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Autonomous Vehicles Regulations: Challenges and Opportunities

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Abstract

Regulating autonomous vehicles is a crucial aspect of integrating this emerging technology safely and effectively into our transportation systems. The regulatory framework varies across countries and regions, but some common principles and considerations for autonomous vehicle regulation include Safety Standards, Licensing and Certification, Data Privacy and Cybersecurity, Liability and Insurance, Infrastructure Requirements, Interoperability, Public Education and Awareness, Testing and Deployment, Regulatory Flexibility, International Collaboration. In this paper, we explore industrial countries' current and future state of autonomous vehicles and their regulation. In particular, we examine the Laws of tort, insurance law, transportation law, and data privacy in each country. The number of autonomous vehicles on the road network is a key factor and impetus for the development of such regulations. Since the transition to driverless vehicles may take a few decades to complete, roads become a hybrid network populated with human-driven and autonomous cars.

Keywords *autonomous vehicles, Data Privacy, cybersecurity, Liability, Insurance, legal challenges, UK, UAE, Germany.*

Introduction

As a result of the surge in private vehicle transportation, the demand for road capacity is increasing every day[1]. Although expanding the road network may seem like an obvious solution, construction and replanning the infrastructure in densely populated areas is challenging [1].

Therefore, road and transportation authorities have been seeking an alternate solution that can reduce traffic with minimal modification to the existing infrastructure[1] [2].

Another factor leading to traffic congestion is car crashes. Traffic accidents are one of the top rising causes of death among youth [3]. According to World Health Organization [3]car *crashes* claim nearly 1.3 million lives every year globally. Human error is considered to be the largest contributor to this figure [3] In addition to the high number of deaths, the negative socio-economical impacts of traffic accidents can be substantial [4]

Autonomous Vehicle Transportation

Traffic management can benefit greatly from vehicle movement prediction[5]. Fortunately, autonomous vehicle behaviour on the road is much more predictable than human-driven cars[6]. In a recent case study[7], the simulation and real-world trials indicated the positive

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impact of AV penetration on road capacity [7]Although the experiments yielded a higher success rate when the ratio of AV to human-driven cars are higher[7].

In addition to predictable behaviour, AVs have proven to tackle major environmental problems such as pollution [1, 2] which has attracted the attention of many governments.

Several countries have already introduced and legalized the use or trial of autonomous vehicles in their existing road networks [8]and many countries are in the process of initiating the driverless cars projects [8].

Challenges and Opportunities

The rapid development of AVs in the past few years can be instrumental in urban transformation [9]. However, looking at the timeline of this transformation, the impacts and challenges vary depending on the share of the automation in the road network [9] Considering the present time as the early stage of the reform, the main challenges are associated with the regulations surrounding AVs [1, 9, 15].

Although the AVs are capable of communicating with other non-autonomous vehicles, the human-error factor makes the movements of the human-driven car uncertain. However, with a higher number of autonomous cars on the road, the driving system becomes more reliable as the driving patterns stabilize.

Report Structure

The flow of this report is organized as follows: The key aspects of autonomous drive regulations are discussed in section two. Subsequently, the current legislation in four countries is thoroughly elaborated in section three. The following section then provides a summary of the latest jurisdictions for driverless cars alongside an analysis of the potential challenges and opportunities for implementation of such regulations. Finally, the overall conclusion of the report outlines the future role of autonomous vehicles and the path that governments must take to ensure a safe autonomous journey integrated with other vehicles. In summary, Figure 1 illustrates the flow of the content of this report.

AV Regulations Review

This section particularly investigates the potentially challenging areas of this transformation from the legislative point of view. This paper aims to clarify the existing and future path of the legislation that ensures the safety of road users in the four categories listed below.

Law of Tort (Civil Law)

The distinction between criminal law and the law of tort is usually clear in many areas, however, when it comes to traffic and particularly AV traffic, the separation of the two becomes challenging [10]. While tort law deals with fair compensation for the harms caused by an accident, criminal law handles cases such as fatal crashes[11]. As the number of AV users rises on the roads, the urgency in establishing a uniform legal framework increases[10]. Currently, non-autonomous vehicles constitute a very large portion of the road network, therefore, applying traditional tort law is a reasonable approach. However, as the number of AVs on the road increases, the legitimacy of traditional tort law will be questioned. The assumptions of the current Geneva and Vienna traffic conventions in 1949 and 1968 will be invalidated as the concept of vehicle driver changes in autonomous drive. Therefore, countries that aim to transform to hybrid or fully autonomous road networks must consider significant changes to the current law of tort[12].

Transportation Law

Autonomous vehicles are designed based on current and short-term future infrastructure. For AVs to co-exist with human-driven cars in the same road network, abiding by current traffic laws are indisputable. Therefore, in the early stages of the transformation, major changes may not be necessary. However, as the AV density increases in the network, transportation laws could be catered specifically to the needs of automated driving systems, such that safety, path planning, and navigation can be optimized.

Insurance Law

Tort and transportation laws play an important role in motor insurance. Currently, insurance companies do not provide a policy covering the damages caused by an automated driving system. The foundation of a car being driven by a human driver is still in use. Therefore, changes in transportation and tort law will significantly impact insurance law. A few law firms have suggested that a new set of policies be issued that covers all damages caused by the autonomous vehicle when in autonomous mode. However, many potential grey areas in these clauses must be clarified. An alternate approach looks at holding manufacturers reliable eliminating the user's role in case an of accident. Perhaps designing policies according to the AV density on the road networks given the timeline would be a better solution.

Data Protection Law

Autonomous cars utilize state-of-the-art technology to navigate safely through the roads with attention to all details of the surroundings. Capturing and processing huge amounts of external and internal data such as distance sensors, cameras, and other relevant data allows the drive system to make decisions. Although this set of data is necessary for the safe operation of AVs, external access to such data raises privacy concerns for users [2, 5]. On the other hand, manufacturers and engineers could benefit from this rich information source to enhance driverless cars' performance. Additionally, the authorities can potentially access the data to determine the cause of the accidents[13].

Literature Review

This section of the paper reviews the current state of autonomous vehicles and the adoption of such technologies in the current infrastructure. Additionally, it discusses the amendments required in the legal department of Transport to generate, clarify and impose driverless cars rules. The overviews are collected from 4 countries that have implemented or started to integrate AVs into their transportation systems.

United Arab Emirates (UAE)

The UAE is the first nation in the Middle East and one of the first governments in the world to establish an Artificial Intelligence office in 2017, ministered by his excellency Omar bin Sultan Al Olama. The strategy will aim to support transportation, health, space, environment, traffic, etc [6, 7]. Further, the UAE's vision for the fourth industrial revolution is to "become a leading global hub and an open lab for the Fourth Industrial Revolution's applications. [7]"

The Federal Decree-Law No. 25 issued in 2018 Article 1 [7], authorizes the cabinet to support temporary licenses for the execution of futuristic projects such as autonomous drive, without any legislation being enacted in the State in respect of such project, to prepare legislation regulating the project's activity in the State. Therefore, the cabinet may set the guidelines,

conditions and control the procedures for licensing and executing such projects, and allow exceptions from any Federal legislation for a limited time.

The supreme legislation committee in the Emirate of Dubai, in administrative resolution, number 501 of 2020 [14], approves the rules, conditions, and procedures related to the testing of autonomous vehicles in the state of Dubai [8]. According to Article 2, the testing entity (referred to as establishment) must get initial approval by submitting documents listed in Table 1.

Table 1 Legal Documents Required for Initial Approval.

Number	Document
1	Technical Specification of the AV
2	Test plan
3	History of test runs
4	Provide a comprehensive accident and civil liability insurance policy issued by an insurance company licensed to operate in the State so that such policy covers all damage that may inflict on individuals or property and is valid as of the date of issuance of the permit
5	Contact Data and CV of the driver
6	Sign a contract for conducting the test run of the autonomous Vehicle

The preliminary approval allows 3 months for the establishment to complete the process to obtain the permit. During this period the establishment must send the AV to Dubai, ensure the settings of the vehicle for the test run, and provide necessary equipment such as high-quality maps and energy/charging essentials. Further, a contingency plan for evacuation, in case of an emergency during the test run must be provided. Additionally, the establishment should submit all forms required in cooperation with RTA. Daily activity and the latest version of the vehicle must be presented to the RTA for final examination.

During the test run, the establishment must only follow the plans previously coordinated with the RTA and adhere to all traffic legislation in the emirate of Dubai. The establishment shall not publish any sort of data without the approval of the RTA. Further, the establishment must provide frequent performance reports including all details of each test run. In the meantime, RTA must be granted full access to all electronic systems of the vehicle.

The AV driver must be at least 25 years old, and hold a UAE-valid driving license and establishment certificate that indicates his complete understanding of the technologies to be subject to the test run.

Law No. 9 of 2023 Regarding Regulating the Operation of Autonomous Vehicles in Dubai

By Law No. 9 of 2023, which was published on April 14, 2023, Highness Sheikh Mohammed bin Rashid Al Maktoum signed the law regulating the use of autonomous vehicles in Dubai.[8]

The new regulation intends to promote Dubai's move to smart mobility[15]. Article 5 states that the Roads and Transport Authority (RTA) would govern the autonomous vehicle industry. The Authority will establish technological, operational, and safety standards for autonomous cars, classify them, and develop policies and long-term goals to improve their performance[15].

Article 8 also addressed the requirements for issuing licenses to autonomous vehicles:

1. The manufacturer is the designated local agent When an autonomous vehicle is registered for the first time in Dubai.

2. The self-driving car must have been registered in the exporting nation and its use must have been established on a public road that has been designated for vehicles of its class and category there[16].
3. To be ready to deal with traffic signs and walk on them, as well as to be ready to deal with road priorities.
4- It must adhere to the security and safety requirements, specifications, and recommendations established by the Authority in this regard to deal with the road and its users[15].

By the general rules of liability established in this regard, according to Article 14's section on civil liability for damages caused by autonomous vehicles, "the operator is liable for damages to persons or property caused by the autonomous vehicle, without prejudice to the operator's right to return to the real perpetrator of such damage."

Australia

Autonomous driving has been a trending subject in Australia among researchers and city planners[17]. Lower traffic congestion, easy and quick mobility, cleaner energy, and reduced number of accidents strengthen the case for autonomous vehicles (AVs) in many advanced countries including Australia [18] Further, Australia has been ranked 15th in the AV readiness index (AVRI) in 2020 which shows a promising infrastructure for such transformational change[19].

Although many parties support the adoption of such technologies for safer and state-of-the-art transportation, the acceptance rate of AVs among the general public may not be very strong[19]. A lack of clear understanding of the operation and integration of AVs in the current infrastructure can be seen as a major contributing factor to the public's stance [20]. Thus, defining a clear set of regulations and policies about safety, liability, and human interaction can help to eliminate these uncertainties and smoothen the path for AVs [20].

Generating policies for AVs can be complex without a clear separation of roles of human driver and automated agent driver [19]. According to the Society of Automotive Engineers (SAE) [21]six levels of autonomy can be defined with descriptions of responsibility for certain tasks such as steering control, environment monitoring, fallback performance, and driving modes [19]. Table 2, illustrates the party responsible for each task.

Table 2 SAE Automated Driving System Levels.

SAE level	SAE name	SAE narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability (*driving modes*)	BASt level	NHTSA level
Human driver **monitors the driving environment**								
0	**No Automation**	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	**Driver Assistance**	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	**Partial Automation**	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes	Partially automated	2
Automated driving system **("system") monitors the driving environment**								
3	**Conditional Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes	Highly automated	3
4	**High Automation**	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes	Fully automated	3/4
5	**Full Automation**	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**		

The authors of [22], categorize the potential problems of AV adoption into road environment issues, vehicle issues, and human issues. Each of these subcategories can be extended to smaller issues that have to be addressed for successful integration and a higher acceptance rate of AVs. These issues are listed in Table 3.

Table 2 AV Adoption Issues.

Name	Issues	Involved agencies	Potential solutions
Road Environment	Transport planning and policy	Federal and state Government	Start trials to figure out the full potential challenges of AVs, and create a uniform approach to standards and regulations at an early stage
	Traffic management	Police and legal forces	
	Intelligent Transport System (ITS)	vehicle manufacturers	
	Infrastructure design		
	Safety		
Vehicle Issues	Free Data	Federal and state Government	Identify manufacturers that are keen to join the trial phase
	data privacy and security	Police and legal forces	Develop and widely disseminate information on self-driving vehicles
	ownership	vehicle manufacturers	
Human Issues	Personal legal liability	Federal and state Government	Assess the role of driver/AV in safety
	Driver training	Police and legal forces	
	performance/penalties	vehicle manufacturers	
	distractions		
	fitness to drive		

The National Transport Commission (NTC) [22], signifies the advantages of driverless cars in the big picture. However, NTC admits that the current state of transportation laws does not support such technologies and a nationwide reform is required to allow innovation and safety. The reform aims to regulate the operation of AVs at all levels in Australia[22]. The end-to-end reform will include regulation related to vehicle standards, drivers, Australian road rules, heavy vehicles, insurance, and passenger legislation as well [22]. The NTC insists on consistency across the country heavily. The overall outcome of the framework will determine matters such as the government's role in road safety, the legal operator of the vehicle in driverless mode, and compensation of damaged entities caused by an automated vehicle accident [22].
Current agreements approved by the transportation ministers include:

Safety at First Supply

Entities that aim to import/manufacture autonomous vehicles in Australia, will be required to complete a self-certification process. Before releasing in the market, the entities must

demonstrate the ability to 14 obligations (listed in Table 4) set by the ministers of transportation.

Control

Australia's transportation ministers clearly define the legal and operational driver of the AV at all SAE levels as shown in Table 5 [22], An autonomous vehicle can only have one driver at a given time; a human driver or an automated driving system [22]

Driving Laws

As of May 2018, the ministers have proposed legislation that allows automated driving systems to operate an AV. Further, a legal entity will always be responsible for driving regardless of the mode. The legislation shall provide flexible compliance and enforcement as well. Currently, the NTC is working on the details of the rules [18].

Table 3 Obligations for Self-Certification of Automated Driving Systems.

1	Safe system design and validation processes
2	Operational design domain
3	Human-machine interface
4	Compliance with relevant road traffic laws
5	Interaction with enforcement and other emergency services
6	Minimal risk condition
7	On-road behavioral competency
8	Installation of system upgrades
9	Verifying for the Australian road environment
10	Cybersecurity
11	Education and training.
12	Data recording and sharing
13	Corporate presence in the country
14	Minimum financial requirements

In-Service Safety

As of June 2020, a national regulator will be established to monitor the regulations and operations of AVs on the road [18]. The automated drive entity officers must exercise due diligence alongside the remote drivers.

Motor Accident Injury Insurance

The national approach agreed on August 2019, requires insurance agencies to include cover for injuries and fatalities caused by AV accidents[18]. The ministers of transport will provide recommendations for plans to the Board of Treasures for consideration.

Table 4 Legal and Operational Driver.

SAE Level	Driver	Hand-back request
0	Human Driver	None
1	Human Driver	None
2	Human Driver	None
3	Automated driving system	Human Driver
4	Automated driving system	None
5	Automated driving system	None

The NTC is currently processing reforms that elaborate on:

In-Service Safety

Where the issues that need to be addressed for the safe operation of AVs for the next couple of decades are presented. The compliance and reinforcement reform will target the safety obligations required to achieve the safety goals [10]. Further, it looks at the authority required to impose such obligations and prioritizes safety risk management [10]. The duties of the in-service regulator should be detailed and coordinated with other enforcement entities. The findings were presented to the ministers of transportation in the first half of 2021; the results are yet to be released [10].

Insurance

Motor accident injury insurance (MAII) responsibility in Australia is not consistent across states. Each state/territory may assign a different government entity or minister accountable for MAII schemes [23] Nonetheless, NTC has focused on the following key elements to be carried out by government agencies involved:

1 Review insurance structures to recover their claims
2 Generate policies that allow access to MAII for those involved in an AV accident

Currently, the NTC is considering allowing data access for insurers to justly examine the liability [18]

Data Access

The data generated by autonomous vehicles can be deemed a rich resource for evaluating network efficiency, safety, and planning [22] The NTC states that vehicle-generated data may include an event data recorder, location, vehicle technical status, driver data, and other sensor data[24]. The ministers are currently discussing the methods the government can access this information without raising commercial, security, and privacy concerns [24]. The latest update on the reform is November 2020 with the status "Delivering recommendations to ministers"[24] Shortly, the NTC will also investigate the next areas of the reform to include passenger transportation laws, heavy vehicles, criminal law, road and resource management, and approval tests for driverless cars[22].

UK and Germany

Similar to many advanced countries, the appearance and development of driverless cars are growing at a rapid rate where the lawmakers and current regulations cannot keep up with the latest updates in the transport system [25]. Since AVs are constantly capturing the environment and recording data, privacy concerns are also involved [26]. Therefore, the challenges that arise with AVs are not limited to traffic accidents, but may also include cyber security and privacy protection [11].

The UK government supports the development and trials of autonomous vehicles with the target of being the leading edge of projects that envision autonomous driving in a document called "The Pathway to Driverless Cars"[27]. Department of Transport (DOT) divides the autonomy level of vehicles into three sub-categories listed in Table 6[28].

Table 5 DOT Autonomy Levels [4].

Level	Name	Description
1	Assistant	Driver fully operates the vehicle. The vehicle features such as lane discipline warning, adaptive cruise control, and emergency brake might be activated.
2	High Automation	In a fully automatic drive, however, a human driver must be ready to take control of some/any part of the trip
3	Autonomous	No need for a human driver

Although utilizing AVs will have numerous benefits such as reduced emissions, higher safety, and less time consumption, the realization of these projects needs time and the majority of vehicles on the road to be autonomous [28].

According to the Vienna convention, every moving vehicle shall have a driver and the driver is responsible for control of his/her vehicle at all times. However, this is not legally binding in the UK jurisdiction and some countries such as the US and China. This convention can be seen as an obstacle in the path of AV trials in member countries[28]. By 2014, France, Italy, Belgium, and Germany requested amendments to Article 8 of the Vienna Convent for granting permission for driverless cars [11]. Thus, as of now, autonomous cars can be tested with a test driver on UK roads given that the operation must be carried out safely [28].

Recent studies estimate a staggering number of 48 million autonomous vehicles across the US and Europe will be on the roads by the coming decade [5]. The rapid development of AVs has caused major challenges specifically in integration with the current road infrastructure and overall safety [5]. A major challenge arises in case of a traffic incident involving one or more AVs where civil liability, criminal law, and insurance law must determine the liability of the parties involved in the accident [5]. The impact of AV adoption is remarkably widespread across numerous state and federal agencies with different authorities including the local government, road and transport departments [5]. Hence, the formation of a new agency responsible for preparation, monitoring, and policy generation is critically required [5]. A government agency called 'The Centre for Connected and Autonomous Vehicles (CAV)' has been established in 2015 to ensure that the country leads in the AV development field [5].

These organizations must produce careful and precise documents, particularly in the liability domain. Three main areas of liability concerned with AVs include:

Insurance Law

The foundation of current insurance policies is based on human drivers where the insurance company covers the injuries and property damages caused by the driver to self or third parties depending on the insurance type. Therefore, a thorough update is required that covers the incidents involving driverless cars [5].

Accident Liability

Another potential issue emerges when determining the liable agent in an autonomous vehicle accident[29]. Although, naturally, the driver is legally responsible, in autonomous vehicles the manufacturer may share the legal responsibility[30]. However, imposing such rules for all AV accident cases may not be fair, thus a further individual examination is required where the actual cause of the accident is determined [31].

Criminal Liability

It is relatively simple to determine the criminal liability in human-driven car accidents. However, when it comes to driverless car crashes deciding the criminal responsibility becomes complicated [11].

Given the challenges above, the current legislation law for road and transport is unable to incorporate autonomous driving into public roads. Therefore, major changes and amendments to the rules are required to ensure a safe transition to an AV-friendly transport network[32].

Germany updated the Road Transport Act in 2021[33] that permits autonomous vehicles to operate provided that each autonomous vehicle must have a designated backup driver liable for legal responsibility in case of an accident [26]. This law recognizes autonomous vehicles that follow the SAE 6-level features. According to this provision, the driver bears the responsibility for all accidents that occur under his/her control [25]. However, the provision's stance on accidents caused by autonomous system failure is still vague. These cases are examined individually, and product law will be applied [26].

The UK recognizes Autonomous vehicles as "*operating in a mode in which it is not being controlled, and does not need to be monitored, by an individual*" which falls under levels 4 and 5 of the SAE Standard shown in Table 2. The Automated and Electric Vehicle Act of 2018, c.18, part 1 clarifies the liability of the insurers. According to section 2 of this act, the insurance is liable given particular circumstances. A summary of this act is given in Table 7.

The amount of liability under this section of the insurer or owner of the vehicle is limited to the amount for the time being specified in section 145(4)(b) of the Road Traffic Act 1988 (limit on compulsory insurance for property damage) [34]. Further, the insurer or owner of an automated vehicle is not liable under section 2 to the person in charge of the vehicle where the accident that it caused was wholly due to the person's negligence in allowing the vehicle to begin driving itself when it was not appropriate to do so.

In Germany, since the approval of the German federal government under the 2015 strategy for automated and connected driving, testing of AVs in real circumstances. Consequently, in 2021, the road traffic act was amended to support highly and fully automatic driverless cars operating on public roads.

Table 6 Insurance Liability.

Section		Circumstances	Liability
1.1	-	- Accident caused by AV when in autonomous mode in public places in GB - AV is insured at the time of the accident - Any person suffers from damages obtained from the accident	Insurance company
1.2	-	- Accident caused by AV when in autonomous mode in public places in GB - The vehicle is not insured at the time of the accident - Any person suffers from damages obtained from the accident	The owner of AV
4.1	-	- software alterations made by the insured person, or with the insured person's knowledge, that are prohibited under the policy, or - a failure to install safety-critical software updates that the insured person knows, or ought reasonably to know, are safety-critical.	Liability limited or excluded

The amount of liability under this section of the insurer or owner of the vehicle is limited to the amount for the time being specified in section 145(4)(b) of the Road Traffic Act 1988 (limit on compulsory insurance for property damage). Further, the insurer or owner of an automated vehicle is not liable under section 2 to the person in charge of the vehicle where the accident that it caused was wholly due to the person's negligence in allowing the vehicle to begin driving itself when it was not appropriate to do so [35].

In Germany, since the approval of the German federal government under the 2015 strategy for automated and connected driving, testing of AVs in real circumstances. Consequently, in 2021, the road traffic act was amended to support highly and fully automatic driverless cars operating on public roads [33].

According to (Autonomous Driving Act art. 1, no. 1, § 1d), driverless cars are defined as vehicles that "can perform the driving task independently within a defined operating area without a person driving the vehicle" and meets the technical requirements listed in Table 8 (in section 1e, paragraph 2).

Table 7 Technical Requirements of AV.

	Technical requirements
1	Independently comply with traffic rules
2	Independently transfer the AV to a minimal-risk state if in a rule-violating state
3	Equipped with an accident-avoidance system
4	Instant alert to the technical support of any impairments, functionality defects
5	Capable of deactivation remotely by a technical supervisor

Data Protection

Germany proposed the idea of using a 'black box' in driverless vehicles similar to airplanes [36][26]. The module will have the capability of data collection and storage. The initial version of the black box raised data protection concerns as the use cases, duration, and purpose were not specifically disclosed [26]. However, in the latest version, the following changes are applied:

Time and GPS location will be stored only when control of AV is transferred between the human driver and the autonomous driving system. And also when the driving system requests a handover to the human driver or a technical issue occurs [37].

Collected data will be stored for a maximum of 6 months, however, if the vehicle has been in an accident the data can be kept for up to 3 years [37].

Insurance Law

According to the Draft Ordinance implementing the Act amending the Road Traffic Act and the Compulsory Insurance Act, autonomous vehicles must have liability insurance to be formally registered. No further information regarding insurance is provided in this document [38].

Analysis

Arguably, in the next decades, autonomous cars will outnumber human-driven vehicles on the roads.

Management of highly autonomous road and transport networks is not as complex as the current road networks. However, until that certain milestone is reached, the traffic legislation must be adjusted to address the challenges of a highly manual/hybrid road network.

Determining the level of autonomy in new vehicles can be difficult as each manufacturer focuses on different aspects of the vehicle. However, the SAE autonomy classification standardizes the autonomy level of vehicles based on the responsibilities of driving by providing a detailed definition for each category. Governments, road, and transport authorities use the SAE level as an internationally accepted standard for determining the autonomy of a vehicle. A quick summary of basic information for each country is provided in Table 9. Globally, over 30 nations are active in the trial and deployment of AVs [32].

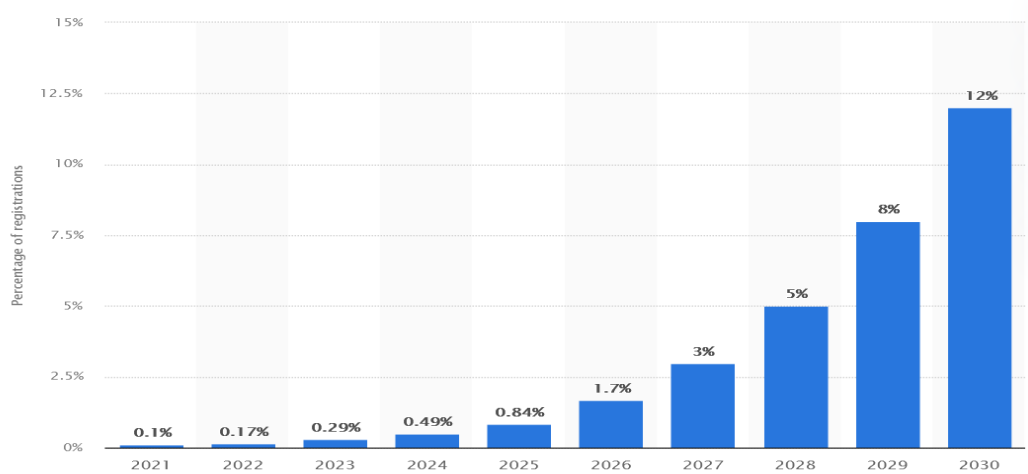
Law Of Tort (Civil Code)

Current Tort legislation is based on a foundation of human drivers. To fairly determine criminal liability, the first step would be an acknowledgment of autonomous driving agents followed by classifying the level of autonomy. Further, in case of accidents involving AVs, the recorded data by the AV can be used as evidence to assist in judging criminal liability [39]. However, this must be adjusted with the data protection policy to ensure that authorities are permitted to access the data [40].

Transport Law

Currently, the number of autonomous vehicles on the roads is incomparable to human-driven cars. A 2018 survey[41], the market penetration of AVs in 2021 is estimated to be approximately 0.1% globally. However, it is expected that this figure will experience exponential growth in the next decade and reach a milestone of around 10% within 10 years [41] as shown in Figure 1.

Figure 1 AV Market Penetration in the World [41]



With such low shares, reshaping the road infrastructure to accommodate AVs may not be feasible. Similarly, the reformation of the transportation law to account for automated driving systems requires a much larger autonomous car on the road to be efficient and practical. Therefore, in the initial stage of migration to AV, the manufacturers must design driving systems that can adapt to the current infrastructure and act by the current transportation law.

Although minor alterations to the existing transportation legislation might be applied shortly, fundamental reform seems unlikely since the fraction of AV users on the road network is microscopic. The studied countries in this report do not mention any amendments to the current transport law.

Insurance Law

The UK is one of the very few countries that has established specific criteria for insurance. According to Table 6 in section 3.4, the insurer is liable for traffic incidents in public places in GB when the autonomous mode is on. Further, there remains a grey area where software tweaks are made by the vehicle owner or by someone else with the owner's knowledge that policy restricts. This scenario is currently in discussion and the latest information seems to advise limited liability from the insurer [26]. Naturally, the vehicle must be insured to claim for damages. In all other cases, the owner bears responsibility for all damages [25]

Other countries mentioned above do not clearly define the liability insurance of AVs, however, the NTC in Australia suggests the government review the insurance structure and issue new policies that include claims from accidents involving autonomous cars [24]. For this purpose, the NTC is examining granting data access to insurers[22]. In the UAE, The RTA requires comprehensive insurance for the autonomous vehicles being operated that is valid for (3 months)[15]. In contrast to transportation law, insurance law around the world varies significantly from region to region. The lack of an insurance plan that covers damages to and caused by autonomous vehicles, is a major obstacle in the automation of transportation. Practicing the traditional insurance law will fail to integrate the autonomous driving system. Therefore, AV owners will have to be fully responsible for all damages, even though, they may not have been in control of the AV during the accident. On the other hand, holding the manufacturers liable for all accidents caused by the automated driving system, will demotivate the manufacturers to shift to AV production. However, this creates a possibility of self-insuring vehicles. Similar to electronics and gadgets that come with warranty and after-purchase services, manufacturers could offer insurance policies that would be liable for such cases.

Data Protection Law

Driverless cars generate and consume massive amounts of data daily to operate. Depending on the vehicle model, the data could include audio, video, odometer, GPS location, and time information [42]. Additionally, a key factor in the success of AVs is communication with other vehicles, remote stations, and infrastructure[43]. A combination of stored vehicle data and communication could pose a potential privacy concern among users. In 2014, a 63-questionnaire with 4886 participants from 109 countries indicated that the majority of the users have no concerns about sharing the data with other vehicles, manufacturers, and transportation authorities [44]. However, the respondents were more hesitant about sharing the data with tax and insurance companies [44]. Further, their main concern about the information was data misuse and hacking.

In the UAE, the information must be accessible to the RTA upon request. And the users are not allowed to share the information with any other entity during the trial phase[14]. Also, In line with Article 11's paragraphs 9 and 12 in-law No.9/2023 regarding the regulation of the operation of autonomous vehicles in the Emirates of Dubai, the operator was required to supply the RTA with information obtained while operating the vehicle, and the operator was prohibited from using the information for any other reasons unless the RTA had already approved its use for specific ones [15].

In a survey conducted among over a thousand UK participants [45], around two third of respondents agreed that direct access of manufacturers to AV's log data would not be unappealing [45]. Similarly, in Australia, data protection concerns were raised during the hearings [20], However, the decision-makers are aware of the public's concern and discussing possible solutions, and setting the boundaries to grant data access [46] [26].

Conclusions

Emerge of driverless cars has attracted the attention of many countries across the world. Stabilizing traffic, minimizing the number of accidents, and reducing air pollution are strong advantages of an autonomous transportation system. However, with human-driven vehicles being the dominant road users, the transformation will occur at a slower pace. Although the technology may have reached the deployment stage, the legislative system is far behind. The lack of a solid legal framework can be an obstacle in the path of AVs. Many governments have started amendments to transportation laws, tort laws, insurance laws, and data protection laws to acknowledge automated driving systems as road users. However, the inconsistencies across the new policies in different countries/states may create confusion for manufacturers and users. Thus, a unified set of rules that specifically caters to the requirements of early-stage hybrid road networks is needed. Categorized autonomous cars based on the autonomy level by the transport authority, determines who is the responsible party in case of an accident. Further, since transportation laws are identical presently, the insurance companies may not need to generate a new set of policies but rather include clauses for automated driving system claims. The law amendments heavily depend on time and state road networks. As the share of driverless cars increases, the refinements may include more clauses that ensure both human-driven and autonomous cars can use the roads safely.

References

[1] D. Fiedler, M. Cap, and M. Certicky, "Impact of mobility-on-demand on traffic congestion: Simulation-based study," in *IEEE Conference on Intelligent Transportation Systems, Proceedings, ITSC*, 2018, vol. 2018-March. doi: 10.1109/ITSC.2017.8317830.

[2] G. Piacentini, P. Goatin, and A. Ferrara, "Traffic control via moving bottleneck of coordinated vehicles," 2018, vol. 51, no. 9. doi: 10.1016/j.ifacol.2018.07.003.

[3] H. Safarpour, M. Safi-Keykaleh, Z. Eskandari, S. Yousefian, F. Faghisolouk, and S. Sohrabizadeh, "Hospital's preparedness in road traffic injuries with mass casualties: Exploring a valid and reliable checklist," *Hong Kong J. Emerg. Med.*, vol. 29, no. 1, 2022, doi: 10.1177/1024907919870662.

[4] R. Manning Smith *et al.*, "Estimating the health burden of road traffic injuries in Malawi using an individual-based model," *Inj. Epidemiol.*, vol. 9, no. 1, 2022, doi: 10.1186/s40621-022-00386-6.

[5] J. L. Zambrano-Martinez, C. T. Calafate, D. Soler, and J. C. Cano, "Towards a centralized route management solution for autonomous vehicles," in *2019 IEEE Global Communications Conference, GLOBECOM 2019 - Proceedings*, 2019. doi: 10.1109/GLOBECOM38437.2019.9013313.

[6] J. L. Zambrano-Martinez *et al.*, "A centralized route-management solution for autonomous vehicles in urban areas," *Electron.*, vol. 8, no. 7, 2019, doi: 10.3390/electronics8070722.

[7] Q. Lu, T. Tettamanti, D. Hörcher, and I. Varga, "The impact of autonomous vehicles on urban traffic network capacity: an experimental analysis by microscopic traffic simulation," *Transp. Lett.*, vol. 12, no. 8, 2020, doi: 10.1080/19427867.2019.1662561.

[8] L. Hansson, "Regulatory governance in emerging technologies: The case of autonomous vehicles in Sweden and Norway," *Res. Transp. Econ.*, vol. 83, 2020, doi: 10.1016/j.retrec.2020.100967.

[9] F. Duarte and C. Ratti, "The Impact of Autonomous Vehicles on Cities: A Review," *J. Urban Technol.*, vol. 25, no. 4, 2018, doi: 10.1080/10630732.2018.1493883.

[10] N. E. Vellinga, "Automated driving and its challenges to international traffic law: which way to go?," *Law, Innov. Technol.*, vol. 11, no. 2, 2019, doi: 10.1080/17579961.2019.1665798.
[11] A. E. Kouroutakis, "Autonomous Vehicles; Regulatory Challenges and the Response From UK and Germany," *SSRN Electron. J.*, 2019, doi: 10.2139/ssrn.3441264.
[12] N. E. Vellinga, "Automated driving and its challenges to international traffic law: which way to go?," *Law, Innov. Technol.*, vol. 11, no. 2, pp. 257–278, 2019, doi: 10.1080/17579961.2019.1665798.
[13] C. Laybats and J. Davies, "GDPR: Implementing the regulations," *Business Information Review*, vol. 35, no. 2. 2018. doi: 10.1177/0266382118777808.
[14] RTA, "Administrative Resolution No. (501) of 2020 Approving the Conditions, Procedures, and Rules Related to Conducting Test Runs of Autonomous Vehicles in the Emirate of Dubai," *Off. Gaz. Gov. Dubai*, vol. 54, no. 458, pp. 1–8, 2020.
[15] T. Supreme and L. Committee, "Law No. (9) of 2023 Regulating the Operation of Autonomous Vehicles in the Emirate of Dubai Page 1 of 13," no. 9, pp. 1–13, 2023.
[16] J. Quispe, "Shaikh Mohammed ben Rasheed, issued law No. 9 of 2023 to the operation of autonomous vehicles in Dubai," *Shaikh Mohammed ben Rasheed, issued law No. 9 2023 to Oper. Auton. Veh. Dubai*, vol. 4, no. 1, pp. 88–100, 2023.
[17] S. Ping-Fat, *Carrier's Liability under the Hague, Hague-Visby and Hamburg Rules*. 2021. doi: 10.1163/9789004479159.
[18] Y. Sun, D. Olaru, B. Smith, S. Greaves, and A. Collins, "Road to autonomous vehicles in Australia : A comparative literature review," *Australas. Transp. Res. Forum*, vol. 16, no. November, 2016.
[19] L. Thiele-Evans, B. Pepper, J. Zeleznikow, N. Foster, and T. Sourdin, "Regulatory approaches to managing artificial intelligence systems in autonomous vehicles in Australia," *Int. J. Law Inf. Technol.*, vol. 29, no. 2, 2021, doi: 10.1093/ijlit/eaab002.
[20] Y. Sun, D. Olaru, B. Smith, S. Greaves, and A. Collins, "Road to autonomous vehicles in Australia: An exploratory literature review," in *Road and Transport Research*, 2017, vol. 26, no. 1.
[21] J. Grayned, "Sae International Levels of Autonomous Driving/ Sensor Packages," no. 3, 2019, doi: 10.4271/j3016.
[22] National Transport Commission, "Lessons learned from automated vehicle trials in Australia," no. December, pp. 8–8, 2020, [Online]. Available: www.ntc.gov.au
[23] M. L. Cunningham, M. A. Regan, T. Horberry, K. Weeratunga, and V. Dixit, "Public opinion about automated vehicles in Australia: Results from a large-scale national survey," *Transp. Res. Part A Policy Pract.*, vol. 129, 2019, doi: 10.1016/j.tra.2019.08.002.
[24] X. Sun and Y. Zhang, "Improvement of Autonomous Vehicles Trust through Synesthetic-Based Multimodal Interaction," *IEEE Access*, vol. 9, 2021, doi: 10.1109/ACCESS.2021.3059071.
[25] M. Alawadhi, J. Almazrouie, M. Kamil, and K. A. Khalil, "Review and analysis of the importance of autonomous vehicles liability: a systematic literature review," *Int. J. Syst. Assur. Eng. Manag.*, vol. 11, no. 6, 2020, doi: 10.1007/s13198-020-00978-9.
[26] A. Taeihagh and H. S. M. Lim, "Governing autonomous vehicles: emerging responses for safety, liability, privacy, cybersecurity, and industry risks," *Transp. Rev.*, vol. 39, no. 1, 2019, doi: 10.1080/01441647.2018.1494640.
[27] Department of Transport, *The Pathway to Driverless Cars*, no. February 2015. 2015.
[28] L. Abdi *et al.*, "Introducing Driverless Cars to UK Roads WORK PACKAGE 5.2 Deliverable D9 Handover Issues in Autonomous Driving: A Literature Review," *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 9, no. 4, 2017.

[29] Barış Soyer and Andrew Tettenborn (eds), *Book Cover Artificial Intelligence and Autonomous Shipping Developing the International Legal Framework*. 2021. [Online]. Available: https://www.bloomsburycollections.com/book/artificial-intelligence-and-autonomous-shipping-developing-the-international-legal-framework/ch6-product-liability-autonomous-ships#/jump/page120

[30] J. Yin, "Tort liability for damage caused by self-driving cars," in *Proceedings - 2021 International Conference on Public Management and Intelligent Society, PMIS 2021*, 2021. doi: 10.1109/PMIS52742.2021.00071.

[31] C. Siyuan, "Regulating Autonomous Vehicles," in *AI, Data and Private Law*, 2021. doi: 10.5040/9781509946860.ch-007.

[32] R. Threlfall, "2020 Autonomous Vehicles Readiness Index," *Kpmg*, pp. 1–70, 2020.

[33] M. Ebers, "Civil Liability for Autonomous Vehicles in Germany," *SSRN Electron. J.*, 2022, doi: 10.2139/ssrn.4027594.

[34] J. Marson, K. Ferris, and J. Dickinson, "The automated and electric vehicles act 2018 part 1 and beyond: A critical review," *Statute Law Review*, vol. 41, no. 3. 2020. doi: 10.1093/SLR/HMZ021.

[35] B. Csitei, "Autonomous and Automated Vehicles in Germany and Hungary, with Special Attention to the Question of Civil Liability," *Acta Univ. Sapientiae Leg. Stud.*, vol. 10, no. 1, 2021, doi: 10.47745/ausleg.2021.10.1.04.

[36] T. Brell, R. Philipsen, and M. Ziefle, "sCARy! Risk Perceptions in Autonomous Driving: The Influence of Experience on Perceived Benefits and Barriers," *Risk Anal.*, vol. 39, no. 2, 2019, doi: 10.1111/risa.13190.

[37] "Adopted-version for public consultation Guidelines 1/2020 on processing personal data in the context of connected vehicles and mobility related applications Version 1.0," no. January, pp. 1–31, 2020, [Online]. Available: https://fpf.org/wp-

[38] J. Davey, "By insurers, for insurers: The UK's liability regime for autonomous vehicles," *J. Tort Law*, vol. 13, no. 2, 2020, doi: 10.1515/jtl-2020-2010.

[39] K. Isanov, "Force-Major Status in Tort Liabilities," *Int. J. Soc. Sci. Res. Rev.*, vol. 5, no. 4, 2022, doi: 10.47814/ijssrr.v5i4.266.

[40] B. Yuan and J. Li, "The policy effect of the general data protection regulation (GDPR) on the digital public health sector in the european union: An empirical investigation," *Int. J. Environ. Res. Public Health*, vol. 16, no. 6, 2019, doi: 10.3390/ijerph16061070.

[41] T. Möller, A. Padhi, D. Pinner, and A. Tschiesner, "The future of mobility is at our doorstep," *McKinsey Cent. Futur. Mobil.*, p. 115, 2019, [Online]. Available: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-future-of-mobility-is-at-our-doorstep#

[42] H. Dawid and G. Muehlheusser, "Smart products: Liability, investments in product safety, and the timing of market introduction," *J. Econ. Dyn. Control*, vol. 134, 2022, doi: 10.1016/j.jedc.2021.104288.

[43] M. Kyriakidis, R. Happee, and J. C. F. De Winter, "Public opinion on automated driving: Results of an international questionnaire among 5000 respondents," *Transp. Res. Part F Traffic Psychol. Behav.*, vol. 32, 2015, doi: 10.1016/j.trf.2015.04.014.

[44] J. Brinkley, J. Gilbert, and S. Daily, "A Survey of Visually Impaired Consumers About Self-Driving Vehicles," *J. Technol. Pers. with Disabil.*, vol. 6, 2018.

[45] A. Davola, "A Model for Tort Liability in a World of Driverless Cars: Establishing a Framework for the Upcoming Technology," *SSRN Electron. J.*, vol. 54, no. 3, 2018, doi: 10.2139/ssrn.3120679.

[46] F. Mostajabi, A. A. Safaei, and A. Sahafi, "A Systematic Review of Data Models for the Big Data Problem," *IEEE Access*, vol. 9, 2021, doi: 10.1109/ACCESS.2021.3112880.