The regulation of self-driving cars - what is the best approach in accordance with the rule of law?

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Abstract

Self-driving cars are promising safer roads, less pollution, leisure time during the travel etc. However, for their safe use in the practice we need sound regulation clearly stating the rules. Namely, the technology is fast developing; the regulation on the other hand is lagging behind. The paper analyses existing legal frameworks on supranational and national level in the field of self-driving cars. The research shows, the national regulations with some exceptions, mostly focus on the testing phase of the self-driving cars and are mostly still requiring some extent of control by the driver.

Keywords: artificial intelligence, automated vehicle, driver, regulation, self-driving car

1. Introduction

Cars are definitely a field, which especially within certain member states represents an important economic player and is subject to lobbying due to maintain current forces in the automotive industry. In this respect, there is a conflict of different personal interests as well as public interest. Namely, the fundamental goal pursued by the self-driving cars is safer driving. According to the European Commission data, in Europe yearly more than 90 % of the accidents are caused by a human error. Furthermore, more than 40 000 people die in car accidents and more than 1.5 million is injured. Therefore, self-driving cars can besides safer driving, contribute also to the fewer traffic congestions, easier parking, environment friendly driving, and easier mobility for the elderly and disabled persons etc.

The self-driving cars impose several legal and ethical questions, which need to be regulated on the EU and national level. For now, new regulation does not seem to follow the trend of fast developing technology. Although various authors (see e.g. Surden and Williams, 2016, Gurney, 2013) highlight it is absolutely necessary and existing legal frameworks only partly useful. Namely, there are certain specific situations of new technologies that are not envisaged by current legislation or not regulated adequately. There are different issues to be solved, such as liability in case of accidents, privacy protection, security risks in terms of intrusions into the system etc. We need regulation that will not hinder the future development of automated vehicles. Meaning we need consistent certification framework and standardized set of safety tests for acceptance of automated vehicles (Hansson, 2020, p. 3).

Beside legal, there are also ethical questions. E.g. a situation when a self-driving car carries a young family, and in order to prevent an accident, needs to choose, between two options, either to turn left and hit a middle age woman, or to turn right and hit a child. Whom should the system primarily protect in such situation? Can we leave a decision to the system or would a human react better in such a situation? Is it justified to see in such case a human as an object and define to sacrifice a middle age woman in order to protect the lives of a young family and a child?

Self-driving cars are already part of our environment and they call for efficient rule making. The paper deals with different legal questions that need to be addressed by new regulation, such as liability, rights and duties of driver etc. The ground for the analysis are the laws of the states that already enacted this content to certain extent (e.g. Germany, Sweden, Norway and United Kingdom). We also look at the latest development on the EU level and Slovene legal situation. Since the paper covers a topic subject to constant changes due to technology advancement, some information in the paper may be at the time of reading obsolete.

2. Some dilemmas surrounding self-driving cars

We can distinguish automated vehicles and autonomous vehicle. The automated vehicle is a motor vehicle (car, bus, truck), which has a technology helping the driver in a way that elements of the driving functions are conveyed to a computer system. The autonomous vehicle is on the other hand a fully automated vehicle, which has technologies that can execute all driving tasks without human intervention (European Parliament Briefing, 2016). Further, we can

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distinguish connected vehicle, which is a motor vehicle equipped with devices to communicate with other vehicles or the infrastructure via the internet (European Parliament Briefing, 2016).

The final goal of the manufacturers is a vehicle that drives by itself, without managing of a human. In theory, five level scale of the self-driving cars was established (see Table 1). Current models on the market are between levels two (e.g. Tesla) and three (e.g. Mercedes).[2] This means, they still need a human behind the steering wheel, who can take over the driving, if needed for the safety reasons. Moreover, the use of the self-driving function is usually recommended only for the nice weather or other beneficial driving conditions.

Table 1: Different Levels of Self-Driving Cars

The Driver	**Human Monitors the Driving Environment**			**Automated Driving System monitors the environment**			**Automation**
	Level 0	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**	
	No Automation	Driver's Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation	

Source: Adapted according to Gelin, Insurance Europe (2017) & SAE International (2014)

However, regardless of these limitations, the reality is that technology is every year more and more progressing and vehicles, with certain self-driving functions are already present on the markets (also Slovenian). Namely, there will be for quite some time a transitional period, when both types of vehicles will be present in the traffic, "regular" and vehicles, with self-driving functions to different extent. These changes will affect everyday life of different participants in the traffic. Therefore, this field should be appropriately regulated. Namely, the introduction of self-driving cars affects especially the following areas: liability, traffic safety, environmental matters, data management and protection, ensuring appropriate infrastructure (also for the communication) and employment. Lack of regulation leads to legal uncertainty and hinders the development and application of the new technologies.

In reviewing current research and literature, we can see that technology is developing very rapidly. The new systems are based on artificial intelligence, which is an interdisciplinary field with intertwining of psychology, philosophy, mathematics, neuroscience etc. The latest achievements enable machines to perform tasks that previously required human thinking. The systems work by partly imitating human intelligence. Current technological development enables computers to learn and make their own decisions by imitating human brain patterns. The system is able to learn, generalize, plan, solve problems, logically deduce, etc.

For self-driving vehicles, we can talk about three technologies that are used: sensors, connectivity, and software or control algorithms. Most of the sensors required for autonomous driving are already available and used in advanced security solutions such as line-up, collision alert, dead-angle monitoring when driving (Gupton, 2018). Sensors are important for the operation of radar, ultrasonic functions and cameras, which collectively collect the data necessary for the safe operation of the vehicle. Connectivity allows vehicles to get familiar with latest traffic, weather, maps, neighborhood vehicles, road infrastructure, etc. The mentioned data is important for monitoring the environment surrounding the vehicle and consequently making the right decisions, such as braking or withdrawal of dangerous conditions. Software or control algorithms are needed to reliably obtain data from sensors and connectivity and to make decisions about control, braking, acceleration, etc. This decision-making part must handle simple and more complicated situations, which may arise while driving, free of mistakes (summarized by Gupton, 2018).

[2] For example, Mercedes's Drive Pilot system is first legally approved level 3 system, will drive only within fenced areas on the German motorway (up to 60km/h). The driver will be able to take hands off the wheel and allow the car to assume total control of its functions. The company will accept legal responsibility for accidents being caused directly by mistake of car system (technology). If the accident was caused due to driver's failure to comply with duty care, the driver will be responsible for the damage (Wilkinson, 2022).

People create algorithms for the functioning of self-driving cars. Moreover, the system itself can learn further actions based on collected information, experiences etc. The content of formed algorithms depends on ethics and, morality of a person that creates them. In relation to forming algorithms we can expose the case of Facebook bots (see Švab, 2018), which created their own language based on the posed rule, that the system should function as efficiently as possible ("performance ways"). However, a man could not follow their language and could not understand why bot took a certain decision. Namely, bot functioned in accordance with the posed "instructions" of high efficiency, without containing also a rule, that it should be clear, why it took certain decision ("interpretative results") (cf. Drevenšek, 2018a). As Jeremy White (in Švab, 2018) says, we cannot blame artificial intelligence for "malicious behavior," since the latter was consistent with the instructions given by a man. Since people are imperfect creatures, we also give incomplete instructions.

In addition to legal problems, ethical dilemmas are also prevalent in the field of self-driving cars. As Jeremy White (in Švab, 2018) says, artificial intelligence or progress is the next level of our evolution, which we must not stop, but we have to behave ethically and responsibly. The same applies to the field of regulation of self-driving cars, which requires a new social consensus, by setting new values. For this purpose, a survey was made by introducing a game "The Machine Game", featuring over 2 million people from 233 countries. The broader public was involved in the preparation of algorithms that reflect public opinion on self-driving cars. Namely, self-driving car is designed to protect the driver. However, different situations can occur, which require weighing who has to be protected primarily. Irrelevant of the region, the research has shown, that the society wants, in the case of self-driving cars, that algorithms are designed to protect human life before life of animals, to preserve the lives of many people rather than few and to preserve the lives of younger people rather than elderly. The survey also showed some differences between the regions. For example, in Asia, there was a smaller tendency to preserve the lives of younger people rather than the elderly, etc. (see Awad et al., 2018). The fact is that regulation should follow or should be based on socially generally accepted values. Only such regulation is also legitimate. This means the society will accept and respect it. Therefore, such global research is very useful in finding a social consensus of the new technological age.

During various discussions, we can see that the introduction of autonomous vehicles envisages safer ride that can save 30,000 lives a year. However, any potential fatal accident in the initial stages of the introduction of such vehicles means delaying further development and the introduction of these vehicles largely in everyday life (Drevenšek, 2018). Such presumptions of safer driving are based on the assumption that only autonomous vehicles are involved in traffic. However, it will take according to some calculations, for example, in the United States at least 25 years, that actual vehicles involved in the traffic will have installed at least some new technologies that allow assistance to drivers at different levels (Barkenbus, 2018). In any case, it may be expected there will be a transitional period when both, regular and autonomous vehicles, will be on the roads.

The essential difference between regular vehicles operated by man and autonomous vehicles is also in the possibility of communication or prediction what a particular vehicle will do. For example, there was an accident between a Google autonomous vehicle and a bus, operated by a man, both of which mistakenly assumed the behavior of another (Surden and Williams, 2016). In fact, self-driving cars communicate in particular with passengers in the vehicle, while communication to other road users is worse, for example with pedestrians, cyclists, other vehicles, etc. (Surden and Williams, 2016). In the case of pedestrians, the possibility of their mutual communication, observation and anticipation of what will happen is reduced. For example, in case of a regular, man-operated vehicle, the pedestrian and the driver have eye contact, whereby the pedestrian can detect whether or not the driver will stop. The driver can also wave the pedestrian to cross the road (Surden and Williams, 2016, speak of the so-called theory of the mind). The nature of self-driving cars on the other hand is "autistic and narcissistic" (Stikker v Teffer, 2018). A pedestrian will find it difficult to communicate with a self-driving car on the same "intuitive" level. For example, when crossing the road with a self-driving car approaching, the latter slows down. A pedestrian could understand this as that the car that will stop. However, this will not necessarily be the case. Namely, the self-driving car could have set as a rule to slow down before the pedestrian crossing, but not to stop. In this case, there could be an accident due to miscommunication between the pedestrian and the autonomous vehicle (Surden and Williams, 2016). It is necessary to realize that autonomous vehicles can be manufactured by different manufacturers and will have certain different functions, algorithms, etc. Therefore, for an average person, the functioning of the system will be difficult to understand (Surden and Williams, 2016). Consequently, great responsibility lies with engineers who produce such vehicles.

Typically, for self-driving cars is that they can ride on the usual roads and can go wherever a human driver goes, with all the decisions being taken by the computer system. Unlimited, computer-controlled movement is a novelty that also

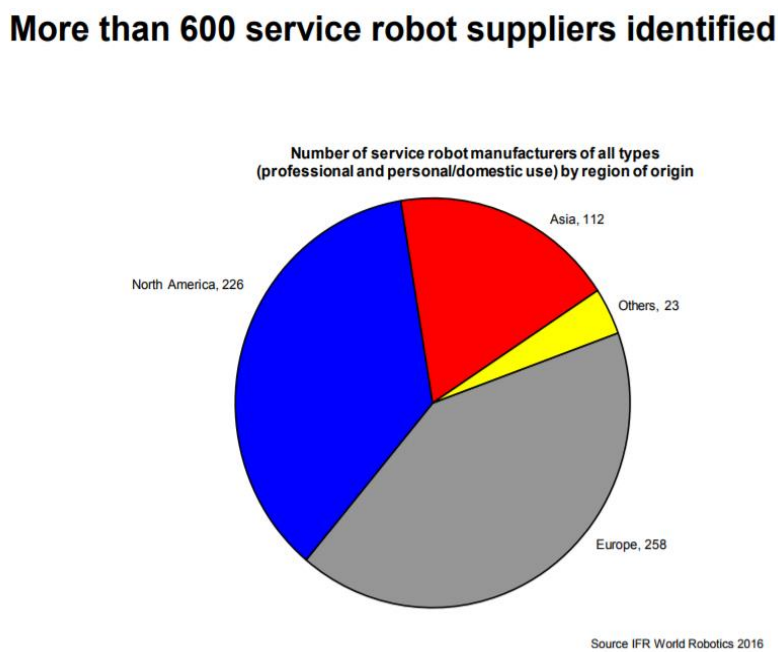
affects existing legal rules on damage. The tort law is based on presumption, that the behavior of others is widely predictable. However, the predictability of handling is not necessarily the case for self-driving cars based on computer-based systems where the machine itself decides what to do (Surden and Williams, 2016). The question that arises is who will be responsible for any damage that may arise from the use of artificial intelligence-based products (such as self-driving cars). Different approaches are advocated in this field that advocate either driver liability or liability of the manufacturer, depending on the type of autonomous vehicle, etc.

In addition to a safer driving, self-driving cars offer also other advantages, such as the option of individual transportation for all, regardless of their ability to drive a car. Moreover, development of greater mobility, linking the automotive industry to IT companies can bring about greater economic growth and increased productivity. However, there are also concerns. For example, is someone who is a good driver really a good operator (of self-driving car); job losses for professional taxi and trucks drivers; the desire of people to still drive their own car, because it is their pleasure; fear of driving in autonomous cars, etc. (Barkenbus, 2018, Valevatn, 2016; Švab, 2018; Teffer, 2018).

3. Supranational and international legal frame relevant for self-driving cars

The European Union has an important share in manufacturing different kinds of new technology products. Therefore, in terms of economic development, this is an important moment and an opportunity for Europe to set its own rules of the game and becomes an equal player on the global market, especially with the USA, China, Japan and the Republic of Korea (cf. Figure 1 as a case of manufacturing robots by region).

Figure 1: Number of Robot Manufacturers (Service Robots) by Region



Source: IFR International Federation of Robotics (2016)

The introduction of autonomous vehicles involves the interplay and cooperation of various stakeholders, from the automotive industry, policy makers to the end user. From the point of view of the competitiveness of enterprises, the development and introduction of new technologies should be encouraged. In doing so, the state has an important role to play, as for example shows the Danish model (Svenšek, 2017). Despite the fact that artificial intelligence is the key to development, less than 50% of enterprises in Europe use it, unlike the US, where two thirds of investments go to the development of artificial intelligence, which is followed by China. The fact is that Europe has a potential with its technological expertise, to which long-term financial investment should also be made. In this context, a state plays an

important role with possible financial support to areas where the market does not function (Drevenšek, 2018) and, of course, with appropriate legislation.

Historically, Europe is characterized by a consumer protection approach by defining (regulating) the requirements that the product must meet before it enters the market, with clearly defined responsibilities of those who are responsible for meeting the security conditions. In the event that these requirements are violated, sanctions are prescribed (Freeman, 2018). As already pointed out, the field of self-driving cars must also be regulated. In doing so, the law has various approaches. In addition to the adoption of legal acts, the quality standards that certain products have to fulfil and, of course, soft law, such as various resolutions, etc. make a significant contribution. All these forms are appropriate for regulating the product of self-driving cars. From the point of view of Europe's competitiveness on a global scale, it would be good if certain guidelines were developed at EU level, to be followed by the national laws of the member states (as for example Declaration of Amsterdam on Cooperation in the field of connected and automated driving, signed in 2016 by the ministries of EU Member States (2018/2089 (INI)); The European Parliament's report on autonomous driving in European transport; Commission Communication On the Road to Automated Mobility: An EU strategy for mobility of the future (COM (2018) 0283); Coordinated Plan on Artificial Intelligence 2021 Review etc.).

In the field of road traffic, several international documents form an international legal framework that needs to be respected by ratifying countries. The Geneva Convention on Road Traffic (1949) promotes the development and safety of international road traffic. Similarly, Vienna Convention on Road Traffic (1968) promotes road safety etc. In accordance with the Article 8 of the Vienna Convention on Road Traffic from 1968, which was accessed by all EU member states (except Spain), a driver has always a full control and is responsible for the behavior of a vehicle in traffic. In March 2014, a Working Party on Road Traffic Safety confirmed amendment of the mentioned article, which confirms that also systems, which can influence car driving and can be overruled or switched off by a human, are in accordance with the Article 8 of the Convention. Namely, Article 8 was amended and since 2016 allows transferring driving tasks to the vehicle itself, under the condition the technologies used are in conformity with United Nations vehicle regulations or can be overridden or switched off by the driver. Despite this change, Vienna Convention still requires a driver in a vehicle. As we can see from different countries, Vienna Convention does not prohibit to test or use automated vehicles. Namely, the Convention does not define that a driver must be in the vehicle, only that he or she has a control over it, but this control is not determined. Which means that the driver controls vehicle even when he or she is not in the vehicle and chooses a destination and path (Ardiyok and Canbeyli, 2020). Therefore, there is another amendment of Vienna Convention prepared by United Nations Economic Commission for Europe's Global Forum for Road Traffic Safety under way (Global Forum for Road Traffic Safety, 2020). It will define also automated driving system and define that presumption of a driver will be satisfied while the vehicle is using an automated driving system, which complies with national technical and other regulations as well as relevant international legal instrument. If accepted by contracting parties it will enter into force by July 2022.

Further, three UN Regulations related to automated driving were adopted: UN Regulation No. 155 on Cyber Security and Cyber Security Management Systems, UN Regulation No. 156 on Software Updates and Software Updates Management Systems, and UN Regulation No. 157 on Automated Lane Keeping Systems.

In 2019 on EU level Regulation (EU) 2019/2144 of the European parliament and of the council of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users was accepted. The regulation is to be applied from sixth of July 2022 on. Regulation uses terms automated and highly automated vehicle. As defined in points 21 and 22 of Article 3 an "'*automated vehicle' means a motor vehicle designed and constructed to move autonomously for certain periods of time without continuous driver supervision but in respect of which driver intervention is still expected or required; (22) 'fully automated vehicle' means a motor vehicle that has been designed and constructed to move autonomously without any driver supervision*".[3] In the procedure of adoption is still an Implementing Act on the Automated Driving System, which is envisaged to be entirely and directly applicable in all member states (See Draft Commission implementing regulation (EU) of XXX laying down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of motor vehicles with regard to their automated driving system, hereinafter Act). However, according to Digital Europe (November, 2021)

[3] Cf. Global Forum for Road Traffic Safety (WP.1) resolution on the deployment of highly and fully automated vehicles in road traffic.

Act or Annexes are not clear how the Act will work in practice in member states, which already plan to have Level 4 automated vehicle (AV) frameworks in place in 2022 (e.g. France and Germany). Finally, this implementing Act will define in more details automated driving system.

Furthermore, EU addresses aspects of ethics and cybersecurity as regards artificial intelligence in the draft of the EU Artificial Intelligence Regulation (2021a). It proposes four different levels risks of specific uses of artificial intelligence: unacceptable risk, high risk, limited risk, and minimal risk.

4. Existing national regulations that can serve as an example

Germany

Germany wants to be the first country to put automated vehicles on the road on regular basis. It adopted a Strategy for Automated and Connected Driving in 2015. In 2017, Ethics Commission's completed report on automated and connected driving. In 2017, Road Traffic Act was amended (Achtes Gesetz zur Änderungen des Straßenverkehrsgesetzes). It enabled instalment and defined requirements of highly and fully automated driving functions in motor vehicles, which represent SAE level 3 (conditional automation)[4] and 4 (high automation)[5]. The highly or fully autonomous vehicle had to respect traffic regulations and acknowledge when the driver needs to take over the control. The latter needed to be done in an adequate time. In addition, the system should allow at any time the driver to manually quash the automated driving mode or deactivate it (Ardiyok and Canbeyli, 2020). When proper use of self-driving system is not possible anymore, the driver should immediately take over the steering (Gleiss Lutz, 2017).

However, in 2021 Act Amending the Road Traffic Act and the Compulsory Insurance Act - Autonomous Driving Act was adopted and came into force on 28 of July 2021. Federal Ministry of Transport and Digital Infrastructure will evaluate it at the end of 2023. This act allows that also vehicles, which can perform automated driving tasks without a driver to be included on the public roads in specific areas (level 4 by SAE).

It regulates motor vehicle with autonomous driving capabilities, which can independently perform driving tasks within specific area, intended for it. The vehicle needs to fulfil certain technical requirements as defined by law (independently comply with the traffic regulations; independently bring the motor vehicle into a minimal risk state if travel can be continued only by violating road traffic law; have an accident avoidance system; immediately notify the technical supervisor of any impairment of its functionality; and be capable of being deactivated by the technical supervisor at any time (Gesley, 2021).

The Federal Transport Authority is competent to check whether the vehicle fulfils technical requirements. In addition, the manufacturer has to submit a certificate confirming that the vehicle complies with technical requirements. Furthermore, the manufacturer needs to ensure cybersecurity (Gesley, 2021).

Specific areas intended for vehicles with autonomous driving capabilities are public road space as defined locally and spatially fur such intent. A state authority should approve it.

Furthermore, a technical supervisor with power to deactivate or enable driving operations of such vehicle is still obligatory from the outside. Moreover, a person who has such vehicle must have additional liability insurance for technical supervisor (Gesley, 2021). Technical supervisor is a natural person and is foreseen to be the person who is a registered keeper of the vehicle. However, he or she can delegate it to another person.

Importantly, accident avoidance system in these vehicles must be outlined in a way to avoid and reduce damage. If an accident is unavoidable, it must give the highest priority to the protection of human life. However, if an injury to human life cannot be avoided, no further weighting based on personal characteristics, such as age, sex, and physical or mental constitution should be done (Gesley, 2021).

[4] The human driver will respond in sufficient time if needed.
[5] The system does not need to be controlled by the human driver.

The tasks, which cannot be performed by the system, are still obligatory by the passengers, such as wearing a seat belt. The technical supervisor is responsible for the passengers that they obey the law.

Registered keeper has to store and save certain information in case of accidents: vehicle identification number; geographical position data; number and times of use as well as activation and deactivation of the autonomous driving function; number and times of authorization of alternative driving maneuvers; system monitoring data, including software status data; environmental and weather conditions; networking parameters such as transmission latency and available bandwidth; name of the activated and deactivated passive and active security systems, data on the status of these security systems, and the instance that triggered the security system; vehicle acceleration in the longitudinal and transverse directions; speed; status of the lighting equipment; power supply of the motor vehicle with autonomous driving function and external commands and information sent to the vehicle (Gesley, 2021).

Slovenia

Slovenia introduced regulation of automated vehicles in 2021 in Road Traffic Rules Act (Official Journal, 156/21, 161/21, hereafter RTRA). However, the regulation predicts only the testing of automated vehicles. It stipulates that such vehicles be of level 1-3 by SAE categorization. Before being tested in designated area, it should be tested on surfaces intended for road traffic. The vehicles shall be marked with a prescribed "CAV" plate, which shall be made of weather-resistant and light-reflecting materials. The driver of an automated vehicle shall be on standby at all times so that he or she can take over the operation of the automated vehicle at any time. The driver of an automated vehicle shall be deemed the driver of a motor vehicle as defined in the Drivers Act. However, the driver should not be a novice driver and needs to be qualified to test such vehicles.

Electronic systems installed in the vehicle have to monitor and record driver's behavior during the testing. If there is an accident, the data need to be made available to an authorized official for a period of 30 seconds before and 30 seconds after the accident or traffic offence[6].

The manufacturer shall have a contract of insurance against liability for damage caused to third parties by the use of the automated vehicle in accordance with the regulations governing compulsory insurance in the field of road transport, for the duration of the testing. The driver when driving the automated vehicle (paragraph 8 of Article 27 a RTRA) shall carry the insurance policy or other proof of insurance.

The proof that a vehicle was pretested on surfaces intended for road traffic and a proof of competence of the driver is a statement by the manufacturer of the automated vehicle or automated driving system. The driver shall carry the declaration with him during testing.

The manufacturer of an automated vehicle or automated driving system shall notify the police and the traffic information center of the intended testing. The notification should include details of the manufacturer, the responsible person of the manufacturer, details of the drivers who will test the automated vehicle, details of the automated vehicle including the number plate number, details of the equipment to be tested and the intended road section and time of the test (paragraph 10 of Article 27 a of RTRA).

Sweden

Sweden wants to promote innovative technology for sustainable transport. Therefore, the Swedish Government adopted Ordinance on Trial Operation with Self-driving Vehicles (entered into force on 1 July 2017, 2017:309). Based on this Ordinance Swedish Transport Agency issues permits for trial operations with automated vehicles on public roads. During the tests with an automated vehicle, there must be a physical driver inside or outside the vehicle. However, by now no legislation on this matter was adopted.[7]

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[6] The data may be processed by the manufacturer of the automated vehicle or automated driving system for a maximum period of one year, and by the competent supervisory authority to the extent and for the duration strictly necessary for the purposes of carrying out the supervision or the offence or criminal proceedings (maximum period of three years from the date of acquisition). After the expiry of the time limits, the data shall be deleted (see paragraph 7 of Article 27 a of RTRA).

[7] In terms of hierarchy of regulation ordinance is lower than a law (Hansson, 2020, p. 5).

It is obligatory that the driver be in the vehicle and can intervene at any time if needed. Advanced driving systems can be used if the car manufacturer confirms that the automated systems do not affect the basic driving functions, meaning that the driver can always take over the control.

Person (legal or natural) carrying out the testing is responsible for ensuring that the activities are conducted in accordance with the permit issued for trial operations (Ordinance on trials of self-driving vehicles, 2017).

Norway

Although Norway is not a member state of the EU, it is linked to it by being a member of the European Economic Area. In 2017, the parliament adopted a law (Testing of Automated Vehicles Act)[8] allowing experiments with self-driving vehicles on the public roads[9], which took for a basis Swedish research on the matter.[10] Norwegian law does not demand a driver physically in or outside the vehicle. However, the applicant to obtain permission for testing needs to prove that he or she has control of vehicle at all time. Nevertheless, he or she does not need to sit behind the steering wheel if the technology can take care of all driving situations (Hansson, 2020, p. 6). Namely, The Road Traffic Act (1965) requires the driver always to pay close attention to the road. Road Traffic Act (Teknologiradet, 2018, p. 46; 60-61) makes individual exceptions for automated vehicles to be used in testing projects.

The application and permit for testing should define a physical person responsible for the testing being carried out in accordance with existing regulations. This person has to ensure that the safety measures are taken where the test is carried out with automated vehicles without a responsible driver. Furthermore, vehicles used for testing are presumed to be insured according to existing laws, and that person performing the tests considers appropriate insurance agreements for the relevant vehicles in collaboration with insurance companies (Teknologiradet, 2018, p. 55).[11]

United Kingdom

Although United Kingdom is not anymore an EU member state, it is interesting to look at it since their regulation was one of the first to deal with this matter in EU space (2017, 2018). Furthermore, UK is heading toward new improvements in the field by introducing Automated Lane Keeping Systems (ALKS), which will enable the driver to safely hand over control to the vehicle. For this, also regulation proposals are already in the process (ALKS regulation adopted in 2020). Further, the Highway Code is in the process of change to clarify the expectations for users of automated vehicles (i.e. to clarify driver's responsibilities, for example when he or she needs to be ready to take back control). According to the existing regulation (Vehicle Technology and Aviation Bill 2016-2017, Automated and Electric Vehicles Act 2018) the insurer is liable for the damage if the accident is caused while the automated vehicle is driving itself and a person (insured or other) is hurt (under the condition that the vehicle is insured at the time of accident). The driving can take place on the roads or other public places in Great Britain and dose not explicitly requests a driver behind the steering wheel. If the automated vehicle is not insured at the time of the accident then the owner of the vehicle is liable for the damage. However, the insurer's liability may be excluded if the insured person made prohibited alterations to the vehicle's operating system or failed to install software.

[8] Entered into force in January 2018.

[9] It allows the testing of automated vehicles in regular traffic.

[10] Analysis of what kind of regulation changes are needed to do testing of self-driving vehicles on public roads and use them on public roads (Hansson, 2020, p. 5).

[11] E.g. in California, responsibility is split between the driver and automatic system during automated driving. During automated driving (levels 3-5), the manufacturer is responsible that the vehicle follows traffic regulations. In Tennessee, the system is considered the driver during automated driving. However, at level 3, the driver is always responsible for the vehicle following the traffic regulations, even during automated driving. For levels 4-5, the manufacturer is responsible during automated driving (Teknologiradet, 2018, p. 56).

Table 2: Overview of national legislation on self-driving cars

Country	Germany	Slovenia	Sweden	Norway	United Kingdom
Regulation	Autonomous Driving Act 2021	Road Traffic Rules Act (2021)	Road Traffic Ordinance (2017); Local authorities / municipalities can issue special traffic laws (road safety should be guaranteed)	Testing of Automated Vehicles Act (2017, into force 2018)	Vehicle Technology and Aviation Bill 2016-2017, Automated and Electric Vehicles Act 2018.
Responsibility	Manufacturer or driver (depends who was in charge and failed).	Manufacturer.	Person carrying out the testing.	Person carrying out the testing.	Insurance company.[12]
Driver in control?	Allows level 4 vehicles. Technical supervisor obligatory from the outside.	Allows testing of levels 1-3. Driver on standby at all times and takes over at any time.	Yes, manufacturer needs to assure that driver can anytime maintain control.	No.	Not necessarily.
Where vehicles can drive?	Specific operating areas in public road space.	Only for testing automated vehicles	Public roads.	Public roads.	Roads and other public places In Britain.
Ethical notions?	Yes. Highest priority to the protection of human life; no discrimination is allowed.	No.	No.	No.	No.

Source: legal sources of selected states as defined in the first line of the Table

From the analyzed sources and selected regulations we can conclude, that despite the fact, that most of the accidents are a consequence of a human factor, most of the current rules (guidelines) persist, that every car has a driver. This means that a human is still sitting behind the steering wheel and takes over the driving in case the system signals an error. In 2016, such case was an accident of a Tesla car resulting in death. It turned out that the system warned a driver 7 seconds before the accident to take over the driving. However, the driver did not respond to the warning.

Therefore, a position of an obligatory takeover of a driving by a human (7 seconds before the accident!) is contradictory to the primary goal, i.e. safe driving without a human factor. Namely, human makes most of the errors, which result in accident. An argument, that in case of self-driving system a human will react quicker and better than a system and thus prevent an accident is not convincing. Namely, already currently when a human drives a car, he or she reacts slowly. Moreover, the reactions will be slower if people will watch movies while driving, and then in the next moment they should switch within seconds to potentially deadly dangerous situation and react quickly to prevent

[12] Insurance companies should compensate for the majority of losses from AVs. Manufacturers, developers and human drivers will bear their respective responsibilities for product defects and user negligence (Taeihagh, Si Min Lim, 2019; see Vehicle Technology and Aviation Bill, 2016-2017). The future regulation proposals go in the direction that company or software developer, which obtained the authorization for self-driving, would face regulatory sanctions in case something goes wrong (Law Commission, 2022). Drivers will remain being responsible for car insurance, checking loads and children wearing seatbelts.

an accident. Of course, also, technology itself cannot be completely trusted and errors are always possible. However, for such situations it would be better, that a system has an incorporated guard of a safe stop over beside the road, until the errors are fixed.

Therefore, for different situations clear liability rules should be set. Moreover, in case of high or full automation (levels 4 and 5) there is a question of procedure to acquire driving license, and what kind of trainings for the "vehicle users" (drivers) will be efficient. Namely, higher level of the automation and less driving by driver himself, leads to reduction of the driving competences. Similar cases occurred in the aviation, where the pilots were so much counting on the autopilot that they could not perform certain tasks by themselves when needed. Consequences in such cases were disastrous. In reviewing current research and literature, we can see that technology is developing very rapidly. The new systems are based on artificial intelligence, which is an interdisciplinary field with intertwining of psychology, philosophy, mathematics, neuroscience etc. The latest achievements enable machines to perform tasks that previously required human thinking. The systems work by partly imitating human intelligence. Current technological development enables computers to learn and make their own decisions by imitating human brain patterns. The system is able to learn, generalize, plan, solve problems, logically deduce, etc.

Based on the analyzed existing regulation of selected states (Table 2) we can conclude that most of them are still referring to the driver at some point, who is still responsible for things such as putting seatbelts, taking care of the insurance etc. Moreover, he or she might have to take over the control of the vehicle. However, there is a whole range, from requiring driver behind the steering wheel to less strict rules. Mainly, the regulation sets requirement to the state to establish a register of self- driving cars. As regards rules on protection of personal data, ethics etc. the analyzed selected acts on the self-driving vehicles do not have these rules (except Germany). However, this does not mean that these areas are not protected in these states. Mostly there is an approach of applying existing laws regulating these specific questions also to the new aspects of technology.

Further, based on the analyzed regulation of selected states we can see most states took the approach of firstly regulating only the testing of autonomous vehicles in specific area. The second step will then be to regulate the use of such by the general public (Shladover, Nowakowski, 2019).

The time trend seems to be that especially the countries where automobile industry is of great economic importance, strive to regulate the matter sooner as to enable testing of automated vehicles in their territory (e.g. UK, Germany, and Sweden). In addition, flexible legal framework, which can attract also foreign investors, producers to come testing their products can be seen as an important encouragement also for other states, which do not have a strong automobile industry to prepare such legal framework in reasonable time (cf. Hansson, 2020, p. 6).

As argued by Hansson (2020, p. 7) shaping of new regulation goes through different phases. Firstly, we have existing regulation, which does not fit to autonomous vehicles, but is still taken as a basis to prepare new regulation. This is so-called transition phase, where existing regulation needs to change due to evolution of technology. Hansson (2020) argues that during this phase there are co-existing three types of regulation modes: existing regulatory standards, self-regulation and elements of open method of coordination. The existing regulatory standards influence the forming of new regulation and are valid until new regulation is formed. On the other hand, private sector (industry) forms its own standards (e.g. SAE) (Hansson, 2020, p. 7). In addition, international regulatory standards and conventions have important influence on national regulation, representing open method coordination, in addition to benchmarks and learning experiences form other countries. Finally, there is a consolidation phase when new regulation is adopted (Hansson, 2020, p. 7).

5. Conclusions

The field of autonomous vehicles is subject to constant change since the technology is fast developing. It is important that technology experts and legislators work together in order to prepare a sound legal basis for safe use of autonomous vehicles. Some steps were already done on the EU and national level, but the future regulation will for sure need to specify more in detail further important questions. Namely, firstly, in order to adopt efficient policy and prepare regulation, basic terminology should be defined. For example, what is understood under the term vehicle and incorporate within it the spectrum of self-driving cars. It is a phenomenon with the cross-border effects. Therefore, already on the EU level (or globally) the same terminology, vehicle categorization and appropriate regulation should be defined. Namely, the parceling of the regulation by the individual member states, leads to lower competitiveness of the EU. Furthermore, it needs to be defined, who can use self-driving vehicles (e.g. age limitation; accomplished

exam with the knowledge of using self-driving system etc.); under which conditions and when and where the use of self-driving vehicles is allowed (e.g. certain parts of roads can be excluded; or driving is not allowed in case of certain weather conditions); who is competent to perform surveillance of the self-driving vehicles (to check functionality, safety of the use in traffic etc.).

References

- Ardiyok, S., Canbeyli, A. (2020). The legal framework for autonomous vehicles in European Union. Business Going Digital. February 2020.
- Awad, E. et al. (2018). The Moral Machine Experiment. Nature, 563, pp. 59–64.
- Barkenbus, J. (2018). Self-Driving Cars: How Soon is Soon Enough?, Perspectives, Vol. XXXIV, No. 4.
- Declaration of Amsterdam, Cooperation in the field of connected and automated driving. https://www.regjeringen.no/contentassets/ba7ab6e2a0e14e39baa77f5b76f59d14/2016-04-08-declaration-of-amsterdam---final1400661.pdf
- Deutscher Bundestag (2017). Achtes Gesetz zur Änderung des Straßenverkehrsgesetzes. Bundesgesetzblatt Jahrgang 2017 Teil I Nr. 38, Bonn, 20. Juni 2017.
- Digital Europe's s comments on the draft Implementing Act on the Automated Driving System (April 2021). https://www.digitaleurope.org/resources/digitaleuropes-comments-on-the-draft-implementing-act-on-the-automated-driving-system/#_ftn2
- Digital Europe comments on the second draft Implementing Act on the Automated Driving System (November 2021). https://www.digitaleurope.org/resources/digitaleurope-comments-on-the-second-draft-implementing-act-on-the-automated-driving-system/#_ftn1
- Drevenšek, S. (2018). Evropsko koketiranje z umetno inteligenco. Svet kapitala.
- Drevenšek, S. (2018a). Bodo algoritmi res boljši sodniki? Svet kapitala.
- European Commission (2018). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions On the Road to Automated Mobility: An EU strategy for mobility of the future, https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180283_en.pdf
- European Commission (2021). Coordinated Plan on Artificial Intelligence 2021 Review, file:///C:/Users/Tina/Downloads/1_en_annexe_autre_acte_part1_v8_vf_C4B261EB-ABA4-5C30-1555482869410384_75787.pdf
- European Commission (2021a). Proposal for a regulation of the European parliament and of the council laying down harmonised rules on artificial intelligence (artificial intelligence act) and amending certain union legislative acts COM/2021/206 final.
- European Commission (2021b). Draft Commission implementing regulation (EU) of XXX laying down rules for the application of Regulation (EU) 2019/2144 of the European Parliament and of the Council as regards uniform procedures and technical specifications for the type-approval of motor vehicles with regard to their automated driving system. https://circabc.europa.eu/sd/a/4664e8a3-0634-4430-8035-9fc07d99b2bf/Com%20Impl%20act%20AD%20V4.1.pdf
- European Parliament (2016). Briefing. January 2016. Automated vehicles in the EU.
- European Parliament (2018). Draft Report on autonomous driving in European transport, (2018/2089(INI)), http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-%2F%2FEP%2F%2FNONSGML%2BCOMPARL%2BPE-623.787%2B01%2BDOC%2BPDF%2BV0%2F%2FEN
- Federal Ministry of Transport and Digital Infrastructure (2017). Ethics Commission Automated and Connected Driving. Germany.
- Freeman, R. (2018). Evolution or revolution? The future of regulation and liability for artificial intelligence. OECD Conference.
- Gelin, T. (2017). Prihodnost mobilnosti. Insurance Europe. XXIII. seminar s področjaavtomobilskega zavarovanja.
- Gesetz zur Änderung des Straßenverkehrsgesetzes und des Pflichtsversicherungsgesetzes - Gesetz zum Autonomen Fahren, Bundesgesetzblatt Jahrgang 2021 Teil I Nr. 48, Bonn, 27. Juli 2021.
- Gesley, J. (2021). Germany: Road Traffic Act Amendment Allows Driverless Vehicles on Public Roads. Library of Congress.
- Gleiss Lutz (2017). New legal rules on automated driving. Available at: https://www.gleisslutz.com/en/automated%20driving.html-0

- Global Forum for Road Traffic Safety (2020). Report of the Global Forum for Road Traffic Safety on its eighty-first session Addendum Amendments to Article 1 and new Article 34bis 1968 Convention on Road Traffic. Geneva 21-25 September 2020.
- Gupton, N. The Science of Self-Driving Cars, The Franklin Institute, https://www.fi.edu/science-of-selfdriving-cars (accessed 2022).
- Gurney, J.K. (2013). Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles. U. Ill. J.L. Tech. & Pol'y 247, pp. 247–277.
- Hansson, L. (2020). Regulatory governance in emerging technologies: The case of autonomous vehicles in Sweden and Norway. Research in Transportation Economics, Elsevier, vol. 83(C), pp. 1-10.
- IFR, International Federation of Robotics (2016). IFR Press Conference Publication of World Robotics 2016 – Service Robots,12 October 2016, Seoul.
- Norway (2018). Regulacija samovozečih vozil, https://lovdata.no/dokument/NL/lov/2017-12-15-112
- Parliament of the United Kingdom (2016–2017). Vehicle Technology and Aviation Bill (HC Bill 143).
- Regulation (EU) 2019/2144 of the European parliament and of the council of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users, amending Regulation (EU) 2018/858 of the European Parliament and of the Council and repealing Regulations (EC) No 78/2009, (EC) No 79/2009 and (EC) No 661/2009 of the European Parliament and of the Council and Commission Regulations (EC) No 631/2009, (EU) No 406/2010, (EU) No 672/2010, (EU) No 1003/2010, (EU) No 1005/2010, (EU) No 1008/2010, (EU) No 1009/2010, (EU) No 19/2011, (EU) No 109/2011, (EU) No 458/2011, (EU) No 65/2012, (EU) No 130/2012, (EU) No 347/2012, (EU) No 351/2012, (EU) No 1230/2012 and (EU) 2015/166, https://eur-lex.europa.eu/eli/reg/2019/2144/oj
- SAE. (2014). Automated driving levels of driving automation are defined in new SAE international standard J3016.
- Shladover, S. E., and Nowakowski, C. (2019). Regulatory challenges for road vehicle automation: Lessons from the California experience. Transportation Research Part A: Policy and Practice, 122, 125-133. https://doi.org/10.1016/j.tra.2017.10.006.
- Slovenia. (2021). Road Traffic Rules Act (Official Journal, 156/21, 161/21
- Surden, H., Williams, M.A. (2016). Technological Opacity, Predictability, and Self-Driving Cars, Cardozo Law Review, Vol. 38:121, pp. 121–181.
- Svenšek, K. (2017). »Na hitro in nepremišljeno obdavčevati robote je lahko slabo«. https://svetkapitala.delo.si/inovacije/na-hitro-in-nepremisljeno-obdavcevati-robote-je-lahko-slabo-4217
- Sweden (2018). "The path to automated driving – market introduction" (SOU 2018:16) https://www.government.se/497e60/contentassets/31cf2d8c8df1465da086e2390028d1cb/summary-sou2018-16.pdf
- Švab, N. (2018). »Še malo in ljudje bodo hodili na digitalne počitnice, da se odklopijo«, 24. ur, znanost in tehnologija.
- Taeihagh, A., Si Min Lim, H. (2019). Governing autonomous vehicles: emerging responses for safety, liability, privacy, cybersecurity, and industry risks, Transport Reviews, Volume 39, Issue 1, 2019, pp. 103-128.
- Teffer, P. (2018). »Society too complex for EU's self-driving cars dream«, Euobserver. https://euobserver.com/science/143762
- Teknologiradet (2018). SELF-DRIVING CARS – the technology behind and the way forward. file:///C:/Users/Tina/Documents/Pravo_in_Robo/It/Norway_Self-driving-cars_WEB2018.pdf
- UK. Law Commission, Reforming the law, Legal reforms to allow safe introduction of automated vehicles announced, 26 January 2022: https://www.lawcom.gov.uk/legal-reforms-to-allow-safe-introduction-of-automated-vehicles-announced/
- Valevatn, J. (2016). Driverless cars – need for political action? Teknologiradet, https://teknologiradet.no/en/driverless-cars-need-for-political-action/
- Wilkinson, L. (2022). British drivers 'will be able to watch TV' in autonomous cars, https://www.carmagazine.co.uk/car-news/motoring-issues/self-driving-cars-driver-responsibility-legal-issues/