SMART SYSTEMS FOR SAFE DRIVING

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Abstract: *Excessive speeds and unsuitable driving speeds are the key cause of the road traffic accident, causing more than 50% of traffic accidents with fatal consequences. The solution to this problem is the application of modern technological solutions, as smart systems in the vehicle. The use of these systems has become an integral part of daily driving experience, and it is necessary to explore the advantages and challenges of their impact on driving safety. In recent years, the process of introducing smart systems in the vehicle is accelerated, such as electronic stability control, intelligent speed control, automatic braking, etc. However, such systems can only help them if drivers know them properly. Therefore, in this work, the selected vehicle sample shows the results of the research conducted with the aim of understanding the use of smart systems and their impact on improving driving safety. The collected data is processed using a computer program, adapted to handle this type of data. The hi-squared test method was used to verify certain hypotheses. The obtained results point to the possibility of significant impacts of smart systems to improve driving safety, and based on which concrete measures for their use are proposed.*

Key words: *unsuitable speed, smart systems, safe driving.*

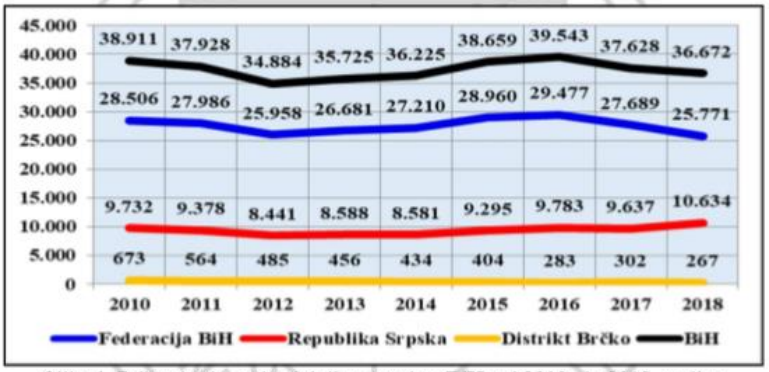
1. INTRODUCTION

In 2020, a 50 percent reduction in the number of fatalities is planned - 15,750), 25,100 people died on the roads of the EU in 2018, and another 135,000 were seriously injured. According to statistical indicators, human error is the cause of 90% of traffic accidents. The new mandatory vehicle safety features that have been adopted will prevent drivers from making fewer mistakes, reduce the number of accidents and pave the way for future connected and automated driverless driving. It is estimated that these measures could save up to 10,500 lives and avoid nearly 60,000 seriously injured between 2020 and 2030, contributing to the EU's long-term goal and vision of approaching zero death rates by 2050. injured in road traffic. On the roads in BiH from 2010 to 2018, the number of fatalities decreased by 78 or 22% (by 2020, a 50 percent reduction in the number of fatalities is planned - 177), and in 2018, 277 people lost their lives in traffic accidents. persons, which is 7% less than in 2017. 1,653 people were seriously injured, which is 2.7% more than in 2017.

2. STATE OF ROAD SAFETY IN BOSNIA AND HERZEGOVINA

The review of the state of road traffic safety in absolute terms refers to the period from 2010 to 2018 for Bosnia and Herzegovina, in accordance with the decade of safety, i.e. the Action Plan for Road Traffic Safety.

Figure 1 shows the number of traffic accidents in Bosnia and Herzegovina and by entities, where it is important to consider the trend from 2010 to 2018 and 2020.



Slika 1. Prikaz broja saobraćajnih nezgoda u BiH, od 2010. do 2018. godine
Izvor. Izradili autori prema podacima [1]

Figure 1. Overview of the number of traffic accidents in Bosnia and Herzegovina from 2010 to 2018. Source. Made by the authors according to the data.

The analysis of the number of traffic accidents from 2010 to 2018 shows that a total of 336,175 traffic accidents occurred in that period, with minor deviations, an average of 37,353 traffic accidents per year, 102 traffic accidents per day. Figure 2 shows the number of people killed in traffic accidents in Bosnia and Herzegovina and by entities, where it is also important to consider the trend from 2010 to 2018 and 2020.

Slika 2. Prikaz broja poginulih u saobraćajnim nezgodama od 2010. do 2018. godine
Izvor: Izradili autori prema podacima [1]

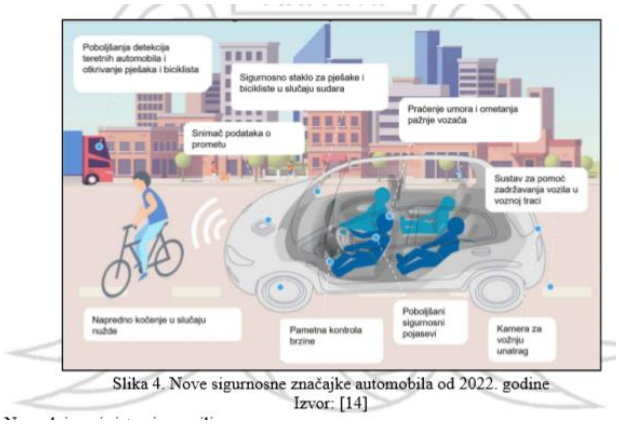
The data from Figure 2 indicate that in 2018 in Bosnia and Herzegovina the least number of people were killed in traffic accidents (277) looking at the observed period from 2010. This is 78 people less or 22% compared to 2010. A total of 2,881 people died in those nine years, or an average of 320 people a year. The data also indicate that in 2018 in Bosnia and Herzegovina there were the least traffic accidents with material damage, 1,315 accidents less than in 2017 or 4.3% less, which may be partly due to the increasing use of the European Traffic Accident Form by drivers who participated in a traffic accident with minor property damage. Analyzing and comparing the trend of planned and actual number of deaths at the level of the state of Bosnia and Herzegovina it can be concluded that the situation is similar, Figure 3. The figure shows that the situation until 2014 was satisfactory in terms of planned and actual deaths in traffic accidents.

Slika 3. Planirani i stvarni trend broja poginulih na cestama BiH od 2010.-2020. godine
Izvor: Izradili autori prema podacima [1]

The trend in the death rate of the number of deaths per hundred thousand inhabitants is slightly declining, especially in the last four years. The lowest number of deaths per one hundred thousand inhabitants since 2010 is in 2018, when the death rate was 7.2 deaths per hundred thousand inhabitants or 72 persons per million inhabitants. However, in 2015, there was an increase in the actual number compared to the planned number of deaths, and this trend continued until 2018. The actual number of fatalities increased by 22% compared to the planned, and compared to 2010 it decreased by 28% or 78 fewer fatalities. Taking into account the set goal of reducing the number of deaths by 50% by 2020, it can be clearly concluded that it will be very difficult to achieve it, because the number of deaths in the next two years should be 56%, and for what there are very small prospects.

3. NEW SAFETY CHARACTERISTICS OF INNOVATIVE VEHICLE SOLUTIONS

In terms of safety, the new vehicle models from 2022 will be equipped with advanced safety features such as advanced emergency braking systems, lane keeping systems and pedestrian and cyclist detection systems for trucks, Figure 4. The team would measures could save up to 10,500 lives and avoid almost 60,000 serious injuries between 2020 and 2030, contributing to the EU's long-term goal of approaching zero death rates and serious injuries by 2050.



Slika 4. Nove sigurnosne značajke automobila od 2022. godine
Izvor: [14]

Advanced new systems in vehicles are: • advanced emergency braking (cars), • facilitating the installation of engine blocking devices due to driver alcoholism (cars, vans, trucks, buses), • detecting drowsiness and attention (cars, vans, trucks, buses) , • recognizing and preventing distractions (cars, vans, trucks, buses), • recording data on events or traffic accidents (cars and vans), • emergency stop signal (cars, vans, trucks, buses), • collision testing for passenger protection - improved seat belts (cars and vans), • increased head impact zone for pedestrians and cyclists-safety glass (cars), intelligent speed assistance (cars, vans, trucks, buses), • assistance in maintaining vehicles in driving lanes (cars, vans), • protection of passengers from a side impact (cars, vans), • reversing camera or detection system (cars, vans, trucks, buses), • tire pressure control system (vans, trucks, buses), • detection and warning of unprotected road users (trucks and buses), • improvements for direct detection of unprotected participants from the driver's position (trucks).

Mentioned new minimum vehicle safety requirements will take effect in 2022. It is important that these requirements will also improve the safety of all road users, not just the passengers in the vehicle. Truck drivers will have better visibility of pedestrians and cyclists around their vehicles, all drivers will find it easier to stay within the set speed limits, and automated emergency braking systems will be able to detect people, not just other vehicles.

4. SMART SYSTEMS FOR SAFE DRIVING

Through the scope and manner of using smart systems in the vehicle, the aim was to investigate the age structure of the vehicle, the level of driver information and knowledge of smart systems, opinions on new technologies and trends, innovative technological solutions and the possible impact of smart systems on driving safety.

4.1. Research methodology

The conducted research consisted of checking the opinions and knowledge of drivers who drove the vehicle using or not smart systems. A survey questionnaire was prepared for the research, the content of which was adapted to this research, in which 27 questions were asked, distributed in individual content areas. The first content area referred to general data related to drivers (gender, age group, possession of a driver's license, participation in a traffic accident). The second content area referred to the make and type of vehicle, year of manufacture and first registration and type of transmission. The third part referred to the opinion, information and knowledge of the use of smart systems and to the assessment of the benefits of smart systems. This problem orientation determined two research goals. The first, to what extent are the opinions and knowledge of drivers related to the use of smart systems and the second, to what extent are smart systems related to driving safety.

4.1.1. Data collection and processing

Data collection was conducted through a survey for drivers [17] in the fourth month of 2019 in the Central Bosnia Canton, Bosnia and Herzegovina. Drivers were interviewed directly by random selection according to the established methodology, after being excluded from traffic. The survey was conducted by students and assistants of the Faculty of Traffic and Transport Engineering Travnik in Travnik with the help and cooperation of the traffic police. The survey was conducted with 302 drivers, which is an appropriate sample for trend research using an appropriate methodology. Frequency distributions and percentages were used to process the data, and the chi-square test method was used to test certain hypotheses. The statistical significance of the differences between the observed distributions of certain results observed on a specific sample with theoretical expectations according to the principle of proportionality of the occurrence of a particular distribution of results was tested by the chi-square test method. The relationship between observed and expected results, statistically significant or not, is the basis for concluding about the possible causes of the observed distributions. All statistical tests were performed at the risk level of

5%. A computer program - Statistical Package for Social Sciences (SPSS 20.0) [18] was used for data processing, which is a program for applying a chi-square test with a database adapted to computer processing.

4.1.2. Hypothesis testing model

To measure the deviation between the empirical and expected theoretical frequencies in a sample of n elements, a chi-square test is used [19]:

where: fi - empirical frequency; fti - theoretical frequency; k - number of classes.

The chi-square test □2, was used to verify the hypotheses about the agreement of the empirical with the theoretical distributions, forming the size □2 according to the stated pattern, with a risk of 5%. In doing so, the condition that the frequencies fi are greater than 5 must be met. If fi is less than 5, which often happens in the initial and final classes, then these classes are included in the adjacent ones. The chi-square test actually checks the probability of a random occurrence of the difference between the observed frequencies (values determined by the research) and the theoretical frequencies (those expected according to the random distribution). If the □2 value reaches the level of statistical significance (eg $p < 0.05$) then it can be argued with 95% certainty that the differences between the observed and theoretical frequencies are not conditioned by chance, but that it is basically a systemic factor.

4.2. Interpretation of research results

The analysis of the research results provides information on the prevalence, frequency and intensity of a particular opinion of the surveyed drivers in response to a particular question. Frequency distributions, percentages, and statistical tests will be used to comment on the results below, in order to link these data and offer possible interpretations of the status quo. The questions that were taken into account were put in relation to individual parameters and tested using the □2 test.

Table 1 shows the number and percentage of drivers surveyed by gender and age group.

Table 1. Number and percentage of respondents

Tablica 1. Broj i postotak anketiranih vozača prema spolu

2. Spol					
		Frekvencija	Postotak	Važeći postotak	Kumulativni postotak
Važeći	žene	57	18,9	18,9	18,9
	muškarci	245	81,1	81,1	100,0
	Ukupno	**302**	**100,0**	**100,0**	

Izvor: Izradili autori prema podacima [17].

4.2.1. Frequencies of occurrence of individual answers and the relationship of individual theses

Frequency of occurrence, individual and cumulative percentage will be used to show the answers of the surveyed drivers to individual questions out of a total of 27. 5. Have you been involved in a car accident so far? Of the 302 drivers surveyed, 200 or 62.2% did not participate in the accident, as

6. What brand of car do you drive? Of the 302 drivers surveyed, 89 or 29.5% said they drive a Volkswagen, followed by 32 or 10.6% who drive an Audi and 29 or 9.6% who drive a Mercedes.

7. What type of car is it? Among 302 drivers, the most common type of vehicle is the Golf 2 and Golf 4, 5.6% each, followed by the Passat with 5.3%.

8. Year of first registration? If the trend is observed, then 2001 to 2004 prevail, which represents 31.5% or 95 vehicles of the total number of surveyed drivers based on the year of first registration, which practically means that vehicles in these categories are aged 15 to 18. . However, it is obvious that there are also older vehicles, more than 20 years old, which represent 13% or 39 vehicles. There are also vehicles up to 10 years old, which represent 26% or 79 vehicles out of a total of 302 vehicles surveyed drivers. Based on these data, it can be concluded that the year of first registration shows a high age of vehicles in the SBK area, the average age is 15 years.

9. Year of car production? Figure 5 shows the frequencies of the structure of the car production years of the surveyed drivers.

Slika 5. Prikaz frekvencija godina proizvodnje vozila anketiranih vozača
Izvor: Izradili autori prema podacima [17]

Figure 5. Display of frequencies of vehicle production years of surveyed drivers Source: Made by the authors according to the data [17]

If the trend is observed, then vehicles manufactured from 2001 to 2004 prevail, which represents 34.0% or 103 vehicles of the total number of surveyed drivers based on the year of production, which practically means that vehicles in these categories are also older than 15 up to 18 years. However, it is obvious that there are also older vehicles for more than 20 years, which represent 17.2% or 52 vehicles. There are also vehicles up to 10 years old, which represent 19.2% or 58 vehicles out of a total of 302 vehicles of the surveyed drivers. Based on these data, it can be concluded that the year of production shows a high age of vehicles in the Central Bosnia Canton area, ie the average age is 14.5 years.

12. What do you think about cars that have smart systems?

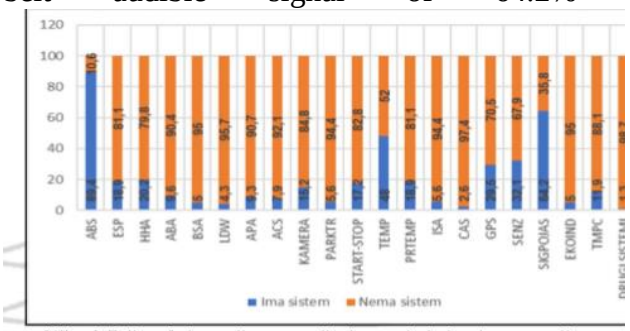
Of the 302 drivers surveyed, 91.1% or 275 said they supported such cars, while 7.3 or 22 considered them difficult to drive. This data points to the conclusion that drivers have support for the use of smart systems.

13. What do you think about using a car without a driver? Of the 302 drivers surveyed, 60.3% or 182 do not support the use of driverless cars, 10.9% or 33 consider them dangerous, 17.5% or 53 consider them smart, while the same percentage of 5, 6% or 17 drivers support it or are not aware of using a driverless car. Thus, 71% of drivers or over two thirds of them do not support the use of driverless cars. This indicates insufficient knowledge of innovative technological

solutions and the advantages that such solutions bring.

14. Which in-vehicle smart system should be used the most? Of the 302 drivers surveyed, 21.5% or 65 (slightly more than one-fifth) reported the Anti-Lock System (ABS), 9.9% or 30 did not know, 9.3% or 28 reported GPS, 6.3% or 19 of them indicate sensors, etc. These data indicate the rare use of certain smart systems, and ABS should be used the most, which is understandable given the age of the vehicle, in the production of which most new innovative technological solutions were not even used.

15. What smart systems does your car have? All 302 surveyed drivers stated which smart systems their car has and which they do not, Figure 6. The vast majority of drivers stated that they do not have the majority of smart systems offered, and only for two stated that 89.4% or 270 of them have ABS. and a seat belt audible signal of 64.2%



Slika 6. Prikaz frekvencija pametnih sistema koje ima/nema vozilo voza
Izvor: Izradili autori prema podacima [17]

So, drivers stated that 98.7% of them do not have other systems in the vehicle, 97.4% of them do not have CAS in the vehicle, 95.7% of them do not have LDW in the vehicle, 95.0% of them do not have an ECO INDICATOR in the vehicle, 94.4 % of them do not have ISA and PARKTRONIC in the vehicle, 92.1% of them do not have ACS in the vehicle, 90.7% of them do not have APA, 90.4% of them do not have ABA in the vehicle, 88.1% of them do not have TMPC in the vehicle, etc. obtained data, it can be argued that the vast majority of vehicles do not have the majority of smart systems, ie that a very small percentage of vehicles up to 5% have the majority of smart systems. Of course, these are new vehicles, and given the age of the vehicles, most of them do not have smart systems.

19. Which smart vehicle system do you use the most while driving? Of the 302 drivers surveyed, 32.1% or 97 (about one third) reported ABS, 6.3% or 19 reported cruise control and sensors, 5% or 15 reported GPS, 4.3% or 13 reported ABS / ESP and GPS / TEMPOMAT, etc., while 9.3% or 41 do not use any system. Based on these data, it can be concluded that drivers use very little smart systems in relation to the age of the vehicle and the equipment of the vehicle with smart systems. They mostly use ABS (about one third of drivers), which is both logical and understandable considering that it is the first smart system that has long been installed in vehicles.

25. Are you for autonomous cars? All 302 surveyed drivers answered the question whether they are for autonomous cars, driverless cars. Most drivers 62.9% are not for autonomous cars, because they are insecure and afraid, 7.9% of them are also not because they think they are dangerous and unsafe, while 29.1% (almost one third) are still for autonomous cars because they think they are safe.

26. If you, as a driver, had a traffic accident, did that vehicle have smart systems? Responses to the inquiry of all 302 surveyed drivers show that 8.3% of them stated that the vehicle had smart systems, and 91.7% stated that the vehicle did not have smart systems. The relative ratio of the number and percentages of surveyed drivers, Table 3, who participated in the accident as drivers in relation to the fact that their vehicle had smart systems shows a statistically significant difference ($\chi^2 = 32.37$; ss = 2; $p < 0.000$), that there is a general tendency that drivers who have been involved in an accident with a vehicle that had smart systems are more likely to be involved in traffic accidents.

Tablica 3. Broj i postotak anketiranih vozača koji su imali saobraćajnu nezgodu s vozilom koje je imalo pametne sisteme

26. Ako ste kao vozač imali saobraćajnu nezgodu, jeli to vozilo imalo pametne sisteme?				Ukupno
		da	ne	
5. Jeste li do sada sudjelovali u saobraćajnoj nezgodi	NE	4	196	200
	kao vozač	19	67	86
	kao putnik	2	14	16
Ukupno		**25**	**277**	**302**

Izvor: Izradili autori prema podacima [17]

27. If you, as a driver, were in a situation where you had a car accident, did any of the smart systems prevent it from happening or mitigate the consequences? All 302 surveyed drivers responded to the inquiry. 5.3% of them stated that the smart system prevented or mitigated the accident, and 94.7% of them stated that it did not. Table 4 shows the relative relationship of participation in a traffic accident and possession or not of a smart system in a vehicle. The relative ratio of the number and percentages of surveyed drivers, who participated in the accident as drivers in relation to the fact that in their vehicle some smart system prevented or mitigated the accident shows a statistically significant difference ($\square 2 = 13.63$; ss = 2; $p < 0.001$), that there is a general tendency for some of the smart systems to prevent or mitigate an accident, more often involved in traffic accidents.

Tablica 4. Relativni odnos broja i postotka vozača koji su imali saobraćajnu nezgodu u kojoj su pametni sistemi spriječili ili ublažili nezgodu

27. Ako ste kao vozač vozila bili u situaciji da imate saobraćajnu nezgodu, je li neki od pametnih sistema spriječio njeno događanje ili ublažavanje posljedica?				Ukupno
		ne	da	
5. Jeste li do sada sudjelovali u saobraćajnoj nezgodi	NE	195	5	200
	kao vozač	75	11	86
	kao putnik	16	0	16
Ukupno		**286**	**16**	**302**

Izvor: Izradili autori prema podacima [17]

o is the answer yes, specify which? Of the 302 drivers surveyed, 94.7% answered that no smart system prevented the occurrence or mitigation of the accident, and 5% of them stated that it was ABS and 0.3% of them stated that it was ESP. The relative ratio of the number of surveyed drivers, who participated in the traffic accident as drivers in relation to the fact that ABS prevented or mitigated the accident in their vehicle shows a statistically significant difference ($\square 2 = 14.64$; ss = 4; $p < 0.007$), and that there is a general tendency for drivers who have ABS in their vehicle to use it more often to prevent an accident or to mitigate the consequences of a car accident.

4.2.2. A review of the results of research on the use of smart systems

Research on the use of smart systems in this work by drivers while driving was considered in terms of gender of drivers, their age structure, possession of a driver's license, participation in a traffic accident and information and knowledge of innovative technological solutions and smart systems and future development trends and applications. Taking into account the age structure of the surveyed drivers, the results point to the fact that they are most represented with 39.1% of drivers aged 30 to 44, which should be viewed as a trend. This is important because of the approach and knowledge of innovative technological solutions and thinking about new smart systems. Looking at the trend, 46.7% of drivers drive more than 15,000 km a year on average, and 20.5% of drivers drive 10,000 to 15,000 vehicles a year on average. There is a general tendency for male drivers to drive significantly more a year. the vehicle travels miles from the female driver. The results show that so far 28.5% of them participated in the accident as a driver, and 5.3% as passengers. The structure of motor vehicles shows that a maximum of 29.5% are represented by VW vehicles, type GOLF 2 and 4 and PASSAT. Based on the year of the first registration, the average age of vehicles in the SBK area is 15 years, with one third falling into the category of 15 to 18 years, and 13% of vehicles are older than 20 and more years. The trend shows that only 26% of vehicles are in the category up to 10 years of age. In relation to the year of production, the trend is dominated by vehicles manufactured from 2001 to 2004. Which represents 34.0% of the total number of samples, which again leads to the conclusion that vehicles are on average 15 to 18 years old, and that only 19.2% of vehicles or one fifth to 10 years of age. Most of the drivers surveyed, more than 91% of them support cars that have smart systems. One fifth of them or 21.5% think that ABS should be used the most in the vehicle, which is

understandable and logical considering the age of the vehicle, which also indicates the rare presence of other and new smart systems. Their vehicles usually have only two smart systems, ABS 89.4% and a seat belt audible signal 64.2%. Most of the smart vehicle systems mentioned in the survey do not have the surveyed drivers. Based on the obtained research results, it can be argued that the vast majority of vehicles do not have the majority of smart systems, ie about 5% of vehicles have the majority of smart systems, and these are new vehicles. Only 8.3% of the vehicles involved in the accidents had smart systems. Drivers who used ABS or ESP prevented from participating in traffic accidents or mitigated the consequences of accidents. The use of driverless cars, ie autonomous vehicles by more than two thirds of the surveyed drivers, 71% did not find support, because they do not support such a solution. The results show that 69% of drivers do not know the meaning of the term autonomous car, are not familiar with innovative technologies and what they consider dangerous.

5. CONCLUSION FINDINGS

Although, according to indicators, the number of road deaths decreased from 2010 to 2018 in both the EU and Bosnia and Herzegovina the very ambitious goal of a 50% reduction in road deaths by 2020 will not be achieved. The first step that needs to be taken, in order to identify new measures for the next decade, is the analysis of existing measures, programs and Action Plans and their implementation so far. More recently, "smart systems" have been installed in vehicles that can help prevent traffic accidents and save lives. With the new safety features of vehicles that will be mandatory from 2022, the increased use of electric vehicles and the development of e-mobility has a certain future in solving urban problems, from congestion, noise to reducing greenhouse gas emissions. The Bosnia and Herzegovina authorities need to launch various initiatives, in addition to addressing the challenges of using, such as co-financing or encouraging a higher level of awareness among citizens, for the procurement of electric vehicles, in order to improve the quality of life and road safety. The results of research on the use of smart systems in vehicles in this paper and in the area of SBK indicate the following: • The average age of vehicles is from 15 to 18 years, which significantly negatively affects the reliability and technical correctness, and thus has a negative impact on driving safety. ie road safety, • most vehicles do not have innovative technological solutions, or smart systems, which significantly affects driving safety, with the most common ABS, which is given the age of the vehicle and understandable, • the development of e-mobility as one of innovative solutions for future urban mobility and reduction of greenhouse gas emissions, has a good perspective in the context of thinking, but weak and uncertain application and implementation, • use of driverless cars, ie autonomous vehicles currently has no support because drivers do not have the necessary knowledge about autonomous cars , about innovative technologies, and consider them dangerous. Recognizing the benefits offered by smart systems in vehicles, as well as their impact on driving safety, it is essential to continue to encourage their application.

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