of the market (transit and export of transport services).
- degree of social responsibility of the organization,
- connecting the EU (TEN network) with its neighbors and strengthening regional integration in the long run, etc.

What should be done?

Apply the approaches ***"Risk-Based Thinking"*** and ***"Risk-Based Management"*** in the management of the organization.

Risk-based thinking: All phenomena in the internal and external environment of the organization important for the its business ***should be considered from the aspects of risks and opportunities*** that may affect the implementation of the organization's activities, ie. from the aspect of ***positive and negative*** influences of their input and output elements on the business of the organization. In doing so, make a selection according to the type, manner and intensity of the impact and possible consequences. The outcomes of applying this approach are one of the most important input elements for applying the ***"Risk Based Management"*** approach.

The ***"Risk-Based Thinking"*** approach consists of systematically dealing with factors that affect or may affect (***positively or negatively***) the organization's operations, which includes:

- ***understanding the context*** of the organization,
- ***consideration of risks and opportunities*** in all elements and processes of the management system,
- ***consideration of possible directions and ways of action of the organization*** in order to provide an adequate response to the influences of business environment factors and to make adequate management decisions.

Adopting and implementing a ***"Risk-Based Thinking"*** approach should be an important basis for strategic and operational planning. It should be borne in mind that this approach is not a risk management system!

Risk-Based Management: Manage the organization as a whole and the processes and systems within it ***using the results of a detailed analysis of risks and opportunities*** arising from the context of the organization. This implies:

- ***Proactive action*** by defining, planning and taking measures in accordance with the identified and / or potential influence of the factors of the context of the organization,
- Making and implementing decisions (strategic and operational) in accordance with ***the estimated effects of uncertainty, ie. expected deviations (positive or negative) from the planned values***.
- Management of processes and systems by applying procedures that:
    - risks (hazards) are eliminated or reduced to a minimum (acceptable) level,
    - eliminate the causes of danger and risk,
    - make maximum use of identified opportunities,
    - create conditions for exploiting opportunities.

It can be said that the described approaches, in fact, represent ***two inseparable parts of a unified approach*** whose goal is to make effective management decisions with ***mandatory consideration of risks and opportunities*** arising from the influence of internal and external business environment. However, given the continuity and variability of these factors, it is obvious that the application of these two approaches has a different function and application. ***Risk-Based Tthinking*** encourages the ***creation of awareness*** in the organization about the comprehensiveness and continuity of existence and changes in risks and opportunities, as well as the need for continuous monitoring and analysis of places, ways and intensity of their occurrence and action. ***Risk-Based Management*** is the application ("materialization") of the outcomes of the ***Risk-Based Approach***, and its goal is to create awareness of the need to consider risks and opportunities in making managerial (strategic and operational) decisions at all levels of management. It is obvious that the separate application of these two approaches cannot give the necessary and possible results!

The described approaches are defined and promoted by the latest editions of international standards for management systems (ISO 9001: 2015, ISO 14001: 2015, ISO 22301: 2019: ISO 26001: 2011, ISO 27001: 2017, ISO 28000: 2007, ISO 31000: 2018, etc. .) like:

- very effective and efficient approaches to issues and problems of management processes and management systems in the organization, which
- encourage the organization to identify and manage the factors in its environment that affect or may affect its business.

These approaches have always, in a certain, but not completely implicit way, been present in the stated standards, but without direct (explicit) expression in the requirements of the standard. Therefore, very often, they were not recognized as a significant factor in the functioning of the management system.

In the latest editions of international standards for management systems, consideration of issues related to risks (and opportunities, chances, possibilities...) is explicitly included in the requirements for the establishment, functioning, maintenance and continuous improvement of the management system to which a particular standard refers.

What can be the benefits of applying these approaches?

Of course, the benefits depend on the consistency in the application of the described approaches, as well as the applied methodology for solving certain issues related to their application. In any case, some significant benefits can be:

- preventing the influence of negative factors in the context of the organization and achieving sustainable success and business continuity,
- exploiting the positive influences of the context factors of the organization in the business of the organization,
- increasing the degree of effectiveness and efficiency of the management system and its subsystems and processes,
- developing awareness of the importance and value of considering issues related to risks and opportunities,
- establishing a proactive culture of continuous improvement of transport (and other) services, processes and systems,
- ensuring the harmonization of processes and services,
- high level of trust and satisfaction of users and other relevant stakeholders.

INTEGRATION OF THE MANAGEMENT SYSTEM OF THE TRANSPORT ORGANIZATION

Since the beginning of mass application of international standards for management systems in the eighties of the last century (series ISO 9000, ISO 14000, OHSAS 18000, ...), a large number of organizations have harmonized some of their management systems with the requirements of appropriate standards. This harmonization was realized, on a case-by-case basis, in different time periods, whereby, most often, the standard for quality management systems was applied (ISO 9001), and then, after a certain period, some of the existing standards (ISO 14001, OHSAS 18001 (now ISO 45001), ISO 27001, etc.). That process continues today.

Many of these management systems have functioned (and still functioning!) as parallel, independent systems, and some of the consequences are:

- duplication of processes, ie. the existence of essentially the same processes in different management systems (eg document management, resource management, checks of management systems, ...), as well as different ways of implementing the same processes in different management systems,
- lack of connections and coordination between different management systems and low volume of use of data, information, knowledge and experience from other systems,
- excessive volume of documentation, duplication of documents and complex document management system,
- unnecessarily large expenditure of resources (human and material) for the functioning and maintenance of these systems,
- insufficient effectiveness of individual management systems and, as a result, insufficient effectiveness and efficiency of the overall management system of the organization,
- insufficient degree of satisfaction of needs, requirements and expectations of relevant stakeholders, etc.

In such situation, there is a need to increase the effectiveness and efficiency of the management system by reducing and / or eliminating the perceived shortcomings of the existing way of functioning of the management system of the organization and its subsystems. The solution was found in the process of ***integrating the management system***, ie. ***merging the existing subsystems of the management system into one functional, effective and efficient whole***. In other words, ***the integration of the management system*** implies ***the creation of the management system of the organization in which all its subsystems and processes in them function in a unique and***

harmonized way, with a high and purposeful degree of interconnection, coordination and cooperation.

In the first phases of the implementation of the process of integrating management systems (and this is often present today), activities was focused exclusively on connecting management systems that were in line with the requirements of relevant international standards. Thus, "integrated" management systems were obtained, which, most often, included only two or three subsystems. These were mainly management systems compliant with the requirements of the international standards ISO 9001, ISO 14001 and OHSAS 18001 (now ISO 45001: 2018). This "integrated" management system did not recognize other subsystems of the organization's management system that existed and functioned in the organization, but were not in line with the requirements of international standards.

To achieve sustainable success and business continuity of the organization, it is very important that the management system of the organization is fully and truly integrated, ie. that all its subsystems function harmoniously and, thus, effectively and efficiently. Such a system should be capable of effective management of key subsystems and processes of management systems, such as: strategic and operational planning, quality management systems for products and services, occupational safety and health, environmental protection, data and information security, etc., customer relationship management as well as other stakeholders, knowledge management, etc., in accordance with the specifics and needs of the organization (eg food safety in the food industry, the competence of testing and calibration laboratories, etc.).

This, in particular, comes to the fore in crisis (emergency) situations when the business of the organization is endangered by the negative effects of certain factors of its business environment. It is important to include all subsystems and all processes of the management system, and formal compliance (certification) of some subsystems of the management system with the appropriate international standards is desirable but not mandatory!

Achieving a high degree of integration of the management system is a process that must be led by the top management of the organization. The process should include the following activities:

- Analysis of the existing degree of integration of the management system, which includes the identification of:
  - interconnections and harmonization of systems and processes,
  - duplication and contradictions of processes and documents,
  - irrational use of resources,
  - other phenomena that negatively affect or may affect the output elements of the process and system.
- Defining, based on the results of the analysis, measures to increase the degree of integration of the management system.
- Planning and implementation of defined measures.
- Monitoring and measuring the effects of implemented measures and defining improvement measures.

The documents ***PAS 99*** and ***Annex SL*** provide significant assistance to organizations wishing to integrate their management system. ***PAS 99 Publicly Avaliable Specification - Specification of a common management system requirement as a framework for integration*** [5], provides guidance for the integration of two or more management systems that comply with the relevant international requirements. standard. ***Annex SL*** prescribes an identical structure of all international standards for management systems. However, these documents primarily refer to management systems that comply with the requirements of relevant international standards, but, in a certain way, can also be applied to management systems and processes that do not comply with these (and other) standards.

It is important to keep in mind that the process of integrating the management system should be an ongoing process in the organization, given the dynamics of change in the internal and external environment of the organization, eg:

- changes in laws and other regulations: any changes in laws, bylaws, standards, etc. which, primarily, refers to one subsystem or process may, to some extent, also refers to other subsystems and processes,
- changes in the operations of competing or partner organizations, as well as other relevant stakeholders,
- changes in organizational structure, size, form of ownership, etc.

The benefits of this process are obvious, and consist, at the very least, in eliminating the shortcomings and consequences of insufficient interconnection of the subsystems of the management system listed in this text.

CONTINUOUS IMPROVEMENTS

The process of continuous improvement is one of the mandatory requirements of all international standards for management systems, but ***it should not be the only and exclusive reason for its existence***.

The need to improve transportation and other services provided by the transportation organization, processes and systems stems from the constant changes in the internal and external environment of the organization. All changes, regardless of the source (external or internal) require an effective response from the organization. The most effective strategic response of the organization is the development and existence of a ***culture*** of continuous improvement of the organization's performance, services, processes and systems, including a high level of ***awareness*** of members at all levels about improvements as the most effective means of responding to the challenges of a very demanding and dynamic market. Therefore, the process of continuous improvement is one of the significant "pillars" of achieving sustainable success and business continuity.

The process of continuous improvement should be lead in two directions:

- improving the technical and technological performance of services, processes and systems,
- Improving organizational performance at all levels of the organization.

The first direction ensures the achievement and maintenance of performance and quality of services, processes and systems in accordance with the needs, requirements and expectations of users and other relevant stakeholders, and the second achieves and maintains a high degree of organizational resistance to business environment. Both directions of action must be harmonized, and the common goal and outcome should be sustainable and continuous business of the organization.

The role of top management, but also of all other levels of management, in the implementation of this process is a key factor in achieving the expected results of the process, and is reflected in the following:

- development of awareness of employees in the organization about the need and importance of continuous improvement,
- development and maintenance of a culture of continuous improvement,
- motivating and stimulating employees to actively participate in the processes of continuous improvement,
- planning and monitoring the implementation of the process of continuous improvement,
- monitoring and measuring the effects of the process of continuous improvement and defining the necessary measures.

APPLICATION OF INTERNATIONAL STANDARDS FOR MANAGEMENT SYSTEMS IN A TRANSPORT ORGANIZATION

It is desirable and very useful, but not mandatory, that ***every organization*** that wants to achieve sustainable success and business continuity, harmonizes its business with the requirements of international standards for management systems, but also other relevant standards in accordance with the characteristics of the organization, its products / services, processes and systems, as well as the needs, requirements and expectations of users and all other relevant stakeholders. This, of course, also applies to transport organizations!

International standards for management systems provide the organization with very useful guidance and significant assistance in solving problems related to the management of the organization as a whole as well as the processes and systems within it. Given that they are based on the achievements, experiences and good practice of successful world organizations, as well as the application of appropriate achievements of modern science in this field, standards for management systems are an unavoidable factor that can positively affect the organization and achieve sustainable success and business continuity. This has been recognized in a large number of organizations, as evidenced by the large number of organizations that have been applying these standards for many years, both in the world and in our country.

Guidelines for achieving ***sustainable success*** are given by the international standard ISO 9004: 2018 [6].

This standard defines the term ***"quality of an organization"*** as ***"the degree to which the inherent characteristics of an organization meet the needs of its customers and other relevant stakeholders in order to achieve sustainable success."*** This definition is derived from the definition of "quality" (product / service) and, in contrast, indicates the achievement of ***the organization's ability to focus on anticipating, meeting and overcoming (exceeding) the needs, requirements and expectations of users and other relevant stakeholders. and, thus, increases their satisfaction and confidence in the overall capabilities of the organization***. In that way, the organization becomes capable of achieving ***sustainable success***, ie. ***"success over a period of time"*** [1]. It is desirable that this time period be as ***long as possible***!

The application of this standard implies the application of all principles of quality management defined by the international standard ISO 9000: 2015 [1], especially the principles of ***"customer focus"*** and ***"relationship management"***, which indicates the essence of achieving ***organizational quality***: ***make the organization capable to fully meet needs, requirements and the expectations of all relevant stakeholders***. ***The quality of products / services*** is ***only one aspect of the overall quality of the organization***. Other, no less important, aspects are:

- the ability of the transport organization to meet the needs, requirements and expectations of relevant stakeholders that, more or less, directly or indirectly related to the quality of the organization's services, such as, for example, environmental protection, safety and health at work, protection data and information, food safety, risk management, energy efficiency, etc.,
- resilience of the organization, ie. its ability to respond effectively and efficiently to the negative

influences of the factors of its business environment,
- the ability of the organization to monitor changes in its business environment and respond adequately to them.

From the above, a logical conclusion follows that, in order to achieve sustainable success by applying the ISO 9004: 2018 standard, it is necessary to substantially apply other, relevant, international standards for management systems, primarily ISO 9001. One of the standards whose application can have a very significant impact on sustainable success is an international standard *ISO 22301: 2019 security and resilience - Business continuity management systems - Requirements* [2].

As can be seen from the title, the standard [2] defines the requirements for the establishment, operation, maintenance and improvement of the management system of business continuity of the organization. Guidelines for the application of this standard are given by the international standard ISO 22313: 2020 [4].

The need for consistent application of these standards arises from the existence of various risks and dangers to the business of the organization in the environment of the organization.

The structure of the ISO 22301: 2019 standard is harmonized with the requirements of the Annex SL document and, thus, with the structure of other international standards for management systems. The essence of the approach defined by the requirements of this standard consists of the following:

- mandatory effective analysis and understanding of the context of the organization, as well as monitoring changes in it,
- leading role of the top management of the organization, as well as all other levels of management and relevant functions in the organization,
- planning, based on identified risks, and implementation of operational procedures to provide the organization's response to possible or manifested negative impacts of bussines environment factors, which may include:
    - organizing the organization's business in conditions of disturbances,
    - planning and providing resources,
    - defining and providing the necessary competencies for the functioning of the business continuity management system (BCMS)
    - development of employee awareness at all levels in the role and importance of BCMS,
    - development and functioning of an efficient information system, including alerting,
    - planning of evacuation procedures for people and property,
    - organizing the life and work of people (members of the organization and others) at the locations to which they were evacuated, including health care, security, supply of food, electricity, etc.,
    - exercising procedures and learning from experiences,
- planning and implementation of measures for recovery of the organization after the cessation of the factors that caused the disruption of the business of organization,
- use of opportunities arising from the positive influences of business environment factors,
- monitoring the effectiveness and efficiency of the business continuity management system,
- planning and implementation of measures to improve the performance of SMKP, as well as other systems related to it,

The requirements of this standard primarily relate to disruptions and business interruptions of the organization resulting from the action of factors with catastrophic consequences such as natural disasters, earthquakes, floods, etc. However, they can, in a certain way, be applied to all other factors that can cause disruption and interruption of the organization's operations, such as social, economic and political changes, market changes, demographic changes, pandemics, etc.

CONCLUSION

A transport organization that wants to survive in the long term on the modern market of transport (and other) services must consider the application of certain procedures that enable it to achieve sustainable success and business continuity.

In this paper, in the basic outlines, presents a comprehensive approach to the issues of achieving business continuity and sustainable success of the transport organization. Also presented are some of the procedures whose consistent application the transport organization can ensure meeting the needs, requirements and expectations of users of its services and all other relevant stakeholders and, thus, a stable market position and survival in a changing and demanding environment.

The application of the described approach and the procedures it implies is, except in transport, possible in all other organizations, regardless of their activity, size, structure and other characteristics. In doing so, it is necessary to take into account the specifics that arise from the activities, structure and other characteristics of a particular organization. The benefits of their application can be significant, and the results achieved will depend on several factors, with the leading role of top management being decisive.

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REVIEW

Selection of the Optimal Toll Collection System for the Purposes of Sustainable Development of Transport in the Republic of Srpska

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Abstract: Transport system has multiple interactions and multidimensional effects on the environment, by way of, amongst other, land acquisition and urban pollution; on economic development with regard to the GDP growth; as well as on social equity in terms of access, quality of life and health of population. This paper considers the possibility of introducing toll collection in the Republic of Srpska. The goal of the developed model is to increase revenue, which could be directed to the sustainable development of transport in the Republic of Srpska. The selection of a toll collection system has been made taking account of: economic, traffic, technical, organizational and exploitation criteria. Multiple-criteria approach has been applied together with the Analytic Hierarchy Process.

Keywords: Toll collection systems, Multi-criteria approach, Analytic Hierarchy Process.

INTRODUCTION

The concept of sustainability, which is widely used in the field of planning, has been present since a few decades ago. Sustainability has its general criteria and principles. As a rule, within a specific strategy or policy of sustainable development, several general and special principles and criteria are combined, the number of which depends on the level of decision-making and the specific problem they are applied to. In order to make complex specific decisions, it is necessary to define criteria and principles, as well as to differentiate the values and goals they relate to. Development planning must be based on scientific knowledge and rationalism. Therefore, planning solutions must be sought through the examination of variants, which enables consideration of the widest range of options in order to choose the best way of sustainable development for a specific geographical area, i.e. enables a choice between alternatives to achieve the desired goal.

Groups of people see the use of a certain space and the proposal of its development in different ways. However, in spite of that, it is possible to form a set of values, which can be considered objective. The goal is to avoid decision-making based on intuition as much as possible, i.e. to rationalize the evaluation process as much as possible. These premises provide opportunities for the application of a popular approach for multi-criteria decision-making, the Analytic Hierarchy Process (AHP), in considering the possibilities of toll collection and choosing the optimal collection system for the purposes of sustainable development of transport in the Republic of Srpska.

Highways, which represent a specific type of road transport, of large capacity, intended exclusively for motor vehicle traffic, also form part of the Republic of Srpska transport system since recently.

And while highways as a creation have been present in the world for a relatively short time (the first highway was built in Italy in 1924), toll collection has been known since ancient times and was widespread as early as during the Roman Empire.

Decision making often represents a complex problem due to the presence of competitive and conflicting criteria among the available alternatives.

The paper is conceived in the following way. After the Introduction, the basic concept of the applied approach, Analytic Hierarchy Approach, is presented. After that, in the third chapter, the existing toll collection systems are defined. In the next chapter, a model for the selection of the toll collection system in the Republic of Srpska is developed. Moreover, one part of this chapter includes the results of the applied multi-criteria model, i.e. recommendations for the introduction of a specific toll collection system in the Republic of Srpska. Finally, the last chapters are devoted to concluding considerations.

ANALYTIC HIERARCHY PROCESS - BASIC CONCEPT OF APPROACH

The AHP approach treats the problem of decision making as a hierarchy of elements important for decision making [7,8,9]. At the top is the goal, the criteria are at the next level, and alternatives at the bottom level. In case at least one of the criteria is decomposed into sub-criteria, a new hierarchical level is formed below the level of the criteria and above the level of alternatives.

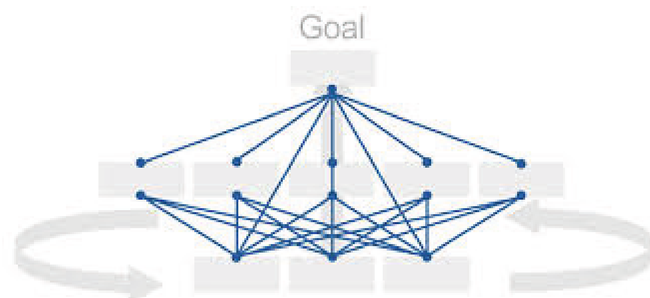

Figure 1: Analytic Hierarchy Process Scheme

AHP implies that the criteria are first compared with each other and that their relative weights in relation to the goal are calculated. The alternatives are then compared in pairs in relation to each criterion and their relative weights in respect to the criteria are determined through an analogous procedure. Vectors of relative weights of criteria and alternatives come out as a result. Finally, the synthesis is performed and the final composite vector of the weight values of an alternative in respect to the goal is determined. Apart from the hierarchical structuring of the problem, AHP also differs methodologically from other methods for the comparison is made in pairs of system elements, at a given level of hierarchy in relation to the elements of the higher level.

Analytic hierarchy approach has a number of advantages, such as: relative simplicity, intuitive approach, possibility of using both qualitative and quantitative information in the decision-making process, matrices, for comparing system elements by pairs, ability of group decision-making, simple calculation of inconsistency index, existence of user-oriented software just like simple interpretation of the results. The biggest advantage of the AHP approach is its ability to identify and analyse the inconsistency of decision makers in the process of evaluation of system elements. Of course, in addition to many advantages, this approach also has some disadvantages, among which, in particular, the difficulties in the application of this approach in the case of a large number of system elements (criteria and alternatives), due to the generation of a large number of comparison matrices by pairs.

EXISTING TOLL COLLECTION SYSTEMS

The existing toll collection systems that are applied in European countries are heterogeneous and vary from country to country (Figure 2). The European Commission is trying, with certain directives, to bring more order to this field, both in terms of the collection type and system, as well as in terms of other non-harmonized issues. The main objective of the EU is *interoperability*, which is to be achieved by way of the “one market - one billing system” policy through harmonized prices and vehicle categories.

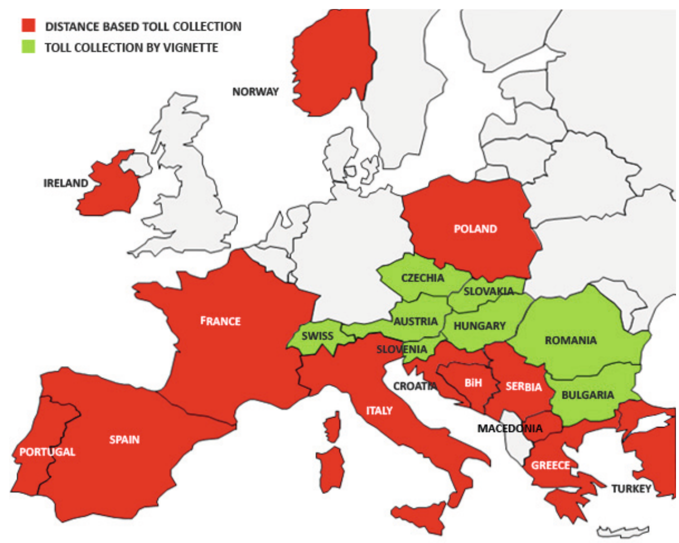

Figure 2. Overview of Highway Toll Collection in Europe

It should be noted though that the toll collection system at the national or regional level was analysed, and not at the urban or separate infrastructure system. All these different systems are based on five basic characteristics, which include:

- Toll collection method (Multi-lane toll collection system with free flow of vehicles and the lane-based toll collection system)
- Toll collection scheme (Distance-Based and Time-Based)
- System organization (Closed and Open Toll Collection System)
- Control (Control of collection based on toll barriers, Control of collection based on license plate recognition and Control by authorized service - police)
- Toll collection technology (Manual toll collection and Electronic toll collection)

MODEL FOR TOLL COLLECTION SYSTEM SELECTION IN THE REPUBLIC OF SRPSKA

A highway is a public road that is specially constructed and designed exclusively for motor vehicle traffic, which is marked as a highway with a prescribed traffic sign, has two physically separate carriageways for traffic from opposite directions with at least two traffic lanes and an emergency lane, without nay intersection with side roads and railway or tram lines at the same level, the traffic on which may be pulled into or pulled out of only through a specific and specially constructed public access road on the appropriate carriageway of the highway.

Highways are used to connect large cities and important economic areas of the country or region, they are intended mainly for long-distance traffic and are connected to the system of European highways. Highways meet the requirements relating to the prescribed traffic and technical elements, or are constructed in phases.

In the Republic of Srpska, the network of highways consists of the following sections:

- Banja Luka - Gradiška (33 km)
- Banja Luka - Doboj (75 km)
- Doboj – Modriča (47 km)
- Banja Luka - Mlinište (92 km)

Furthermore, the below-listed sections are planned under the strategy of development of the highway network for the next 20 years:

- Modriča - Bijeljina - border with Serbia (91 km)
- Banja Luka - Prijedor - Novi Grad (72 km)
- Bijeljina - Zvornik - Foča - Trebinje (350 km)
- Pale - Rogatica - Višegrad - Vardište (91 km)
- Ljubinje - Trebinje - border with Montenegro (71 km)

Elements of the Developed Model

In considering the criteria for the possibility of introduction of toll collection in the Republic of Srpska and selection of the optimal toll collection system for the purposes of sustainable development of transport, the following groups of criteria should be taken into account: economic (total toll revenue, investment costs, operating costs), technical (toll collection system adaptability, interoperability of the toll collection system, modern nature of the solution, possibility of control of the collection process, vulnerability of the collection system) and organizational criteria (organizational effort in exploitation and the level of possible abuses).

Based on the foregoing, in considering the possibility of introducing toll collection on the network of highways in the Republic of Srpska, the relevant criteria have been elaborated and differentiated and are presented below:

- K1 - implementation cost
- K2 - operating costs
- K3 - maintenance costs
- K4 - total revenue
- K5 - revenue dynamics (advance, continuous, cash-flow)
- K6 - risks (level of abuse, vulnerability)

Potentially, four different toll collection systems can be applied in the Republic of Srpska that will be discussed further below, and they can be presented as follows:

- A1 – toll-free system
- A2 - closed toll collection system
- A3 - open toll collection system
- A4 - vignette system

Forming of Model and Results

The first hierarchical level contains only the objective, the second one contains the criteria and the third one contains the alternatives. In the *Super Decisions* program, the basic levels are formed first, with a description of the name. This is followed by the creation of nodes in the levels, their connectivity, i.e. the creation of a model. The next step is comparison of the pairs of elements in the completed model.

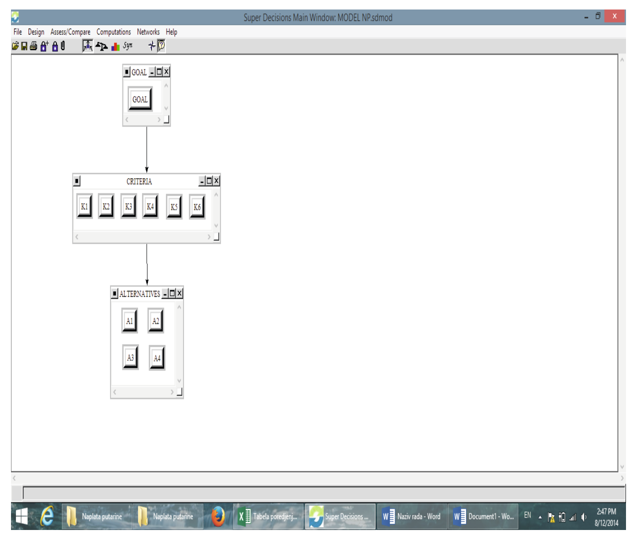

Figure 3. Appearance of the model

A comparison of the importance of specific criteria in relation to the set goal was made first. The goal of the developed model is to increase revenues that could be directed to the sustainable development of transport in the Republic of Srpska. The comparison of criteria, i.e. the definition of their relative importance, was performed on the basis of the fundamental *Saaty scale* [9], with grades ranging from 1 to 9 (Table 1).

Table 1. Evaluation of Criteria

	K1	K2	K3	K4	K5	K6
K1	1,00	0,20	3,00	0,14	5,00	5,00
K2		1,00	5,00	0,14	5,00	5,00
K3			1,00	0,11	1,00	3,00
K4				1,00	9,00	9,00
K5					1,00	3,00
K6						1,00

The final ranking of alternatives is provided in Table 2 and Figure 4.

Table 2. Ranking List

RANKING	TOLL COLLECTION SYSTEM	WEIGHT
1	A4 – VIGNETTE SYSTEM	0.321
2	A2 – CLOSED SYSTEM	0.270
3	A1 – TOLL-FREE SYSTEM	0.237
4	A3 – OPEN SYSTEM	0.172

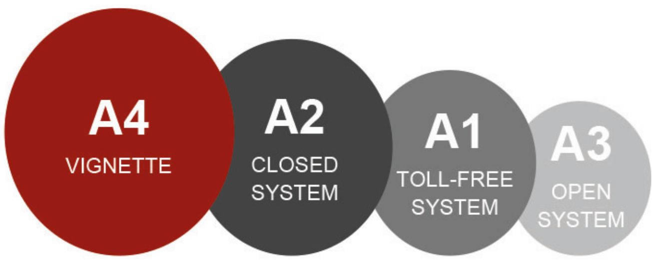

Figure 4. Ranking view

Super Decision software for AHP analysis has made it easy to obtain and verify the results, just like to present it in a clear and elegant way. This approach provides elements to support decision-making, by adequate data processing in the process of multi-criteria evaluation of variant solutions.

Therefore, in considering the possibility of introducing a toll collection system in the Republic of Srpska, it has been shown, based on this analysis and the simulations conducted by data processing, that it is necessary to introduce a toll collection system, and the Alternative A4 is offered as an optimal solution, which is a toll collection system based on the use of vignette.

CONCLUSION

The problem of selection of the toll collection system in the Republic of Srpska has been treated as a task of multi-criteria ranking of the four alternatives, by considering six criteria and using the Analytic Hierarchy Process.

Each toll collection system is scored according to the defined criteria taking into account the importance of each of the different evaluation factors, in order to obtain a ranking of results that is least sensitive to changes in the weight of the criteria.

As a result of the application of this method in considering the possibility of introduction of toll collection in the Republic of Srpska and the selection of the optimal toll system for the purpose of sustainable transport development, the ranking of alternatives shows that, taking into account economic, traffic, technical, organizational and exploitation criteria, the vignette system represents the best solution.

The vignette as a toll collection system represents a very simple model, which is why it has been introduced by almost all smaller European countries. Also, they have a certain advantage compared to other collection systems, first of all because of the simplicity of collection, which provides certain benefits for each country's budgets through advance payments, then avoiding of possible congestion and delays due to collection and, also, achieving of better traffic safety.

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IZBOR OPTIMALNOG NAČINA NAPLATE PUTARINE ZA POTREBE ODRŽIVOG RAZVOJA TRANSPORTA U REPUBLICI SRPSKOJ

Rezime: Transportni sistem ima mnogostruke interakcije i multidimenzionalne efekte na okruženje, pored ostalog, zauzimanjem zemljišta i urbanim zagađenjem; na ekonomski razvoj, u pogledu rasta BDP-a; kao i na socijalnu jednakost, u smislu pristupačnosti, kvaliteta života i zdravlja stanovništva. U ovom radu se razmatra mogućnost uvođenja naplate putarine u Republici Srpskoj. Cilj razvijenog modela je povećanja prihoda koji bi se mogao usmeriti na održivi razvoj transporta u Republici Srpskoj. Izbor sistema za naplatu putarina izvršen je razmatranjem: ekonomskih, saobraćajnih, tehničkih, organizacionih i eksploatacionih kriterijuma. Primenjen je višekriterijumski pristup, Analitički hijerarhijski proces.

Ključne reči: Sistemi za naplatu putarine, Višekriterijumski pristup, Analitički hijerarhijski process

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REVIEW

Telematics of new vehicles for the purpose of pedestrian safety

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Abstract: Pedestrians are a vulnerable group of traffic users who most often suffer serious physical injuries in collisions with motor vehicles, which very often have a fatal outcome.

The modern automotive industry is investing great efforts in the development of active and passive protection systems for all traffic participants, including pedestrians.

Pedestrian protection is tried to be achieved by changing the shape of the front parts of the vehicle, by using plastic materials with higher deformation potential which, in collision with the body of the pedestrian, will spend most of the impact energy on its own deformation and thus maximally spare the delicate biological tissue of the pedestrian.

Instead of protruding, rigid metal structures of insignificant elasticity and deformation potential, today's cars are characterized by appropriate body design, use of high elasticity materials and deformation of contact surfaces, specially shaped and integrated bumpers, elastic and raised bonnet, headlights integrated into the contour of the vehicle front which are capable of absorbing part of the impact energy.

Modern research shows a certain efficiency of these improvements on modern cars. Most of these studies are of the experimental type and are done in strictly controlled conditions on dolls, often commissioned and funded by wealthy automobile corporations, while there is less research in real field conditions.

Recently, experiments have been made with testing the active bonnet, the airbag under the bonnet, and the google model of gluing the pedestrian body.

Keywords: safety, pedestrian, vehicle, bonnet.

INTRODUCTION

In order to obtain a clearer insight into the consequences of traffic accidents involving pedestrians, it is necessary to observe them according to the consequences that occur in collision processes. Pedestrian injuries are determined in a forensic procedure. The severity of the pedestrian injury depends on several factors, such as the shape of the vehicle with which the pedestrian's body came into contact, the mass and speed of the vehicle at the time of impact, the height, weight, and position of the pedestrian's center of gravity, the characteristics of the ground on which the body of the pedestrian was thrown after the collision, and the like.

There are three types of vehicle collisions with pedestrians: frontal, which can be complete or partial, lateral impact, and running over the body of a pedestrian.

One of the most important factors is the profile shape of the front part of the vehicle, which can be classified into three basic shapes: wedge, pontoon, and box shape. It is known that preventive detection of pedestrians can prevent a vehicle from crashing into them. In addition to these active preventive systems, there are also passive safety systems, which refer to mitigating the consequences of a collision if it occurs.

In this paper, we will show the importance of researching new standards of car equipment and its efficiency in the area of speed range in settlements, in the zone of upper limits of maximum allowed speeds in settlements.

THE IMPACT OF SPEED ON PEDESTRIAN CASUALTIES

Traffic science, i.e. the traffic profession in Bosnia and Herzegovina, failed to warn the population of the harmful consequences of the legally prescribed tolerance and impunity for drivers in the event of such speeding. Wrong expert attitudes have always resulted in an increase in the number of traffic accidents and consequences.

When it turns out that certain attitudes have been overcome, they change very quickly in all national legislations.

The Law on Basics of Road Traffic in Bosnia and Herzegovina (ZOOBS)[4] has established tolerance for the measured speed of vehicles by not punishing the driver if he exceeds the speed limit by 10 km/h. Research[2] proves the harmful consequences of this legal provision. The error tolerance of the measuring device is very small (3 km/h for speeds up to 100 km/h and 3% for speeds over 100 km/h) compared to the tolerance of 10 km/h predicted by the ZOOBS.

Research dealing with the speed of cars hitting pedestrians shows[1] that:

- at a speed of 30 km/h, 10% of pedestrians die;
- at a speed of 40 km/h, 20% of pedestrians die;
- at a speed of 50 km/h, 40% of pedestrians die;
- at a speed of 60km/h, about 80% of pedestrians die.

Especially significant is the research of pedestrian casualties in settlements at speeds less than 60 km/h, in frontal collisions, in circumstances related both to active and passive safety systems of new generations of vehicles.

If a pedestrian is hit by a vehicle moving at 80 km/h or more, his chances of survival are negligible.

High collision speeds diminish the benefits of the protection system.

ACTIVE PEDESTRIAN PROTECTION SYSTEMS

Pedestrian detection system

The pedestrian detection system has been well developed by Volvo. It is based on components such as radar and cameras, which serve to identify pedestrians when they are in the zone of dangerous traffic situations before the immediate collision of the vehicle (Figure 1).

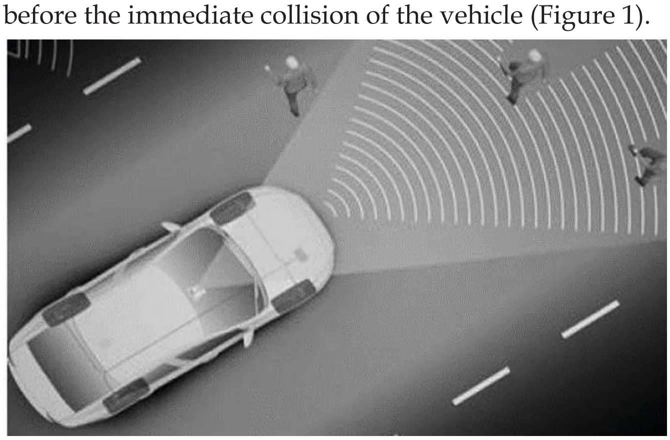

Figure 1. The mode of operation of the camera and radar in the pedestrian detection system[5]

The system operates in several stages and levels depending on the distance between pedestrians and vehicles at the moment of collision. After having identified a pedestrian in the collision zone, an audible signal is activated and a red light is reflected in the upper part of the windscreen in order to warn the pedestrian of a dangerous situation. In the event that the driver does not respond to the above warnings, the system activates the vehicle's brakes, slows down or ultimately stops the vehicle.

The described pedestrian detection system is capable of preventively avoiding a collision with a pedestrian at speeds less than 40 km/h, while at speeds up to 80 km/h it will reduce the consequences of a traffic accident.

If this system were to be part of the equipment in the new vehicles, Volvo estimates that the percentage of pedestrian fatalities caused by a frontal collision could be reduced by 25% compared to conventional ones.

Night View - a system for better visibility

This system for better visibility is specifically designed for traffic in low visibility conditions. In these conditions, there is an additional risk, given that with poor visibility, there may be a loss or drop in concentration. The lighting system is not efficient enough in the described conditions. The Night View system is functional in night driving conditions i.e. in conditions of poor visibility.

The Night View system[5] includes two types of equipment:

1. active light signal amplifiers,
2. passive and more complex thermal systems.

Light signal amplifiers function as aids such as IR binoculars, cameras, and night glasses. They significantly amplify the light with internal optics in order to amplify the image of the traffic situation in front of the vehicle sufficiently. Such an amplified light image is reproduced on the LCD in the vehicle itself, so the driver now sees on the display what he did not see clearly before in a real situation. This system works well when there is enough light to obtain a useful projection. The problem of using this system is related to complete darkness when it becomes completely useless, as well as in conditions of intense fog.

Unlike light amplifiers, thermal analysis systems operate in the absence of any light. In their system, they use thermal cameras, i.e. they detect IR light emitted by objects that as such can radiate heat. The system consists of a heat detector, an optical component, a screen, and a processor. The optical part of the system has the function of collecting IR light at a distance of 300 m, which is then analyzed and processed by a heat detector, so that it detects light of focused wavelength which is then converted into an image in a specific processor, and finally displayed on the screen. Thermal cameras are located in front of the car's radiator and must be protected from mechanical damage, most often by grilles. This system can function in the dark, but it is more expensive than the previously described system (Figure 2).

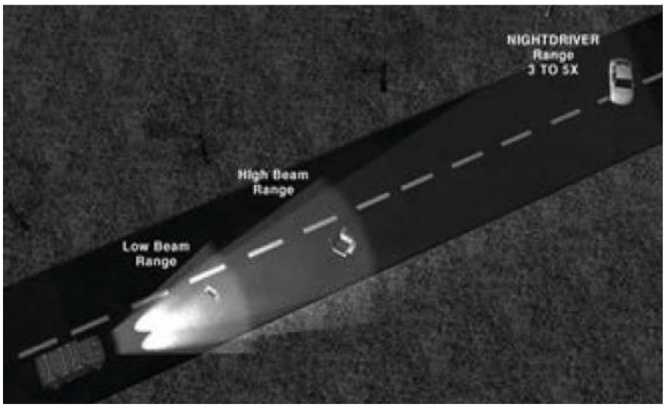

Figure 2. Night View system range [5]

PASSIVE PEDESTRIAN PROTECTION SYSTEMS

Car construction

The impact of technical improvements of modern cars can reduce the severity of injuries to the lower extremities of pedestrians.[3] In collisions with motor vehicles, pedestrians in the first place usually suffer injuries to the lower extremities. The modern automotive industry is investing great efforts in the development of active and passive protection systems for all traffic participants, including pedestrians. Pedestrian protection is tried to be achieved by changing the shape of the front parts of the vehicle, by using plastic materials with higher deformation potential which, in collision with the body of the pedestrian, will spend most of the impact energy on its own deformation and thus maximally spare the delicate biological tissue of the pedestrian. Instead of protruding, rigid metal structures of insignificant elasticity and deformation potential, today's cars are characterized by appropriate body design, use of high elasticity materials and deformation of contact surfaces, specially shaped and integrated bumpers, elastic and raised bonnet, headlights integrated into the contour of the vehicle front which are capable of absorbing part of the impact energy, as well as other details. These solutions have been serially installed in motor vehicles since the 1990s and are constantly being improved.

Modern research shows a certain efficiency of these improvements on modern cars. Most of these studies are of the experimental type and are done in strictly controlled conditions on dolls, often commissioned and funded by wealthy automobile corporations, while there is less research in real field conditions. The aim is to compare lower extremity injuries in pedestrians injured by modern car models compared to pedestrians injured by older car models and to determine whether modern motor vehicles really cause less lower extremity trauma to pedestrians. Observing the injuries of the lower extremities through the prism of the AIS classification, a significant difference was obtained in the injuries of the lower extremities between the observed groups, to the detriment of the injured by older car models (p = 0.034). The most common injuries are fractures of the lower leg bones and dislocations of larger joints.

The technical improvements of modern cars concerning changes in the shape and construction of their front parts really have a protective effect on the lower extremities of pedestrians and reduce their trauma in the event of a frontal collision with a pedestrian. Confirmation of these results should be sought in future research that would take into account the speed of motor vehicles, but also a more precise description of the resulting fractures of the lower extremities. However, these studies are applicable for speeds less than 50 km/h.

Active bonnet

The active bonnet belongs to the systems of passive pedestrian protection, especially in the case of traffic accidents of a frontal collision with a pedestrian. It works by lifting the bonnet automatically or partially after the sensor detects a frontal collision with a pedestrian. The system is controlled by sensors built into the front bumper. The bonnet is lifted 65 mm in a time of 40 ms regardless of the strength of the impact.

This system reduces the risk of injury when in contact with the frontal part of the vehicle. A pedestrian thrown on the bonnet will not come into contact with hard and blunt parts under the bonnet. The bonnet is designed to absorb impact energy, so the risk of injury will be less since the pedestrian's head will be protected from contact with the engine. This system is credited to the company Citroën, which presented the innovative active bonnet technology with its C6 model (Figure 3).

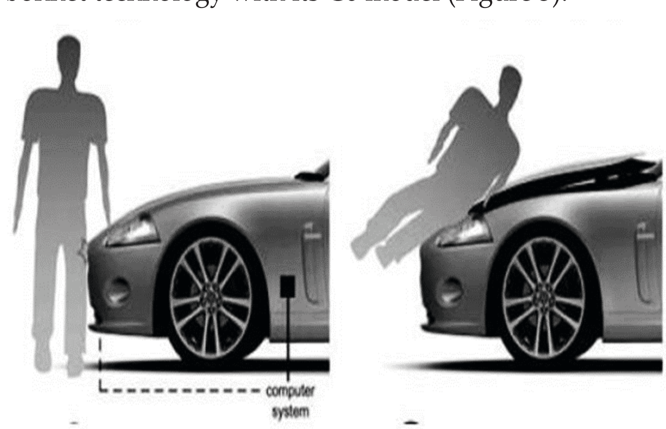

Figure 3. Demonstration of the operation of the active bonnet system in the event of a collision with a pedestrian [5]

Pedestrian airbag

The pedestrian airbag is similar to the airbags found in a car. They are activated in milliseconds and opened in front of the vehicle's windscreen, closing the pedestrian-airbag contact profile. When activated, the airbag system is filled with gas, its inflation raises the bonnet by a height of 10 cm (it is partially opened in order to keep the front fixed and the rear free). The obtained distance between the rigid parts in the engine compartment and the bonnet opens the space for the deformation of the bonnet, whose task is to amortize the consequences of the impact on the pedestrian.

The parts of the pedestrian airbag system are (Figure 4):

1. pedestrian protection module,
2. pedestrian airbag,
3. two discharge drive joints,
4. seven pedestrian sensors.

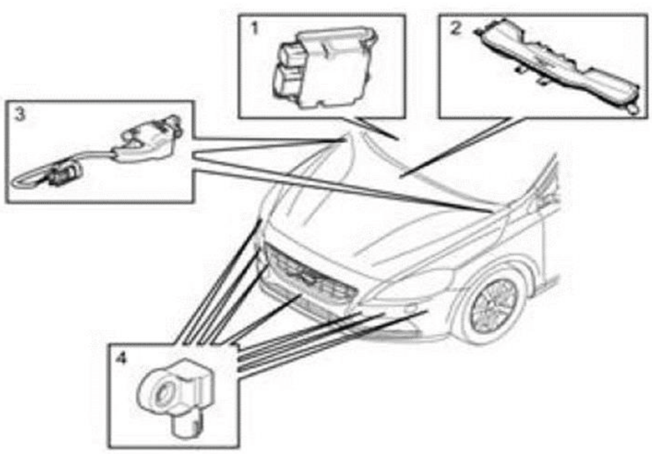

Figure 4. The parts of a pedestrian airbag system[5]

Google patent of gluing pedestrians to a vehicle

The systems described above have the task of reducing the consequences of a primary impact on pedestrians, but a secondary impact to the ground, another vehicle, or another pedestrian should also be analyzed. Google experts are considering a solution to keep the pedestrian's body on the vehicle in order to reduce the injury caused by the pedestrian's body falling to the ground.

In the event of a collision of the pedestrian's body with the vehicle, it is necessary to activate the adhesive coating which should keep the pedestrian's body on the vehicle and continue to carry it glued until the vehicle stops. This system needs to be combined with other known pedestrian protection systems. It is designed as equipment for future smart cars developed by Google. It should be noted that this system, unlike the previously mentioned, is in an early stage of development and cannot be developed until Google solves the problem of glue and its current i.e. temporal function, as well as the termination of the gluing function, after which the body of the pedestrian should be separated from the car after the accident and given medical assistance [1] .

It is an innovation that is based on an adhesive coating whose mass is on the front of the vehicle and which is activated in the event of a collision between a vehicle and a pedestrian or animal. Google's described adhesive coating of the vehicle works in the same way as adhesive tapes for catching flies (Figure 5).

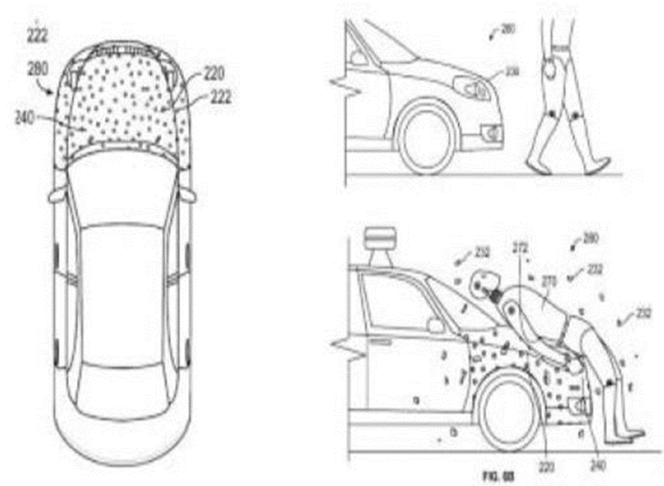

Figure 5. Sticky surface on the front of a Google vehicle [5]

CONCLUSION

Designers of new generations of cars are trying to make effective pedestrian protection systems in traffic where there are the most of them, i.e. in settlements, in zones of speeds less than 60 km/h. The presented active pedestrian safety systems in the form of equipment for pedestrian detection and automatic braking enable the avoidance of collisions with pedestrians at speeds of 40 km/h, and the reduction of consequences at speeds up to 80 km/h.

Night View systems that provide better visibility at night and in reduced visibility conditions also have significant security risk reduction effects. The constructive design of the bumper and the front profile of the vehicle reduces the consequences of collisions of vehicles with pedestrians in the first contact phase of the body with the front part of the vehicle.

Some of the automotive industries are conducting experiments with vehicles colliding with pedestrians.

Experiments with an active bonnet or pedestrian airbag work effectively in the second phase of a vehicle collision with a pedestrian, while the Google patent for gluing pedestrians to a vehicle prevents the consequences of the third phase, prevents the consequences of the third phase, i.e. bouncing the body off the vehicle and falling to and sliding on the ground.

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[1] Zahavi Y. and Ryan, M. James. Stability of Travel Components Over Time. *Transportation Research Record*, 750 (1980), 70-75.

Book [2]

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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.

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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.

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