NEW TECHNOLOGIES IN TRAINING DRIVERS, DRIVING TEST AND DRIVING IN THE FUTURE

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Summary: Various changes have been introduced into driver training and driving exams over the past period in an attempt to improve the ability of new drivers and reduce the risk of involvement in road accidents. The changes introduced are intended to address the driver's inexperience and behavior of new drivers. This is primarily about introducing a minimum number of hours of driving on the road before passing the driving test, improving the quality of training through new content and methods to achieve high-level skills, longer driving times for exams, self-driving, and hazard perception testing. After obtaining a driving license, trial periods were introduced with restrictions and safeguards for new drivers for up to two years. Despite these measures, participation in road accidents for new drivers between the ages of 18 and 24 is still increasing relative to other age groups. Research suggests that this is likely due to two key factors, lack of driving experience and age-related factors, such as biological development, distraction, sensitivity to environmental events, and psychophysical status. What else can be changed in driver behavior by introducing new technologies, such as e-learning, modern driving simulators, smart vehicle systems, or in the future are autonomous vehicles operated by driverless computers.

Keywords: new technologies, driver training, driving test, driving in the future

1. INTRODUCTION

Road safety in the European Union (EU) has been greatly improved over the past decades, thanks to strong and effective action at EU, national and local level to improve the behavior of road users, vehicles and infrastructure. This is why roads in the EU are the safest roads in the world. The increased safety can be largely attributed to the EU legislative requirements on vehicle safety introduced in recent years as part of the EU's road safety policy [1]. The automotive industry continues to innovate, and regulatory requirements need to be reconsidered in order to ensure that the EU's continued presence in the field of international development continues, as well as its ongoing work to save lives. Impressive progress in reducing road accidents has recently slowed, with an estimated cost of at least € 100 billion a year in road fatalities and injuries [2], and hundreds of families are still affected every year by the effects of road accidents.

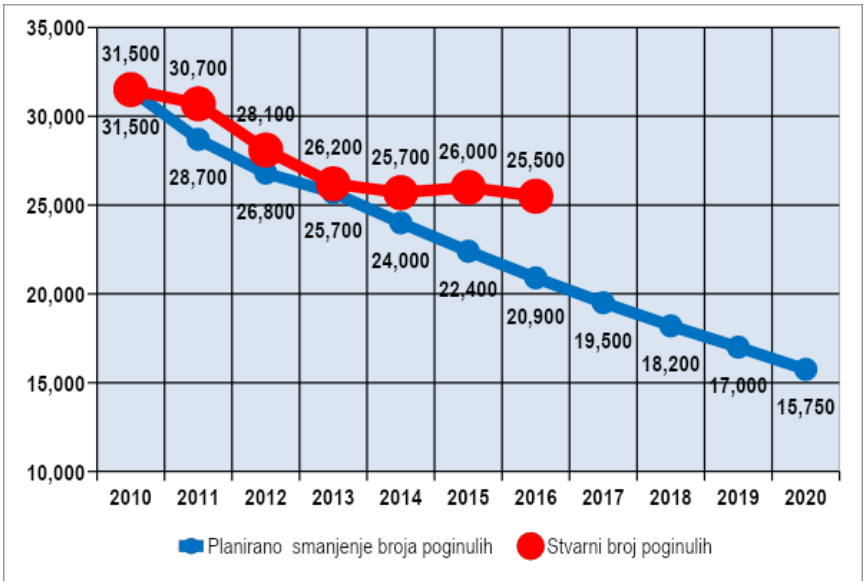
Active safety features and their technological development result in gradual automation of vehicles. They are considered to be key technologies for improving and supporting vehicle automation, which contributes to the digitization of the internal market.

As increased levels of vehicle independence have become a priority for automakers, accurate, resilient, durable and accessible sensor technologies are becoming widely available. They are necessary for the full detection of the vehicle environment, thereby contributing to safety, especially with regard to unprotected road users and reducing congestion and resulting pollution, bearing in mind that 15% of traffic jams in Europe are the result of road accidents [3]. The European Commission intends to contribute to the priorities of promoting the most efficient innovation, the digitalisation of the internal market by fostering security features that are considered key technologies to enhance and support the widespread automation of vehicles.

2. THE IMPACT OF NEW TECHNOLOGIES ON DRIVING AND ROAD SAFETY

In the EU Member States, 500 people are killed weekly in road accidents, most of them drivers, 105 pedestrians and 38 cyclists, and around 2600 people are seriously injured. Sweden has the lowest death toll in road accidents with 2.8 and the United Kingdom with 2.9 deaths per 100,000 inhabitants. At EU level, the estimated total costs generated by the death of a person in a car accident are estimated at EUR 1.1 to 1.3 million. It is estimated that the social costs (rehabilitation, health care, material damage, etc.) incurred as a result of fatalities and injuries on the roads amount to at least EUR 100 billion. In order to achieve the strategic goal of reducing the number of road fatalities by half, from around 31 000 in 2010 to 15 000 by 2020, additional efforts are needed in the EU, given that the objective in question will obviously not be met. Despite all measures being taken, 25,500 people were killed on EU roads in 2016, down 500 from 2015 and 6,000 from 2010, Figure 1.

Figure 1. Planned and actual death toll on EU roads 2011-2020.



According to EC estimates, 135,000 people were also seriously injured on the roads. However, this is not a sufficient step forward to achieve the goal. Most, on average, 55% of fatalities occur on roads outside settlements, 38% occur in urban areas, while only 7% of accidents are caused by highways. A total of 30% of road fatalities are related to pedestrians and cyclists, while this figure in urban areas is almost 43%. These figures generally indicate areas of improvement that can be targeted by amended pedestrian and general safety regulations. The average death rate in car accidents in 2010 was 6.3 deaths per hundred thousand inhabitants, in 2014 it was 5.1 and in 2015 it was 5.15, while in 2016 it was 5 or 50 deaths per million population, which is the best condition so far.

Another significant statistical indicator relates to unprotected road users, with the number of pedestrians being reduced to a lesser extent than expected, while the number of bicyclists killed has recently increased. Innovative technologies and technological advances are increasingly influencing road safety, with significant potential for future improvements in road safety, especially in the area of active vehicle safety and automated and networked driving. Experts say that approximately 95% of road accidents involve some level of human error, while an estimated 75% of accidents are caused solely by human error. According to research results, speeding, distraction and alcohol-fueled driving are among the main causes of human-induced accidents.

Particular attention should be paid to unprotected road users and passengers in the vehicle who are at risk because of their age, that is, the elderly and children. Attention should also be paid to the assessment of technologies utilizing interactions between drivers, vehicles and driver environments such as intelligent transport systems (ITS), contributing to developments in the digital field in line with the Digital Single Market Strategy. Improving the vehicle's minimum safety standards is one of the most effective ways to reduce mortality from serious road injuries. The application of these proposed technologies can necessarily have a major impact on safety, such as the use of a seat belt. For example, the prevalent technology that helps drivers maintain their current driving speed is intelligent speed assistance, which is already offered by several manufacturers in Europe, including Volvo, Ford, Honda, Mercedes, Citroen, Renault and Peugeot.

3. APPLICATION OF NEW TECHNOLOGIES IN DRIVER TRAINING

For the purpose of applying new technologies in driver training, and in the specific case of the application of a modern driving simulator, a survey of the candidates' opinions on the quality of the services provided and the quality of training carried out on a modern driving simulator was conducted.

3.1. Aim of the research

The research consisted of checking the opinions and assessments that stem from the specific thinking of driver candidates towards the use of a modern driving simulator in the post-test training process. Such a problematic determination defines the aim of the research, which is manifested in obtaining and considering the opinion of the candidate about the effects of training a certain number of hours on the driving simulator after passing the test, and before training on the vehicle.

3.2. Data collection

Two survey questionnaires were prepared to collect the data, tailored to the content of the survey. The first questionnaire concerned the training of candidates in a modern driving simulator after passing the test, and the second questioned the opinions of driving instructors on the effects of training candidates on the driving simulator prior to on-board training. The questionnaire on the collection of data on the use of a modern driving simulator to train driver candidates after passing the test consisted of two parts, with a total of 32 questions.

Research results on the use of a driving simulator after passing the test

Of the 35 candidates surveyed who have trained in the modern driving simulator (54.5%) are men and (45.5%) are women. In comparison to the age group, out of 35 candidates surveyed, most of them are more than 25 years old (24.4%), from 19 to 20 years (19.6%), followed by candidates 18 to 19 years (18.2%) , then 17 to 18 years (11.2%), 20 to 21 years (10.4%), 21 to 22 (7.8%), and 22 to 23 (7.8%). Table 1 shows the percentage of candidates surveyed who stated the number of training hours on the simulator. Of the interviewed candidates, 36.3% practiced for three hours, 36.3% spent five hours, 18.3% spent four hours, 9.1% practiced one hour.

Table 1. Percentage of candidates surveyed on the number of training sessions in the simulator

RB.	1. How many hours have you practiced	Percent
1.	0	0,0
2.	1	9,2
3.	2	0,0
4.	3	38,3
5.	4	16,2
6.	5	36,3

Table 2 shows the percentage of candidates interviewed who expressed their enjoyment during simulator training. Of the interviewed candidates, 63.7% said they enjoyed themselves and 36.3% did not enjoy simulator training.

Table 2. Percentage of candidates surveyed on enjoyment during simulator training

RB.	2. Did you enjoy practising	Percent
1.	Yes	63,7
2.	No	36,3

Table 3 shows the percentage of candidates surveyed who stated how much they helped to practice on the simulator. Of the interviewed candidates, 39.3% said a lot, 27.2% said they were mediocre, 23.3% said little and 10.2% did not help.

Table 3. Percentage of candidates interviewed for simulator training assistance

RB.	3. How much did practising on the simulator help you	Percent
1.	A lot	39,3
2.	Mediocre	26,2
3.	A little	23,3
4.	It did not help	10,2

Table 4 shows the percentage of candidates surveyed who stated how realistic the exercises on a driving simulator are with on-board exercises. Of the interviewed candidates, 18.2% said they were very realistic, 54.5% said they were quite realistic and 27.3% said they were a little realistic.

Table 4. Percentage of candidates surveyed about the reality of training in the driving simulator

RB.	4. How realistic are the exercises on the simulator	Percent
1.	Very realistic	18,2
2.	Quite realistic	54,5
3.	A little realistic	27,3
4.	Are not realistic	0,0

Table 5 shows the percentage of candidates surveyed who stated how long it took to adjust on the vehicle. Of the interviewed candidates, 9.1% said they needed 15 minutes, 27.3% said they needed 30 minutes, 18.2% said they needed 45 minutes minutes (45.4%) stated that they needed one lesson.

Table 5. Percentage of candidates surveyed on the time required to adjust to a vehicle

RB.	5. How much time did you need to get used to a vehicle	Percent
1.	15 min	9,1
2.	30 min	27,3
3.	45 min	18,2
4.	1 ns	45,4

Table 6 shows the percentage of candidates surveyed who stated how good the guidance they received while driving. Of the interviewed candidates, 45.4% said they were very clear and sufficient and 54.6% said they were basically good. None of the candidates stated that the instructions could have been clearer or that they were not good.

Table 6. Percentage of candidates interviewed regarding the statement of good guidance

RB.	6. Were the practice instructions good	Percent
1.	Very clear nand enough	45,4
2.	Basically good	54,6
3.	Could have been clearer	0
4.	Were not good	0

Table 7 shows the percentage of candidates surveyed who expressed their views on how realistic driving was when driving on a simulator. Of the interviewed candidates, 33.3% said it was very realistic, 36.3% it was quite realistic, 18.2% it was very realistic and 12.2 %) that it was not realistic.

Table 7. Percentage of candidates interviewed about the reality of driving a simulator

RB.	7. How realistic is the car management on the simulator	Percent
1.	Very realistic	33,3
2.	Pretty realistic	36,3
3.	A little realistic	18,2
4.	Not realistic	12,2

Table 8 shows the percentage of candidates interviewed who stated their reality about driving on a simulator. Of the interviewed candidates, 36.3% of them declared a lot of realities, 27.3% of them declared a pretty reality, 27.3% said a little about reality (9.1%) pleaded no reality.

Table 8. Percentage of candidates surveyed about the reality of driving in a simulator

RB.	8. How much reality is there in driving on the simulator	Percent
1.	A lot of reality	36,3
2.	Quite much reality	27,3
3.	A little reality	27,3
4.	No reality	9,1

Table 9 shows the percentage of candidates surveyed who stated their driving time on the simulator. Of the interviewed candidates, 9.1% said it was too long, 33.3% said it was enough, 35.3% said it was optimal (22.3%) it was declared to be too short.

Table 9. Percentage of candidates surveyed on simulator driving time

RB.	9. Was there enough time to drive on the simulator	Percent
1.	Too long	9,1
2.	Enough	33,3
3.	Optimal	35,3
4.	Too short	22,3

Table 10 shows the percentage of candidates surveyed who said they liked / disliked simulated driving. Of the candidates surveyed, 47.4% said it was simple, 16.2% did not like the appearance of dizziness, 15.2 5 said they were confused and (21.2%) said they were amazed.

Table 10. Percentage of interviewed candidates who like / dislike simulated driving

RB.	10. What do you like about the simulated drive	Postotak
1.	The simplicity of driving	47,4
2.	Dizziness	16,2
3.	Confusion	15,2
4.	Amazement	21,2

Table 11 shows the percentage of candidates surveyed who stated their problems when using a driving simulator. Of the candidates surveyed, 72.2% said they had no problems and 27.3% said they had problems (nausea).

Table 11. Percentage of candidates surveyed on problems using the simulator

RB.	11. Did you have problems while using the simulator	Percent
1.	No	72,7
2.	Yes	27,3

Table 12 shows the percentage of candidates surveyed who stated that they improved driving on a simulator. Of the interviewed candidates, 72.2% said no and 27.3% said they would improve.

Table 12. Percentage of candidates surveyed on driving simulator improvement

RB.	12. Does the driving on the simulator need improvement	Percent
1.	No	72,7
2.	Yes	27,3

Table 13 shows the percentage of candidates interviewed who voted for their performance. Of the interviewed candidates, 36.3% of them declared themselves excellent, 18.2% very good, 27.3% said good (18.2%)) declared the assessment sufficient.

Table 13. Percentage of candidates interviewed for evaluation of their work

RB.	13. Evaluate your work on the simulator	Percent
1.	1	0
2.	2	18,2
3.	3	27,3
4.	4	18,2
5.	5	36,3

Table 14 shows the percentage of candidates surveyed who expressed their impressions and recommendations for using a driving simulator. Of the interviewed candidates, 54.5% said that everyone should try a simulator ride, 31.3% said they had no recommendation and 14.2% did not respond.

Table 14. Percentage of candidates surveyed on recommendations for using a simulator

RB.	14. What are your recommendations for practicing on the simulator	Postotak
1.	I have no recommendations	31,3
2.	Everyone should try it	54,5
3.	No answer	14,2

3.4. Interpretation of research results

Analysis of the results of the survey provides information on the representation,

frequency and intensity of the opinion of the drivers candidates surveyed. Frequency distributions and percentages were used for the split below. The results obtained indicate the following:

- Candidates from 17 to 20 years of age (48.9%) predominate in terms of age,
- most candidates have not used a modern driving simulator so far (81.8%),
- the majority of candidates stated that they practiced in the driving simulator for 3 to 5 hours (90.8%),
- the exercise helped them a lot and mediocre said (66.5%) candidates,
- That the driving skills on the simulator and in a car are realistical, declared (72.7%) candidates,
- the adaptation time required for the training vehicle takes one hour for (45.4%) candidates and for (27.3%) 30 minutes,
- that the instructor's instructions for performing simulator exercises were basically good (54.6%) and very good declared (45.4%) candidates,
- That managing the vehicle on the simulator is quite real and very real declare (69.6%) candidates, and that the drive was real declared (45,4) candidates,
- for (68.6%) candidates the simulator driving time was sufficient and optimal,
- Candidates mostly enjoy simplicity and amazement for the type of practising (68.6%),
- (72.2%) candidates did not have any problems during training on the driving simulator,
- the majority of candidates stated that they were satisfied with the way of work (63.7%);
- (54.5%) of the candidates stated that it was excellent and very good for their work, and suggested that all candidates who study in driving school should try a simulator ride.

Consideration of the possibility of using a modern driving simulator in the driver candidate training process and the possible effects of such a training method, while providing trainer feedback on the effects of training on a modern driving simulator with advantages and disadvantages, will provide suggestions for measures to introduce such technology into training.

4. POSSIBLE CHANGES BY INTRODUCING NEW TECHNOLOGIES IN DRIVER TRAINING

The application of new technological solutions in the driver training process has become a necessity. Some of these measures relate to the use of modern driving school simulators, the use of vehicles incorporating smart devices, such as uphill movement devices, parking assist cameras, reversing cameras, parking choices and assistance parking, parking sensors, etc. Modern driving simulators have in practice proven to be very useful for driver training, with the potential to significantly reduce the incidence of accidents in the period after obtaining a driver's license. Driving simulators have been found to be more suited to higher order tasks and procedural skills. The driver can master the basic situations and learn the risk perception and awareness skills of the situation without the potential danger arising from them and by repeating the various scenarios the simulator allows. Driving simulators could prove to be a very useful tool in driver education, for practicing situations similar to road situations, which would pose an increased risk to new drivers.

E-learning is becoming increasingly interesting and popular for road safety education. It could potentially complement road safety education, especially in areas

where learning is required about risks such as fatigue, inattention, alcohol, etc. The e-learning program should therefore be interactive to improve efficiency. E-learning tools offer opportunities for testing.

The implementation of new technological solutions include intelligent roads, intelligent vehicles and intelligent transport systems (ITS). Cybernetic and information upgrades of classic roads create intelligent roads, which in addition to basic functions provide better information to drivers, traffic management, management of variable traffic signaling, greater safety and more. Intelligent vehicle systems are designed to alert the driver to the functions of collision warning, off-roading, vehicle re-routing, pedestrian detection and more. If the driver responds improperly to light or sound alerts, the systems can take control of the vehicle. Intelligent vehicle solutions include automatic vehicle control, keeping a safe distance, and the electronic management of buses and trucks by special traffic lanes.

According to research, the most effective new technologies in the area of active vehicle safety that can be avoided by road accidents can contribute to a significant improvement, especially IntelligentSpeedAssistance-ISA, Autonomous Emergency Braking-AEB, emergency alert Lane Departure Warning (LDW / LCA), driver vigilance and distraction monitoring system, and Alcohol Interlocks, engine lockdown devices if the driver is under the influence of alcohol.

In the area of passive safety, as a measure to mitigate the effects of road accidents, a seat belt reminder system on all seats, as well as improving pedestrian injuries in the event of a head-on-front impact, and detection of cyclists in the event of an immediate collision, which are feasible as required technologies and already available on the market with effective conditions of use. Other areas of great interest relate to improving direct visibility and removing blind spots on trucks to protect unprotected road users.

In the current global context, "good" driving is not only safe and considerate to other road users, but also environmentally conscious driving. There are three levels of environmental awareness that can be incorporated into effective driver training and driving exams:

- general principles relating to the environment and transport (eg use of alternatives, less polluting modes of transport, avoiding unnecessary travel),
- making decisions before driving (eg car selection, regular tire pressure check),
- practical eco-conscious driving techniques.

The application of eco-driving rules enables smarter and more modern driving styles, predicting traffic situations, avoiding unnecessary and sudden brakes, driving control, making it safer. Such techniques are easier for new drivers to learn, compared to experienced drivers, who have developed deep-rooted behaviors and personal driving styles.

CONCLUSION

The issue of new technologies and vehicle safety in the context of the application of new technologies and smart driver training devices is increasingly being raised. The purpose is to enable the driver to drive more safely and comfortably by monitoring the flow of traffic and the behavior of the driver, informing them, alerting them when necessary, and preventing the driver from reacting in a timely manner.

Analysis of the results The use of a modern driving simulator for driver training after passing the test with the aim of improving the training model shows that most

candidates are satisfied with the use of the driving simulator. While using the driving simulator in the training process, most candidates practiced 3 to 5 hours, which they thought was sufficient and helped a lot, as the simulator's real skills are with those on the vehicle. They think that using a driving simulator is very realistic when compared to on-board training, and that they like the simplicity and accessibility. They were satisfied with their way of working and suggested that all candidates undergo a training course in the driving simulator.

The analysis of the driving instructor's opinion on the use of a modern driving simulator for driver training prior to on-board training shows that the simulator is well suited for training, that simulator training has helped driver candidates, and that candidates have best practiced steering and shifting.

Taking into account the results of the research, measures have been proposed to improve the driver training system in the context of improving road safety by defining driver training objectives, improving training processes and models, reducing risk exposure and applying new technologies. Emphasis should be placed on the use of modern driving simulators and e-learning when implementing new technologies.

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