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Original scientific paper

Commercial vehicles safety management

Dusan Mladenovic[1], Djordje Stanisavljevic[2], Ivan Ivkovic[3], Dragan Sekulic[4]

Abstract – **Monitoring and analysis of commercial vehicles safety is an important component of traffic safety management. In highly developed countries, despite the increase in the number of vehicles on the road, the number of fatalities in traffic accidents is decreasing. Successful commercial vehicles management needs to provide better efficiency, increase traffic safety and decrease environmental impact. In this paper, an analysis of the commercial vehicles` road safety in the Republic of Serbia will be presented with a comparison at the EU level. This paper aims to present the potential impact of the commercial vehicles` active safety systems on improving road safety in the Republic of Serbia. The obtained results will show the potential number of fatalities in commercial vehicles accidents that could be avoided by using some of the commercial vehicles` active safety systems.**

Keywords – **commercial vehicles, traffic safety, safety management.**

I. INTRODUCTION

Commercial vehicles, trucks and buses, have a significant impact on the economic and social development of every society. Road freight transport is the backbone of trade and commerce on the European continent. Trucks offer the most flexible freight transport and they carry 71.3% of all freight transported over Europe. The performance of road freight transport (measured in billion tonne-kilometres) grew by 14.3% between 2000 and 2014. Despite an increase in freight transport, fatalities involving heavy goods vehicles decreased by 53% between 2001 and 2014. [2]. Buses are the most cost-efficient and flexible form of public transport with the lowest carbon footprint per passenger of any form of motorized transport. In the EU, 55.7% of all public transport journeys (or 32.1 billion passenger journeys per year) are made by urban and sub-urban buses [1]. Commercial vehicles are also an important part of multimodal transport.

Continuous increase in the number of vehicles on the road leads to new challenges in commercial vehicles safety management. The projected increase in demand for freight transport in the future, between 2010 and 2050, is about 57% [10]. Increasing transport needs leads to an increase in the number of vehicles on the road, which creates new challenges for improving road safety and reducing emissions. It is therefore very important that increasing mobility level is accompanied by adequate improvement of road safety, which is primarily reflected in the reduction of the number of fatalities in traffic accidents. Due to limited capacities and limited possibilities of constructing new roads, better optimization of the use of the existing infrastructure is required, which can be achieved with better management.

Successful commercial vehicles management needs to comprise three main components: safety, efficiency and environmental impact. In this paper, the focus will be on safety. Commercial vehicles are involved in many fatal traffic accidents, which mainly occur due to driver error. Traffic accidents involving commercial vehicles usually have more severe consequences due to the mass of commercial vehicles. In addition to the direct consequences of traffic accidents involving commercial vehicles (fatalities, injured, material damage, emergency service costs, etc.) the consequences of these accidents are also the lost productivity of commercial vehicles, costs of insurance of cargo and passengers, loss of confidence in the transport company, etc. On improving commercial vehicles safety, advanced active safety systems can significantly influence, by eliminating weaknesses and wrong driver decisions. Nowadays, mechatronic systems and components are present throughout almost the entire modern vehicle [11].

II. ANALYSIS OF COMMERCIAL VECHILES SAFETY IN THE REPUBLIC OF SERBIA

Commercial vehicles safety analysis includes analysis of fatal traffic accidents that occurred on the territory of the Republic of Serbia in the period from 2013 to 2018. Data for this analysis are used from "The integrated database of characteristics of traffic safety" of the Road Traffic Safety Agency of the Republic of Serbia. Certain values obtained by analysis for the Republic of Serbia are compared with the values for the level of EU. At the time of writing this paper (conducting the research), only data about road accidents up to 2016 were available for the EU level [12].

The analysis includes all fatal traffic accidents involving commercial vehicles, regardless of whether the accidents were caused by the failure/error of a commercial vehicle driver. An ETAC study (European Truck Accident Causation) found that truck drivers were responsible for the occurrence of 25% of traffic accidents and that 86% of road accidents were caused by human error [9]. In the EU, no other occupational group suffers as many fatalities in the workplace as professional drivers [6].

[1]PhD Dusan Mladenovic, Faculty of traffic and transport engineering, Vojvode Stepe 305, Belgrade, Serbia, d.mladenovic@sf.bg.ac.rs
[2]Djordje Stanisavljevic, student of Faculty of traffic and transport engineering, Vojvode Stepe 305, Belgrade, Serbia, djordjevr@gmail.com
[3]PhD Ivan Ivkovic, Faculty of traffic and transport engineering, Vojvode Stepe 305, Belgrade, Serbia, i.ivkovic@sf.bg.ac.rs
[4]PhD Dragan Sekulic, Faculty of traffic and transport engineering, Vojvode Stepe 305, Belgrade, Serbia, d.sekulic@sf.bg.ac.rs

In the Republic of Serbia, in the period from 2013 to 2018, 954 people were killed in traffic accidents involving commercial vehicles. Of these, 765 people were killed in traffic accidents with trucks, and 189 people were killed in bus accidents (Fig. 1.).

In the period from 2013 to 2016, the average annual percentage of fatalities in accidents involving trucks of all road fatalities in the Republic of Serbia is 21%, and at EU level 15%. In the same time period, the average annual percentage of fatalities in accidents involving buses or coaches of all road fatalities in the Republic of Serbia is 5,5%, and 2,5% at the EU level (Fig. 2.).

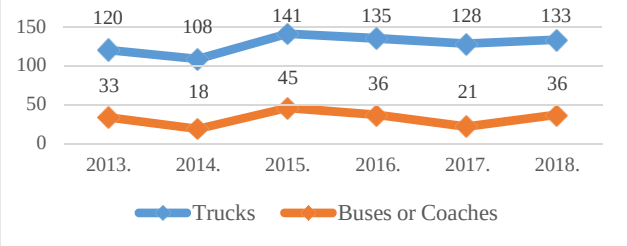

Fig. 1. Number of fatalities in accidents involving commercial vehicles in the Republic of Serbia

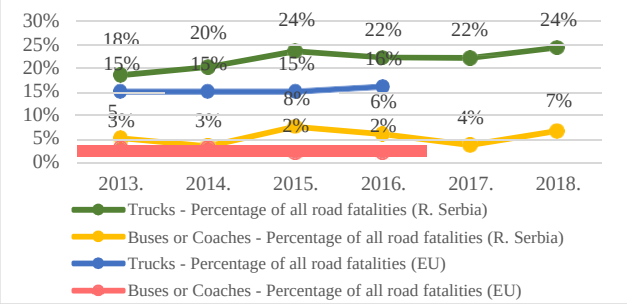

Fig. 2. Percentage of fatalities in accidents involving commercial vehicles of all road fatalities

Between 2013 and 2016, at the EU level, the fatality rate per million population in accidents involving commercial vehicles has an almost constant value. In the observed period, the fatality rate per million population in the Republic of Serbia for trucks is up to 2.6 times higher than at the EU level, and up to 4.5 times higher for buses. On every million inhabitants in the EU, an average of 9.2 people annually were killed in traffic accidents involving commercial vehicles and that number in the Republic of Serbia is 22.3 (Fig. 3).

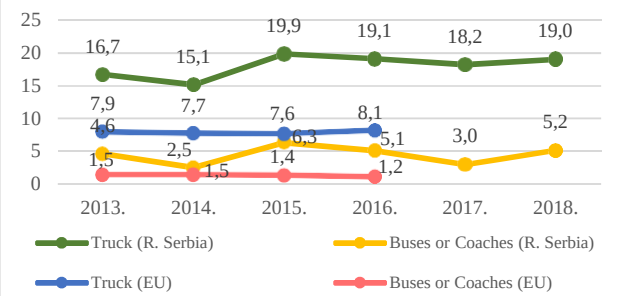

Fig. 3. Fatality rates per million population in accidents involving commercial vehicles

In the Republic of Serbia, 48% of all fatalities in accidents involving commercial vehicles are passenger car occupants, 46% at the EU level, and 31% are vulnerable road users in the Republic of Serbia, and 25% at the EU level (Fig. 4., Fig. 5.).

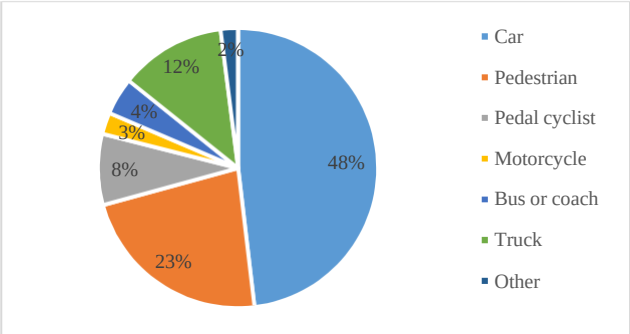

Fig. 4. Distribution of fatalities in accidents involving commercial vehicles by road user type, Republic of Serbia, 2013-2018

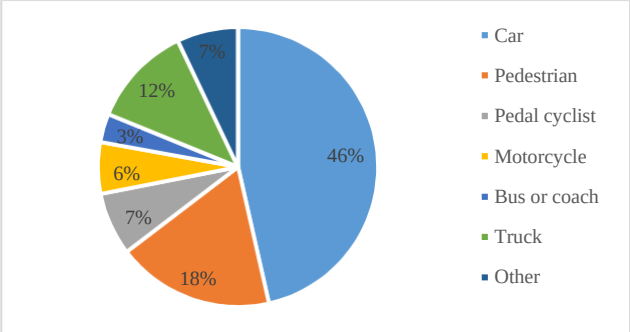

Fig. 5. Distribution of fatalities in accidents involving commercial vehicles by road user type, EU, 2013-2016

The most fatal traffic accidents involving commercial vehicles are from the group of accident type “RA with minimum two vehicles-without turning” (42%), followed by the „RA with pedestrians“ (25%), „ RA with minimum two vehicles-turning or crossing“ (20%), „RA with one vehicle“ (7%) and „RA with parked vehicles” (6%) (Fig. 6.).

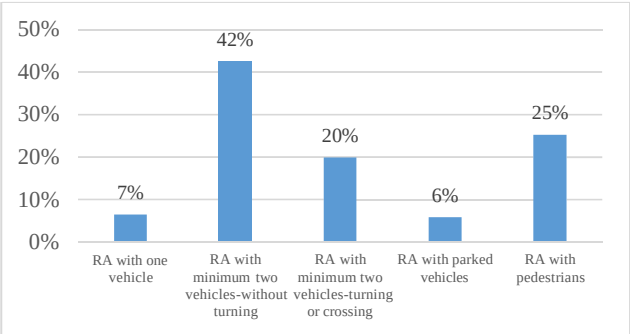

Fig. 6. Distribution of fatal accidents involving commercial vehicles by accident type, Republic of Serbia, 2016-2018

The distribution of fatal traffic accidents involving commercial vehicles shows that more traffic accidents occurred in the urban areas, 55% to be exact, while 45% occurred outside the urban areas (Fig.7.).

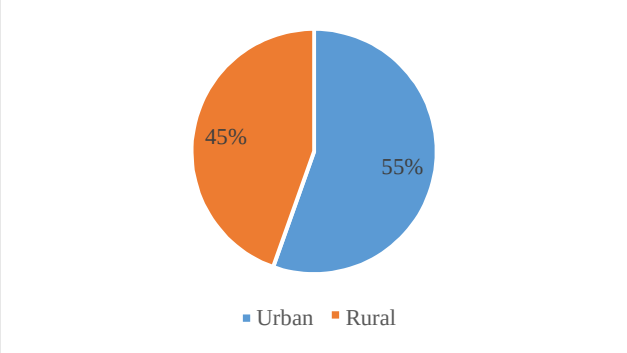

Fig. 7. Distribution of fatal accidents involving commercial vehicles by road type, Republic of Serbia, 2013-2018

III. COMMERCIAL VEHICLES ACTIVE SAFETY SYSTEMS

Automated systems in vehicles offer significant potential in reducing the number of traffic accidents, increasing the comfort of drivers and reducing greenhouse emissions.

Electronic Stability Control (ESC) system stabilizes vehicle movement in all driving conditions and situations within the limits of physics [11]. ESC system has a great influence on the prevention of rollover of commercial vehicles. ESC systems can lead to an estimated 18% reduction in overall fatal crash involvement risk [3].

Brake Assist System (BAS) aims to solve the problem of insufficient pressure on the brake pedal in critical situations. The system monitoring the way that the driver uses the brake pedal, and if recognizes the panic requirement for braking, automatically increases the pressure in the brakes [5]. BAS system can reduce the risk of fatal crash involvement in rear-end, side and head-on crashes, crashes with pedestrians, parked (stopped) vehicles and object on road by 8% of each [3].

Collision warning system is designed to warn the driver if recognizes that a risk of collision exists, thereby directing the driver`s attention to the danger [4]. Commercial vehicles can be equipped with systems that monitor the black spots around the vehicle and warn the driver of potential collision when cornering, changing lanes or driving reverse. This system can reduce the risk of fatal crash involvement in rear-end, side and head-on crashes, crashes with pedestrians, parked (stopped) vehicles and object on road by 12% of each [3].

Intelligent speed adaptation (ISA) systems warn and/or prevent the driver from speeding [4]. ISA is a collective term for various systems. Depending on how it works, the ISA system can be open, half-open and closed. In this paper, the effects of a closed ISA system, which limits the speed automatically if the speed limit is exceeded, will be analyzed. ISA system can reduce risk of fatal crash involvement in rear-end, side and head-on crashes, crashes with pedestrians, parked (stopped) vehicles and object on road by 50% of each [3].

Adaptive Cruise Control (ACC) is a system that will enable the vehicle to maintain a driver-defined distance from the preceding vehicle while driving within a maximum speed limit - also set by the driver [7]. The fatal accidents prevention potential of the ACC system is 25% for rear-end collisions [3].

Lane departure warning (LDW) systems assist drivers in keeping their lanes by warning drivers when their vehicle is in danger of leaving the lane unintentionally (mainly due to lack of driver attention). These systems don`t have a direct impact on the direction of vehicle movement [7]. LDW systems can reduce the risk of fatal crash involvement in head-on and crash during parallel driving, run-off-road collisions and run-of-road and collision with an object outside road by 25% of each [3].

Alcohol ignition interlocks systems check the alcohol intoxication of the driver when starting the vehicle and prevent the start of the vehicle when the driver is intoxicated (breath test) [8]. During driving the system also checks intoxication at specific intervals. These systems can reduce the risk of fatal drunk driving crashes by 75% [3].

Drowsy and fatigued driver detection systems monitor the condition of the driver. These systems tracking predefined parameters and warn the driver of drowsiness, distraction and inattention [7]. The fatal accidents prevention potential of these systems is 10% [3].

IV. IMPACT OF COMMERCIAL VEHICLES ACTIVE SAFETY SYSTEMS ON IMPROVING ROAD SAFETY IN THE REPUBLIC OF SERBIA

In this paper, given that in the Republic of Serbia the representation of active safety systems in commercial vehicles is extremely small, the evaluation of the potential impact of these systems on improving road safety is based on the assumption that all vehicles are equipped with individual systems and all systems are all-time during driving turned on.

Based on the calculation method, possible annual effects of commercial vehicles` active safety on improving road safety are assessed and shown in Table I. In this table, the possible annual reduction in the number of fatal accidents and fatalities, in the Republic of Serbia, is shown. The greatest effects are provided by the Intelligent Speed Adaptation (ISA) system. In other words, using this system in all commercial vehicles, it is possible to annually prevent the occurrence of 59 fatal traffic accidents, thus saving 68 lives. By using the Electronic Stability Control (ESC) system in all commercial vehicles, it is possible to annually prevent the occurrence of 24 fatal traffic accidents and thus save 28 lives.

TABLE I
POTENTIAL EFFECTS ON IMPROVING ROAD SAFETY OF COMMERCIAL VEHICLES ACTIVE SAFETY SYSTEMS

System		Head-on crash	Side crash	Rear-end collisions	Crash during parallel driving	Crashes with parked (stopped) vehicles	Run-of-road collision	Run-off-road and collision with object outside road	Crash with pedestrian	Total
Electronic stability control	Fatal accidents	-	-	-	-	-	-	-	-	23.9
	Fatalities	-	-	-	-	-	-	-	-	27.9
Brake assist system	Fatal accidents	3.9	0.9	1.5	-	0.5	-	-	2.6	9.4
	Fatalities	5.0	1.0	1.7	-	0.6	-	-	2.6	10.9
Collision warning system	Fatal accidents	5.9	1.3	2.3	-	0.7	-	-	3.8	14.0
	Fatalities	7.4	1.6	2.5	-	1.0	-	-	3.8	16.3
Intelligent speed adaptation	Fatal accidents	24.5	5.5	9.5	-	3.0	-	-	16.0	58.5
	Fatalities	31.0	6.5	10.5	-	4.0	-	-	16.0	68.0
Adaptive cruise control	Fatal accidents	-	-	4.8	-	-	-	-	-	4.8
	Fatalities	-	-	5.3	-	-	-	-	-	5.3
Lane departure warning	Fatal accidents	12.3	-	-	0.3	-	1.3	1.0	-	14.8
	Fatalities	15.5	-	-	0.3	-	1.5	1.0	-	18.3
Alcohol ignition interlocks	Fatal accidents	-	-	-	-	-	-	-	-	7.5
	Fatalities	-	-	-	-	-	-	-	-	8.3
Drowsy and fatigued driver detection systems	Fatal accidents	-	-	-	-	-	-	-	-	13.3
	Fatalities	-	-	-	-	-	-	-	-	15.5

V. CONCLUSION

This paper aims to point out the importance and possible level of contribution of active safety systems of commercial vehicles. As human errors continue to be a major cause of traffic accidents, measures aimed at reducing human errors play a significant role. The driver clearly needs help, and modern vehicle systems can eliminate his weaknesses and wrong decisions. The vehicle should prevent a traffic accident when a driver error occurs, a road fault or other hazardous situation, and the vehicle should prevent or mitigate the consequences of a traffic accident.

The presence of modern systems in vehicles is directly linked to the average age of the fleet. Newer vehicles equipped with modern active and passive safety systems are safer than old ones. Financial subsidies and benefits (in the form of reduced vehicle registration taxes, etc.) for the purchase of a new vehicle equipped with state-of-the-art active safety systems can contribute to improving traffic safety.

Proper use of advanced systems is just as important as installing them. In order to take full advantage of the effects that the systems provide, adequate driver training is required. No system can go beyond the laws of physics. At best, systems can make the most of what is available. Modern vehicle systems can also have a negative impact on the driver. If the driver relies too much on the systems while driving, his attention may be reduced. Reduced attention can also be affected by the large amount of information and alerts that the driver receives from the system. Too much confidence in the systems can cause the driver to take some risky traffic manoeuvres.

It is necessary to establish monitoring of the effect of modern active vehicle safety systems and evaluate their short, medium and long-term impact on traffic safety. Systems with proven efficiency should be provided by law as a mandatory part of the equipment of all vehicles. Today, most active safety systems can be shut down by the driver. The subject of discussion must be whether it is in the interest of traffic safety, because what is the purpose of the system if they are switched off in an emergency?

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