

# DRIVER TRAINING CHALLENGES, BARRIERS AND NEEDS ARISING FROM ADAS DEVELOPMENT

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## Abstract:

Year to year, vehicles are becoming more advanced, and manufacturers offer newer support systems. Progressive technology development must be followed by relevant sociological changes, including establishing a proper user awareness level. Even though compulsory driver training, required before obtaining a license, consists of selected support features, e.g. ABS (Anti-lock Braking System), it does not provide novice drivers with the necessary practical skills and knowledge of all automation features available on the market. To reduce the human error factor, the European Parliament adopted new regulations, including minimum safety requirements for new vehicles. This paper identifies the gap between the current approach toward teaching automation and necessary changes that should be made to ensure road safety. It provides an overview of ADAS functions allowed to be used during driving license exam of category B in different European countries. Moreover, the publication contains results of work carried out under the Trustonomy project. Outcomes obtained from the questionnaires were used to develop new driver training curricula. The publication discusses the developments of a survey conducted among 83 Polish drivers and 91 car fleet managers. The paper reveals their attitude and expectations towards driver training. The results indicate that despite the awareness of ADAS's positive impact on safety (80% of drivers vote, 96% of car fleet managers votes), many people still didn't take part in any training and still do not know how to use systems properly. Even more worrying is the fact that more than 50% of drivers admitted they acquired knowledge about system operation based on their own mistakes. Many responders expressed their interest in acquiring new knowledge. This situation indicates an urgent need to introduce changes to the driver training system. Therefore, the publication highlights different regulatory boundaries across Europe and stresses the need to update existing curricula to introduce proper automation-related training.

**Keywords:** Automated Vehicles, ADAS, Driver Training, driving license examination

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## 1. Introduction

Driving a car necessitates a human not only to obtain a licence but also to possess knowledge of safe driving. Moreover, entering the era of transport autonomy, a human driver has to broaden his knowledge to be familiar with automation features implemented in a vehicle. Thus, a gap between technology SoA and current driver training system has been identified (Merriman et al. 2021).

As for 2020, at the European Union level, driver training is regulated by Directive 2006/126/EC of the European Parliament and of the Council. The document issued on 20 December 2006 provides a high-level description of the principles of issuing driving licences, minimum examination requirements, and knowledge and skills which should be demonstrated by candidates for drivers during theoretical and practical tests. Thus, the directive sets a minimum standard for training, allowing EU member states to regulate the pre-examination training process in detail. Still, it does not expand the necessary knowledge to be transferred during the training course on issues related to progressing autonomy (Directive 2006/126/EC).

In March 2020, the Association of Australian and New Zealand Road Transport and Traffic Authorities, Austroads, published a report (Austroads, 2020) in which they found out that consumers most commonly prefer receiving training through dealerships, at point of sale and delivery. However, research has shown that dealerships often provide inaccurate or incomplete information about Advanced Driver Assistance Systems (ADAS) and Automated Driving Functions (ADFs). Austroads has also conducted a risk analysis to assign levels of risk to performance gaps for each system-specific driver task. It has been concluded that within 1-2 years, it is extremely important to:

- provide safety-related public education and support integration into existing optional knowledge and/or skills training for ADAS/ADF,
- support integration into existing mandated learning programs, through routine curriculum reviews, for ADAS/ADF.

According to the Eurobarometer Report (Special Eurobarometer 496, 2020), in terms of automated functions already featured on some vehicles, respondents are most familiar with automated transmission and cruise control. However, overall the results suggest

respondents are not yet ready to fully adopt connected and automated vehicles (according to Zhang and Kamargianni (2023) technology interest and perceived usefulness proved to be factors that strongly influence the uptake of automated mobility; 27 studies exploring AVs implementation were reviewed, factors grouped into socio-demographic characteristics, travel behaviour, geographical-related characteristics and latent variables.). Therefore, if these vehicles are set to play an essential role in achieving the European policy objectives, efforts are needed to raise awareness of the options and their implications and to engage citizens and build their trust with respect to this innovative type of technology.

## 2. Literature review

That is also a case for the scientific community, e.g. Trustonomy project (H2020) deals with trust and acceptance of automated and autonomous vehicles, as well as driver training curricula. The early assumptions are that both distrust and over-reliance on technology increase the risk of an accident. Accordingly, confidence in automation will increase immediately after the training (in line with the principle that we are afraid of the unknown; Ostafin et al. (2021), 2 groups of 141 and 152 people prescreened for anxiety, life meaning, anxiety and depression.). Still, the information provided about the system's limitations will increase the driver's awareness and responsibility. These corroborate with Safe-D findings suggesting that any ADAS training prior to driving will improve trust compared to no training at all. On the other hand, Abraham et al. (2018), based on year-to-year survey ( $N_{2016}=2954$ ,  $N_{2017}=2976$ ; respondents owning a vehicle not longer than 30 years or with a production year earlier than 1981), pointed out that an increased global scepticism towards automated driving result in decreased trust. The report considers a comparison of online surveys deployed a year apart that gathered information on inclination to use differing levels of automation. Respondents indicated an unwillingness to purchase a self-driving vehicle, citing trust, including fear of malfunction, safety concerns, and difficulty programming software that is reliable 100% of the time, as major concerns. The authors fear that as long as the emphasis is not placed on the "soft" aspects of automated vehicles (e.g. trainings), there is no way to widely

accept and successfully commercialise the growing technology.

The benefits of additional driver training on driving automation systems have been demonstrated by research conducted by employees of the Johannes Gutenberg University in Mainz and the Fresenius University in Idstein (Germany) (Castritius et al., 2020). They analysed drivers attitude toward the acceptance of platooning (level 2) on German motorways among 10 professional drivers (quantitative and qualitative surveys were conducted before and after platooning experience). The surveys showed that most drivers were intrigued by the new technology, and most importantly, there was a clear increase in acceptance following the real-traffic driving experience. Before the training, drivers expressed concern about the short distance between moving vehicles and were sceptical about the reliability of the entire system. In addition, drivers expressed concern about losing control of the vehicle and problems with their takeover. However, after the training, the drivers found increased driving comfort, and most of them would like to use the platooning system if it was available in their company.

Similar results has been recently published by Zheng et al. (2023). Thirty-nine adults (20 younger + 19 older) took part in their simulator study focusing on ACC-dedicated driver training in two forms: basic (system functionality, operational procedures, and limitations) and comprehensive (basic training + ACC background and roles of responsibilities). Participants' situational trust and ACC usage was evaluated before, during, and after experiencing an emergency event. Results showed that the comprehensive training promoted drivers' situational trust in ACC, ACC usage, and the acceptance of aVs. Compared to younger drivers, older drivers used ACC less, reported less dynamic situational trust, higher levels of workload, and lower acceptance.

Another research (61 participants) studied the effects of two ADAS training approaches in a remote face-to-face study – limitation-focused and responsibility-focused (highlighting that the driver must remain engaged in the driving task) (DeGuzman and Donmez, 2022). Both methods appeared to be similarly effective. There were no significant differences between approaches in terms of knowledge of situations in which ADAS would not work, appropriate situational reliance intention, or trust in takeover scenarios. Compared to the responsibility-focused

video, the limitation-focused video was associated with lower trust in no takeover scenarios and negative bias at post-training

Carney et al. (2022) studied mental models in relation to advanced driver assistance systems on a group of 39 new owners of vehicles equipped with ACC (no experience with ACC before the study). Over 6 months, weekly reports on drivers experiences and usage of ACC were collected. After that participants completed a simulator drive to check their behaviour in situations when the system reaches its operational boundaries. The research showed that understanding of functionality was very high and did not change over time. Understanding of system limitations, on the other hand, showed slight increases throughout the period and seems to have driven the overall change in mental model assessment scores. Additionally, confidence in responses increased as well. The results enrich studies of Rossi et al. (2020) and Beggiato et al. (2015), which revealed that knowledge and understanding of ACC functionality occurs rather quickly while limitations are more difficult for first time users as they are mostly learned over time through experience (Larsson, 2012, Beggiato et al., 2015).

In Europe, Germany is one of the few countries that allow the use of driver support systems on an exam (therefore drivers have to learn their operation during driving lessons). However, the assessment of system's correct use is not clearly defined. In 2019, Dekra, together with TÜV, published a guideline (Dekra, TÜV, 2019), which describes detailed recommendations for the examination grade. Dekra and TÜV researchers introduce two principles:

- when assessing driving skills, the most important issue is the correct decision taken by the driver,
- when operating systems whose operation is independent of the driver's will (e.g. AEBS), the examiner decides whether the driver has made a mistake.

The first rule requires the driver to be fully aware and responsible for correct driving. According to the examiner, the driver must properly determine whether the support system does not meet the required assumptions of a given task. In the event that the system does not work properly, the driver must take control of the car to safely complete the manoeuvre. The second rule requires the examiner to decide whether the system activation (e.g. automatic braking) resulted from a driver's error.

However, all these activities must be preceded by appropriate training. At the same time, it should be remembered that the driver training system should not only focus on new drivers or people buying new cars from a dealer. Instead, the training should be tailored to the specific vehicle, support system version, as well as the participant's experience and knowledge. It should also highlight the need to remain alert during driving, because the evolution of advanced vehicle technologies gives more space for unintended mechanical, visual, and/or cognitive driver distraction (Hulme et al. 2021).

### 3. Method

In this paper, literature research was carried out to identify articles and legal regulations related to using automation features in driver training and during license examinations. Since vehicles are becoming more advanced, driver training has been in focus, but there is no information on the methods of teaching future ADS drivers. Furthermore, there is a lack of legal regulations for expanding curricula hitherto on ADS-related issues. Although many scientists have taken into account future transport systems and there is a lot of electrification teaching guidelines, hardly any approaches to automation have been made. This paper will not review sensors, technologies and interfaces used to collect and display real-time performance data. Similarly, this paper does not review frameworks or architecture of automation features. Instead, this paper focuses on behavioural aspects of forevisioned technology changes and the legal backgrounds of transferring sought and necessary knowledge and skills.

Existing regulations were searched using EUR-lex portal and web search engines. There are many different county-oriented local laws for conducting training and examination sessions. However, this paper summarises the law in chosen European countries, indicating local discrepancies.

The publication also includes the results of an opinion poll on training in driving automation functions and their expected safety impact. The study was aimed at private individuals (83 drivers) and car fleet managers (91 responses).

The first research group was chosen randomly among people who agreed to vote in an online poll posted on project's social media. Due to privacy concerns, the authors resigned from gathering information about gender and age. Mostly people, who

are active drivers in Poland have 1 (43%) or 2 cars (45%), and the mean vehicle age reported by respondents was 10,35. In this study drivers were asked about their consideration of vehicle purchase, replacement, factors deciding about specific car choice, relation with automation features (safety, comfort, limitations, usage, experienced failures) and thoughts about automation-focused driver training.

The second research group was chosen among SKFS members (pol. Stowarzyszenie Kierowników Flot Samochodowych, ang. Car Fleet Managers Association). On average they manage fleet of 394 vehicles, while minimum value was 12 and maximum 5000. According to the responses the mean vehicle age in fleet is 3,21. In this poll, the authors again resigned from questions about age and gender, however basing on Zippia report from 2023 there are a lot less women in fleet management than men. Zippia's statistics (numbers based on 2021) shows that in U.S. 16.8% of all fleet managers are women, while 83.2% are men, and the average age of an employed fleet manager is 45 years old. It can be noted that the majority of fleet managers in Poland are men. Participants of the second poll were asked questions about managed fleet, reasons for vehicle replacement and purchase, factors deciding about specific car choice, relation with automation features (safety, comfort, limitations, usage, experienced failures) and thoughts about automation-focused driver training.

The publication is based on the analysis carried out on the Trustonomy project.

### 4. Introduction of the new mandatory systems

In 2021 European Parliament announced that only in 2020, 18 800 people were killed on EU roads. Almost half of the road fatalities are caused by passenger cars. It needs to be stressed out that about 95% road accidents were caused by human error (European Parliament Portal, 2020). To increase road safety and reduce the human error factor, the European Parliament adopted new regulation to improve road safety. The foreseen technological changes comprise a number of updated mandatory minimum safety requirements for new vehicles. Came into force in 2022, the Regulation (EU) 2019/2144 of the European Parliament and of the Council of 27 November 2019 introduced new mandatory technolo-

gies. The list below summarises all new features being compulsory since 2022. Among all these are all new models sold on the EU market by 2024 have to be equipped with safety features such as (Regulation (EU) 2019/2144):

- intelligent speed assistance;
- alcohol interlock installation facilitation;
- driver drowsiness and attention warning;
- advanced driver distraction warning;
- emergency stop signal;
- reversing detection;
- event data recorder.

The introduction of new mandatory systems should be undertaken in parallel with the development of theoretical and practical driving courses. The authors point out that systems implementation requires a division into two issues and related areas. It is a different matter to supplement the knowledge of the use of systems for active drivers, and another to conduct training in this area for new adepts of driving a car. However, the lack of guidelines for the provision of information and teaching on ADAS systems during the examination makes this subject unfamiliar to both types of drivers. This should be changed and is one of the EU recommendations in the Reducing Casualties Involving Young Drivers And Riders In Europe report (Atchison et al., 2016). Implementing subsequent systems to achieve level 5 autonomy makes sense if vehicle users are aware of how to use them correctly and what their limitations are. Their knowledge should be expanded gradually. During such training, attention should be paid to the knowledge of vehicle construction, operation of sensors, which may not work or have limited performance under certain conditions. The driver should be familiar with the system limits and know what to do in such conditions.

Particularly for levels 2 and 3 of SAE automation levels (SAE J3016), three categories of skills that will be necessary to act as an autonomous vehicle supervisor can be distinguished (Baker, 2015):

- information exchange,
- awareness,
- cooperation on a driving task.

Modern drivers will have to adapt to different levels of automation and understand the division of tasks between automation and manual control for each level. Therefore, all drivers using automation levels from 1 to 3 should be required to be familiar with the

electronic AV functions available on their vehicles. Among all, drivers should be able to:

- activate and deactivate systems,
- understand the principle of operation,
- understand limitations,
- understand the causes of potential failures,
- react appropriately to potential failures.

## 5. Driver support systems on examination

Due to the lack of information on systems, ongoing education of all car users is vital. It ought to be at least reflected in the driver training system – the course participants should receive updated information about the systems that are mandatory in cars and the systems to be installed in the next 2-5 years. Today, the participants of driving courses are obliged to obtain knowledge about the ABS system (anti-lock braking system). Nevertheless, this knowledge is still strictly theoretical. Implementing subsequent systems to achieve level 5 autonomy makes sense if vehicle users are aware of how to use them correctly and what their limitations are; and then their knowledge will be expanded gradually. There are no EU wide rules on driver training, driving schools or driving instructors. There are however minimum EU standards for (Directive 2006/126/EC):

- the driving test – the candidate needs to pass both a practical test and a theory test,
- the driving examiners – must successfully complete a training program and be subject to periodic quality assurance and training.

The above-mentioned Directive 2006/126/EC does not specify the requirements for drivers to have knowledge of safety systems. Although, ABS, ASR and ESC systems are discussed during the standard driver training course, information on other systems is a matter of instructor involvement. The same applies to the use of a vehicle equipped with parking sensors, a rear reversing camera, mirrors that automatically lower when reversing, and a hill support system during the examination. The analysis of the use of modern technology on the examination in European countries is provided in Table 1. The “v” means that use of the system is allowed during the exam, “x” indicates that it is not possible, and “n/a” occurs when no legal basis has been identified that excludes or confirms the applicability of the system. Both active and passive (e.g. active cruise control) are usually permitted to be fitted in the vehicle, but

they cannot be used during the exam. However, some countries, such as the United Kingdom, expect the candidate to make effective use of driving aids, e.g. adaptive cruise control and lane departure warning systems (Driver and Vehicle Standards Agency). Currently, many national agencies for drivers and vehicles have hardly any provisions regarding semi-autonomous functions or technologies to alert drivers during driving tests. Therefore, on the one hand, the candidate should be able to control the vehicle anytime without using advanced technologies. On the other hand, whilst provisioning road safety, the examiner should be able to assess the safe use of individual driving support systems by the candidate for driver. Consequently, there is an ongoing discussion on enabling the admission of vehicles equipped with assistance systems for use during the practical part of the examination. However, this is associated with a broader problem mainly related to the lack of unification in operation and activation of individual systems by various vehicle manufacturers.

Therefore, for now, the examiner makes a final decision on which systems the examined person can use during the practical test. In the UK, the exam drive is carried out using navigation. At the moment, the training process has not kept pace, not only with the technological development of vehicles but, above all, future drivers are not gaining the necessary knowledge about mandatory vehicle equipment. Therefore, the curriculum should include new technologies that influence driving.

The interesting thing is that alternative power sources may also affect the process of getting a driving permit. For example, in the United Kingdom, DVSA (Driver and Vehicle Standards Agency) classifies electric vehicles as automatic. Therefore, if the candidate passes the test in an electric car, he will be authorised to drive only automated vehicles. However, the rules for driving tests are the same for electric and traditional cars (Driving Test Tips).

In Poland, driving schools and WORDs (pol. Wojewódzki Ośrodek Ruchu Drogowego, ang. Voivodeship Road Traffic Centre) usually use cars such as Hyundai i20 or - less often - Opel Corsa. Although these are good cars, trainees will not learn to use all kinds of assistants consciously. This is due to the basic configuration and not having most of the autonomous features that are currently in use.

Pursuant to the Regulation of 28 June 2019 on examining applicants for driving licenses, training,

examining and obtaining qualifications by examiners as well as templates of documents used in these matters during the driving test, it is not forbidden to use parking sensors, rear reversing camera, mirrors automatically lowering when reversing, hill start assist system (if this system does not activate after applying or applying the parking brake). This means that the above technologies can be used during the exam. For other systems (e.g. Active Cruise Control, Blind Spot Sensor, and Lane Keeping Assist - both active and passive), they can be fitted to vehicles but cannot be used during the test.

In Finland, there is no specific regulation for allowing to use supportive technologies. The authorities have not forbidden the use of new technologies during the exam, consequently it means that they are allowed to use. However the decision is on the examiner. Of course, the driver has make use of the new technologies in a proper way.

An interesting fact is that from July 2018, in the territory of Wallonia (Belgium), a risk assessment test (GOCA-Risk Perception Test) is performed before taking the practical exam. It consists of two parts (Le Moniteur Automobile, 2021):

1. Risk Perception Test – the test is used to check that the candidate has sufficient skills to assess potential risks. The candidate is to watch 5 short videos and answer several questions. Minimum grade required: 6/10.
2. Self-safety test - also consists of 5 videos. The candidate is asked to identify 10 types of risk by clicking on them. In each video, from 0 to 3 types of risk are presented. The test is over after 10 clicks. You need to get 6/10 (1 point for each identified risk). Clicking into the void or in an area where there is no risk is a wasted click, and thus lost the point.

According to Horswill et al. (2021) even an online hazard perception training course for drivers, incorporating a range of evidence-based strategies and can improve key behaviours associated with accident risk. Unfortunately, traditional training courses focus on skills that are not correlated with crash involvement, such as vehicle handling.

What is even more interesting, Swiss traffic centres do not have their cars for exams. Each candidate supplies the car on their own – usually in agreement with the driving school (no requirements as to the brand, model, production date etc.). Therefore, in the role of test vehicles, you can see various, exotic, as

for a driving school, cars such as the Golf GTI. Parking sensors, a rear view camera and an electric handbrake can be used for exams. The following requirement is provided in the regulations: "The vehicles used during the test may not be equipped with unusual accessories to facilitate driving". However, it has not been possible to identify what is classified as unusual equipment (Le Conseil Fédéral, 2020).

### 6. The need to implement ADS-targeted driver training – survey results

The development of technology and progressing through the next levels of car autonomy are foreseen to significantly reduce the number of accidents resulting from human error. Before this happens, however, a difficult transitional period is ahead. During that time, drivers with different experiences behind the wheel will meet on the roads, and – more importantly, vehicles with differentiated car autonomy level will appear.

Even though there are many projects related to autonomous vehicles, such as WEpod - operating in Wageningen in the Netherlands, or Waymo – an autonomous passenger vehicle on the roads of California. No information regarding projects working on using ADAS systems during the driver’s license test in European Union countries has been found.

The survey results on a group of 83 people clearly indicate that despite the awareness of the positive impact of driving automation systems on safety (80% of votes), many people still do not know to use them properly (Figure 1). Among the group of respondents, only 7% of participants received training

in the use of driver support systems. This means that less than every fifteenth user of automation functions knows how to use them safely and consciously. Consequently, drivers' ignorance leads to an increase in the number of accidents, their consequences and, as a result, deaths on the roads - a counter-productive effect.

The dynamic development of systems and their number cause a situation where users either have no knowledge about them and do not use them or use them, learning from mistakes. Vehicle users, in large part, declare that they do not read manuals. On the other hand, the manual describing "driver assistance" in some cases has more than 100, and the entire manual is 400-900 pages, which means that most users will never read the instructions, although they should. Currently, the manual is the only source that allows the user to learn and understand the operation of the systems. Therefore, it is worth verifying the quality of the information contained in the manual. Moreover, vehicle manuals are often written incomprehensibly and are too long and complex, discouraging a thorough reading of their content. They also often contain translation errors and typos, making it difficult to assimilate the information. To what extent reading the instructions guarantees the correct use of the systems the vehicle is equipped with is unknown. Too long instructions and the lack of reliable training materials result in a lack of reliable and up-to-date knowledge among users, which leads to very dangerous situations.

Table 1. The use of modern technology on the examination in European countries (GOV UK; Dz.U. 2019 poz. 1206; BGBl. I 2013; Office de la circulation et de la navigation )

Automation feature	UK	Poland	Finland	Germany	Switzerland (Friborg)
Parking Sensors	v	v	v	v	v
Reverse Camera	v	v	v	v	v
Navigation	v	n/a	v	v	n/a
Electronic Handbrakes	v	v	v	v	v
Hill Hold Technology	v	v	v	v	x
Lane Departure Warning	v	x	v	v	x
Blind Spot Monitoring	x	x	v	v	x

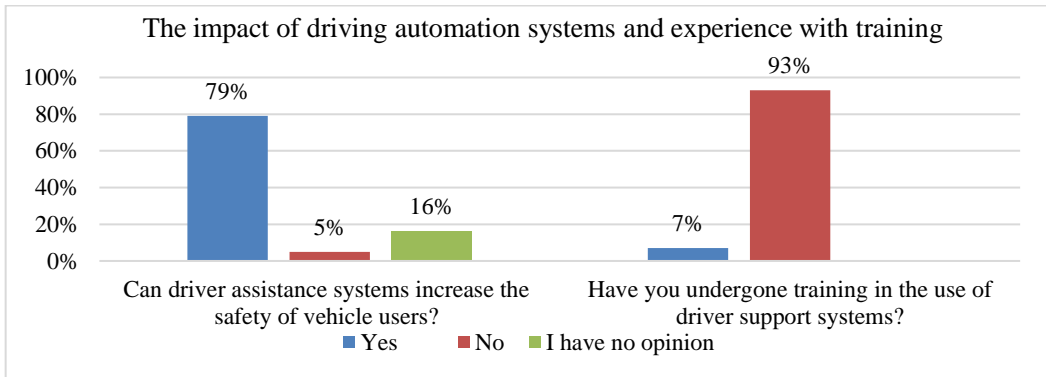


Fig. 1. Survey results on the impact of driving automation systems and targeted training – questions 9 and 15

Among people who had not been trained in the use of support systems, more than half declared that they acquired knowledge about the operation based on their own mistakes (Figure 2). Unfortunately, most systems activate only at significant conditions, e.g. speed. This means that around 53% of drivers learned the systems while driving without knowing about the possible responses of the system. In addition, learning while driving causes additional stress and mental workload, adversely affecting the drivers' ability to perceive the traffic situation, attention, awareness and, above all, the ability to intervene in dangerous situations. It should be noted that such behaviour directly contributes to the increased level of danger on the roads. Detailed results showing how drivers learn about the operation of the driving automation functions are presented in the Figure 2.

The results provide information on the scale of knowledge gap and, thus the dangers of inappropriate use of new technologies in vehicles. Almost a quarter of respondents (24%) admit they cannot use the systems with which their vehicle is equipped. Suppose the drivers who learn to use the systems while driving (by making mistakes) are considered. In that case, the alarming results are obtained of an enormous 77% of unaware drivers who are a potential hazard on the road. At the same time, it should be remembered that in the coming years, the vehicles will be more and more advanced with an increasing number of assistants and, above all, systems that will actively perform the Dynamic Driving Task. This means that the level of misunderstanding will grow over the next few years. The danger is even higher because a driver who does not under-

stand the system's behaviour may, in a dangerous situation, conflict with ADS to regain control when the vehicle tries to avoid a collision in a way other than assumed by the driver. In such a situation, avoiding an accident may not be possible.

In the survey, we asked the participants to describe the situations in which the system did not work properly (or as expected) and a collision occurred. 5% of them have come across such situations, e.g.:

- vehicle stopping during overtaking with lane change,
- the car braked unexpectedly and the car behind ran into the car in front,
- the adaptive cruise control did not break the vehicle sufficiently.

All of the above situations could be avoided (or their consequences minimised) if drivers knew how ADAS systems work, were aware of their limitations and did not leave them unattended. For example, the first situation is probably the result of overtaking on a single lane road with adaptive cruise control activated. The vehicle in the opposite lane was recognised as an obstacle and the overtaking could not be completed. It was enough to temporarily deactivate ACC, overtake the vehicle and set the desired speed again. There are many examples, but the underlying cause is a lack of knowledge that could be eliminated by introducing appropriate driver training – complementary for active drivers and full training for new drivers.

However, it is comforting that the vast majority of participants (70%) would like to take part in additional training in the use of driver support systems, and a small group is willing to spend their private



funds on it. According to the survey results, 29% of participants declared that this kind of training should be compulsory.

On the other hand, even people who received training on ADAS function implemented in their cars (6%) were not acknowledged with system limitations. Five respondents admitted that they had undergone training organised by the driving technique improvement centre. Despite a professional approach and qualified staff, they were not informed about systems limitations. Drivers didn't obtain information when each system may not work correctly (e.g. unfavourable weather, too high/low speed, an object suddenly appearing on the road) or that sensor maintenance (from dust, snow, etc.) is required for the proper functioning. Survey results conclude that

changes to the training system should be properly thought out, analysed and implemented at the national or European level.

Due to the fact that a large part of the vehicle fleet in Poland are business vehicles, the survey was also conducted among 91 car fleet managers. Most participants admit that their fleet includes vehicles equipped with driver assistance systems. They also believe that these systems can increase the safety level.

The results presented in Figure 3 show that most fleet vehicles are equipped with: Autonomous emergency braking, Lane keeping assist (LKA) or Lane Departure Warning (LDW), Adaptive Cruise Control, or Cruise Control.

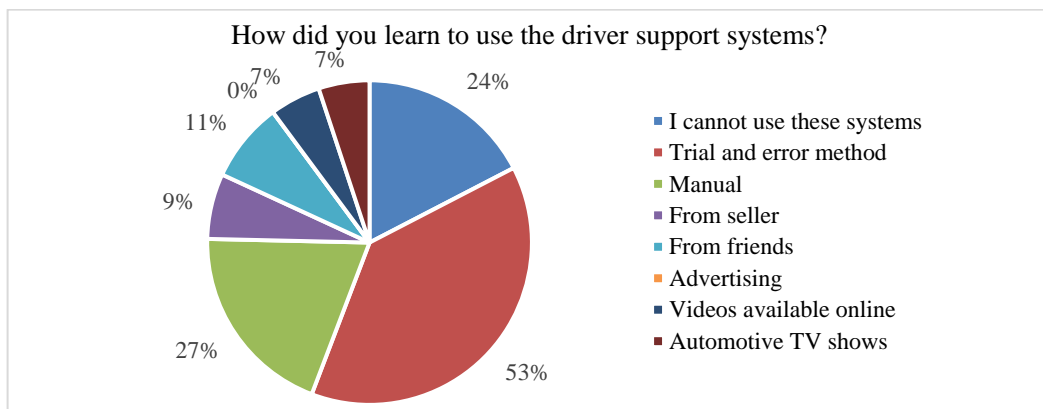


Fig. 2. Survey results on the impact of driving automation systems and targeted training – question 17

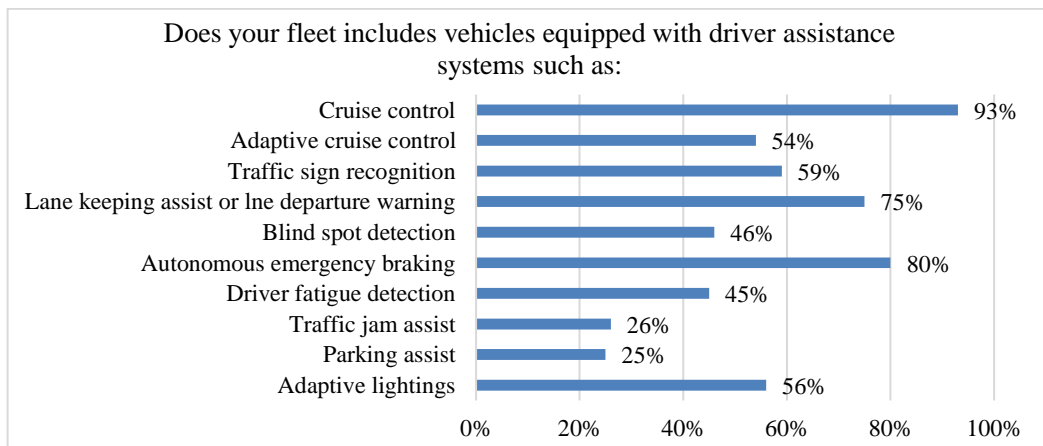


Fig. 3 Driver assistance systems in fleet

As with private drivers, fleet managers admit that driver assistance systems can increase vehicle users' safety levels (96%). Despite this, only 46% (42/91) people answered that their company's safety policy provides periodical driver training. Eighteen of them admit that as a part of periodical training, drivers also participate in training on the use of driver assistance systems. Sixty-six participants, who said that drivers are not participating in such training, admit this is an interesting idea. However, only seven of 91 responders don't think this training is essential (Figure 4). The reason why training does not take place participants indicates low budget, lack of time, and lack of centres providing such services. For 18 people who answered that employees take part in ADAS training, the survey also consisted of one question about the scope of knowledge transferred during the training. According to the obtained results, training often includes knowledge of the principle of operation and a correct understanding of system messages. In some companies, drivers also receive information about systems activation, their limitations, or sensors' lo-

cation. Training is carried out mostly both in theoretical and practical form. Units carried out the training are the driving technique improvement centre (39%), in-company training department (39%), and vehicle supplier (22%).

In the next question, participants were asked if all drivers (including individual drivers) should periodically and compulsorily participate in training on using systems implemented in cars if they have been considered mandatory vehicle equipment according to applicable regulations. Again, 81% of car fleet managers' group participants answered yes, and only 19% said no. Most responders also said they would be interested in additional employee training using driver assistance systems if such training were available (87%).

During the research, car fleet managers and drivers were asked what issues should be included in ADAS training. According to the respondents, the training should primarily include: operation principles, a proper understanding of systems messages, system activation, deactivation and its limitations. Results are shown in Figure 5.

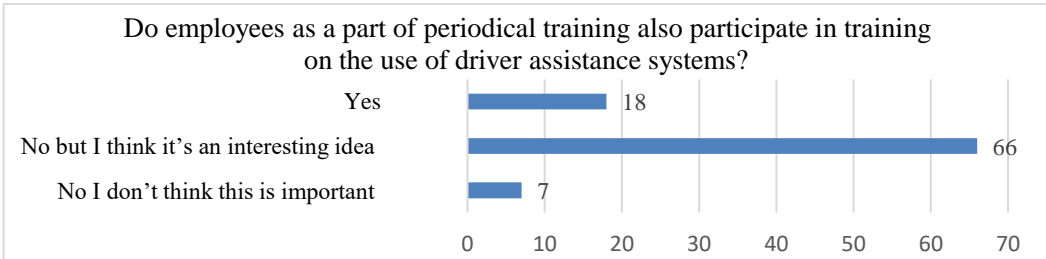


Fig. 4. Use of driver assistance systems as part of periodical training

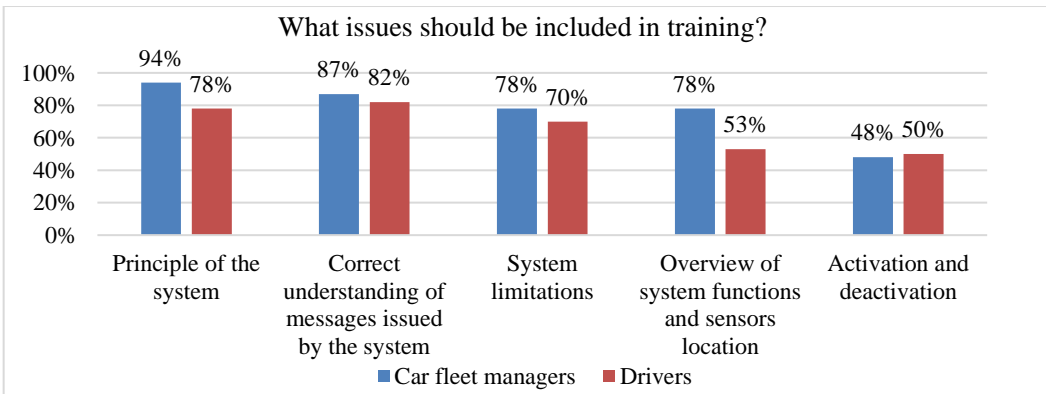


Fig. 5. Issues, which should be included in the training

One of the last questions concerned the unit responsible for automaton-related driver training. 42% of drivers and 37% of car fleet managers believe that the responsibility is on the government. More than half of car fleet managers think that (for fleet vehicles) it should be employee responsibility, 29% of drivers think that dealers or vehicle manufacturers should be responsible for preparing drivers on using implemented in the car features. At the same time, it can be seen that people expect lawmakers to react to the changing automotive reality, and they count on introducing updates to the existing training system. In the last question, fleet managers and drivers were asked about preferred training forms. Most participants stressed that training should be carried out in a specialised unit (e.g. driving technique improvement centre or traffic centre) in theoretical or practical form. Results are shown in Figure 6.

### 7. Conclusions

Technological development has a significant impact on the change of vehicle equipment. The newly implemented driver assistance systems aim to increase road safety and travel comfort. However, it should be remembered that they will only perform such functions if properly used. Therefore, the need to expand and adapt the driver training system was identified in order to increase road safety. Presented research showed that despite awareness of potential ADAS influence on road safety, most drivers do not have a basic scope of knowledge in operating these systems (93% wasn't trained).

Considering that some of these systems will soon be compulsorily installed in vehicles, it seems necessary to introduce legal regulations regarding the use of systems during driving exams. Additionally, due to the wide popularity of driver support systems, it is essential to develop training methods for drivers and candidate drivers that take knowledge in operating these systems, risk perception and decision making (Faus et al. 2023). These training concerns not only compulsory installed systems but also the most popular ones.

The authors point out that driving schools use the same vehicles that WORDs use to examine candidates for drivers. This introduces an additional barrier in teaching support systems, as it requires additional legal changes to introduce the issue of automation to the exam. Only then will training centres decide to purchase vehicles equipped with the systems, and candidates for drivers will be able to gain practical knowledge.

The European Commission perceived this problem. Therefore currently, some research initiatives and projects focusing on developing new methods of training drivers are carried out. For example, driver training was one of the pillars of the Trustonomy project, implemented by the international consortium under the Horizon 2020 program. The results of the surveys allowed to learn about the state of knowledge among drivers and car fleet managers as well as to develop training methods reflecting the needs and expectations of users.

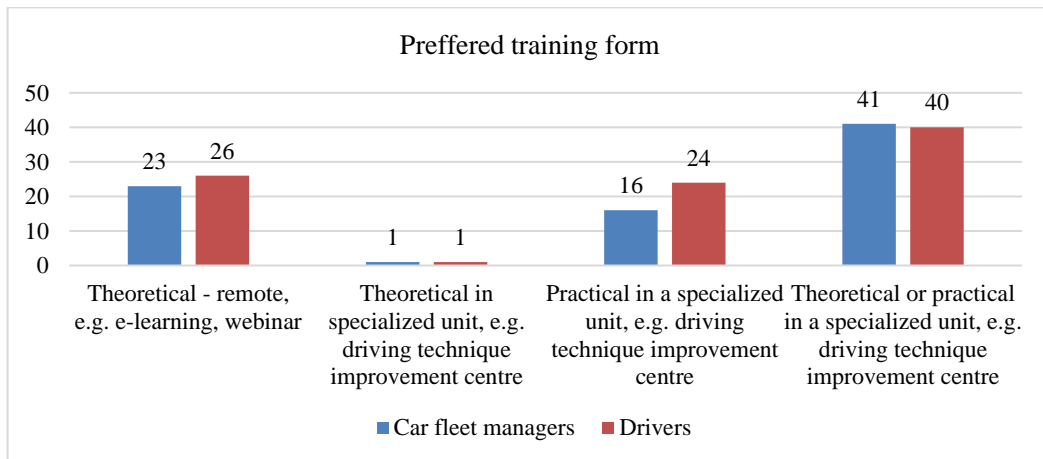


Fig. 6. Preferred form of training

Involving drivers in the Trustonomy project allowed to examine their feedback on particular devices, curricula and methods. System updates and corrections were composed based on participants' opinions and responses. Presented research summarises current knowledge level and future user expectations according to the new driver training. Responders expressed their interest in this kind of training if it is accessible.

Willingness to improve skills in the face of Automated Driving creates the needs and opportunities for lawmakers to extend and standardise the driver training process and adapt existing regulations governing driving license exams. The study showed a great need to introduce proper legal framework, as the majority of drivers are learning system operation and limitations while driving without knowing about the possible response (53%). At the same time, it is worth noting that there is a niche on the market that private training centres and driving improvement centres an opportunity to extend the offer with additional courses that would teach drivers to use automated driving features safely. The driver training curricula has to be comprehensive and concise. The training has to be efficient and tailor-made with a practical part conducted by a professional trainer.

The challenges of driver training can be seen in fast-changing technology differences between vehicle brands. For example, electric and traditional powered vehicles need different skills for maintenance and driving. A training organisation can't have all types of vehicles for driver training. This change means that a big part of training must be made at workplaces and by manufacturers. The curricula has to be comprehensive and concise. The training has to be efficient and tailor-made with a practical part conducted by a professional trainer. As the functionalities of automation are increasingly blurring the fine lines that distinguishing different transport modes, an autonomous shuttle bus may serve a similar function as an autonomous taxi/robo-taxi, both coinciding with the concept of Shared Autonomous Mobility Services (Bala et al.; 2023). Therefore, only responsible introduction of automated mobility enables full acceptance of autonomous vehicles.

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