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Autonomous Vehicles: legal implications and possible solutions

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TESIS DE DOCTORADO EN COTUTELA

Autonomous Vehicles: legal implications and possible solutions

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ABBREVIATIONS AND ACRONYMS

AEB Automatic Emergency Braking

ACC Adaptive cruise control

ADAS Advanced Driver Assistance Systems

ADS Automated Driving Systems

AEVA 2018 Automated and Electric Vehicle Act 2018

ALKS Automated Lane Keeping System

AV Autonomous Vehicle

AVs Autonomous Vehicles

DGT Dirección General de Trafico

DLT Distributed ledger technology

DSSAD Data Storage System for Automated Driving

ENISA European Union Network and Information Security Agency

ESA European Space Agency

ESG Environmental, Social and Governance

GDPR General Data Protection Regulation

IEEE Institute of Electrical and Electronics Engineers

IMO International Maritime Organisation

LCS Insurance Contract Law

LGDCU General Law for the Defence of Consumers and Users and other complementary laws

LRCSCVM Law on Civil Liability and Insurance in the Circulation of Motor Vehicles

NAHSC National automated highway system

NHTSA National Highway and Transportation Safety Administration

NRP National Recovery and Resilience Plan

pBFT Practical Byzantine Fault Tolerance

PLD Product Liability Directive

PNIEC National Energy and Climate Plan 2021-2030

PoG Proof of Gaming

PoS Proof of Stake

PoW Proof of Work

SAE Society of Automotive Engineers

SFDR Regulation Sustainability-Related Disclosures in the Financial Sector

SOA Directive 2009/103/EC on insurance against civil liability in respect of the use of motor vehicles

SUVs Sport Utility Vehicles

RD 1507/2008 Regulation on liability insurance for the circulation of motor vehicles

TCMV Technical Committee for Motor Vehicles

TFEU Treaty on the Functioning of the European Union

TRLGDCU Text of the General Law for the Defence of Consumers and Users

UNCITRAL United Nations Commission on International Trade Law

UNECE United Nations Economic Commission for Europe

USC United States Code

INTRODUCTION

The dissertation represents an attempt to enlighten the legal issues that the spread of automated vehicles imposes to jurists to face.

This work is divided into VIII Chapter. The first one describes the technology and the development of autonomous vehicles in recent years.

More precisely, the first chapter begins by retracing the late 19th century, when Carl Benz registered patent no. 37435, describing it as 'Vehicle with gas engine operation'. After tracing the history of the advent of the automobile and the first (even if still rudimentary) attempts to reproduce a self-driving car, the current state of the art is analysed.

In this regard, the innovative technology on which is based automated driving systems is examined, highlighting that these vehicles are equipped with sophisticated driver assistance systems: the so called 'ADAS' (Advanced Driver Assistance Systems).

After having analysed the current state of the art, the six levels of autonomous driving drawn up by the SAE (Society of Automotive Engineers) and globally accepted to classify and identify degrees of vehicle automation, are set out.

The second chapter is dedicated to the examination of the regulation already enacted related to civil liability in case of accident, with a particular focus on Italian, Spanish.

In particular, after analysing the regulations issued at European level on civil liability, the Italian and Spanish legal systems are described, highlighting similarities and differences, as well as the legislative measures enacted in these two legal systems related to road tests of self-driving vehicles.

The last part of the second chapter focuses on the possible commercialisation of autonomous driving vehicles in the aforementioned legal system.

The third chapter describes the product liability regime with a particular focus on Italian, Spanish and US legislation. This Chapter analyses the possible consequences in case a defective vehicle is put on the market, and it causes a damage to its passengers or third parties (i.e. walkers, passengers of different vehicles).

The fourth chapter focuses on the interaction between blockchain and automated vehicles. After highlighting the main features of blockchain, the potentials that the interaction between these two technologies could entail in the long run are analysed.

In chapter five insurance regulation is examined in order to understand if the current regulation is applicable to automated vehicles.

First, this chapter describes the Italian insurance system, paying particular attention to the description of the regulation of black boxes in the Private Insurance Code and the Smart Road Decree.

Next, the Spanish insurance system is described, highlighting, among other things, the possible implications of a quick deployment of self-driving vehicles.

The insurance system for self-driving vehicles introduced by the UK is also analysed, deepening the most innovative measures already adopted by the UK.

Finally, a reflection is made on further potential developments in the European insurance system, highlighting the importance of black boxes.

Chapter six focuses on the environmental impact of automated vehicles in order to understand if the introduction of these technology could really lead to considerable benefits for the environment. In particular, this Chapter examines the possible beneficial impacts that the introduction of self-driving cars may have on the environment. However, the analysis shows that in addition to the possible benefits, there could also be possible risks engendered by a considerable increase in the number of self-driving vehicles.

Lastly, in chapter seven the risk related to the use of machine learning will be stressed. In particular, this Chapter, after examining the interaction between autonomous vehicles and machine learning, analyse the ethical implication, facing the so called “ethical dilemma”.

Next, one of the most recent and relevant European measures on AI is thoroughly analysed.

After illustrating the technology underlying so-called connected cars, possible risks connected to the use of this technology are highlighted and, more specifically, the case of abusive access to the software of self-driving cars is examined.

Finally, the legislation currently in place is examined in order to verify whether the protection of third parties is really ensured.

The eighth chapter is dedicated to conclusion resignation.

Chapter I: Historical origins and analysis of autonomous driving technology

1. The origins of autonomous driving

The invention of the automobile, which dates back to the end of the 19th century, when Carl Benz registered patent no. 37435[1], was undoubtedly the most significant sociological and economical event of the period[2]. In fact, the rapid spread of automobiles during the 20th century clearly demonstrates the importance of the phenomenon. Although in the first decade of the last century, the diffusion of automobiles remained an exclusive prerogative of the wealthiest social classes, later, thanks to some American entrepreneurs like Henri Ford, automobiles became accessible to everyone. In fact, the opportunity to purchase cars by the less opulent population made the automobile a particularly popular tool, because of the transformation of those vehicles into affordable commodities.

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[1] Patent DRP 37435 "*Vehicle with gas engine operation*" submitted by Carl Benz, Mannheim and dated 29 January 1886, in *www.unesco.org.*

[2] For a careful analysis of the origins of autonomous vehicles see F. Kroger, *Automated Driving in Its Social, Historical and Cultural Contexts,* in *Autonomous Driving* edited by M. Maurer – J. C. Gerdes – B. Lenz – H. Winner, Springer, London, 41-68. FALTA AÑO

As cars became more widespread among the public, so did the number of fatal accidents. In the United States, for example, some 200,000,00 American citizens died in the early 1920s as a result of fatal accidents caused by driver error.

Therefore, already in the early 1920s, the idea of a self-driving vehicle began to spread, especially in the United States. The relevant potential of this technology was immediately evident.

In the following, it will be retraced the main historical stages through which the development of this technology has been articulated.

On 5 August 1921, Radio Air Service engineers presented the first driverless car to the public at McCook Air Base in Dayton. In reality, the car was not fully autonomous, but remotely controlled[3].

[3] An article on the topic was published on The Washington Herald. See: *Driverless Auto, Guided by Radio, Navigates Street*, in *The Washington Herald*, 6 August 1921, 5.

Another example of a driverless car dates to the 1920s in the United States of America, where the company '*Houdini radio control*' devised a vehicle, nicknamed '*American Wonder,*' in which it was not necessary to keep one's hands on the steering wheel[4] . This was the Chandler 1926 model which, unlike modern automated cars, was driven by means of radio waves that were received by an antenna on the roof of the car, through which impulses were transmitted to the engine, so that the car moved in the desired direction. It was, therefore, a radio-controlled car that could be controlled up to five miles.

During the 1930s, the futuristic idea of driverless vehicles was fuelled by literature and film. The press repeatedly described the characteristics of self-driving cars. Similarly, in 1935, the General Motors Commission produced a short film, entitled *"The Safest Place"*[5], in which a driverless car obeys all road rules, thus representing the safest form of driving.

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[4] H. Green, *Radio-Controlled Automobile,* in *Radio News*, November 1925, 90 ff.
[5] *The Safest Place, 1935,* directed by CHEVROLET, at: *www.youtube.com.*

Around the same time, the American oil and automobile industries also began working on ultra-modern designs for the highways of the future. A significant impetus for the development of automatic driving was given by Shell, an oil company that, in 1937, decided to design a model of the City of Tomorrow[6], where the so-called automatic highways were developed. Later those models were exhibited at the 1939 New York World's Fair. From this historical period automated driving ceases to be conceived as a form of remote driving and moves towards a fully automated transport system.

However, the economic crisis of 1929 and the Second World War led to a slowdown in the growth of the automotive industry, which, however, picked up again after the war. Suffice it to say that the rapid spread of automobiles in major European countries[7], which was matched by a significant expansion of road networks, was described as an "*automotive miracle*"[8].

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[6] P. D. Norton, *Fighting Traffic. The Dawn of the Motor Age in the American City*, Cambridge 2008, 249.

[7] In Italy it went from one million four hundred thousand cars in 1958 to fourteen million in 1974. Similarly, in France, there were one million three hundred cars on the market in the early 1950s, rising to almost twelve million during the 1970s.

[8] F. Pasolini, *Storia dell'automobile in Italia,* Rome, 2007, *passim.*

In the 1950s, however, smart roads and smart cars received renewed attention from the public. In fact, the 1950s recorded numerous initiatives in the show business and press industries that focused precisely on self-driving vehicles. As an example, one only needs to think of the advertisement published in Life Magazine by the Americas Independent Electric Light and Power Companies where the image of the classic American family in a self-driving car is reproduced [9]. Similarly, Walt Disney's film "*Magic Highway USA*" dates back to 1958, tells the history of transport and it ends with a futuristic image of a self-driving vehicle[10].

The enthusiasm, aroused by the automobile, translated into a widespread feeling of freedom that it has been annihilated by the extreme repetitiveness of industrial work and the excessive rigour of the social conventions of the time. It is no coincidence that the semiologist Roland Barthes argued in 1963 that lashing out at a car was the only area where the love of power and imagination still had free rein[11].

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[9] Advertising of *Americas Independent Electric Light and Power Companies*, published in *LIFE Magazine* Vol. 40, 30 January 1956, 8.

[10] J. P. Telotte, *The mouse machine. Disney and technology,* Chicago, 2008, *passim.*

[11] R. Barthes, *Mythologie de l'automobile,* in *Ouvre completes. Tome II, Livres, texte, entretiens 1962-1967,* Paris, 2002, 234-242.

In fact, RCA labs began testing radio-controlled electric cars in US cities that were propelled by electromagnetic fields provided by circuits embedded in the roadway. The cars designed were equipped with sensors able to detect position and speed of other vehicles on the road and a traffic counter system was able to provide guidance information to the vehicles on the road. In later years, General Motors released prototype cars, named “Firebird I”, “Firebird II” and “Firebird III”, which were not intended for sale. Firebird II was equipped with a sophisticated guidance system intended for use on a specific type of road with an electric cable embedded in the roadway that would send wave pulses to the car to help the driver avoid accidents[12].

Later, in the late 1970s, Japan and the US made great progress in the field of autonomous driving research, trying to develop self-driving cars that were not necessarily connected to highways equipped with guide wires.

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[12] For more information, refer to: '*The story of Firebird II*' at *www.gmheritagecenter.com*.

In 1977, Sadayuki Tsugawa's team at the Mechanical Engineering Laboratory in Tsukuba, Japan, created an autonomous vehicle equipped with cameras and, therefore, capable of recording and processing (on-board) images. However, this was still an embryonic version, as the car did not exceed a speed of 10 km/h and had no object detection function[13].

The first self-driving car comparable to the models currently on the market can be found in the '*Vamors*' *van* (*Versuchfahrzeug fur autonome Mobilitat und Rechnersehen*), a 5-ton Mercedes Benz van that only appeared on German roads in 1986. This vehicle could cover a distance of twenty kilometers at a speed of 96 km/h with only the support of computers and video cameras, without being equipped with radar or GPS technology[14]. However, data processing took far longer than the time it takes the human brain to process

[13] S. Tsugawa – T. Yatabe – T. Hirose – S. Matsumoto, *An Automobile with Artificial Intelligence*, in *International Joint Conference on Artificial Intelligence (IJCAI),* 1979, 893-895.

[14] This model was developed by Ernst Dickmanns from the University of the Federal Armed Forces in Munich (Germany), and it was inspired by an earlier car project conceived in Japan in 1977 by the Tsukuba Mechanical Eingineering Laboratory, which was based on reading images captured by cameras placed on the bodywork. For more information see: L. Maci, *Self-driving car, all about autonomous driving: when it will arrive, what it will look like, who will produce it,* in *EconomyUp*, 16 November 2017.

images, so that the first self-driving cars had to proceed at reduced speeds and on predetermined routes.

Subsequently, *EUREKA12-PROgraMme for a European Traffic of Highest Efficiency and Unprecedented Safety* (PROMETHEUS) was launched[15]. As part of this project, two other vans called '*VaMP*' and '*VITA-2*' were designed and tested in 1994 on the streets of Paris over a distance of 1000km at a speed of 130km/h. The software was able to capture and process in real time the image sequences taken by four cameras[16] .

The *Intermodal Surface Transportation Efficiency Act* dates to 1991, through which the US Congress authorized the United States Department of Transportation to create an '*automated vehicle and highway system*' by 1997[17]. In this perspective, the National automated highway system (NAHSC) consortium was also established. In the same years, numerous embryonic

[15] It is a project launched in 1987 involving experts from various European countries, in particular car manufacturers, researchers, university institutes, engineers and authorities.

[16] U. Jenn, *The Road to Driverless Cars: 1925-2025,* in *Eingeneering.com*, 15 July 2016.

[17] *Intermodal Surface Transportation Efficiency Act of 1991* (ISTEA), in *www.fhwa.dot.gov.*

projects were presented which, however, had a partial and limited level of automation[18].

In this regard, Dickmanns' team developed two S-Class robotic vehicles (W 140) with Mercedes Benz as part of the PROMETHEUS project: VaMP (UniBw Munich) and VITA-2 (DBAG), which, in October 1994, travelled more than 1,000 km autonomously on the three-lane motorways around Paris, in the midst of heavy traffic [19]. In addition to the PROMETHEUS project, also worth mentioning is the ARGO project, where the University of Parma used a Lancia Thema to travel 2000 km in Italy with a camera in 1998[20].

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[18] One example is the presentation of twenty autonomous vehicles at the NAHSC presentation in San Diego in 1997. Equally worthy of mention is the presentation at the University of Parma of a car capable of processing and following road signs.

[19] E. D. Dickmanns – R. Behringer – D. Dickmanns – T. Hildebrandt – M. Maurer – F. Thomanek – J. Schiehlen, *The Seeing Passenger Car 'VaMoRs-P'*, in: *Masaki, I. (ed.) Proc. of Int. Symp. On Intelligent Vehicles '94*, Paris, 1194, 68-73; B. Ulmer, *VITA -2, Active Collision Avoidance in Real Traffic,* in *Masaki, I. (ed.) Proc. of Int. Symp. on Intelligent Vehicles '94,* Paris, 1994, 1-6; F. Thomanek – E. D. Dickmanns – D. Dickmanns, *Multiple Object Recognition and Scene Interpretation for Autonomous Road Vehicle Guidance*, in *Masaki, I. (ed.) Proc. of Int. Symp. on Intelligent Vehicles '94*, Paris, 1994, 231-236.

[20] See "*The ARGO Project*", University of Parma and University of Pavia, Italy, at: *www.argo.ce.unipr.it*, where it is stated that: "*The ARGO Project started in 1996 at the University of Parma, Italy, after the experience in the PROMETHEUS European Project, whose main goal was the investigation of innovative technological solutions to enhance road safety. Within this project the first vision algorithms and computer architectures were developed and tested on MOB-LAB,*

In the decades that followed, car companies such as Uber and Tesla succeeded in perfecting this technology and succeeded in bringing cars with a full level of automation onto the market.

2. Autonomous vehicles: structure and functioning

Nowadays self-driving cars are capable of driving on the road by themselves, without a human driver[21]. In fact, scientific and technical progress has advanced to the point of developing electronic driving aids that can completely

the MOBile LABoratory available to all the Italian Research Units involved in the Project. The original target of the ARGO project was the development of a system able to improve road safety by controlling and supervising the driver activity. Further developments, however, allowed to extend the functionality to automatic driving. The specifications that characterize the system developed within our research project are that · its cost must be kept small; · it must not rely on specific road infrastructures;· it must not use active sensors".

[21] *Ex multis:* J. Ibañez-Guzmán - C. Laugier - J.D. Yoder - S. Thrun, *Autonomous Driving: Context and State-of-the-Art,* in *Eskandarian*, A. (eds) *Handbook of Intelligent Vehicles*, Springer, London, 2012; Verma Nilesh Radheshyam, et al. "Self-Driving Car." *IOSR Journal of Computer Engineering (IOSR-JCE)*, 22.1 (2020), 12-16; M. M. Parmar-R. R, Rawlo-J. L. Shirke -Savita Sangam, *Self-Driving cars,* in *International Journal for Research in Applied Science & Engineering Technology (IJRASET*), (2022) 2305 ff.; S. Jain, *Self-Driving Car*, in *International Journal for Research in Applied Science & Engineering Technology (IJRASET),* (2021), 2027 ff; M. Navarro-Michel, *La aplicación de la normativa sobre accidentes de tráfico a los causados por vehículos automatizados y autònomos,* in *Cuadernos de Derecho Transnacional* (2020), Vol. 12, Nº 1, 945 ff.

replace the human being when driving a vehicle. In recent years, the relentless progress of digital technologies in industrialised countries has particularly influenced the transport sector. The following will therefore describe the results of this progress in the transport sector, analysing the structure and functioning of this outstanding technology.

The innovative technology on which is based automated driving systems is composed of a series of sensors installed in the car connected to the smart infrastructure of the smart city. These cars are equipped with sophisticated driver assistance systems: the so called "ADAS" (acronym for the new *Advanced Driver Assistance Systems*)[22]. The

[22] *Ex multis:* L. Eckstein – A. Zlocki, *Safety Potential of ADAS – Combined Methods for an Effective Evaluation.* ESV, 2013; A. Knapp - M. Neumann - M. Brockmann - R. Walz - T. Winkle, *Code of Practice for the Design and Evaluation of ADAS, Preventive and Active Safety Applications*, *eSafety for road and air transport, European Commission Integrated Project*, Response 3, European Automobile Manufacturers Association—ACEA, Brussels, 2009, at *www.acea.be*; E. Donner – T. Winkle – R. Walz – J. und Schwarz, RESPONSE 3—*Code of Practice für die Entwicklung, Validierung und Markteinführung von Fahrerassistenzsystemen (ADAS),* in Technischer Kongress 2007, Verband der Automobilindustrie (VDA), Sindelfingen, 231-241; S. Becker – M. Brockmann – C. Jung – J. Mihm – H.L. Schollinski – J. Schwarz – T. Winkle, *ADAS — from Market Introduction Scenarios towards a Code of Practice for the Development and Evaluation,* RESPONSE 2, *European Commission, Final Public Report*, Brussels, 2007; E. Donner – H. L Schollinski – T. Winkle – C. Jung – E. Dilger – C. Kanz – J. Schwarz – E. Bastiansen – L. Andreone – S. Becker – J. Mihm – P. Jarri – F. Frost – W. Janssen – H. Baum – W. Schulz – T. Geissler – M. Brockmann, *Methods for Risk-*

aforementioned devices are capable of guaranteeing safer cars, protecting not only drivers and vehicle passengers, but also pedestrians, cyclists and passengers of other vehicles. These innovative technologies consist of a series of sensors, which work together with on-board software to monitor driving and intervene in the event of an emergency. Specifically, with the ADAS protocol, cars are equipped with a centralised system, integrated within the on-board computer, to assist the driver in various situations such as braking, lane keeping and speed adjustment.

To fully understand the innovative scope of this phenomenon, the following are some of the main *Advanced Driver Assistance Systems* with which self-driving cars are equipped.

Among the main vehicle collision avoidance systems is the so called "*Adaptive cruise control*" (ACC)[23]. This device adjusts speed while driving, taking into account traffic conditions

Benefit-Analysis of ADAS: Micro Perspective and macroscopic socioeconomic evaluation, RESPONSE 2, *European Commission Public Report*, Project Deliverable D2, Brussels, 2004.

[23] See: W. Wachenfeld - H. Winner, *The Release of Autonomous Vehicles,* in *Autonomous Driving. Technical, Legal and Social Aspects,* edited by M. Maurer – J. C. Gerdes – B. Lenz – H. Winner, Springer, 2016, 428 ff.

and the safe distance to be maintained from other cars. It often makes use of several different sensors, working in synchrony with other technologies to ensure an appropriate pace for each situation.

One more important ADAS technology for assisted driving is the so called "*Automatic Emergency Braking*" (AEB)[24]. Using special sensors, the car is able to detect the distance to cars, pedestrians and cyclists and, in case of emergency, braking in order to prevent an accident.

One of the most important and sophisticated ADAS is the so called "*Driver fatigue detector*", that monitors the driver's attention using sensors and internal cameras. This system is capable to intervene with acoustic warnings and specific requests if it detects that the driver's attention is low and, in the absence of a response, procedures are activated, such as vehicle control by the on-board computer.

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[24] See: T. Winkle, *Safety Benefits of Automated Vehicles: Extended Findings from Accident Research for Development, Validation and Testing,* in *Autonomous Driving. Technical, Legal and Social Aspects,* edited by M. Maurer – J. C. Gerdes – B. Lenz – H. Winner, Springer, London, 2016, 346 ff.

The "*Collision warning with vehicles*" fulfils the same preventive purpose. In fact, one of the primary goals of car ADAS systems is to avoid accidents. The device is normally focused on a specific area such as the area behind the car. In this case, if an over-approaching car is detected, all systems are activated to prepare the car for the possible rear-end collision[25].

Finally, the most innovative devices deserve a mention. In fact, the innovative ADAS for blind spot monitoring feature cameras and sensors to detect possible dangers and warn the driver. This improves driving safety to reduce the risk of traffic collisions and accidents with pedestrians and cyclists.

A further innovation to ensure safe car driving is the "*Traffic Sign Recognition*". Through the installation of the latest generation of cameras, connected directly to the on-board system, the car can rely on a road sign recognition device. This technology allows the car to see speed limits, any roadworks in progress and any type of indication. Finally

[25] A. Koustanai – V. Cavallo – P. Delhomme – A. Mas, S*imulator Training With a Forward Collision Warning System: Effects on Driver-System Interactions and Driver Trust*. Hum. Factors J. Hum. Factors Ergon. Soc. 54, 2012, 709–721.

driving safety is further assured by the so-called “Lane Keeping Systems”, that can make sure that the car stays inside the lines even in curves.

It is estimated that the transport sector will undergo radical transformations in the coming years as a result of the market introduction of so-called '*autonomous vehicles*' (AVs), which are divided into five different levels of autonomous driving. The following section will explain these levels in more detail.

3. Autonomous driving levels

In the field of self-driving cars, there are six levels of autonomous driving, although only the last two represent an example of completely autonomous vehicles.

The SAE (Society of Automotive Engineers) created this now globally accepted subdivision to classify and identify degrees of vehicle automation. *SAE International* has highlighted, on a scale of zero to five, the different degrees of automation with which a vehicle can be equipped[26] .

If level zero (*No Driving Automation*) indicates the ordinary way of driving vehicles, since all forms of autonomy are absent[27], level one (*Driver Assistance*) and level two (*Partial Driving Automation*) refer to vehicles which present forms of assisted driving and partial driving automation [28] . In particular, at the first level, the driver is supported by systems (i.e., anti-collision devices, speed governors such as cruise control and distance detectors) that warn him of certain dangers and help him improve safety[29]. Cars that fall in level 2 can actively intervene in case of a possible accident by managing the steering or braking automatically if an

[26] The classification drawn up by SAE International, '*Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles*' (2018), can be found at: *https://www.sae.org/standards/content/j3016_202104/*, last see 31 August 2024. It should be noted that this subdivision has also recently been adopted by the National Highway Traffic Safety Administration (NHTSA) in: *https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety*, last see 31 August 2024.
[27] Examples of level 0 vehicles are any vehicle registered before the year 2000 and even later if they do not have any driving aid function.
[28] The main difference between Level 1 and Level 2 vehicles is that the latter offer more driver assistance functions than Level 1 vehicles.
[29] Examples of level 1 vehicles are, among others, a Mercedes Benz Class S or Ford Tauros which have a speed control programme.

emergency situation is detected. The cars of level two can actively support the driver, braking and accelerating the car[30]. However, in both hypotheses profiled, the driver retains powers of control over the car.

In level three (*Conditional Driving Automation*) cars can drive themselves in certain conditions. These vehicles can also monitor the traffic and, if the driver does not perform the correct manoeuvre, the car does it instead. Indeed, at this level, the vehicle is able to analyse the environment and make the decision to accelerate and overtake other vehicles when the situation is opportune. Autonomous mode can be activated in controlled environments such as motorways, dual carriageways or interurban roads, while in other cases human intervention will be required. In other words, a conditional driving automation vehicle is able to drive itself if certain conditions happen. However, the presence of a human driver is necessary[31].

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[30] Examples of level 2 vehicles are Tesla vehicles, the Infiniti Q50, the Mercedes-Benz S65, the Audi A7 or the Volvo XC60.

[31] After Japan partially amended the Road Traffic Act (Road Traffic Act No. 105 of 1960) to promote the research and commercialisation of automated vehicles (the amendments came into force on 1 April 2020), on 11 November 2020, Honda announced that it had received authorisation to test SAE level 3 vehicles on public roads in Japan under certain conditions. Honda

Level four and five vehicles do not require constant human control and are perfectly capable of 'self-driving'. The main difference between *High Driving Automation* (level four) and *Full Driving Automation* (level five) is the presence or absence of manual commands to allow the human passenger to regain control of the car in the event of unforeseen events not known or knowable by the *software*. In fact, Level 5 cars are designed to cope autonomously with any unforeseen events and, although the passenger may retain supervisory power over vehicle functions in some cases, the traditional means of control available to humans while driving, such as the steering wheel and pedals, tend to be absent. As a result, the only driverless vehicles are those that can be categorised as level five, as human input, when permitted, is entirely marginal, as well as possible.

4. State of art and deployment of autonomous vehicles technology

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Motor Co Ltd in March 2021 became the world's first carmaker to sell a vehicle with level 3 self-driving technology.

Having said this with regard to the classification of automation levels, some clarifications need to be made.

Technological progress involves not only cars, but all means of transport, even the aerospace [32] and the maritime industries[33]. By way of example, it worths to recall the military drone ships, which have already been used for surveillance operations, detection of explosive or radioactive material or, in any case, for risky operations[34]. Similarly, the unmanned submarines are often used for military purposes and for mapping the ocean floor. Another example that should be

[32] Panzeri, *I sistemi aerei a pilotaggio remoto (SAPR): profili giuridici,* in *Riv. dir. econ. trasp. amb.*, 2016, 39 ff.; Severoni, *La disciplina normativa attuale degli aeromobili a pilotaggio remoto,* in *Dir. trasp.*, 2016, 65 ff.; Rosafio, *Considerazioni sui mezzi aerei a pilotaggio remoto e sul regolamento ENAC,* in *Riv. dir. nav.*, 2014, 787 ff.; Sia, *Profili attuali della disciplina giuridica dei mezzi aerei a pilotaggio remoto e il regolamento dell'Ente nazionale dell'aviazione civile italiana (ENAC),* in *Dir. trasp.*, 2014, 743 ff.; U. La Torre, *La navigazione degli UAV: un'occasione di riflessione sull'art. 965 c. nav. in tema di danni a terzi sulla superficie,* in *Riv. dir. nav.*, 2012, 553 ff.; U. La Torre, *Gli UAV: mezzi aerei senza pilota*, in Tranquilli Leali-Rosafio (a cura di), *Sicurezza, navigazione e trasporto*, Milano, 2008, 93; Masutti, *Prospettive di regolamentazione dell'uso dei velivoli senza pilota (UAV) nello spazio aereo comune,* in *Dir. trasp.*, 2007, 783 ff.; and, with reference to military use cfr. Borgia, *L'uso militare dei droni. Profili di diritto internazionale*, Napoli, 2018.

[33] R. Lobianco, *Navi senza equipaggio e profili di responsabilità,* in *Resp. civ. e prev.*, 2021, 3, 756 ff; Zampella, Navi autonome e navi pilotate da remoto, spunti per una riflessione, in Dir. trasp., 2019, 586.

[34] See: U. La Torre, *Unmanned Ships and Shore Control Operators,* in *Dir. transp.*, 2019, 489.

mentioned is the so-called tugboat Svitzer Hermond, which has been operating since 2017 in the port of Copenhagen.

Furthermore, with the EU-sponsored *Maritime Unmanned Navigation through Intelligence in Networks* (MUNIN project), it was possible to confirm the concrete technical, economic and legal feasibility of entrusting long-distance liner transport to unmanned vessels[35].

Similarly, in the aerospace industry, there has been a considerable increase in the use of autonomous vehicles[36] .

By way of example, it worths to mention the project involving 'Hera', where engineers, tasked with designing the planetary defense system against the Didymos asteroid couple on behalf of the European Space Agency (ESA), developed advanced technology to enable the spacecraft to drive itself in space, adopting an approach similar to that of self-driving cars[37]. Hera will perform the world's first asteroid deflection

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[35] For more information, please refer to: *Maritime Unmanned Navigation through Intelligence in Networks* (MUNIN project), *Final Brochure*, at www.unmanned-ship.org/munin, 2 and 3.

[36] D. Yang-X. Jiao-K. Jiang-Z. Cao, *Driving Space for Autonomous Vehicles,* in *Automot. Innov.* 2, 241-253 (2019).

[37]For further information, refer to the website of the European Space Agency at: *https://www.esa.int/Space_Safety/Hera*.

test, carrying out a detailed post-impact survey of the target asteroid, '*Dimorphos*', orbiting in a binary asteroid system known as Didymos.

Regarding self-driving cars, as mentioned in the previous paragraph, research has now progressed to the point where vehicles of level 4 on the SAE scale are now coming onto the market. At the moment, Tesla is the market leader in AV, producing models with different systems of automation. The model S is provided with a "full self-driving capability", being able, under certain circumstances, to drive and to decide which path overtake, to stop or to continue driving. This is possible because model S is provided with a large number of systems of automation, such as navigate on autopilot, auto lane change, summon, full-self driving computer, traffic light and stop sign control. However, due to the lack of uniform regulation, the spread of this technology is slowing down. In fact, despite the ability of these cars, human presence is not only still needed but it is also legally required. In this regard, producers use to warn buyers about this circumstance, stating that an active driver supervision is requested because the activation and use of these devices are dependent on achieving a regulatory approval, which may take longer in some jurisdictions[38].

Indeed, even if the US legislature was among the first in the world to authorise the testing of this technology, there are numerous differences between the regulatory approaches adopted by individual states. Nevertheless, Nevada was the first state to authorise autonomous vehicles in 2011, almost all states have enacted several laws on autonomous vehicles nowadays[39] .

While, at the federal level, the National Highway and Transportation Safety Administration (NHTSA) published the new Federal Guidelines for Automated Driving Systems (ADS) on 12 September 2017[40], which follows the previous 2016 guidelines, it must be made clear that this is a non-binding measure. Indeed, the guidelines are voluntary in nature and

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[38] See: *https://www.tesla.com/it_IT/models/design#overview*.

[39] Currently, no less than twenty-one states (Alabama, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Louisiana, Michigan, New York, North Carolina, North Dakota, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Virginia and Vermont, and Washington, D.C.) have passed laws related to autonomous vehicles.

[40] The guidelines can be found at: *www.nhtsa.gov/sites/nhtsa.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf.*

do not contain any compliance requirements or special enforcement mechanisms.

Similar problems have emerged in the European Union too. The European legal system lacks a provision exclusively and specifically dedicated to the use of automated vehicles in the EU. For this reason, several EU members have adopted regulatory provisions in this regard[41].

Germany, for example, passed an amendment on 12 May 2017 by which it amended the law regulating road traffic, the so-called *Straßenverkehrsgesetz,* (StVG) of 1952, expressly regulating the harmful consequences resulting from an accident caused by a driverless car[42] .

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[41] It is important to keep on mind that France is the first European country to adapt its road and traffic regulations to allow the operation of fully automated vehicles on public roads. Both France's Traffic Rules and the Transport Code are being adjusted, which could lead to the first self-driving vehicles being allowed to operate on public roads at the end of 2022.

[42] On this point: Eighth Act Amending the Road Traffic Act, promulgated in the Federal Law Gazette I of 20 June 2017, 1648, at *https://www.bmvi.de/SharedDocs/EN/Documents/DG/eight-act-amending-the-road-traffic-act.pdf?__blob=publicationFile.* On German law and in particular on the supervisory duties that remain with the driver, see P. Buck-Heeb-A. Dieckmann, *Die Fahrerhaftung nach § 18 I StVG bei (teil-)automatisiertem Fahren*, NVZ, 2019, 113 f.

However, this is not an isolated case. In the Spanish jurisdiction, as early as 2015, a regulatory provision directed all self-driving cars up to level 5 according to the SAE scale and issued by the *Dirección General de Tráfico* (DGT)[43], was enacted. This provision has the merit of bearing an express definition of autonomous vehicle, which is defined as: '*Any motor vehicle equipped with technology that allows its operation or driving without requiring the active control or supervision of a driver, whether such automated technology is enabled or disabled, permanently or temporarily*'.

Like other European states, Italy has also issued a regulation, the so-called Smart Road Decree of 28 February 2018[44], aimed at allowing road tests of so-called *driverless cars.* Based on the aforementioned regulations, the first road tests of *self-*

[43] INSTRUCTION 15/V-113, available at: www.dgt.es.
[44] Decree of 28 February 2018, *Implementation modalities and operational tools for road testing of smart road and connected and automated driving solutions,* at *https://www.gazzettaufficiale.it.* On this point: E. Mureden, *Autonomous cars e responsabilità civile tra disciplina vigente e prospettive de jure condendo,* in *Contr. e impr.*, 3/2019, 895; D. Cerini, *Dal decreto smart roads in avanti: ridisegnare responsabilità e soluzioni assicurative,* in *Contr. e impr.*, 2018, 401; S. Scagliarini (a cura di), *Smart roads e driverless cars: tra diritto, tecnologie, etica pubblica*, Torino, 2019; S. Pellegatta, *Automazione nel settore automotive: profili di responsabilità civile, in Contr. e impr.*, 2019, 1420.

driving cars started in May 2019 in the cities of Turin and Parma[45].

In order to diminish the lack of homogeneity in the legislative dispositions existing in the various Member States, the European Commission issued a delegated regulation in March 2019 that aims to intensify the deployment of cooperative intelligent transport systems (C-ITS) on EU roads[46].

Subsequently, the Commission's Technical Committee for Motor Vehicles (TCMV) published guidelines on the exemption procedure for the EU type-approval of automated vehicles on 9 April 2019 in order to harmonise Member States' practices for the national assessment of automated vehicles and to simplify the mutual recognition of such assessment, as well as to ensure fair competition and transparency. The guidelines focus on level 3 and 4 automated vehicles according to the SAE scale.

[45] On this point: *https://stream24.ilsole24ore.com/video/italia/via-libera-sperimentazione-veicoli-guida-autonoma/ACKncE.*
[46] C-ITS have the function of connecting all road users and traffic managers in order to share information in real time.

Despite attempts to regulate the phenomenon, the lack of uniform legislation hinders the spread of this technology. In particular, the lack of an uniform regulation providing for consequences in the event of an accident and regulating civil and criminal liability profiles, gives rise to fears among those working in the field. In the following section, some of the major risks raised using this technology will be highlighted. Then an in-depth analysis of existing and forthcoming legislation in the US and EU will be conducted

Chapter II: The legal framework of autonomous driving

1. Self-driving cars advantages and possible risks

The deployment of AVs among consumers could have undoubted benefits, but just as many risks. In the following, an attempt will be made to highlight the benefits that could be derived from the spread of such vehicles, without neglecting the aspects that it needs to regulate. In order to do so, some real events will be taken as examples.

The biggest and most obvious benefit that could result from the use of this technology is the reduction of accidents and deaths on the road. *The National Highway Traffic Safety Administration* (NHTSA) estimates that more than 36,000 people were killed in traffic accidents in the United States in

2019[47]. In Italy, for example, ISTAT estimates that there were approximately 3,200 victims of car accidents[48] .

These worrying scenarios should lead us to look with some favour on the introduction of a technological innovation that aims to reduce the accident rate on the road. However, some recent events might suggest that the safety that self-driving cars promise to bring on urban streets is still a distant mirage[49].

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[47] National Highway Traffic Safety Administration (NHTSA), 2019 Fatality Data Show Continued Annual Decline in Traffic Deaths, at *https://nhtsa.gov*. On further economic, social and environmental benefits see also UK Department for Transport, The Pathway to Driverless Cars. Summary report and action plan (London 2015), 6 as well as the results of research conducted by ETH Zurich (S. Hörl - F. Becker - T. Dubernet - K. W. Axhausen, *Induzierter Verkehr durch autonome Fahrzeuge: eine Abschätzung*, 2019, 161 available at *www.ethz.ch*.

[48] Istat, Road accidents in Italy, available at: *https://www.istat.it/it/archivio/245757*. Similar dates have been recorded in the maritime sector. According to an estimate by the Ministry of Infrastructure and Transport (Report on maritime accidents and accidents on board ships, 27 December 2018, on *https://www.mit.gov.it/node/13568*), 48.2% of the claims would be caused by human error, while the European Maritime Safety Agency (EMSA) attributes 57.8% of the claims occurring between 2011 and 2017 to human error (see: EMSA, Annual Overview of Marine Casualities and Incidents, 2018, 33). According to other estimates, human error would affect percentages around 96% of cases. Thus Pribyl-Wegel, *Autonomous Vessels, How an Emerging Disruptive Technology Is Poised to Impact the Maritime Industry Much Sooner Than Anticipated,* in *The Journal of Robotics, Artificial Intelligence & Law*, vol. I, 2018, 22.

[49] See: B. I. Shimelman, *How to Train a Criminal: Making Fully Autonomous Vehicles Safe for Humans*, in *Connecticut Law Review*, vol. 49, 2016, 327-354.

Suffice it to say that in Tempe, Arizona, a *self-driving car,* part of the Uber fleet[50], was responsible for the first road homicide committed by an automated vehicle[51]. The aforementioned case raised the question of who was responsible for the death of the woman involved in the accident[52] .

Although *self-driving cars,* as explained above, must have sensors to detect the passage of pedestrians or, more

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[50] Uber Technology Inc. was founded in 2008 under the original name UberCab and a modest initial investment ($200,000). It operates in North and South America, Europe, the Middle East, Africa, and Asia Pacific. Underlying Uber's success is the innovative way of matching user and driver via the platform, but there is also the imbalance between supply and demand caused by the insufficient number of licenses. On this point see: E. Morozov, *Silicon Valley: the lords of silicon, Turin*, Codex ed., 2016; S. Galloway, *The Four: the hidden DNA of Amazon, Apple, Facebook and Google*, London, Bantam Press, 2017. See also: A. Hagiu - J. Wright, *Multi-Sided Platforms,* in *International Journ. Industrial Organization*, n. 43, 2015, 162; G. Colangelo, *Big data, piattaforme digitali e antitrust,* in *M.C.R.*, 2016, 425. For an in-depth analysis on the regulation of Uber, see: M. Midri, *Nuove tecnologie e regolazione: il caso Uber,* in *Riv. trim. dir. pub.*, 2018, 1017 ff. The Court of Justice has held that Uber is not a mere intermediary, but the organiser of the service: matching via the platform is not an autonomous service but is instrumental to the transport service: ECJ. EU, Grand Chamber, 20 December 2017, Case 434/15, Elite Taxi v. Uber Spain and Judgment 10 April 2018, Case 320/16, Uber France, and infra, n. 2.

[51] On this point: R. Randazzo, *Uber crash death in Tempe: A closer look*, at *www.eu.azcentral.com;* G. Gardner, *Uber Won't Face Charges in Fatal Arizona Crash, But Prosecutor Urges Further Probe*, at *www.forbes.com*.

[52] On this point: I. Bogost, *Can You Sue a Robocar?* at *www.theatlantic.com*.

generally, the presence of any solid object (e.g., pavements, cones, other cars) in order to avoid car accidents, in this particular case the emergency braking system on the car was disabled. Furthermore, the investigation revealed that the so-called '*safety driver*' (the individual in charge of supervising the driving of the car), was intent on watching a television program on his smartphone[53] .

Despite these inconsistencies, the competent public prosecutor's office decided not to prosecute Uber.

More recently, an accident caused by one of Tesla Model S vehicles resulted in the death of two pedestrians in Woodlands, Texas, triggering a fire that was exceedingly difficult to put out (about 4 hours and 23,000 liters of water). However, the causes of the accident are still not entirely clear and, in a recent post on Twitter, Elon Musk stated that the

[53] For an in-depth analysis of the criminal consequences for the perpetrators of road accidents caused by the use of smartphones while driving in the Italian legal system see: G.M. Evaristi, *L'utilizzo dello smartphone alla guida nei delitti di omicidio e lesioni colpose stradali*, in *Dir. pen. cont.* 2/19, 460 ff.

autopilot mode had not been activated and that this car did not have the full self-driving capability[54].

Even if no autonomous driving modes were involved in this case (the matter has not yet been officially clarified), Tesla vehicles have caused numerous suspicious accidents. For this reason, the NHTSA stated that it would send a team to Detroit to investigate the dynamics of an accident that seriously injured two people because the car allegedly drove them under a tractor-trailer[55]. Similarly, it is worth mentioning two other accidents, in Florida in 2016 and 2019, in which vehicles using autopilot mode caused an accident resulting in the death of passengers.

Doubts about the safety of these vehicles were also shared by the European Union, which, on 21 April 2021, published a proposal for a regulation on the use of artificial intelligence, COM (2021) 206, and counted self-driving cars among the

[54] The news was retrieved from an article by C. Jones, Tesla Model S crashes in Texas, leaving two dead and sparking a blaze that lasts hours, available at *http//eu.usatoday.com/story/money/2021/04/18/tesla-model-s-car-crash-leaves-two-dead-texas-and-ignites-blaze/7276828002/.*

[55] For more information, see the article: *Tesla Autopilot safety under investigation after 'violent crash,' NHTSA says,* at*: https://eu.usatoday.com/story/money/cars/2021/03/16/tesla-autopilot-safety-nhtsa-investigation/4714393001/.*

systems that create a high risk for the health and safety or fundamental rights of natural persons.

The fatal accident that took place in Tempe, the mysterious dynamics of the accidents involving Tesla vehicles, and the recent issuance of the proposed European Regulation on Artificial Intelligence call for a more in-depth analysis of the issue[56]. In the following paragraphs, an attempt will be made to outline the legislation currently enacted and the legislative interventions that are planned. Finally, an attempt will be made to outline the applicable liability regime, highlighting the differences between the US system and the Italian and Spanish systems.

2. Introduction about the liability regime for self-driving cars

The description of the risks engendered by the introduction of automated vehicles onto the market makes it extremely important to examine whether the existing provisions on

[56] The question of the liability profiles of self-driving cars in the event of an accident caused by automatic vehicles will be dealt with in more detail in the following chapters.

driver liability and producer liability can be considered extensible to self-driving vehicles or whether a more specific regulation should be introduced instead.

In fact, the regulatory approach involving the market for new technologies diverges widely depending on the national legislative framework or the different regulatory initiative adopted by supernational institutions, such as the European Union, involved in the process.

In fact, the EU, in addition to pursuing the goal of regulating new technological phenomena, aims to make the European model a global reference, adopted in other geopolitical regions (the so-called "Brussels effect")[57]. Indeed, the model adopted in Europe is the regulatory one.

In the following, the EU existing legislation will be analysed, focusing on the regulations in force in Spanish and Italy.

[57] See: A. Bradford, *The Brussels Effect: How the European Union Rules the World, New York*, 2020, *passim*. It should be noted that there are also different approaches. Suffice it to say that while the model adopted in the United States is a self-regulatory, antitrust-based model, the Chinese model, on the other hand, appears to be a dirigiste model, affected by the country's political regime, although it cannot be overlooked that China is proving to be increasingly sensitive to the production of standards.

Subsequently, the US experience will be considered, and the currently applicable regime will be highlighted.

2.1 The self-driving cars liability regime in EU

In first place, it is important to offer a picture of the state of art of the liability legislations enacted in the EU legal framework.

The EU did not enact a uniform regulation for claiming the compensation in the EU members in case of car accident. Indeed, each EU country has different rules for claiming the compensation and for this reason, EU countries apply different concepts of liability for damages and injuries in car accidents and the time limits vary from one EU country to another. Nevertheless, there are some relevant regulations that must be considered for this analysis. In the following, an analysis of the main legislative measures adopted by the EU in this field will be conducted.

As a result of these different rules, car accidents victims may have difficulties in receiving a fair compensation for harm suffered. Nevertheless, in accordance with the Rome II

Regulation[58] and in order to increase legal certainty, it has been stated that the applicable time-limits for bringing a claim are determined by the law of the State where the accident occurred.

In fact, in 1973, the Council of Europe enacted the "*European Convention on Civil Liability for Damage caused by Motor Vehicles*", in order to achieve a greater unity between the member States of the Council of Europe and to prevent negative consequences caused by the lack of a common liability regime in case of motor vehicles accidents[59].

Article 4 of the ECCLDMV states that: "*the keeper of a vehicle shall be liable for damage caused by the vehicle*". Moreover, Article 4 of the ECCLDMV gives a definition of "keeper",

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[58] See: REGULATION (EC) No 864/2007 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 July 2007 on the law applicable to non-contractual obligations (Rome II), at: *https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:199:0040:0049:EN:PDF*. See: T.C. Hartley, *Choice of law for non-contractual liability: selected problems under the Rome II Regulation,* in *International Law Quarterly*, 2009, 899-908; G. Légier, *Le règlement "Rome II*", in *JPC,* 2007, 24; A. Dickinson, *The Rome II Regulation. The Law applicable to non-contractual obligation*, Oxford, 2010, 385 ff.

[59] For the sake of clarity, it should be noted that Regulation (EC) No 392/2009 of the European Parliament and of the Council of 23 April 2009 governs the liability of carriers of passengers by sea in the event of accidents.

establishing that: "*keeper, in relation to a vehicle, means the person who controls the use of the vehicle. The person under whose name a vehicle is registered, or, in the absence of registration, the owner of a vehicle shall be presumed to control the use of the vehicle, unless the contrary is proved. The occasional user of a vehicle shall not be considered to control the use of the vehicle, unless he has taken possession of the vehicle illegally. Each Contracting State may, however, implement the provisions of this sub-paragraph with the modifications it considers necessary".* In other words, in case of accidents caused by automated vehicles where it is not possible to identify a person who controls the use of the vehicle, the liability should be attributed, by presumption, to the owner or the person under whose name a vehicle is registered.

There is another important aspect to take into account. The Convention establishes that the liability of the keeper is reduced if a victim or person suffering damage, other than a keeper of a vehicle involved in the accident, has committed a fault which contributed to the damage. Moreover, if the damage resulted by a car accident is caused by two or more vehicles, the keepers of the vehicles which caused the damage shall be liable for such damage in full (*in solidum*). In this regard, article 9 of the Convention states that: "*the contribution of the vehicles to the damage shall be determined having regard to the circumstances of the accident, such as the fault of ill-health of a driver or passenger, the inherent risks of the vehicles or the irregular behaviour of a vehicle, whatever may be its cause, for instance a defect of the vehicle, the intervention of a third party, or a natural event other than a grave natural disaster of an exceptional nature".*

The Convention provides a possible liability limitation in case of external events that can incur and contribute to the damage causation, but it does not say when and if the external events could reduce or exclude the keeper liability in case of damage.

At the same time, Directive 72/166/EEC of 24 April 1972[60], which has undergone numerous amendments over the years, was issued on the approximation of the laws of the Member

[60] See: COUNCIL DIRECTIVE of 24 April 1972 on the approximation of the laws of the Member States relating to insurance against civil liability in respect of the use of motor vehicles, and to the enforcement of the obligation to insure against such liability (72/166/EEC), at: *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31972L0166.*

States relating to insurance against civil liability in respect of the use of motor vehicles, and to the enforcement of the obligation to insure against such liability. In particular, Article 3 of the aforementioned directive calls upon Member States to take all necessary measures to ensure that civil liability in respect of the use of vehicles is covered by insurance.

Subsequently, Directive 2009/103/EC of 16 September 2009[61] on insurance against civil liability in respect of the use of motor vehicles and the enforcement of the obligation to insure against such liability was issued.

On 19 February 2020, the European Commission published the White Paper "*Artificial Intelligence - A European Approach to Excellence and Trust*"[62], highlighting the potential benefits

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[61] See: DIRECTIVE 2009/103/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 September 2009 relating to insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability, at: *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0103#:~:text=Each%20Member%20State%20must%20take,the%20basis%20of%20those%20measures*.

[62] See: WHITE PAPER On Artificial Intelligence - A European approach to excellence and trust, Brussels, 19.2.2020 COM(2020) 65 final, at: *https://commission.europa.eu/system/files/2020-02/commission-white-paper-artificial-intelligence-feb2020_en.pdf*

and risks of artificial intelligence, identifying some security requirements and presenting proposals on some key elements. In this regard, the European Commission, in its report of 21 November 2019, Liability for Artificial Intelligence and other Emerging Digital Technologies, established an Expert Group[63] to address issues related to liability and new technologies.

Furthermore, in the European Parliament Resolution of 20 October 2020[64], recommendations were made to the Commission on a liability regime for artificial intelligence, formulating a proposal for a European regulation on liability for the operation of artificial intelligence systems[65].

See also: I. Zurita Martin, *Las propuestas de reforma legislativa del Libro Blanco europeo sobre inteligencia artificial en materia de seguridad y responsabilidad civil,* in *Actualidad Juridica Iberoamericana,* 14/2021, *passim.*

[63] See:*https://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/JURI/DV/2020/01-09/AI-report_EN.pdf p. 65.*

[64] See: European Parliament resolution of 20 October 2020 with recommendations to the Commission on a Digital Services Act: adapting commercial and civil law rules for commercial entities operating online (2020/2019(INL)),at:*https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020IP0273#:~:text=%E2%80%94%20The%20proposal%20aims%20to%20strengthen,to%20content%20moderation%20and%20curation.*

[65] See: P. Alvarez Olalla, *Propuesta de regolamento en materia de responsabilidad civil por el uso de inteligencia artificial del Parlamento Europeo, de 20 de octubre de 2020,* in *Revista CESCO de Derecho de Consumo,* no. 37/21.

Having said that, we will now analyse the Italian and Spanish regulations on civil liability.

2.2 Italian regulations for damage caused by vehicles

First of all, it should be pointed out that the discipline that currently governs driver liability in the event of a road accident is dictated by Article 2054 of the Civil Code, which expressly states that: "*The driver of a vehicle (Omissis) is obliged to compensate for the damage caused to persons or property by the circulation of the vehicle, if he does not prove that he did everything possible to avoid the damage*". From the first paragraph of the rule, it is clear that the provision identifies the driver as the party liable to pay compensation for the damage caused to persons or property by the circulation of the vehicle[66].

[66] According to the most authoritative scholars, this is an aggravated special liability case, for presumed fault; in the part where, in the fourth paragraph, the driver is also liable for defects construction or maintenance defects of the vehicle, this is strict liability. Thus C.M. Bianca, Civil Law. 5. *La responsabilità*, III ed., 2021, 725 ff.

Therefore, the prerequisites for the rule to be operative are given by the circumstance that a vehicle, by which is meant any means of locomotion on land that does not presuppose the use of rails (bicycles, animal-drawn carts and tractors are also included in the scope of the rule) has caused damage while in circulation.

In order to delineate the contours of the concept of circulation, it is possible to draw on the definition provided by the Highway Code with Legislative Decree No. 285 of 30 April 1992, which includes in the concept not only the vehicle in motion, but also the stopping or parking of the same. Therefore, Italian jurisprudence has deemed Article 2054 of the Italian Civil Code applicable also to events involving parked or stopped cars[67].

The rule introduces a presumption of fault on the driver, holding him liable for the damage caused, unless he proves that he did everything possible to avoid the damage. In other words, the driver bears the burden of proving that he did everything possible, by carrying out appropriate and effective

[67] Cass. 28 November 1990, no. 11467.

manoeuvres with skill and diligence, in order to avoid the event.

The second paragraph of the aforementioned provision states that: "*In the event of a collision between vehicles, it shall be presumed, until proof to the contrary, that each of the drivers equally contributed to producing the damage suffered by the individual vehicles*"[68]. Therefore, Article 2054 of the Civil Code places a further presumption, establishing that, in the case of a collision between vehicles, it must be presumed that each of the drivers contributed equally to causing the damage. Italian jurisprudence established that this rule constitutes the criterion for the distribution of the liability among the parties, since, in most cases, it would be impossible to identify with certainty the incidence of the individual culpable conduct in causing the damaging event[69].

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[68] See: M. Franzoni, *La responsabilità civile fra sostenibilità e controllo delle attività umane,* in *Danno e Responsabilità,* 2022, 5; P. Trimarchi, *La Responsabilità civile: atti illeciti, rischio, danno*, Milano, 2019, *passim*; G. Visintini, *Trattato breve della responsabilità civile*, Padova, 2005, 786 ff.; P.G. Monateri, *La responsabilità civile. Le fonti delle obbligazioni,* III, *Tratt. dir. civ.* edited by Sacco (Torino 1998), 1095 s. In jurisprudence, see Cass. 13 April 2017 no. 9646, in *Arch. giur. circol. e sinistri*, 2017, 733 where the Court reiterated the necessity of assessing in concrete terms the conduct of the driver, who bears the burden of proving that he has exercised the utmost diligence to the exclusion of any fault.

[69] Cass. 27 June 2007, no. 14834.

Moreover, the fact that one of the drivers is actually at fault does not automatically override the presumption of fault on the part of the other driver, who, on the other hand, will be required to prove that he has diligently observed all traffic regulations.

The third paragraph of the provision then states that: "*The owner of the vehicle, or, in his stead, the usufructuary or the purchaser under reservation of title, is jointly and severally liable with the driver, if he does not prove that the circulation of the vehicle took place against his will*"[70], while, paragraph four states that: "*In any case the persons indicated in the preceding paragraphs shall be liable for damage resulting from construction defects or faulty maintenance of the vehicle*". It follows that the provision also identifies the owner or usufructuary and the purchaser with retention of title as being jointly and severally liable for damage resulting from defects in the construction or maintenance of the vehicle.

[70] C.M. Bianca, *Diritto civile. 5. La responsabilità,* cit., 732-733. For a critical review of the case law on product liability, with particular reference to the burden of proof on the defect of the product, see A.R. Fusaro, *Responsabilità del produttore: la difficile prova del difetto,* in *Nuova giur. civ. comm.*, II, 2017, 896-906.

According to the prevailing doctrine, this is a hypothesis of strict liability[71] for the act of others, since the imputation criterion does not presuppose an analysis of the diligence performed by the owner, usufructuary and the purchaser with retention of title. In fact, the mere realisation of the damage entails a joint liability of the parties aforementioned.

According to the jurisprudence, only the demonstration that the circulation of the vehicle took place against the will of the person identified as responsible would allow the latter not to be liable for the damage caused by the vehicle[72].

As a matter of fact, from a first reading of the aforementioned provision, it would not appear that there are any reasons preventing its application also to self-driving vehicles[73]. On the contrary, should Article 2054 of the Civil

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[71] With reference to fault in the objective sense, as a breach of a duty of conduct, and the difference that remains with strict liability see C. Castronovo, *Responsabilità civile* (Milan 2018), 412 ff.

[72] Cass. 1 August 2000, no. 10027; Cass. 27 October 1998, no. 10698; Cass. 9 December 1992, no. 12015.

[73] For an analysis of the liability regime applicable to highly automated vehicles, see: A. Albanese, *La responsabilità civile per i danni da circolazione di veicoli ad elevata automazione,* in *Europa e Diritto Privato*, 2019, 995 ff.; A. Davola-R. Pardolesi, *In viaggio col robot: verso nuovi orizzonti della r.c. auto ("driverless")?,* in *Danno e resp.*, 2017, *passim*; U. Ruffolo, *Self-driving car, auto driverless e responsabilità*, in Ruffolo (ed.), *Intelligenza artificiale e*

Code be deemed applicable, it would also be possible to hold the driver jointly and severally liable with the owner or usufructuary or the purchaser under reservation of title for damage caused due to defects or lack of maintenance of the vehicle. This is, of course, without prejudice to these parties' right of recourse against the manufacturer, which we will deal with later.

Now, it has been said that from a first reading there would appear to be no grounds for opposing the possible application of Article 2054 of the Civil Code[74]. However, it is

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responsabilità, Milano, 2017, 31 ff.; R. Lobianco, *Veicoli a guida autonoma e responsabilità civile: regime attuale e prospettive di riforma (I e II parte)*, in *Resp. Civ. e Prev.,* 2020, 724 ff. e 1080 ff.; Pellegatta, *Autonomous Driving and Civil Liability: The Italian Perspective,* in *Giureta - Riv. dir. econ. trasp. am*b., 2019, 135 ff.; Benelli, *Auto a guida autonoma: profili di responsabilità civile e prospettive di riforma,* in *Dir. trasp.*, 2019, 351 ff.; Comenale Pinto-Rosafio, *Responsabilità civile per la circolazione degli autoveicoli a conduzione autonoma. Dal Grande Fratello al Grande Conducente*, in *Dir. trasp.*, 2019, 367 ff.; Severoni, *Prime considerazioni su un possibile inquadramento giuridico e sul regime di responsabilità nella conduzione dei veicoli a guida autonoma*, in *Resp. Civ. e Prev.*, 2018, 356 ff.; B. Cappiello, *"A.I. in a Vehicle": extra-contractual liability issues*, in *Giur. Comm.*, 2021, 1127 ff.; A. Davola, *Veicoli autonomi, sinistri stradali e nuovi modelli di responsabilità civile,* in *Opinio Juris in Comparatione,* 2018, 111 ff.

[74] See F. Bartolini, *Auto a guida autonoma e problemi di responsabilità civile,* in *Il Diritto nell'era digitale. Persona, Mercato, Amministrazione e Giustizia*, edited by R. Giordano – A. Panzarola – A. Police – S. Preziosi – M. Proto, Milan 2023, 312: "*Per il presente, così come per il futuro non troppo remoto, è condivisa l'opinione per cui « le norme sulla responsabilità "da cosa", da attività o da prodotto appaiono sufficienti a risolvere la quasi totalità degli*

important to remember that level 4 or 5 vehicles do not have a driver in the proper sense, whereas the notion of driver refers to the person driving the vehicle. In these hypotheses, therefore, the only person liable could only be the owner of the vehicle. On the other hand, the presumption of fault referred to in the first paragraph of Article 2054 of the Civil Code could be overcome by the owner making available the data recorded by the vehicle's "*black box*", which should memorise the succession of events and, therefore, any manoeuvres performed by the vehicle to avert the harmful event.

Therefore, in the case of level 4 or level 5 vehicles, Article 2054 of the Civil Code should be considered applicable since it identifies the owner of the vehicle, whether a private individual or a company, as the party responsible for the damage caused by the circulation of the vehicle and considers the passengers as third parties transported who, therefore,

interrogativi in materia di responsabilità da produzione o gestione di entità dotate di intelligenza artificiale». In particolare, si è compreso come le regole attuali sulla circolazione dei veicoli possano resistere, con qualche aggiustamento interpretativo, alle novità dell'automazione".

may avail themselves of the protection offered by the first two paragraphs of Article 2054 of the Civil Code.

2.2.1 Italian regulations for autonomous vehicles road test

Italy has recently issued a regulation, the so-called Smart Road Decree of 28 February 2018[75], aimed at allowing road tests of driverless cars[76].

Article 1(f) of the aforementioned decree defines a '*self-driving vehicle*' as '*a vehicle equipped with technologies capable of adopting and implementing driving behaviour without the active intervention of the driver, in certain road*

[75] Decree 28 February 2018, *Modalità attuative e strumenti operativi della sperimentazione su strada delle soluzioni di Smart Road e di guida connessa e automatica*, (GU Serie Generale n.90 del 18-04-2018), aimed at promoting the valorisation of the existing infrastructure heritage, the realisation of useful infrastructures, the technological adaptation of the national road network in line with the EU and international framework of digitisation of road infrastructure, also in support of connected vehicles and with more advanced levels of automatic driver assistance, as well as' reducing road accidents and ensure continuity with the European C-ITS services (Article 3, paragraph 1).
[76] See I. Ferrari, *Analisi comparata in tema di responsabilità civile legata alla circolazione dei veicoli a guida autonoma,* in *Smart Roads e Driverless cars: tra diritto, tecnologie, etica pubblica,* edited by S. Scagliarini, Torino, 2019, 108-109.

environments and external conditions'[77]. Although the second part of the provision excludes from the definition vehicles equipped with driver assistance systems activated by a driver in order to obtain assistance in driving the vehicle, the definition is excessively broad, as it is not suitable for distinguishing vehicles equipped with partial autonomy (think of SAE level 3 vehicles) from vehicles equipped with full autonomy (SAE levels 4 and 5).

Moreover, it is not clear why the legislator limits the use of autonomous driving technologies to '*certain road areas and external conditions*'. It would seem, almost, that the definition provided refers to vehicles in which autonomous driving is totally interchangeable with manual driving. If this were the case, the consequence would be that SAE level 5 vehicles would be excluded from the definition of Art. 1(f) of the "Smart Road" decree.

Article 9 then states that authorisation from the Ministry of Infrastructure and Transport is required for road testing of

[77] With regard to the definition of vehicle, R. Lobianco, *Veicoli a guida autonoma e responsabilità civile: regime attuale e prospettive di riforma — I parte,* in *Resp. civ.* prev., 2020, 724, points out the need for an adjustment of the definition.

self-driving vehicles. In particular, authorisation may be requested by the vehicle manufacturer and, jointly or severally, by university institutes and public and private research bodies conducting experiments on vehicles equipped with automated driving technologies[78].

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[78] Art. 9, Decree 28 February 2018, (so called Smart Road Decree): *"1. La sperimentazione su strade pubbliche di veicoli a guida automatica è autorizzata dal Ministero delle infrastrutture e dei trasporti - Dipartimento per i trasporti, la navigazione, gli affari generali e il personale - Direzione generale per la motorizzazione. 2. L'autorizzazione di cui al comma 1 può essere chiesta, singolarmente o in maniera congiunta, dal costruttore del veicolo equipaggiato con le tecnologie di guida automatica, nonché dagli istituti universitari e dagli enti pubblici e privati di ricerca che conducono sperimentazioni su veicoli equipaggiati con le tecnologie di automazione della guida. 3. L'autorizzazione può essere rilasciata con riferimento unicamente a veicoli che siano già stati omologati, nella versione priva delle tecnologie di guida automatica, secondo la normativa vigente. Rimane impregiudicata la facoltà per le fabbriche costruttrici di veicoli a motore e di rimorchi, loro rappresentanti, concessionari e commissionari, per i costruttori delle tecnologie di guida automatica, nonché per gli istituti universitari e gli enti pubblici e privati di ricerca che conducono sperimentazioni su veicoli di effettuare prove di validazione su strada di un nuovo modello precedenti l'avvio della produzione in serie, ai sensi del decreto del Presidente della Repubblica 24 novembre 2001, n. 474. 4. L'autorizzazione è rilasciata per uno o più veicoli, con riferimento a ciascuno dei quali è indicato il proprietario, appartenenti alla stessa classe e categoria ai sensi dell'art. 47 del codice della strada, dotati di tecnologie di guida automatica appartenenti ad una famiglia omogenea con prestazioni funzionali simili e in grado di garantire un identico livello di sicurezza su strada, eventualmente anche in diverse versioni. A seguito della autorizzazione, i veicoli sono iscritti in un apposito registro tenuto dal soggetto autorizzante e ricevono in dotazione un contrassegno speciale di autorizzazione alla sperimentazione, le cui caratteristiche sono stabilite nell'Allegato B, parte integrante del presente decreto, che deve essere esposto sia sul lato anteriore sia su quello posteriore del veicolo durante l'attività sperimentale. 5. I veicoli autorizzati alla sperimentazione circolano, durante l'attività sperimentale, con targa di prova rilasciata ai sensi*

Paragraph 3 of Article 9 specifies that this authorisation will only be granted in favour of vehicles already type-approved, in the version without the automated driving technology. If the authorisation is granted, the vehicles will be entered in a special register kept by the authorising party and will be provided with a special experimental authorisation mark.

Art. 10 of the decree also states that the driving tests must be carried out with the presence of a supervisor inside the vehicle, who must have held a driving licence for at least five years and have successfully passed a safe driving course or a specific course for experimenters of driverless vehicles at an accredited body. Art. 10(2) states that the supervisor must always be able to manage the vehicle's operating mode and to interchange automatic mode with manual mode. In any

del decreto del Presidente della Repubblica n. 474 del 2001. 6. L'autorizzazione si riferisce alla esecuzione delle sperimentazioni su uno o più ambiti stradali e, per ciascuno di essi, per le specifiche infrastrutture stradali indicate dal soggetto richiedente dopo avere ottenuto il nulla osta dall'ente proprietario della strada".

case, the rule states that the supervisor retains responsibility for the vehicle in both operating modes[79].

The application for authorisation to carry out road tests on the self-driving vehicle must be addressed to the Ministry of Infrastructure and Transport - Department for Transport, Navigation, General Affairs and Personnel - Directorate General for Motorisation and contain the indication of the owner of the self-driving vehicle, the road sections on which it is intended to carry out the tests the documentation proving that the authorisation to conduct the experimental tests has been obtained from the road owner, for each proposed infrastructure section, the indication, for each proposed road section, of the external, weather and visibility

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[79] Art. 10, Decree 28 February 2018, (so-called Smart Road Decree): "*La conduzione su strada del veicolo automatizzato durante la sperimentazione è effettuata da un supervisore che possiede da almeno cinque anni la patente di guida per la classe del veicolo in prova, ha superato con successo un corso di guida sicura o un corso specifico per sperimentatori di veicoli a guida automatica presso un ente accreditato in uno dei Paesi dell'Unione europea, ha condotto prove su veicoli a guida automatica in sede protetta o su strada pubblica, anche all'estero, purché in uno Stato in cui la sperimentazione dei veicoli a guida automatica è regolamentata, per una percorrenza di almeno mille chilometri e possiede le conoscenze necessarie, adeguatamente documentate, per prendere parte alle prove in veste di supervisore. 2. Il supervisore deve essere in grado di commutare tempestivamente tra operatività del veicolo in modo automatico e operatività dello stesso in modo manuale e viceversa. Il supervisore ha la responsabilità del veicolo in entrambe le modalità operative*".

conditions and the road and traffic conditions in which the tests may be conducted.

In addition, Article 11(1)(a) identifies the owner of the self-driving vehicle as the liable party pursuant to Article 196 of the Highway Code and Article 2054(3) of the Civil Code[80].

The authorisation for experimentation is valid for one year but may be renewed at the request of the holder.

However, pursuant to Article 18, the authorising party may suspend or revoke the authorisation if it finds, also as a result of non-compliance by the authorised party and reports of

[80] Art. 11(1)(a), Decree 28 February 2018, (so called Smart Road Decree): "*1. Il costruttore del veicolo equipaggiato con le tecnologie di guida automatica, nonché gli istituti universitari e gli enti pubblici e privati di ricerca che conducono sperimentazioni su veicoli equipaggiati con le tecnologie di automazione della guida presentano la domanda di autorizzazione alla sperimentazione su strada del veicolo a guida automatica al Ministero delle infrastrutture e dei trasporti - Dipartimento per i trasporti, la navigazione, gli affari generali e il personale - Direzione generale per la motorizzazione, che contiene: a) l'indicazione del proprietario del veicolo a guida automatica, quale soggetto responsabile ai sensi dell'art. 196 del codice della strada e dell'art. 2054, comma 3, del codice civile, ovvero di altro soggetto obbligato in solido, ai sensi del citato art. 196*".

findings during roadside checks, that the continuation of the experiments may cause a traffic safety risk[81].

Article 19 stipulates that the authorisation holder must conclude a specific civil liability insurance contract for the self-driving vehicle, pursuant to Law No 990 of 24 December 1969, and deposit a copy with the authorising party[82].

Based on the aforementioned regulations, the first tests (on circuits) of self-driving cars began in May 2019 in the cities of Turin and Parma. Only recently (and, more precisely, on 27 May 2023) has the testing of self-driving vehicles been extended to public roads.

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[81] Art. 18, Decree 28 February 2018, (so called Smart Road Decree): "*1. Il soggetto autorizzante può sospendere o revocare l'autorizzazione se ravvisa, anche a seguito di inadempienze del soggetto autorizzato e di segnalazioni relative a quanto emerso in sede di controlli su strada, che il proseguimento delle sperimentazioni può causare un rischio per la sicurezza della circolazione. Nei casi in cui emergono inadempienze, violazioni e in caso di incidente stradale, l'organo di polizia intervenuto effettua una segnalazione circostanziata all'ente autorizzante*".

[82] Art. 19, Decree 28 February 2018, (so called Smart Road Decree): "*1. Il richiedente deve dimostrare di avere concluso il contratto di assicurazione per responsabilità civile specifica per il veicolo a guida automatica, ai sensi della legge 24 dicembre 1969, n. 990, depositando una copia presso il soggetto autorizzante, con un massimale minimo pari a quattro volte quello previsto per il veicolo utilizzato per la sperimentazione nella sua versione priva delle tecnologie di guida automatica, secondo la normativa vigente. 2. Il contratto di assicurazione indica espressamente che l'assicuratore è a conoscenza delle modalità di uso del veicolo e che il veicolo è utilizzato in modalità operativa automatica su strade pubbliche*".

2.3 Spanish regulations for damage caused by vehicles

The Spanish regulation for damage caused by vehicles is similar to the Italian one but has some differences that need to be emphasised[83].

Article 1.1 of Royal Decree No 8 of 29 October 2004 states that: "*The driver of motor vehicles is liable, by virtue of the risk created by driving, for damage caused to persons or property while driving. In the case of personal injury, he shall only be exonerated from this liability when he proves that the damage is due to the exclusive fault of the injured party or to force majeure causes unrelated to driving or operating the*

[83] *Ex multis*: M. Navarro-Michel, *La aplicación de la normativa sobre accidentes de tráfico a los causados por vehículos automatizados y autónomos*, in *Cuadernos de Derecho Transnacional*, vol. 12, (2020), nº 1, pp. 941-961; E. Hernáez Esteban, *Inteligencia artificial y vehículos autónomos: el régimen de la responsabilidad civil ante los nuevos retos tecnológicos*, in *Revista Aranzadi de Derecho y Nuevas Tecnologías*, nº 49, 2019, pp. 197 ff.; Nuñez Zorrilla, *Inteligencia artificial y responsabilidad. Régimen jurídico de los daños causados por robots autónomos con inteligencia artificial*, Madrid, Ed. Reus, 2019; J. Ercilla García, *Normas de derecho civil y robótica. Robots inteligentes, personalidad jurídica, responsabilidad civil y regulación*, Cizur Menor, Thomson-Reuters Aranzadi, 2018; S. DíazAlabart, *Robots y responsabilidad civil*, Madrid, Editorial Reus, 2018.

vehicle; vehicle defects or the breakage or failure of one of its parts or mechanisms shall not be considered force majeure. In the event of property damage, the driver shall be liable to third parties when he is civilly liable pursuant to articles 1902 et seq. of the Civil Code, articles 109 et seq. of the Criminal Code, as well as pursuant to the provisions of this law"[84].

Article 1 of Royal Decree 8/2004 therefore identifies the driver as the liable party obliged to compensate the injured party for the damage suffered as a result of the risk caused by his driving. It follows that the liability regime laid down by Spanish law is closely linked to the figure of the driver. The second paragraph of the aforementioned provision then

[84] Real Decreto Legislativo 8/2004, de 29 de octubre, por el que se aprueba el texto refundido de la Ley sobre responsabilidad civil y seguro en la circulación de vehículos a motor, Articulo 1.1: *"1. El conductor de vehículos a motor es responsable, en virtud del riesgo creado por la conducción de estos, de los daños causados a las personas o en los bienes con motivo de la circulación. En el caso de daños a las personas, de esta responsabilidad sólo quedará exonerado cuando pruebe que los daños fueron debidos a la culpa exclusiva del perjudicado o a fuerza mayor extraña a la conducción o al funcionamiento del vehículo; no se considerarán casos de fuerza mayor los defectos del vehículo ni la rotura o fallo de alguna de sus piezas o mecanismos. En el caso de daños en los bienes, el conductor responderá frente a terceros cuando resulte civilmente responsable según lo establecido en los artículos 1.902 y siguientes del Código Civil, artículos 109 y siguientes del Código Penal, y según lo dispuesto en esta Ley"*, at: *https://www.boe.es/buscar/act.php?id=BOE-A-2004-18911*.

states that, in the event of personal injury, in order to be exempt from liability for the damaging conduct, the driver will be required to prove that the damage was due to culpable conduct from the injured party or that the damage was caused by force majeure. It is important to note that this liability exemption is not related to the driving or to the vehicle malfunctioning. It follows that vehicle defects cannot be considered force majeure[85]. In these cases, in fact, the legislator identifies a presumption of causality between risk and damage, which can only be rebutted by proving the existence of grounds for exoneration[86].

[85] *Ex multis*: Supreme Court judgment No. 536/2012 of 10 September; Supreme Court judgment No. 1222/2008 of 16 December; Judgment of the Provincial Court of Gipuzkoa No. 33/2014, 11 March.

[86] Supreme Court Judgment No. 40/2013, 4 February: "*- El principio de responsabilidad objetiva -en cuya legitimidad constitucional no es necesario entrar aquí-, en efecto, no solo supone el establecimiento de criterios de imputación ajenos a la concurrencia de culpa o negligencia, sino que comporta también establecer una presunción de causalidad entre las actividades de riesgo y la consecuencias dañosas que aparezcan como características de aquellas, como ocurre con los daños derivados de una colisión cuando se trata de la responsabilidad objetiva por el riesgo creado por la conducción de un vehículo de motor. Esta presunción solo puede enervarse demostrando que concurren las causas de exoneración configuradas por la ley como excluyentes del nexo de causalidad entre la acción y el daño.*
- La solución del resarcimiento proporcional es procedente solo cuando pueda acreditarse el concreto porcentaje o grado de incidencia causal de cada uno de los vehículos implicados y que, en caso de no ser así, ambos conductores responden del total de los daños personales causados a los ocupantes del otro vehículo con arreglo a la doctrina llamada de las condenas cruzadas".

Finally, the third paragraph of the provision states that, in the case of damage to property, the driver is liable towards the injured party if the conditions set out in Articles 1902 et seq. of the Spanish Civil Code and Articles 109 et seq. of the Spanish Criminal Code are met. In this case, therefore, in order for the driver who caused the damage to be exonerated, he must prove full diligence in driving[87].

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[87] Supreme Court judgment No. 536/2012 of 10 September: "*En supuestos de colisión recíproca de vehículos constituye jurisprudencia de esta Sala, a partir de la STS de 16 de diciembre de 2008, RC núm. 615/2002 , que el artículo 1.1 I y II LRCSVM 1995 establece un criterio de imputación de la responsabilidad derivada de daños a las personas causados con motivo de la circulación fundado en el principio objetivo de la creación de riesgo por la conducción. Este principio solamente excluye la imputación (artículo 1.1 II) cuando se interfiere en la cadena causal la conducta o la negligencia del perjudicado (si los daños se deben únicamente a ella) o una fuerza mayor extraña a la conducción y al funcionamiento del vehículo, salvo, en el primer caso, que concurra también negligencia del conductor, pues entonces procede la equitativa moderación de la responsabilidad y el reparto de la cuantía de la indemnización (artículo 1.1 IV LRCSVM 1995). El riesgo específico de la circulación aparece así contemplado expresamente en la ley como título de atribución de la responsabilidad, frente a la tradicional responsabilidad por culpa o subjetiva en que el título de imputación es la negligencia del agente causante del resultado dañoso. Esto es así tanto en el supuesto de daños personales como de daños materiales, pues en relación con ambos se construye expresamente el régimen de responsabilidad civil por riesgo derivada de la conducción de un vehículo de motor («daños causados a las personas o en los bienes»: artículo 1.1 I LRCSCVM). Respecto de los daños materiales, sin embargo, la exigencia, que también establece la LRCSCVM, de que se cumplan los requisitos del artículo 1902 CC (artículo 1.1 III LRCSCVM) comporta que la responsabilidad civil por riesgo queda sujeta al principio, clásico en la jurisprudencia anterior a la LRCSCVM sobre daños en*

From this first reading, it might be possible to conclude that the current regulation in Spanish law is not applicable with regard to level 4 and 5 autonomous vehicles, since in the latter it is not possible to recognise a driver in the technical sense.

However, paragraph 3 of Article 1 of Royal Decree 8/2004 of 29 October states that: "*The non-driver owner is liable for personal injury and property damage caused by the driver when he is linked to the latter by one of the relationships regulated by articles 1.903 of the Civil Code and 120.5 of the Criminal Code. This liability shall cease when the said owner proves that he used all the diligence of a good family man to avoid the damage. The non-driving owner of a vehicle without compulsory insurance shall be civilly liable with the driver of the vehicle for personal injury and property damage caused by the latter, unless he proves that the vehicle was stolen from him*".

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accidentes de circulación, de inversión de la carga de la prueba, la cual recae sobre el conductor causante del daño y exige de ese, para ser exonerado, que demuestre que actuó con plena diligencia en la conducción".

From Article 1.3 of the LRCSCVM, it is possible to retrace the owner's liability for the actions of others, such as its liability for the conduct of the driver. The provision expressly refers to Article 1903 of the Civil Code, which identifies certain categories of persons held liable for the actions of others due to *culpa in vigilando* or *in eligendo*[88].

More specifically, Article 1903 of the Civil Code, referred to Article 1.3 of the LRCSCVM states that: "*Parents are liable for damage caused by children under their care. Guardians are liable for damage caused by children under their authority and living in their company. Guardians with full powers of representation are liable for damage caused by the person in their care, provided that he or she lives with them. Owners or directors of an establishment or company shall also be liable*

[88] See: E. Q. Cervantes, *Comentario a la sentencia del Tribunal Supremo de 23 febrero de 1976 sobre culpa extracontractual derivada de accidente de circulaciòn. Applicaciòn analògica del articulo 1.903 del Codigo Civil*, in *Editum*, 78: *"El artículo 1903 se refiere a las obligaciones que nacen de una actuación dañosa realizada por aquellas personas que están bajo la dependencia y vigilancia de otras y que vienen fundadas en las llamadas culpa in eligendo o culpa in vigilando y parte del supuesto de varias personas que viven relacionadas por un vinculo familiar de padres e hijos, siempre que éstos vivan en su compañía; y también al tutor y al sometido a tutela. Asimismo se refiere la citada norma a personas que viven relacionadas por un vínculo de empresa, o dependencia, estableciendo también normas acerca de la responsabilidad del Estado".*

for damage caused by their dependants in the service of the branches in which they have employed them or in the course of their duties. The persons or entities owning a non-university educational establishment are liable for the damage caused by their under-age students during the periods in which they are under the control or supervision of the educational staff of the establishment, carrying out school or extracurricular and complementary activities". As can be seen, the provision does not include the owners of objects used by others among those liable. It follows that, from a first reading of these provisions of the LRCSCVM, it does not seem possible to identify a discipline similar to the Italian one, which identifies in the owner of the vehicle a subject who is always liable for damages caused to third parties[89].

However, Article 1905 of the Spanish Civil Code states that the owner of an animal (or the person who uses it) is liable for the damage it causes, even if the animal escapes or runs away. This liability shall only cease if the damage was caused by force majeure or by the fault of the person who suffered it. In the absence of a provision similar to Article 2054 of the

[89] Please, see par. 2.2.

Italian Civil Code, an extensive interpretation of Article 1905 of the Spanish Civil Code could be applied in order to find the owner of autonomous vehicles liable.

It should be further specified that, as regards the direct liability of the driver, the reference to Article 1903 Civil Code does not exclude the application of Article 1902 of the same Code in case the owner of the vehicle is liable of assigning or authorising the use of the vehicle on the ground of *culpa in vigilando* or *in eligendo*. In these scenarios, whether this is interpreted in the strict terms of fault on the part of the person assigning the vehicle (i.e. the owner is aware that the driver is not fit to drive it), or whether it is interpreted, on the basis of more objective parameters, (i.e. the owner authorises his son to drive the car thus assumes the risks inherent in driving)[90].

[90] This principle was affirmed by the Provincial Court of Tenerife in its judgment no. 512/2012, of 31 October: "(...) *having been credited with the condition of the owner of the vehicle that caused - in the percentage indicated - the damage to the appellant's vehicle, the driver of the vehicle being linked to the appellant by a paternal-filial relationship and both living in the same household, having expressly stated in the claim for compensation that she was in possession of the due authorisation to drive the vehicle (...), without, on the contrary, having proved that the fact that the appellant has the right to drive the vehicle (.), without, on the contrary, having proved the existence of any circumstance that would exempt the owner from such liability, it is clear that he must be liable for the damages that the applicant claims against him*".

2.3.1. Spanish regulations for autonomous vehicles road test

On 26 April 2009, Instruction 10/TV-66 of the DGT was issued, providing an initial regulation for road tests of self-driving vehicles. In 2015, given the significant technological advances in the automotive industry, the DGT was forced to integrate the regulations set forth in Instruction 10/TV-66 for tests conducted with automated guided vehicles. Therefore, on 13 November 2015, it published Instruction 15/V-1136 according to which those interested in conducting tests with vehicles equipped with an automation system of SAE level 3 or higher will have to apply for special authorisation from the Sub-Directorate General for Mobility Management of the DGT[91].

The instruction regulates the requirements to be met by applicants for authorisation, the requirements for

[91] DIRECCIÓN GENERAL DE TRÁFICO (2014), Instrucción 15/V-113. Autorización de pruebas o ensayos de investigación realizados con vehículos de conducción automatizada en vías abiertas al tráfico en general. On 23 November 2015, ten days after the approval of the instruction, the first test of autonomous vehicles on Spanish roads was carried out by the PSA Peugeot-Citroën group.

autonomous vehicles and the requirements for the driver. It is worth noting that the Instruction requires the same requirements and makes the different levels covered by the Instruction subject to the same test procedure, making no distinction between SAE level 3, 4 and 5 vehicles.

More specifically, the parties authorised to apply for permission to carry out research tests and trials on automated and autonomous vehicles are vehicle manufacturers, second stage manufacturers [92] and official laboratories.

The authorisation procedure consists of three phases. The first stage is documentary in nature and has the function of disclosing the characteristics of the vehicle and identifying potential risks and defects that may occur during the test. In the event that the inspection carried out reveals that the vehicle for which the applicant wishes to obtain authorisation for road tests has risks or defects that cannot be accepted for driving, passing the first stage will be subject to a further

[92] Second-stage manufacturers are defined as bodybuilders in accordance with Article 47 of the General Vehicle Regulations. See: Real Decreto 2822/1998, of 23 December, approving the General Vehicle Regulations.

inspection showing that these risks or defects have been resolved.

The purpose of the second stage inspection is to ensure the safety of the tests. If, after inspection of the vehicle exterior, engine compartment, interior, wheels, underbody, or any other component, it is deemed that the minimum safety levels are not met, the application will be rejected.

During the third stage, a dynamic test is carried out to check the correct functioning of both the conventional driving mode and the system for switching from automated to manual mode.

Authorisation to test the operation of this type of vehicle, which lasts two years and can be extended for identical periods, is only granted if all three stages of the procedure are passed[93]. The tests will take place in test scenarios, as

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[93] DIRECCIÓN GENERAL DE TRÁFICO (2014), Instrucción 15/V-113: "*2. ALCANCE DE LA AUTORIZACIÓN La presente autorización es de ámbito nacional y establecerá los tramos de vía urbana e interurbana por las que el vehículo está autorizado a realizar las pruebas o ensayos Los titulares de la autorización, serán responsables de que los vehículos reúnan las características técnicas adecuadas para la circulación por las vías públicas y del cumplimiento de todos los requisitos exigidos en la presente*

these are the situations for evaluating the circulation of the test vehicles in real traffic conditions. During the tests, the presence in the vehicle of a driver who has held a driving licence for at least two years is always required.

The system holds the driver responsible for driving and operating the vehicle at all times. It is important to note that this principle applies to the driver of a level 3 and 4 vehicles as well as to the driver of a level 5 vehicle.

After allocating liability to the driver of the self-driving vehicle, the instruction stipulates that the decision, granting or denying the special authorisation requested, shall be issued within 1 month. The authorisation granted shall state the type of test to be carried out, its route and other conditions under which it is to be carried out. Moreover, the Directorate General of Traffic shall forward the authorisation

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instrucción. La duración de la autorización será por un plazo máximo de 2 años, pudiendo prorrogarse sucesivamente por idénticos periodos de tiempo. La circulación fuera del alcance de la autorización deberá realizarse siempre en modo convencional. Los vehículos deberán estar matriculados. En caso contrario, deberán obtener una autorización temporal de circulación conforme al art. 44 del RGV que les permita circular por las vías abiertas al tráfico en general".

to the administrations with competence in traffic matters in the territorial area in which the tests are to be carried out[94].

On 10 October 2017, the Popular Parliamentary Group presented a debate to the Congress of Deputies on the promotion and development of the autonomous vehicle to encourage Spain to become one of the reference countries in terms of autonomous vehicles[95].

Having said that, it is clear that Spanish legislator is encouraging the deployment of autonomous vehicles and technological innovation. Indeed, Spain has been one of the first European countries to enact such regulations and to

[94] DIRECCIÓN GENERAL DE TRÁFICO (2014), Instrucción 15/V-113: "4. RESOLUCIÓN. *La resolución, concediendo o denegando la autorización especial solicitada será dictada por el Subdirector General de Gestión de la Movilidad en el plazo de 1 mes desde la entrada en el registro de la Dirección General de Tráfico. En caso de que el itinerario autorizado para la realización de las pruebas incluya vías cuya competencia corresponda a otras administraciones con competencia en materia de tráfico, el plazo de resolución de 1 mes contará desde el día siguiente a la recepción del preceptivo informe por parte de la administración correspondiente. En la Autorización que se conceda constará el tipo de ensayo a realizar, su itinerario, y demás condiciones en que deba desarrollarse. La Dirección General de Tráfico dará traslado de la autorización a las administraciones con competencia en materia de tráfico del ámbito territorial en que se desarrollen las pruebas.*".

[95] Journal of Sessions of the Congress of Deputies. Plenary and Permanent Deputation, no. 80, 10 October 2017. File number 162/000451: by the Popular Parliamentary Group in Congress, on the promotion and development of autonomous vehicles, pp. 33 et seq.

approve road test. It is desirable that the Spanish legislator continues in this direction so as to make Spain one of the most avant-garde countries in Europe.

3. Commercialisation of self-driving cars

The importance of vehicle type-approval procedure in both Spain and Italy will be enlightened in this paragraph.

At paragraph 2.2.1. we already noted that Article 9(3) of Smart Road decree specifies that the authorisation to conduct road test of automated vehicles will only be granted in favour of vehicles already type-approved.
In Italy, the vehicle type-approval procedure is governed by Decree No 277 of 2 May 2001[96], according to which the circulation of motor vehicles is subject to certain tests aimed at certifying their safety.

[96] Decreto 2 maggio 2001, n. 277, Disposizioni concernenti le procedure di omologazione dei veicoli a motore, dei rimorchi, delle macchine agricole, delle macchine operatrici e dei loro sistemi, componenti ed entità tecniche, at: *https://www.gazzettaufficiale.it/atto/serie_generale/caricaDettaglioAtto/originario?atto.dataPubblicazioneGazzetta=2001-07-12&atto.codiceRedazionale=001G0336*.

Similarly, in Spanish law, Article 1 of the RGV provides that, in order to circulate on Spanish roads, motor vehicles must first obtain the corresponding administrative authorisation, aimed at verifying that they are in perfect working order, since the circulation of vehicles that do not have this authorisation is prohibited (Article 1).

More generally, it should be noted that there are two main procedures: EC type-approval procedure and national type-approval procedure.

Directive 2007/46/EC[97], transposed into both Italian and Spanish jurisdiction, identifies the documentary and administrative requirements for obtaining EC type-approval.

This Directive has been replaced by Regulation 2018/858[98], in turn amended by Regulation 2019/2144 of the European

[97] Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0046.

[98] Regulation(EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending

Parliament and of the Council on type-approval requirements for vehicles[99].

According to Article 4 of the latter regulation, manufacturers will have to prove that all new vehicles placed on the market are equipped with certain devices in order to obtain type approval[100]. More specifically, vehicles will have to be equipped with systems capable of monitoring driving conditions and ensuring the safety of the vehicle and the driver. By way of example, the standard requires vehicles to

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Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC, at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R0858.

[99] 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 (Text with EEA relevance)

[100] Art. 4 (I), Regulation (EU) 2019/2144 of the European Parliament and of the Council: "*Manufacturers shall demonstrate that all new vehicles that are placed on the market, registered or entered into service, and all new systems, components and separate technical units that are placed on the market or entered into service, are type-approved in accordance with the requirements of this Regulation and of the delegated acts and implementing acts adopted pursuant to it*".

be equipped with a driver drowsiness and inattention warning system, an advanced driver distraction warning system, an emergency lane keeping system, an intelligent speed assistant, an advanced emergency braking system, a tyre pressure monitoring system, an interface for the installation of alcohol breath tester or an event recorder.

Article 11 provides for even more specific requirements for automated and autonomous vehicles, which, according to the aforementioned provision, will have to be equipped with systems that provide the vehicle with real-time information on its state and the state of the surrounding area, driver-readiness monitoring systems (for non-completely autonomous vehicles), event data recorders for automated vehicles, or systems to provide safety information to other road users. Article 11(2) mandates the Commission to adopt, by means of implementing acts, provisions on uniform technical procedures and specifications for these systems and for the type-approval of automated and fully automated vehicles with regard to these systems, in order to ensure the safe operation of automated and autonomous vehicles on public roads[101].

Directive 2001/95/EC on general product safety [102], transposed into Italian law by Art. 102 - 113 of Legislative Decree 206/2005 'Consumer Code' and into Spanish law by Royal Decree 1801/2003 on general product safety (hereinafter Directive 2001/95), aims to ensure that any

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[101] Art. 11 (I), Regulation (EU) 2019/2144 of the European Parliament and of the Council: "*1. In addition to the other requirements of this Regulation and of the delegated acts and implementing acts adopted pursuant to it that are applicable to vehicles of the respective categories, automated vehicles and fully automated vehicles shall comply with the technical specifications set out in the implementing acts referred to in paragraph 2 that relate to: (a) systems to replace the driver's control of the vehicle, including signalling, steering, accelerating and braking; (b) systems to provide the vehicle with real-time information on the state of the vehicle and the surrounding area; (c) driver availability monitoring systems; (d) event data recorders for automated vehicles; (e) harmonised format for the exchange of data for instance for multi-brand vehicle platooning; (f) systems to provide safety information to other road users. However, those technical specifications relating to driver availability monitoring systems, referred to in point (c) of the first subparagraph, shall not apply to fully automated vehicles. 2. The Commission shall by means of implementing acts adopt provisions concerning uniform procedures and technical specifications for the systems and other items listed in points (a) to (f) of paragraph 1 of this Article, and for the type-approval of automated and fully automated vehicles with regard to those systems and other items in order to ensure the safe operation of automated and fully automated vehicles on public roads. Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 13(2)*"

[102] Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety.

product marketed in the territory of the European Union achieves a certain safety standard.

Having said this, in relation to automated and autonomous vehicles, it would seem appropriate to consider whether it is necessary to introduce more specific sectoral legislation concerning the safety of these vehicles, as has been done for products that entail possible risks for the consumer due to the characteristics of the product itself.

The offer for sale of autonomous vehicles will only be possible where these vehicles ensure a higher level of safety than conventional vehicles. However, waiting until a safety standard is too high could considerably delay the introduction of autonomous vehicles on the market. At present, numerous national and international organisations are trying to draw up guidelines for achieving a uniform safety standard for autonomous vehicles[103].

[103] Major initiatives include those of the NHTSA, the SAE, the International Organisation for Standardisation (ISO), the British Standards Institution (BSI) and the European Union itself.

However, the first country to publish non-binding guidelines for autonomous vehicle safety standards was Singapore, in January 2019. Singapore's Technical Reference (TR 68) is divided into four parts: vehicle behaviour, vehicle safety, cybersecurity and data format[104].

[104] Singapore's Technical Reference TR 68, January 2019, at www.singaporestandardseshop.sg, p. 6: "*This Technical Reference (TR) was prepared by the Working Group on Basic Behaviour appointed by the Technical Committee on Automotive under the direction of the Manufacturing Standards Committee. TR 68 is intended to support the development of AV technology and deployments and consists of the following parts under the generic title "Autonomous vehicles": Part 1 – Basic behaviour Sets out fundamental behaviours AVs should exhibit while driving on public roads in order to co-exist safely with entities on the roads such as other vehicles, cyclists, and pedestrians. Part 2 – Safety Sets out the safe design and continuing safety management process requirements, supported by competent personnel and organisational quality certifications that organisations should have in place so that the AVs driving on public roads are inherently safe and behave in the manner that they are designed to. Part 3 – Cybersecurity principles and assessment framework Sets out principles and assessment framework for organisations to support development and management of AVs. The assessment framework is intended to provide a cybersecurity safeguard for AVs to satisfy prior to on-road deployment. Part 4 – Vehicular data types and formats Sets out what data, resolution, capture frequency and the format in which they should be transmitted so that there is seamless communication between sending party and receiving party. This TR is a provisional standard made available for application over a period of three years. The aim is to use the experience gained to update the TR so that it can be adopted as a Singapore Standard. Users of the TR are invited to provide feedback on its technical content, clarity and ease of use. Feedback can be submitted using the form provided in the TR. At the end of the three years, the TR will be reviewed, taking into account any feedback or other considerations, to further its development into a Singapore Standard if found suitable*".

During 2020, at the World Forum for Harmonisation of Vehicle Regulations [105] of the United Nations Economic Commission for Europe (hereafter UNECE), binding international guidelines for automated vehicles were published, following the approval of the UN ADAS Lane Keeping ADAS regulation[106]. It is a document that is also intended to have an effect on countries that are not members of the Forum, such as the United States, as they will necessarily have to comply with the requirements of the regulation in order to market their products in Forum member countries.

The regulation, for example, stipulates that the speed limit is 60 km/h when the Automated Lane Keeping System (ALKS)

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[105] "*The World Forum for Harmonization of Vehicle Regulations (WP 29) is a permanent working party in the institutional framework of the United Nations with a specific mandate and rules of procedure. It works as a global forum allowing open discussions on motor vehicle regulations. Any member country of the United Nations and any regional economic integration organization, set up by country members of the United Nations, may participate fully in the activities of the World Forum and may become a contracting party to the Agreements on vehicles administered by the World Forum. Governmental and non-governmental organizations (NGOs) may also participate in a consultative capacity in WP.29 or in its subsidiary working groups*", more information are available at: *https://unece.org/transport/vehicle-regulations/world-forum-harmonization-vehicle-regulations-wp29*.

[106] Regulation no. 157 on Automated Lane Keeping Systems (ALKS), available at: *https://unece.org/sites/default/files/2023-12/R157e.pdf*.

function is activated, while also stipulating that this function can only be activated on roads where pedestrians and cyclists are prohibited and where there is a physical barrier separating the two directions of travel. For its use, it requires the vehicle to be equipped with readiness recognition systems capable of monitoring the driver's presence, attention and ability to take the wheel. It also requires the vehicle to be equipped with a black box, the so-called Data Storage System for Automated Driving (DSSAD), which is always operational when the ALKS function is activated.

At the UNECE World Forum, in addition to the UN Lane Keeping ADAS regulation, a regulation on vehicle cybersecurity and a regulation on vehicle software updates (hereafter 'software') were also adopted. These regulations stipulate that from July 2022, new vehicles without a cybersecurity certificate will not be allowed to be sold in Europe and will be mandatory for all new vehicles produced from July 2024.

With regard to road infrastructure safety, Directive 2008/96/EC on road infrastructure safety management[107] was enacted, subsequently amended by Directive 2019/1936, which also deals with the adaptation of infrastructure to connected and automated vehicles[108].

The introduction of these provisions has meant that any manufacturer of autonomous vehicles will have to comply with the minimum requirements for placing motor vehicles on the market under the existing legislation, without prejudice to the possibility of adopting safety measures that go beyond the minimum required on the basis of the state of technology at the time the product is placed on the market.

The EU type-approval system ensures that each Member State certifies that each type of vehicle and each type of system, component and separate technical unit intended for that type of vehicle has been tested and inspected for compliance with

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[107] Directive 2008/96/EC of the European Parliament and of the Council of 19 November 2008 on road infrastructure safety management, at: *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0096*.

[108] Directive (EU) 2019/1936 of the European Parliament and of the Council of 23 October 2019 amending Directive 2008/96/EC on road infrastructure safety management, at: *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L1936*.

the type-approval requirements contained therein, and that their manufacturer has obtained the relevant type-approval certificate. In other words, manufacturers are obliged to produce their vehicles, systems, components and separate technical units in accordance with the EU type-approval system. Vehicle manufacturers must certify this by issuing a certificate of conformity for each vehicle. Every vehicle with a valid certificate of conformity must be able to be placed on the market and registered in the Union (Report of Regulation 2018/858).

Once the appropriate type-approvals have been obtained in accordance with the requirements of Regulation 2018/858, Regulation 2019/2144 and national legislation, the procedure for placing automated and autonomous vehicles on the market will be almost similar to that for placing conventional vehicles on the market, as the main difference concerns the pre-marketing phase with obtaining type-approvals.

It therefore seems necessary to implement controls during the type-approval phase in order to ensure uniformly high safety levels within the EU.

In the following Chapter, the existing regulations related to defective products will be highlighted.

Chapter III: Comparative law concerning autonomous driving

1. European product liability law

This chapter will focus on the European product liability law and, in particular, on the Italian and Spanish regulations. Subsequently, the US product liability law will be analysed in order to highlight similarities and differences among US and European regulations.

The European Union's approach has evolved over the last few years[109]. In fact, the first steps taken by the Union were avowedly aimed at promoting new legislative interventions, with the promulgation of specific sectoral rules, as explicitly stated in the recommendations of the European Parliament of February 2017[110], which urged the Commission to draw up

[109] A. Amidei, *Intelligenza artificiale e diritto -Intelligenza artificiale e product liability: sviluppi del diritto dell'Unione Europea,* in *Giur. It,* 2019, 1657 ff.; U. Salanitro, *Intelligenza artificiale e responsabilità: la strategia della Commissione Europea,* in *Riv. Dir. Civ.,* 2020, 1246 ff.; A. Fusaro, *Quale modello di responsabilità per la robotica avanzata? Riflessioni a margine del percorso europeo,* in *NGCC*, 2020, 1344 ff.

[110] Report with recommendations to the Commission on Civil Law Rules on Robotics: "*General principles concerning the development of robotics and artificial intelligence for civil use, 1. Calls on the*

a proposal for a directive mainly dedicated to civil law rules on robotics. Subsequently, the approach reached by the most recent EU documents published on the subject seems to have

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Commission to propose common Union definitions of cyber physical systems, autonomous systems, smart autonomous robots and their subcategories by taking into consideration the following characteristics of a smart robot: – the acquisition of autonomy through sensors and/or by exchanging data with its environment (inter-connectivity) and the trading and analysing of those data; – self-learning from experience and by interaction (optional criterion); – at least a minor physical support; – the adaptation of its behaviour and actions to the environment; – absence of life in the biological sense; 2. Considers that a comprehensive Union system of registration of advanced robots should be introduced within the Union's internal market where relevant and necessary for specific categories of robots, and calls on the Commission to establish criteria for the classification of robots that would need to be registered; in this context, calls on the Commission to investigate whether it would be desirable for the registration system and the register to be managed by a designated EU Agency for Robotics and Artificial Intelligence; 3. Stresses that the development of robot technology should focus on complementing human capabilities and not on replacing them; considers it essential, in the development of robotics and AI, to guarantee that humans have control over intelligent machines at all times; considers that special attention should be paid to the possible development of an emotional connection between humans and robots – particularly in vulnerable groups (children, the elderly and people with disabilities) – and highlights the issues raised by the serious emotional or physical impact that this emotional attachment could have on humans; 4. Emphasises that a Union-level approach can facilitate development by avoiding fragmentation in the internal market and at the same time underlines the importance of the principle of mutual recognition in the cross-border use of robots and robotic systems; recalls that testing, certification and market approval should only be required in a single Member State; stresses that this approach should be accompanied by effective market surveillance; 5. Stresses the importance of measures to help small and medium-sized enterprises and start-ups in the robotics sector that create new market segments in this sector or make use of robots;" see: *https://www.europarl.europa.eu › A-8-2017-0005_EN.*

partially disavowed this original approach, also by virtue of a general principle of technological neutrality. It seems, therefore, that the European Union is in favour of a work of careful interpretation of the precepts already in force, which could lead to satisfactory results even without introducing new provisions.

In particular, the first step in the Union's reflection on the interaction between A.I. and product liability was represented by the aforementioned Resolution approved by the European Parliament on 16 February 2017, bearing recommendations to the Commission concerning civil law rules on robotics[111]. With this document, the Brussels Parliament invited the Commission to draft and submit to the EU legislator a proposal for a directive to identify civil law rules aimed at uniformly regulating various aspects related to the use of advanced robotics and artificial intelligence. The topics touched upon in the Resolution are numerous, but the Parliament devotes prominent attention to issues related to the allocation of civil liability, which are the common

[111] European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)), at: *https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017IP0051.*

denominator of all the issues touched upon by the Resolution.

With particular regard to the rules on product liability, the matter was regulated by Directive 85/374/EEC of 25 July 1985[112], transposed into the national laws of all Member States. One of the objectives of the Directive, in addition to the aims of ensuring undistorted competition between economic operators, avoiding differences in the level of consumer protection between Member States and facilitating the transaction of goods, is to guarantee an environment of stable and fair competition that enables companies to place innovative products on the market, thus contributing to the general economic growth of the European Union.

Recently, the European Parliament issued also a new resolution on the general topic of multilevel management of artificial intelligence[113], again urging the Commission to

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[112] Council Directive of 25 July 1985 on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products, at: *https://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:31985L0374*

[113] See: European Parliament resolution of 3 May 2022 on artificial intelligence in a digital age (2020/2266(INI)), at: *https://www.europarl.europa.eu/doceo/document/TA-9-2022-0140_IT.html*

review the existing legislation to ensure that it is fit for purpose, and 'regretting' that the process of updating and adapting the current liability rules has not yet been completed [114]. In addition to the European Parliament Resolution, the European Commission had, over the past two years, already launched a series of wide-ranging initiatives aimed at inaugurating what is termed a *'European approach to artificial intelligence'*[115].

In this context, a process was undertaken to examine and update also Directive 85/374/EEC in order to understand

[114] See: § 143, 144 e 146 of the European Parliament resolution of 3 May 2022 on artificial intelligence in a digital age (2020/2266(INI)), at: *https://www.europarl.europa.eu/doceo/document/TA-9-2022-0140_IT.html.* See also: T.S. Cabral, *Liability and Artificial Intelligence in the EU: Assessing the adequacy of the current Products Liability Directive,* in *MJ*, 2020, 1-21; D. Wuyts, *The product liability Directive -More than Two Decades of Defective Products in Europe,* in *JETL,* 2014.

[115] The UE's approach to AI is to implement trust and achieve high levels of excellence in order to compete globally. Indeed, the UE aims to meet these results: "*1. enabling the development and uptake of AI in the EU; 2. becoming the place where AI thrives from the lab to the market; 3. ensuring that AI works for people and is a force for good in society; 4. building strategic leadership in high-impact sectors*" Regarding the implementation of trust among users, EU approach is based on 3 inter-related legal initiatives: "*1. a European legal framework for AI that upholds fundamental rights and addresses safety risks specific to the AI systems; 2. a civil liability framework - adapting liability rules to the digital age and AI; 3. a revision of sectoral safety legislation (e.g. Machinery Regulation, General Product Safety Directive)*". Further details are available at: *https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence.*

whether or not the rules currently in force can guarantee an adequate level of protection both to consumers and entrepreneurs. Indeed, the technicality of Artificial Intelligence and new technologies could generate the need to specifically regulate the phenomena. To this end, a specific group of experts was set up (Expert Group on Liability and New Technologies [116]), in order to carry out an initial assessment of the Directive. At the outcome of this assessment, the Directive was considered, on the whole, still suitable to regulate the sector of reference, even though it is necessary to adapt its structure to the new technologies introduced on the market, among which are self-driving cars.

[116] The Expert Group on Liability and New Technologies in 2019 drafted a Report named "*Liability for Artificial Intelligence and other emerging technologies*", pursuing the purpose to examine the existing liability regimes in the wake of emerging digital technologies in order to verify the adequateness of those existing regulations. The conclusions of the Expert Group on Liability and New Technologies is that: "*the liability regimes in force in the Member States ensure at least basic protection of victims whose damage is caused by the operation of such new technologies. However, the specific characteristics of these technologies and their applications – including complexity, modification through updates or selflearning during operation, limited predictability, and vulnerability to cybersecurity threats –may make it more difficult to offer these victims a claim for compensation in all cases where this seems justified. It may also be the case that the allocation of liability is unfair or inefficient. To rectify this, certain adjustments need to be made to EU and national liability regimes*".

The issue concerning the level of autonomy of A.I. and the related problem of accountability has led the European Parliament to express some fears related to the risk of a 'liability gap' for harmful events caused by artificial intelligence as a consequence of its learning process that is so autonomous as unpredictable. These issues have already been denounced in the European Parliament Resolution of February 2017, where such concerns were expressed, for the first time in the European context, in a policy document. Moreover, in the EU context, the issue of accountability has also been declined from an ethical point of view. In particular, the issue concerns the degree of autonomy that it will be convenient to allow A.I., especially when applied to certain sectors deemed particularly sensitive.

This is the so-called 'human-centric' approach, expressly recommended by the European Parliament [117] and with

[117] The EU approach to AI is focused on ensuring trust through a human-centric approach to AI. Specifically, the EU: "*has a strong regulatory framework that will set the global standard for humancentric AI. The General Data Protection Regulation ensures a high standard of protection of personal data and requires the implementation of measures to ensure data protection by design and by default5. The Free Flow of Non-Personal Data Regulation removes barriers to the free movement of non-personal data and ensures the processing of all categories of data anywhere in Europe. The recently adopted Cybersecurity Act will help to strengthen trust*

specific regard to A.I. applications in the health sector, and the Ethical Guidelines for Reliable Artificial Intelligence[118] drawn up by the group of experts set up under the aegis of the Commission. This document proposes seven 'ethical pillars' on which the design and implementation of forms of artificial intelligence should be based. The first of these ('human agency and oversight') preaches the need to ensure that A.I. systems do not undermine human autonomy or cause other detrimental effects, leaving open the possibility of appropriate control measures by the 'human in command'. Having said that, it is important to focus on the European liability regime. It must be pointed out that the liability regulations laid down by Directive 85/374/EEC is a regime of 'strict liability'. Therefore, in order to obtain compensation

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in the online world, and the proposed ePrivacy Regulation6 also aims at this goal". In this regard, the EU specifies that: "*AI technology should be developed in a way that puts people at its centre and is thus worthy of the public's trust. This implies that AI applications should not only be consistent with the law, but also adhere to ethical principles and ensure that their implementations avoid unintended harm. Diversity in terms of gender, racial or ethnic origin, religion or belief, disability and age should be ensured at every stage of AI development. AI applications should empower citizens and respect their fundamental rights. They should aim to enhance people's abilities, not replace them, and also enable access by people with disabilities*". *Communication: Building Trust in Human Centric Artificial Intelligence*, 8 April 2019, at: https://digital-strategy.ec.europa.eu/en/library/communication-building-trust-human-centric-artificial-intelligence.

[118] *Ethics guidelines for trustworthy AI,* 8 April 2019, at: https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai.

for the damage suffered, the injured party does not have to prove the existence of any subjective element on the part of the producer, but "only" the existence of the defect in the product, the damage suffered and the causal link between the defect and the damage (the topic will be the subject of further discussion below).

In fact, considering that the liability for the defectiveness of a product could be addressed to a vast number of subjects involved in the production and distribution chain of the goods (including also the manufacturer of a component of the finished product if the overall defectiveness of the latter is attributable to one of its specific components) the scheme outlined avoids a heavy burden of proof for the injured party.

In fact, the product liability regime disregards the fault of the producer or the fault of the producer of one of the components.

This regulatory framework makes it irrelevant, for the purpose of identifying the liable party, whether the producer of the goods foresaw that a potential chain of events leading to damage could result from a certain defect in the goods. As seen, the European regulation allows one to avoid investigating whether there was any culpability on the part of the producer, as this falls outside the elements that must be proven for product liability.

However, in the context of smart products, the fact that the occurrence of a "distorted" conduct of A.I. was not foreseeable on the part of its producer cannot in any case exclude the producer's liability for the damage caused by a defect in the good. Whether or not the manufacturer was able to understand and foresee the conduct of the A.I. would, at most, constitute an element of exclusion of its fault in relation to the resulting harmful event. However, the manufacturer would be liable for the defect of the product regardless of its foreseeability. It follows that, in the light of the regulations currently in force, the risk arising from the placing on the market of a defective product is always borne by the producer, who is called upon to take appropriate measures to manage it, also contractually in internal relations with his suppliers, and to insure it.

In any case, it would be advisable to partly reconsider the provisions of Directive 85/374/EEC in light of the introduction of new 'smart' technologies on the market. However, we are not suggesting a complete overhaul of the regulation, but rather the development of more specific provisions that apply only to smart products, taking into account the unique characteristics of these technologies. In particular, it would be advisable to clarify when a smart product can be considered defective.

According to Article 6 of the Directive: "*a product is defective when it does not provide the safety which can legitimately be expected taking into account all circumstances, including the presentation of the product, its intended use and the time of its putting into circulation*". According to the sixth recital in the preamble to the Directive, this assessment must be made in the light of the legitimate expectations of the public. According to the current structure of the legislation, therefore, the 'defect' consists of a misalignment of the product in relation to the standards that users are reasonably entitled to expect, in application of what the US doctrine defines as the 'consumer expectations test'. Having said that, it is necessary to adapt the aforementioned definition to products animated by artificial intelligence, and it will be necessary to reflect on whether the current notion of 'defect' can be adapted to cases in which the damage was generated by a smart product.

2. Italian Product Liability Law

This section will analyse the possible incompatibilities between the current liability regime in the Italian jurisdictions and the characteristics of fully autonomous driving. The manufacturer's liability for manufacturing defects is regulated at European level by Directive 85/374/EEC of 25 July 1985 (the so-called "Product Liability Directive" or PLD), implemented in Italy by Presidential Decree No. 244 of 24 May 1988, subsequently integrated into the Consumer Code, established by Legislative Decree No. 206/2005, under Title II - Liability for Defective Products (Articles 114-127)[119].

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[119] C. Castronovo, *La legge europea sul danno da prodotti: una interpretazione alternativa del D.P.R. 224/1988,* in *Dir. comm. internaz.*, 1990, 13 ff.; U. Carnevali, *Art. 1. Responsabilità del produttore, La responsabilità per danno da prodotti difettosi* (Milano 1990), 6; E. Rajneri, *Prodotto difettoso,* in *Dig. disc. priv.* (sez. civ.), 2016 (Milanofiori Assago 2016), 614 ff.; A. Thiene, *Responsabilità per danno da prodotti difettosi, Commentario breve al diritto dei consumatori*, edited by G. De Cristofaro - A. Zaccaria, 735 ff.; G. Alpa, *L'attuazione della direttiva comunitaria sulla responsabilità del produttore. Tecniche e modelli a confronto,* in *Contr. impr.*, 1988, 588.

The PLD establishes a system of non-contractual strict liability on the part of the producer for damage caused to third parties by defects in one of its products (Art. 114 of the Consumer Code)[120]. Any movable good, even if incorporated in another movable and immovable good, falls within the scope of the Directive (Art. 115(1) of the Consumer Code, which refers to Art. 2 PLD), including electricity[121]. Art. 117(1) defines a defective product as one that does not offer to consumers the safety that he may legitimately expect in view of all the circumstances of the case, including: "*(a) the manner in which the product was put into circulation, its presentation, its obvious characteristics, and the instructions and warnings given; (b) the use for which the product may reasonably be intended and the conduct which, in connection therewith, may reasonably be expected; (c) the time during which the product was put into circulation*".

[120] In fact, E. Rajneri, *Prodotto difettoso*, cit., 614-615, states that sometimes the foreseeability and avoidability of damage are implicitly reflected by the applied law in the concept of defectiveness. In this regard, the author recalls the recurring maxim in case law according to which the producer's fault would be inferred from the defect. See also in this sense the judgment of Trib. La Spezia 4-1-2019 no. 3.

[121] It should be further specified that Article 2 of Directive 85/374/EEC excludes agricultural, natural and hunting products from the definition of products, without prejudice to the option provided for in Article 14 (a) for member states to include such products in their national legislation, an option which our country has availed itself of.

In the light of the aforementioned provision, it has been grouped the range of possible defects of a product into three categories[122]: manufacturing defects, proper of a single product or of a few isolated specimens of the same line; design defects, which are present in all the specimens of the same product line and which may also include defects arising from insufficient testing by the manufacturer; instructional defects, where the defect is not inherent in the product but arises due to the lack of clarity or lacunae in the instructions for its proper use provided to the consumer by the manufacturer. In this respect, Art. 117(3) of the Consumer Code, which specifies that a product is also defective when it offers a lower degree of safety for the consumer compared to the other specimens of the same series.

[122] See: Engelhard-De Bruin, EU Common Approach on the liability rules and insurance related to Connected and Autonomous Vehicles, Utrecht Centre for Accountability and Liability Law, 2017, 58; Van Wees, Aansprakelijkheidsaspecten van (deels) zelfrijdende auto's (Aspetti di responsabilità civile per veicoli a guida parzialmente autonoma), in Aansprakelijkheid, Verzekering & Schade, 28/2015, 170 ss.; Gasser et al., Legal consequences of an increase in vehicle automation, BASt-Report (Part 1), 2013, 20; Funkhouser, Paving the Road Ahed: Autonomous vehicles, Products Liability, and the Need for a New Approach, in Utah Law Review, 2013, 449.

Article 118, which recalls Article 7 of the Directive, establishes a series of factors excluding the producer's liability for a wide range of circumstances; particularly relevant to our analysis are the factors (4) "*(b) the defect that caused the damage did not exist when the producer put the product into circulation*" and "*(e) the state of scientific and technical knowledge at the time the producer put the product into circulation did not yet permit the product to be regarded as defective*" (5). For the above-mentioned exclusion factor (*sub* para. b), Art. 124 admits simple exculpatory proof by the producer when, taking into account the circumstances, "*it is probable that the defect did not yet exist at the time when the product was put into circulation*". Any contractual clause introducing further exclusion factors beyond those indicated in Art. 118 is expressly excluded (Art. 124).

Since this is a regime of extra-contractual liability, the injured party is required to prove the defect, the damage and the causal link between the two (Article 120), a burden that, depending on the type of product, can be more or less easily discharged by the injured party. In the presence of contributory negligence on the part of the injured party, the compensation due to him/her is reduced in proportion to his involvement in the production of the accident (Article 122). The right to compensation is prescribed in three years from the day on which the injured party became aware of the damage, the defect and the identity of the person responsible (art. 125) and is subject to a forfeiture period of ten years from the day on which the defective product was put into circulation (art. 126).

These premises make it possible to affirm that the system outlined appears inadequate to efficiently protect potential injured parties in an accident caused by the manufacturing defect of an autonomous driving vehicle, since liability is essentially limited to the parties most capable in legal-economic terms of preventing the damage, namely the manufacturer and the programmer[123].

It seems clear, therefore, that the legislation analysed establishes a regime of tort liability where the injured party has to prove the presence of the defect, the damage and the

[123] The same opinion is also held by F.P. Patti, The European Road to Autonomous Vehicles, in Bocconi Legal Studies Research Paper Series, 2019, 13 ff.

causal link between the defect and the damage suffered, a burden which, given the novelty of the technologies under consideration as well as their considerable complexity, will plausibly be rather complex and costly to fulfil. In addition to the complexity of the burden of proof on the injured party, there is also a considerable degree of legal uncertainty regarding the outcome of a lawsuit against the manufacturer to obtain compensation for damages, since this type of litigation would be a novelty in the world of automobile insurance, resulting in a lack of precedents.

Article 117(1) pivots the concept of product defect around the level of safety legitimately expected. However, it is not easy to determine the level of safety 'legitimately expected' of a radically new technology. While it is true that much of the literature and the legislators themselves have repeatedly affirmed that self-driving cars must be 'absolutely safe to drive', they emphasise that it is in any case unreasonable to expect a product to be totally defect-free[124]. The expected

[124] See e.g. Opinion of the European Economic and Social Committee on the " Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Towards automated mobility: an EU strategy for the mobility of the future " 2019/C 62/43, in OJEU, 2019.

level of safety and performance around which consensus seems to coagulate is that of the 'perfect human driver', a higher level than that of the 'expert driver' normally applied to civil liability for conventional vehicles, in view of the degree of technological enhancement provided by the sensors and computing power of autonomous vehicles.

Once again, however, determining whether or not the vehicle was able to comply with the 'diligence' required of it in the various situations, i.e. whether or not the 'perfect driver' could have avoided the occurrence of an accident, remains a question that the Court will have to decide on a case-by-case basis, with the consequent timeframes and legal uncertainty for the injured party, especially in the first years of the introduction of the technology.

Moreover, Art. 121 establishes also that the manufacturer itself could take recourse against the manufacturers of the components (including the programmer), imputing to them a contributory negligence. At the same time, however, the manufacturers of the component parts held liable could in turn argue that they are not liable for having complied with the instructions given to them by the manufacturer or argue in their defence that they must comply with industry standards.

The framework is also regulated by Art. 118(e), according to which the producer of the defective part or good could always exonerate himself by proving that the presence of such a defect was not reasonably verifiable given the technological knowledge at the time the product was put on the market. This is a very broad exception, which could be highly relevant given the very rapid changes and innovations in robotic and digital technologies underlying the products under consideration. It should not be forgotten that the manufacturer could also invoke the contributory negligence of the injured party, accusing him/her of improper use of the vehicle. In this case, the clarity and completeness of the product instructions for use provided by the manufacturer, as well as the proof that the injured party had scrupulously complied with them, will be of decisive importance.

It is clear that the complexity of the regulations described, and the innovativeness represented by self-driving vehicles could cause, at least in the first period of time, uncertainties and delays in the event of applications to ascertain the degree of producer liability. However, it seems legitimate to assume that, following the first claims, the judicial authorities and insurers involved will gain more and more experience in the matter, leading to the gradual establishment and subsequent consolidation of shared solutions in practice.

However, it is equally plausible to assume that the uncertainty regarding the final outcome of any litigation on the matter and the strong media attention that the first accidents caused by self-driving vehicles are expected to receive, could have the effect of drastically reducing potential purchasers' confidence in the new vehicles, slowing down their diffusion and reducing manufacturers' own investments in their improvement.

Another issue to be taken into account in the product liability regime concerns the recoverability of damages, which does not extend to the damage suffered by the defective product itself.

Likewise, damage caused to infrastructure and public property is expressly excluded. It follows that, even if there is thus a manufacturing defect, the owner could not obtain compensation from the manufacturer on the basis of the Product Defect Directive for damages other than those expressly provided for in the European Product Defect Directive.

A further important aspect emerges with regard to self-driving cars. In fact, we need to reflect on the appropriateness of the PLD regime and its applicability to software, on whose actual inclusion within the definition of 'products' the debate is open, and no definitive conclusion has yet been reached there [125].

[125] T. Evas, *EU Common Approach on the liability rules and insurance related to Connected and Autonomous Vehicles*, 2018, at: https://www.europarl.europa.eu/RegData/etudes/STUD/2018/615635/EPRS_STU(2018)615635_EN.pdf. The possibility of subsuming software as a product is corroborated by the provisions of Directive (EU) 2019/771 of the European Parliament and of the Council of 20 May 2019 on certain aspects of contracts for the sale of goods (hereinafter DCCB), which introduces the concept of 'goods with digital elements', defined as 'any tangible movable object that incorporates or is interconnected with digital content or services in such a way that the absence of such digital content or services would prevent the good from performing its functions' (Art. 2.5(b) DCCB). This DCCB makes it possible to state that software can be a product for the purposes of product liability. Moreover, Art. 11 of Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 establishing a framework for the deployment of Intelligent Transport Systems (ITS) in the field of road transport and for interfaces with other modes of transport provides that Member States shall ensure that liability issues related to the deployment and use of ITS applications and services are addressed in accordance with Union law, in particular the Product Liability Directive, as well as relevant national legislation.

In fact, the principle laid down in Article 117(2) (Art. 6(2) PLD), according to which "*a product may not be regarded as defective merely because a more improved product has at any time been placed on the market*", appears manifestly unsuitable for computer products that have been on the market for a long time and for which the owner has the possibility of carrying out periodic updates.

If the malfunction of a self-driving vehicle is caused by a failure to update the software for reasons beyond the owner's control, the presence of updated vehicles (and thus 'more improved products' within the meaning of Article 117(2)) on the market could exclude the failure to update from being considered a defect, and consequently also exclude the producer's liability[126].

Furthermore, should there be an anomaly in the on-board software or in the central coordination computer, such an event would be particularly unpredictable if only because, as

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126 See: P. Machnikowski, *European Product Liability, An Analysis of the State of the Art in the Era of New Technologies*, 2016, 60 ff., at https://eui.idm.oclc.org/login?url=https://doi.org/10.1017/9781780685243.

mentioned earlier, the application of the PLD to software is still a matter of debate. If one were to lean in favour of an affirmative answer, one would have to further determine what level of security can reasonably be expected from such products. It would be reasonable to assume that software would always be functional, even in the face of the presence of pre-installed back-up programmes that would have to replace the main software if it were to present an anomaly. The manufacturer, in fact, could act in recourse against the programmer of the software, and it would also always be possible for both to invoke the exclusion for development risks if it were proven that the anomaly that had occurred was not knowable at the time of release.

The conclusions become more complicated if the anomaly was caused by the failure to update the software[127]. In this case, an oriented interpretation of Art. 117(2) would have to be provided and it would be necessary to define whether software already on the market is to be considered after

[127] On the general applicability of the producer's liability rules to damage caused by defects in software, see A. Zaccaria, *La responsabilità del 'produttore' di software*, in *Contr. impr.,* 1993, 302.

updating for all intents and purposes as "new products" as opposed to their non-updated version.

This, moreover, raises questions of no immediate solution as to the factor of exclusion of liability for development risks. In case the update had permitted the resolution of a bug discovered after the vehicle had been placed on the market and the non-updated software was actually considered a separate product from its updated version, the paradoxical situation would arise whereby the manufacturer would be liable for damages under Article 114 of the Consumer Code for the updated versions of the software, while for the non-updated versions it could still avail itself of the defence of development risks.

Conversely, if the updated and non-updated versions of the same software were eventually considered to be the same product, in the event that the malfunction was caused by the update itself the manufacturer could avail itself of the exclusion factor, arguing that the defect did not exist when the product was put on the market.

On the other hand, if the failure to update occurred due to the user's negligence, the liability would be attributable to him, provided that the compulsoriness and urgency of the update were sufficiently clear, since, otherwise, the litigation could be based on a possible lack of information.

A part of the doctrine has rightly pointed out that self-driving cars are destined to become more and more widespread, which will make it necessary to set up a road network that will take care of the control and coordination of the entire car fleet. The road mobility of the future will thus be characterised not by today's autonomous cars, but by a network of controls similar to that which regulates air traffic. If, on the one hand, such a system could result in an optimisation of the driving performance of individual vehicles and a reduction in 'ordinary' accidents, on the other hand, any anomaly in the central computer would reverberate on the proper functioning of the entire car fleet controlled by the software, with the possibility of causing very considerable damage. According to a part of the doctrine, this reconstruction allows liability for damage caused by a failure of the communication technologies of the road network, the central software or the data network to be brought within the scope of Article 2051 of the Civil Code[128].

Finally, in the event that an accident is caused by improper use of the vehicle, it will be necessary to check, on a case-by-case basis, whether the manufacturer's instructions for use were sufficiently clear, explicit and unambiguous. If the answer is affirmative, the user would remain entirely liable, while if the answer is negative, the manufacturer would be liable for damages due to defective instructions.

On the other hand, a case-by-case analysis would be required in the event that the CAV was used in a context (e.g. a certain type of road in certain weather conditions) for which it had

[128] See: R. Lobianco, *Veicoli a guida autonoma e responsabilità civile: regime attuale e prospettive di riforma,* in *Resp. civ. e prev.*, 2020, 4, p. 1080 ff.; C. Ingratoci, *Autonomus vehicles in smart roads: an integrated management system for road circulation*, in Dir. trasp., II, 2020, « [...], regulation related to the implementation of driverless circulation seems to indicate the smart road manager as the person responsible for the implementation of network platform services, as a reference point for safety of automated road traffic system, entrusting him/her with a duty of oversight». The author emphasises the technological similarities that are likely to occur between the centralised coordination of autonomous driving of the future and what is already present in air traffic today, similarities that are likely to lead to the imposition on the road network manager of a liability regime similar to that of the airport manager (subject to appropriate distinctions given the differences between the two types of mobility under consideration).

not been pre-tested, resulting in an unforeseen and accidental malfunction (so-called corner-case). In this case, the judge's investigation would have to focus on whether the circumstance in which the accident occurred was actually so exceptional and unforeseeable that the manufacturer did not even take it into account for the list of cases of non-use of the vehicle (a list that would have to be exhaustive), it would be up to the judge to ascertain whether this omission was attributable to the manufacturer's negligence or whether the exceptional and unforeseeable context was such as to justify recourse to the exception for development risks.

According to one part of the doctrine, this scenario implies a reduction of protection for the pioneers in the adoption of autonomous driving, who would risk not being adequately protected in truly exceptional circumstances that the manufacturer and the programmer could not have foreseen.

Lastly, it is necessary to mention a further scenario, which will be analysed in greater detail in chapter VI, and which concerns the case of an accident caused in the event that, due to the impossibility of avoiding an accident, the on-board software is forced to decide to damage one subject in order to spare another. In these hypotheses, the automotive industry has repeatedly affirmed the need for the EU legislator to draw up a 'code of ethics for robotics' that would allow the software to choose in an automatic and deterministic manner which is the most 'expendable' subject in each possible circumstance of an accident that cannot be avoided.

If such a 'code of ethics' for on-board software were to be codified and adopted as a technical standard by the industry, the question of liability for an accident in which the vehicle, in its inability to avoid the accident, 'deliberately' damaged one subject in order to spare another, since this is the way it is programmed, would in any case remain open. In fact, if, on the one hand, the manufacturer could avail himself of the exclusion factor consisting of compliance with legal regulations and technical standards, on the other hand, liability would inevitably fall on the user of the vehicle, as he would be liable under Article 2050 of the Civil Code for the use of a dangerous vehicle. It would therefore be a matter of strict liability, even though the user could in turn exonerate himself by demonstrating that he had done everything possible to avoid the occurrence of the accident (or its actual impossibility of avoiding it).

3. Spanish Product Liability Law

Liability for defective products is regulated in Spain by the rules contained in Royal Legislative Decree 1/2007, of 16 November, approving the Revised Text of the General Law for the Defence of Consumers and Users (henceforth TRLGDCU)[129]. Spain has implemented the European Directive on defective products and, therefore, the Spanish regulations are very similar to the Italian ones. Below, we will try to identify the most important features and some specific issues will be analysed below.

Article 136 TRLGDCU states that: "*any movable property is considered to be a product, even if it is attached to or*

[129] Among the main authors who have addressed the issue of the application of defective product provisions to autonomous vehicles and, more generally, to artificial intelligence systems, see: M. Navarro-Michel, *Vehiculos Automatizados y responsabilidad por productos defectuoso,* in *Revista de Derecho Civil, vol. VII, núm. 5, 2020,* pp. 175-223; S. Navas Navarro, *Smart Robots y otras màquinas inteligentes en nuestra vida cotidiana*, cit., 92 ff.; Id., *Danos ocasionados por sistemas de inteligencia artificial,* Granada, 2022, 79 ff.; Id., *Responsabilidad civil del fabricante y tecnología inteligente. Una mirada al futuro*, in *Diario La Ley*, nº 35, 27 December 2019, pp. 1-11.

incorporated in another movable or immovable property, as are gas and electricity". According to some Spanish scholars, the breadth of the definition makes it possible to include a vehicle, whether automated, autonomous or connected, into the category of a product for the purposes of defective products legislation. It follows that, according to this thesis, the manufacturer of an autonomous driving vehicle is liable for the defect of the product placed on the market[130].

Another part of the Spanish scholars pointed out that the concept of product must be revised in order to include digital products and artificial intelligence systems. At the same time, the concept of producer should be revised in order to include all actors in the production chain[131].

The Spanish legislation also provides for certain cases of exemption of the producer's liability in the same way as the Italian legislation and, more generally, the European directive. In fact, Art. 140.1.e) of the TRLGDCU allows the producer to be exonerated from liability if it is proved: "t*hat*

[130] M. Navarro-Michel, *Vehiculos Automatizados y responsabilidad por productos defectuoso,* cit., 181 ff.
[131] S. Navas Navarro, *Danos ocasionados por sistemas de inteligencia artificial,* cit., 81 ff. and 108-109.

the state of scientific and technical knowledge existing at the time of putting the product into circulation did not allow the existence of the defect to be appreciated". The most relevant aspect is not what the producer was able to know, but the scientific and technical knowledge that makes the detection of a defect possible.

Therefore, the state of the art at the time the product was put into circulation (not the state of the art at the time the damage occurred) and the impossibility of detecting the defect on the basis of science and technology will be taken into consideration, irrespective of any possible culpable conduct on the part of the producer.

The moment of putting the product into circulation must be taken into consideration in order to determine the producer's liability. This is a particularly relevant issue, as seen above, because this moment is relevant to the very definition of defective product (Arts. 137.1, 140.1.b) and e) of the TRLGDCU).

Therefore, even in Spanish law the manufacturer can invoke the so-called development risks as a ground for exemption of its liability. However, in order to increase user confidence in the new automobile sector, part of the doctrine, adhered to the proposal made by the European Commission's Expert Group on Liability and New Technologies (Conclusion 14). These scholars have suggested that the possibility for the manufacturer of automated vehicles to invoke the development risk exemption would be excluded.

In this regard, some of these scholars emphasized that the cause of exoneration of liability provided for in Art. 140.1 e) TRLGDCU and concerning development risks should be excluded, whereas it should be held that a product follow-up obligation arises whose non-fulfilment would give rise to a negligent liability of the manufacturer[132].

Similarly to the Italian doctrine, Spanish scholars have considered the issues that arise in the event of malfunctioning of the software installed in autonomous cars. Given that, neither the TRLGDCU nor Directive 1985/374 stipulate that their scope of application is limited to tangible

[132] S. Navas Navarro, *Danos ocasionados por sistemas de inteligencia artificial,* cit., 109.

goods. Indeed, the scope of application of these rules may extend to intangible goods such as software.

Similarly to what has been observed in relation to Italian law, also in Spanish law the producer of a final product often merely assembles products of other companies. It follows that, according to the prevailing doctrine, the software should be considered as another component. The main consequence that follows from this interpretation is the possibility of applying the product liability rules, with the consequent possibility of placing the liability on the producer of the final product. Therefore, the injured party will not be required to discover the origin or cause of the defect and identify the producer of the component part.

Furthermore, Art. 140.2 TRLGDCU expressly states that: "*The manufacturer of an integral part of a finished product shall not be liable if it proves that the defect is attributable to the design of the product in which it was incorporated or to the instructions provided by the manufacturer of that product*". It follows that the manufacturer of the finished product cannot exonerate himself by claiming that the defect lies in one of the parts, components or raw materials supplied. However, if the defect was caused by the defect of one of the components, the final producer will be entitled to claim against the manufacturer of the defective component by reason of his participation in the causation of the damage" (Art. 132 TRLGDCU).

However, according to a part of Spanish doctrine, this view should be revised, as continuing to claim that software is a component of the vehicle, especially at higher levels of automation, could mislead the interpreter. In the case of self-driving vehicles, it seems reductive to consider the software as just one of many components and, consequently, the relationship with the software supplier could not be assimilated to that in place with other suppliers. It has been observed that the software manufacturer has the task of supervising after-sales performance and correcting bugs. It follows that, according to a part of Spanish doctrine, in relation to highly automated vehicles, the software manufacturer is jointly and severally liable with the manufacturer of the final good, without being able to invoke the cause of exoneration set forth in Article 140.2 TRLGDCU.

A further issue that seems worth exploring concerns whether any post-sale software update can be considered a new version of the product. Considering that Art. 137.3 TRLGDCU states that "*a product may not be considered defective merely because it has subsequently been put into circulation in an improved form*", any update of the safety software constitutes a new version of the product. Updates that merely concern improvements without impacting on safety will continue to be regulated from the time the previous vehicle was put into service.

4. The regulation of liability for damage caused by autonomous vehicles in the United States

In recent years, an increasing number of US states have enacted measures to regulate the use of self-driving vehicles[133].

Nevada was the first state to introduce a legislation in 2011 that takes into account AVs by providing a definition of 'self-

[133] A. Di Rosa, *Autonomous Driving: tra evoluzione tecnologica e questioni giuridiche,* in *Dir. Quest. Pubb.,* 2019, 140 ss.

driving vehicle'[134]. Nevada's law on self-driving vehicles allows them to circulate on the national highways, leaving it to an internal authority to define the safety principles to be applied to such vehicles and stipulating that, for the purposes of obtaining a driving licence, the driver will not be required to play a necessarily active role while driving the vehicle. Furthermore, the law excludes from the group of self-driving vehicles those that have driving assistance systems (semi-driverless cars) [135] and defines the driver as: '*[...]the person [who] causes the autonomous vehicle to engage, regardless of whether the person is physically present in the vehicle while it is engaged*'.

Florida, in 2012, adopted a deregulation measure [136] that leaves wide margins of permissiveness for the practical experimentation of this new technology[137] through road tests

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[134] «"Autonomous vehicle" means a motor vehicle that uses artificial intelligence, sensors and global positioning system coordinates to drive itself without the active intervention of a human operator», NEV. REV. STAT. § 482A.030 (2011).

[135] *Adopted Regulation of the Department of Motor Vehicles LCB*, note 534, § 2. File No. *R084-11*, NEV. DMV § 2, disponibile in: *www.leg.state.nv.us/register/RegsReviewed/$R084-11_ ADOPTED.pdf*.

[136] H.B. 1207 Fla., 2012 Leg. (Fla. 2012), poi codificato in FLA. STAT. chs. 316, 319 (2013).

[137] *Florida Highway Safety and Motor Vehicles*, Autonomous Vehicles Report, 10th February 2014, at:

without requiring any special licences, except for the payment of a large sum as a guarantee to the Department of Highway Safety and Motor Vehicles.

Similarly, since 2012, California has also adopted a legislative policy of deregulation in order to incentivise companies to carry out road tests and develop the technologies for the use of fully autonomous vehicles[138].

In 2016, Michigan adopted a law on automated driving trials[139], expressly regulating the liability regime for testing operations. Specifically, the Michigan legislature identified the manufacturer as the responsible party, placing the onus on them to indemnify the individuals they require to participate as test drivers.

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http://www.flhsmv.gov/html/HSMVAutonomousVehicleReport2014.pdf.

[138] See Californian Senate Bill Cal. S.B. 1298 (2012), adopted along the lines of that of Florida: *California Department of Motor Vehicles, Testing of Autonomous Vehicles* at: *https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/testing).*

[139] Senate Bill n. 996, 8 December 2016.

Also of interest is the legislation enacted by Tennessee in 2016[140], which banned the circulation of automated vehicles on the sole grounds that the driver is not a human being[141].

The United States, therefore, has a rather variegated approach, which differs according to the legislative policies of each state. The United States has not adopted a top-down approach through the introduction of unitary regulation at the federal level. Rather, the chosen bottom-up approach has been conditioned by the general principle within the American common-law system that *'what is not prohibited, is permitted'*.

Nevertheless, for some years now, there has been discussion about whether certain policies and rules concerning self-driving vehicles should be introduced at federal level in the United States. To this end, a federal law was enacted in 2015,

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[140] Senate Bill n. 1561, 2 May 2016.

[141] The reference can be found on the webpage of the Tennessee General Assembly, available at: *http://wapp.capitol.tn.gov/apps/BillInfo/default.aspx?BillNumber=HB1564&GA=109.*

the Fixing America's Surface Transportation (FAST) Act[142], which came into force on 4 December 2015.

The FAST Act, Section VI, entitled the Transportation for Tomorrow Act (2015), provides for the allocation of resources of $100 million per year, for the five-year period 2016-2020, to fund an Intelligent Transportation Systems Programme, including projects for research and development, technological innovation, and restructuring of federal road and highway systems. The aim is to develop technologies at the federal level that are functional for the future use of self-driving vehicles.

In the United States, the National Highway Traffic Safety Administration (NHTSA), the federal-level authority in charge of setting the Federal Motor Vehicle Safety Standards, is responsible, among other things, for promulgating and enacting legal acts that are intended to be respected in all states. The NHTSA thus plays a valuable role in the enactment of uniform rules within the different states.

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142 *Fixing America's Surface Transportation Act*, 19 Stat. 1312 Public Law 114-94-Dec.4, 2015, at: *https://www.congress.gov/bill/114th-congress/house-bill/22.*

In fact, the absence of uniform regulations in the different states has a direct effect on the regulations applicable in the case of accidents involving autonomous vehicles. It follows, in fact, that the only possible option is to apply the existing rules on product liability in case the damage was caused by a malfunction of the autonomous vehicle.

In the following, it will be making the effort to identify product liability risks in the U.S. to manufacturers of AVs, the source of those risks, and how manufacturers can manage those risks.

4.1 Product liability issues related to AV in the U.S.

The implementation of a product liability system has led manufacturers to develop models with a greater capacity to avoid accidents and reduce the negative consequences of a malfunction. However, this has been a gradual process, which has been shaped by some interesting court cases that seem worth mentioning.

One of the first cases of Anglo-American tort law concerned a road accident. Indeed, one of the most important British cases in the development of U.S. tort law, Winterbottom v. Wright, involved a mail coach driver who was thrown from his horse-drawn mail carriage after it broke down, allegedly due to the defendant contractor's failure to maintain the carriage in a safe condition[143].

Subsequently worth mentioning are two of the most significant products liability cases in American history, arisen from auto accidents. In MacPherson v. Buick Motor Co., the New York Court of Appeals upheld a favourable verdict for a car owner ejected from his Buick car after a defective wooden wheel on the car collapsed[144]. Similarly, in

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143 Winterbottom v. Wright, 152 Eng. Rep. 402 (1842) where a mail coach driver was seriously injured when a vehicle broke down due to lack of repair because the defendant failed to keep the coach in safe and secure condition, resulting in Plaintiff's injuries. The case is about the existence of a defendant duty of care to plaintiff. The judgment stated that although the defendant took on a duty to maintain the carriages, he undertook no duty towards the plaintiff. For this reason, the defendant is not liable for plaintiff's injuries.

144 MacPherson v. Buick Motor Co., 217 N.Y.382, 111 N.E. 1050 (1916) where the plaintiff, after buying a car from a retail dealer, was injured when a defective wheel collapsed. Plaintiff sued Buick Motor Co. (defendant), the original manufacturer of the car, on an action for negligence. During the trial, it emerged that the defendant had purchased the faulty wheel from another manufacturer and the defendant failed to inspect the wheel. The judgments stated that if a product is expected to be dangerous if negligently made and the product is known to be used by

Henningsen v. Bloomfield Motors, Inc.[145] the New Jersey Supreme Court enacted a verdict against Chrysler and a dealer after the wife of the purchaser had an accident.

It should be noted that several scholars in those years highlighted the inadequate safety level of cars, emphasising the urgent need for public intervention that, through the introduction of mandatory regulations, would impose minimum safety standards, compliance to which would be a prerequisite for the manufacturer's access to the market. The research conducted by a task force of the Division of Medical Sciences, the National Academy of Sciences, and the National Research Council, entitled '*Accidental Death and Disability: The Neglected Disease of Modern Society*' and published in 1966, dates back to the same time period, where accidents

consumers in the normal course of business, a duty of care exists. For this reason, the Court affirmed that a manufacturer of an assembled product is liable if place product to be used by consumers on the market without any inspection or supervision.

[145] Henningsen v. Bloomfield Motors Inc., 32 N.J. 358, 161 A.2d 69 (1960) where the plaintiff, injured from a steering malfunction of a car purchased from the defendant, sued the defendant for breach of an implied warranty of merchantability imposed by the Uniform Sales Act. In this case, the judgment stated that in case of gross inequality between the contractual parties, a disclaimer of liability may be enforced only if it is brought to the purchaser's attention clearly and explicitly.

caused by cars are compared to an 'epidemic' that required public intervention.

These solicitations led to the enactment, in 1966, of the Highway Safety Act, placed in the United States Code (USC) [146]. Through the introduction of this body of legislation, the federal legislature expressly incorporated the so-called *'crashworthiness doctrine'*, according to which there is an obligation to place on the market motor vehicles that provide a reasonable level of protection in the event of an accident. The vehicle safety statutes have been supplemented by regulations to further detail the minimum requirements that vehicles must meet in order to guarantee a high level of protection[147].

This system of regulations was further strengthened by the introduction of a crash test programme by the NHTSA in 1979, whereby the most popular models of cars were subjected to crash tests in order to encourage and raise

[146] Title 49, United States Code, Chapter 301, Motor Vehicle Safety.
[147] Examples include the Federal Motor Vehicle Safety Standards, published in the Federal Register in 1967 and subsequently updated periodically by the National Highway Traffic Safety Agency (NHTSA), which define the minimum structural and strength standards that different types of vehicles must meet to ensure an adequate level of protection in the event of an accident.

consumer awareness of the risks involved in driving cars and at the same time, to push manufacturers to raise vehicle safety levels.

The creation of a system of minimum safety standards has led to the emergence of the problem of the manufacturer's liability for damage caused by a product that does not comply with legislative standards. On the basis of the aforementioned pre-emption doctrine, it is the legislator who, through the Agencies, outlines safety standards that are given decisive importance in assessing the defectiveness of a product, explicitly or implicitly stating (express or implied pre-emption) whether or not compliance with the standards exempts the manufacturer from liability.

By way of example, it is useful to mention the case involving Sport Utility Vehicles (SUVs) whose construction standards, drawn up by the NHTSA in 1991, had proved insufficient to guarantee a high standard of safety in the event of a rollover. The US courts argued that the product safety regulations only dictated a standard of protection and therefore condemned the manufacturers to pay compensatory damages and sometimes even punitive damages. Subsequently, the NHTSA, incorporating the direction taken by the courts, issued new rules in 2005 to raise the safety standard for SUVs.

The standard was accompanied by an explicit pre-emption clause that acted as an upper limit beyond which the manufacturer could not be held liable. This resulted in a limitation of liability actions against manufacturers.

A further limitation of the liability of the car manufacturer came from the use of the so-called implied pre-emption theory, which was applied in Gaier v. American Honda Company[148]. In this case, the injured party complained about the absence of airbags in his car, despite the fact that the District of Columbia state law contained an obligation to do so. The federal court, however, excluded the manufacturer's liability, arguing that federally mandated automobile safety standards prevail over state regulations both when the latter contain more restrictive requirements and when they provide a lower level of protection than that guaranteed by the federal legislature.

[148] Gaier vs. American Honda Company, 529 US 861 (2000) and Morgan vs. Ford Motor Co., No. 34139 (W.V. Sup. Jun. 18, 2009).

However, it should be noted that while §3111 of the United States Code establishes that federal standards always prevail over those set by individual legislatures, §30102 states that Federal Motor Vehicle Safety Standards represent minimum safety levels that are not sufficient to exclude a manufacturer's civil liability for damages caused by defects in the design of the vehicle or information about its proper use.

One of the most famous court cases in the history of the product liability regime in the United States is the Ford Pinto case, where the victim received a jury award in the amount of over $2.5 million in compensatory damages and an award of punitive damages to punish and deter Ford in the amount of $125 million (although the punitive damages award was later reduced to $3.5 million)[149]. The reason why the Court awarded such a high amount is because during the trial emerged that the accident was caused by Ford’s decision not to use inexpensive parts in its cars that would have prevented the accident.

[149] Grimshaw v. Ford Motor Co., 119 Cal. App. 3d 757, 771-72, 813, 823-24 (1981).

Indeed, the Ford Pinto case, it was proved that Ford had known about the problems with its fuel system and, specially, that Ford knew that a part costing $11 could have prevented accidents. Nonetheless, on the basis of cost/benefit analysis, Ford decided that the overall cost of the part exceeded the overall value of the human lives that would be lost and decided to not add the part to the Pinto's design.

In later years a similar case involved some Toyota cars, that accelerated without warning and were difficult to stop, resulting in accidents. In this case emerged that a software malfunction resulted in unintended acceleration. For this reason, Toyota decided to settle the various legal actions against the company.

Another high-profile product liability legal case was caused by a malfunction of ignition switches in certain General Motors cars. Indeed, in the late 1990s, GM decided to change switches for small cars to make them work more smoothly. Unfortunately, it happened that this modification slipped switches unexpectedly from 'run' to 'accessory,' causing engines to stall and making cars harder to control[150]. It turns out that, even in this case, the Company was aware of the problem before the accidents, but decided not to replace the switches, causing several deaths.

In the United States, the compensation of damage caused by an AV depends on a careful analysis of which defective element caused it. In fact, the Restatement (Third) of Torts: Product Liability of 1998 defines a product as a tangible good[151]. It follows that errors committed by software or algorithms used by an autonomous vehicle do not give rise to product liability, since software is not a product for these purposes[152].

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[150] Krisher, Tom, GM's ignition switch: what went wrong, COLUMBUS DISPATCH, Jul. 8, 2014, available at *http://www.dispatch.com/content/stories/business/2014/07/08/gms-ignition-switchwhat-went-wrong.html*.

[151] According to §19(a), 'a product is a tangible personal property that is commercially distributed for use or consumption'. The provision clarifies that electricity may be a product when the context of its distribution and use is sufficiently similar to that of other tangible goods.

[152] R. Caro, *Robotics and the Lessons of Cyberlaw*, in *California Law Review,* vol. 103, (2015), pp. 513- 563, 536; J.S. Brodsky, *Autonomous Vehicle Regulation: How an Uncertain Legal Landscape May Hit the Brakes on Self-Driving Cars*, in Berkeley *Technology Law Journal,* vol. 31, (2016), pp. 851-878, 863.

In order to avoid the occurrence of cases not covered by protection, some authors have proposed that software incorporated in a final product should not be excluded from the product liability regime and propose the expansion of the product liability regime to include software in the final product. To this end, part of the doctrine argues that when software is essential to the functioning of the product, the product liability regime should apply to software design defects[153].

According to the mass production criterion, some courts apply the defective goods regime to mass-produced software, and not to software that complies with the purchaser's specifications, which is a service. In any case, it is the courts that determine whether it is a product or not, based on the

[153] See: M.D. Scott, *Tort Liability for Vendors of Insecure Software: Has the Time Finally Come?,* in *Maryland Law Review*, vol. 67, (2008), n. 2, 425- 484, p. 467; N.A. Sales, *Regulating Cyber-Security,* in *Northwestern University Law Review,* vol. 107, (2013), n. 4,1503-1568; R.J. Duplechin, *The Emerging Intersection of Products Liability, Cybersecurity, and Autonomous Vehicles*, in *Tennessee Law Review,* vol. 85, (2018), n. 3, 803- 846; S.A. Elvy, *Transactions and the INTERNET of Things: Goods, Services, or Software?,* in *Washington and Lee Law Review,* vol. 74, (2017), n. 1, pp. 77-172.

existence of grounds that justify the imposition of a strict liability system[154].

However, if the supplier has an involvement in the development of the final product, exercising control over the design and/or manufacture of the final product, then it will be jointly and severally liable with the manufacturer of the final product[155].

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[154] See L.B. Levy-S. Y. Bell, *Software Product Liability: understanding and minimizing the risks*, in *High Technology Law Journal*, vol. 5, (1990), 1-27.

[155] H. Bowbeer, *Component Suppliers: Drawing Common Sense Boundaries for Liability*, in *Kansas Journal of Law & Public Policy*, vol. 10, (2000), 112; M. S. Madden, *Component Parts and Raw Material Sellers: From the Titanic to the New Restatement*, in *Northern Kentucky Law Review,* vol. 26, (1999), 535-572.

Chapter IV: blockchain and automated vehicles

1. Introduction

In order to realise the goal of implementing the safety thresholds of driverless cars, it has been suggested to link self-driving cars with blockchain technology. It has already been observed that the use of automated vehicles is growing rapidly. They are destined to be routinely used in the transport industry, in healthcare, in the military field and in the agriculture sector and supply chain management.

However, as already explained, these vehicles are prone to errors and many incidents have occurred in recent times[156]. The vulnerabilities that are still present in these systems and the need to ensure high levels of protection in the field of cyber security have led the scholars to question how to implement security in these systems.

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[156] K. Wiggers, *Waymo's Driverless Cars Were Involved in 18 Accidents Over 20 Months*, 2020, at: https://venturebeat.com/2020/10/30/waymos-driverless-cars-wereinvolved-in-18-accidents-over-20-month/.

According to some interpreters, blockchain technology can offer a solution to the vulnerability of these systems. Indeed, given blockchain's ability to ensure data transparency and high levels of protection in data storage, it is possible to use this technology to implement security levels in data management.

Blockchain-based storage is certainly very secure against hacking and other external attacks, as the same data is stored on all nodes of the blockchain. As a result, the risk of data loss is very low. In addition, the pseudonymisation allows users' sensitive information to be protected.

However, in order to analyse in more detail, the interactions that can take place between these technologies, it is necessary to look further into the analysis of blockchain technology. After describing the functioning and structure of this technology, the analysis will focus on the interaction that can occur between these two technologies and their evolutionary potential.

2. Background: the origins of blockchain

The advent of blockchain has had a disruptive impact in the technological and legal worlds. Although Amara's law states that, when new technologies are introduced, there is a tendency to overestimate their impact in the short term and underestimate their impact in the long term[157], no one doubts the countless potential applications of this technology in the future. Indeed, it is estimated that blockchain will have an even greater impact in the near future than other technological innovations such as social networks, big data and robotics.

The blockchain can be likened to a distributed ledger or a digital ledger composed of rings (blocks) that contain a certain number of transactions. Indeed, within the blocks, data can be inscribed, stored and made accessible by autonomous systems[158].

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[157] The so-called Amara law was coined by an American researcher, Roy Amara, according to which: "*We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run*" see The Age, 31 October 2006 and "Oxford Essential Quotations", edited by S. Ratcliff, Oxford University Press, 2016.

[158] For an in-depth discussion on the birth of blockchain: A. Perna, *Le origini della blockchain*, in AA.VV., *Blockchain e Smart Contract*, edited by R. Battaglini and M. T. Giordano, Milan, 2019, 3 ff.

The origin of the blockchain, which is connected to the creation of bitcoins, dates back to 31 October 2008, when Satoshi Nakamoto published a document entitled: '*Bitcoin: A Peer-to-Peer Electronic Cash System*' [159] on the website "*www.metzdown.com*". This file contained a description of a system that, through an agglomeration of different scientific techniques, was intended to create a digital currency, called 'Bitcoin'. On 9 January 2009, the source code of bitcoin was published on a web platform that aims to develop projects in a shared manner[160].

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[159] The abstract of S. Nakamoto's contribution, Bitcoin: *A Peer-to-Peer Electronic Cash System*, available at *www.bitcoin.org*: "*A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone*".

[160] Bitcoin Core is an open-source project that uses the MIT license, a free software license created by the Massachusetts Institute of Technology (MIT), available at *www.bitcoin.org.*

The innovativeness of this technology lies not in the creation of a digital currency, but in overcoming the phenomenon of 'double spending', that indicates the use of the same currency in multiple transactions at the same time, through the duplication of the primary currency unit. However, the use of cryptography and blockchain technology prevents such abusive behavior [161]. For this reason, each bitcoin is transferable but not duplicable, precisely in order to prevent the same coin from being transmitted simultaneously to two or more parties.

This approach makes it possible to configure bitcoins, and cryptocurrencies more generally, as a unique digital resource that can rise to the role of an accounting post within the blockchain ledger.

Indeed, the idea of creating a digital currency was not innovative, but no one before the advent of blockchain had

[161] In reality, there is a risk that a group of miners, taking advantage of the decentralised structure of the system, could come to control more than half of the system. This advantageous position could be exploited to delete previous registrations and spend the same unit of currency again. The so-called '50+1 attack' constitutes an entirely remote hypothesis in which the risk of double spending could materialise. On this point see: A. Contaldo, F. Campara, *Blockchain, cryptocurrencies, smart contracts, industry 4.0*, Pisa, 2019, 160.

been able to overcome the problem of currency duplication. In fact, in the digital world, every piece of data is susceptible to infinite reproductions. In contrast, the blockchain introduces the concept of 'digital scarcity', understood as irreproducibility *ad libitum*, through which it is possible to give value to an intangible asset, making it unique and well identified.

In other words, the system devised by Satoshi Nakamoto places the virtual currency in a blockchain, which is designed to guarantee transactions and prevent duplication of the same[162]. The success of this solution derives from the union of principles, techniques, and rules belonging to different scientific areas. Indeed, the blockchain-bitcoin system makes

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[162] Here is a passage from the article Bitcoin: *A Peer-to-Peer Electronic Cash System*, 2, in which S. Nakamoto explains how to avoid the phenomenon of double-spending: "*We need a way for the payee to know that the previous owners did not sign any earlier transactions. For our purposes, the earliest transaction is the one that counts, so we don't care about later attempts to double-spend. The only way to confirm the absence of a transaction is to be aware of all transactions. In the mint-based model, the mint was aware of all transactions and decided which arrived first. To accomplish this without a trusted party, transactions must be publicly announced, and we need a system for participants to agree on a single history of the order in which they were received. The payee needs proof that at the time of each transaction, the majority of nodes agreed it was the first received".*

use of cryptography, distributed peer-to-peer (p2p) networks, consensus algorithms, game theory and monetary policy[163] .

Unlike in centralised systems[164], where the task of supervising the correctness of transactions falls to a single party, in decentralised systems (such as the one used by the blockchain) transactions, recorded on a single historical register shared between the nodes[165] of the network, are public. In these hypotheses, the party receiving cryptocurrencies must be in possession of a cryptographic key that proves the existence of the consent of the majority of the nodes as to the validity of the transaction. In fact, each node participating in the network has a private key and a public key, both created by a specific algorithm. In order to receive cryptocurrencies, the public key is sufficient, while in order to send cryptocurrencies, it is necessary to be in possession of both keys. That said, the proper transfer of cryptocurrency units presupposes that the transferor enters the receiver's public key and signs the transaction with his

[163] K. Werbach, *Trust, But Verify: Why the Blockchain Needs the Law,* in *33 Berkeley Tech. L.J.*, 503 ff. (2018).
[164] For a more detailed discussion of the three distinct ledger models, please refer to the following section.
[165] A 'node' is defined as each computer participating in the network that owns and operates a copy of the distributed register.

own private key. The network has a list, where all transactions are recorded, thanks to which it is possible to verify the validity of the coin before each transfer, averting the danger of double spending.

This brief premise makes it possible to state that bitcoin and blockchain are in a relationship of connection and dependence. More precisely, it must be considered that blockchain is the technology, while bitcoins constitute an application of the former. It follows that the application of the blockchain cannot be limited to the cryptocurrency phenomenon but is potentially unlimited[166].

This insight was further developed by Vitalik Buterin[167] , who, in 2013, thought of linking the smart contract programming language to the blockchain, through the creation of 'Ethereum', a virtual, decentralised system on which smart contracts can be executed. This platform was launched in

[166] The creator of bitcoins himself soon realised that the scope of the blockchain could be much wider than it was originally intended for. This assumption was demonstrated through the so-called Genesis Block (the first block of the bitcoin chain), which was the headline of the newspaper 'The Times' of 3 January 2009. In essence, although bitcoins are functionally connected to the blockchain, the latter is 'free to exist' without bitcoins.

[167] Vitalik Buterin is a Russian programmer, creator of the Ethereum platform.

2014, through a pre-sale of Ether (Ethereum's cryptocurrency), which, through a crowdfunding campaign, raised the equivalent of about $18 million in bitcoin in 42 days.

Today, there are numerous applications of blockchain technology on a national and international level. However, before analysing this in more detail, it is necessary to illustrate the structure and functioning of blockchain in order to fully appreciate its disruptive scope.

3. Structure and Functioning of the Blockchain

First, it should be clarified that the term blockchain can refer to the traditional distributed and shared ledger that makes use of bitcoins, or to different systems that make use of different cryptocurrencies, but use the same technological structure based on the blockchain[168]. In the following, we will resort to the second meaning of blockchain, which alludes to

[168] The term blockchain (with a capital 'B') would indicate the bitcoin ledger, while the term blockchain (with a lowercase 'b') would indicate alternative ledgers. On this point see A. Contaldo-F. Campara, *Blockchain, cryptocurrencies, smart contracts, industry 4.0*, Pisa, 2019, 3.

all distributed ledgers, although some differences can be found between them (think of validation protocols)[169].

Furthermore, it should be noted that the term blockchain is not a synonym for distributed ledger technology (hereafter, 'DLT'). In fact, distributed ledgers (DLT) are the broader genus, of which blockchain is one species[170].

In particular, three distinct models of ledger can be configured: the centralised ledger, which relies on a central entity entrusted with the management of the system and its access rules; the decentralised ledger, which envisages, instead of one, several entities in charge of controlling the

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[169] See: D. Carboni, *Le tecnologie alla base della blockchain,* in AA.VV.*, Blockchain e Smart Contract*, edited by R. Battaglini and M. T. Giordano, Milan, 2019, 33 ff; C. Poncibò, *Il diritto comparato e la blockchain*, Napoli, 2020, 37 ff.; M. Maugeri, *Smart contracts e disciplina dei contratti*, Bologna, 2021, 25.

[170] This is a misunderstanding in which the Italian legislator also seems to have fallen into, where, in Article 8-ter, paragraph 1, Law No. 12/2019, it uses the expression 'technologies based on distributed ledgers', as if it were a synonym of the term 'blockchain', which represents, instead, only a particular model of distributed ledger. See: S. Gaschi-V. Portale, *La definizione di blockchain e distributed ledger,* in AA.VV.*, Blockchain e Smart Contract*, edited by R. Battaglini and M. T. Giordano, Milan, 2019, 19 ff.; L. D'Agostino-R. Piselli, *La definizione di tecnologia a registro distribuito e di smart contract nella legge di conversione del decreto semplificazioni. Un primo commento critico*, in AA.VV., *Blockchain e autonomia privata. Fondamenti giuridici,* edited by A. Nuzzo, Roma, 15 ff.; M. Simbula, *La normativa italiana sulle DLT*, in AA.VV., *Blockchain e Smart Contract*, edited by R. Battaglini and M. T. Giordano, Milan, 2019, 135 ff.

system; the distributed ledger, which disregards the existence of a central entity and embraces an open, distributed and shared logic, based on consensus[171].

The main difference between centralised ledgers and distributed ledgers is, therefore, the presence of the ledger on the servers of all network participants. In fact, while in centralised ledgers the ledger is located exclusively on the server of the single entity in control of the system, in the case of distributed ledgers this information is shared. Therefore, the single node will be able to process and control all the information entered into the ledger independently of the other nodes. However, transactions, in order to be validated, must be approved by the majority of network participants, as they must conform to consensus logic.

The blockchain can thus be defined as a distributed and shared database that is based on an alternative mechanism of trust. The nodes participating in the network, using peer-to-peer technology, control the system directly and without

[171] J. Bevilaqua, *Le varie tipologie di blockchain*, in AA.VV., *Blockchain e Smart Contract*, edited by R. Battaglini and M. T. Giordano, Milan, 2019, 51 ff.

the help of a central entity or intermediary third parties. Moreover, the operation of the consensus mechanism makes it possible to guarantee the trustworthiness of the system, since all nodes have an interest in honest conduct. Indeed, should one of the nodes participating in the network be attacked, the activity of the other nodes would not be affected, and the information recorded by them would not be affected.

Blockchain also ensures a high level of transparency, as information on transactions that have already taken place or are in the process of being validated is accessible to anyone. Likewise, the use of this technology raises security levels, as cryptography makes recorded data unchangeable, ensuring the robustness and reliability of the system. A further distinguishing feature of blockchain is the absence of intermediaries. This feature makes transactions more convenient, as the costs faced by the parties are considerably reduced.

That said, blockchain can take on a different guise depending on its public, private or hybrid nature.

Permissionless blockchains are accessible to anyone and allow all members of the network to see the transactions executed on it, since every member of the network participates in the verification of these transactions. A further advantage of using this model is the absence of a controlling entity. Ethereum and Bitcoin make use of permissionless blockchains.

By contrast, permissioned blockchains or private blockchains are manned by so-called 'trusted' entities that authorise certain, previously identified, entities to access the distributed ledger. In these systems, the entry of a new piece of data on the blockchain is bound to the authorisation of the entities operating the network. This type of blockchain is much faster than permissionless blockchains and, for this reason, it is used by Ripple, Corda, and all platforms that make use of the 'Practical Byzantine Fault Tolerance' (pBFT) protocol.

Finally, it is worth mentioning the so-called hybrid blockchains, which combine elements typical of the other two types of blockchain.

4. Consensus protocols and algorithms

Before moving forward with the analysis, it is important to underwrite the differences between consensus protocols and algorithms.

Protocols fulfil the function of ensuring the integrity and security of the information recorded in the distributed ledgers (DLT) and embody the set of all the rules shared by the other nodes participating in the system.

By the contrast, the consensus algorithm is functional to identifying the exact mechanism through which these rules are respected by the network. The protocol establishes, *inter alia*, the size of the blocks, the way in which the distributed consensus policy is to be regulated, the incentive policies and the remuneration of the nodes. On the other hand, the consensus algorithm takes care of verifying the interactions of the nodes and validating the transactions executed through network consensus[172].

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[172] See: A. Davola, *Algoritmi decisionali, soft data e accesso al credito: una soluzione blockchain-based per rispondere alla vacuità normativa,* in AA.VV., B*lockchain e autonomia privata. Fondamenti*

Although there are very different consent algorithms, it is possible to consider that each of them pursues the same goal: achieving consent.

The main consensus mechanism is based on Proof of Work (PoW). In that model, nodes compete with each other in solving complex mathematical problems, the solution of which gives the 'winning' node the right to validate a transaction. In practice, miners try to solve the problem in order to obtain the so-called hash (i.e. the connecting string between two blocks). It is clear that the node's computing power is directly proportional to the chances of obtaining the solution to the mathematical problem, since a more powerful computer will be able to make a greater number of attempts and, consequently, reach the solution of the problem more quickly. However, a new block can only be validated if the other nodes in the network validate the solution proposed by the miner, repeating the operation. This mechanism, requiring a very high use of electricity for its operation,

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giuridici, edited by A. Nuzzo, Roma, 121 ff.; C. Poncibò, *Il diritto comparato e la blockchain*, cit., 48 ff.

entails very high costs[173] . In addition, the growth of the chain corresponds to a proportional increase in energy expenditure and costs, leading to a considerable lengthening of the validation time for each block[174].

Moreover, it is worth noting that solving such problems generates, as mentioned above, an enormous expenditure of electricity (it is estimated that the use of energy needed to

[173] R. Rosso, Bitcoin, the energy to mine it is equal to that used by half of Italy. And the environmental costs?, in an article published on 23 November 2021 on *www.ilfattoquotidiano.it*, notes that: "*Data from the University of Cambridge's Bitcoin Electricity Consumption Index show that the Bitcoin network consumes about 150 terawatt-hours (TWh) of electricity each year, other sources indicate an updated consumption of over 200 TWh/year. The virtual currency's electricity footprint is almost ten per cent of Russia's entire energy production, 27 per cent of the UK's needs, 75 per cent of that of a country like the Netherlands, 126 per cent of the energy consumed in the Czech Republic. The system also has a powerful, disastrous positive feedback effect: the more the income of the currency miners grows, the more powerful the machinery they can use becomes. And so, the energy consumption of the cryptocurrency ecosystem will also increase*".

[174] In 2009, mathematical problems were solvable by anyone with an ordinary computer, as the initial difficulty of the questions was very low. As a result, it was not necessary for users to have computers with very high computing power, such as those in use today. However, in order to hoard more bitcoins, miners started to make use of computers with ever greater computing power, leading to a considerable increase in the difficulty of the mathematical problems to be solved. This relentless competition has led to the creation of so-called mining farms or mining pools, centres equipped with extremely powerful computing systems capable of achieving performance unmatched by an ordinary computer. In essence, the competition between nodes has led to the centralisation of calculation capacities in the hands of a few nodes equipped with the appropriate computational capacities to solve the mathematical problems submitted to them.

mine bitcoins is nowadays comparable to that needed to light up the entire state of Argentina). The paradox that the evolution of this mechanism has generated is obvious: decentralisation is gradually turning into centralisation, as only a few nodes possess the adequate computational capabilities to solve such problems.

In order to overcome the drawbacks of using Proof of Work, it has been suggested to use Proof of Stake (PoS), in which the possession of a larger number of crypto-asset shares gives a greater chance of validating transactions. In such a system, blocks are not mined (hence, we do not speak of mining), but coined (we speak of forging). The nodes, in order to validate transactions and become validators, must deposit a share of their cryptocurrency within the network, which cannot be spent but only serve as collateral.

The selection of validators is done through an automatic selective process that makes use of different factors (the amount of cryptocurrencies deposited, the so-called coin age, a randomisation factor), so that even nodes with not particularly high shares of cryptocurrencies are selected. However, it is clear that the possession, over time, of a larger amount of cryptocurrencies deposited as collateral increases the chances of nodes being selected as validators. It should be pointed out that when a node is selected as a validator and mints a new blockchain, a certain period of time must elapse before it is selected again, as the system aims to prevent nodes in possession of a considerable amount of stakes from dominating the blockchain.

Specifically, the task of validators is to check the validity of the operations contained in the block, validate the block and add it to the blockchain. Once these operations are completed, the validators get a reward. In case the network finds a fraudulent transaction, the validator would be punished with the loss of part of his or her cryptocurrency share and would not be able to serve as a validator again[175].

The advantages of using such a consensus algorithm are that it is less energy-consuming than PoW. Moreover, it achieves a higher level of security. Indeed, nodes with high shares of

[175] In the PoS system, there would be a possibility to circumvent network controls and enter into fraudulent transactions: owning 51% of the cryptocurrencies in circulation. However, this is a completely unfeasible hypothesis since the costs incurred to obtain such a majority would not find a profit margin in the validation fee that would exceed the costs incurred. Suffice it to say that the value of the reference cryptocurrency would fall considerably.

crypto assets are supposed to be disincentivised from engaging in dishonest conduct, as they would be damaged. Moreover, the use of PoS would allow for real-time electronic payments, whereas the PoW mechanism, requiring a considerable amount of time to validate transactions, would preclude the possibility of using cryptocurrencies for immediate purchases[176].

Recently, a further consensus algorithm has emerged. Proof of Gaming (PoG) allows network participants to earn rewards by accumulating experience. Such a system was adopted by Ulti Arena[177], and it will be used on Binance Smart Chain,

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[176] The potential of PoS has been grasped by Ethereum, which, although currently using a PoW-based consensus algorithm, is working on replacing this consensus mechanism with PoS. The definitive switch from PoW to PoS could increase the use of this technology, as it would, on the one hand, reduce the detrimental effects on the environment and, on the other hand, make blockchain technology more efficient. In this regard, on 1 December 2020, the Ethereum 2.0 Beacon Chain was released and, as a result, the so-called phase 0 officially began, which is designed to ensure the transition to the new version of the platform. During this phase, the validators will be in charge of protecting the Beacon Chain, i.e. the 'central blockchain' of the Ethereum 2.0 system, which will create a register of all Ethereum 2.0 validators. The next stage involves the fragmentation of the main chain into numerous shards, subchains in which internal validations can be carried out using the PoS. Although the transition from PoW to PoS is under way, it is not possible to estimate exactly when this process will be completed. Cf. V. Portal, Ethereum 2.0: what it is and what it entails, at *www.blog.osservatori.net*.

[177] Ulti Arena is the first NFT marketplace for game assets using PoG (for more information, see *www.ultiarena.com*).

although the use of PoG on other networks in the near future is not excluded.

5. The application of blockchain technology to autonomous vehicles

As already noted, blockchain fulfils an extremely important function for the secure management, storage, transfer and sharing of data processed in autonomous vehicle systems. Data include, but are not limited to, vehicle identification, wear and tear, insurance, loans, user experiences, mileage.

Therefore, blockchain represents a possible solution to the security problems of autonomous vehicles, since thanks to blockchain, attempts to gain unauthorised access to AV control systems or the data they collect would be recognised and rejected almost instantaneously, keeping both drivers and pedestrians safe. Even if the security of the blockchain were somehow attacked, the effects would be minimal compared to a centralised server that could provide access to all vehicles simultaneously[178].

Moreover, a further element cannot be overlooked: AVs must be able to collect, process and manage huge amounts of data in real time and very quickly. Suffice it to say that in the case of traffic accidents or unforeseen events (e.g., the sudden fall of a tree on the road), the communication and reaction speed of the system is determined in order to ensure the safety of passengers. Although blockchain cannot absolutely and certainly avert accidents, an effective and fast method of data management could minimise them. Blockchain may be the solution that AVs require to the problem of speed of reaction and data analysis.

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[178] S. Jain-A. Neelu Jyothi-P. Srikanth- B. Kishor Vinayak- N. Bharathram- K. Adarsh-K. Charalambos, *Blockchain and Autonomous Vehicles: Recent Advances and Future Directions*, in IEEE Access, 2021, *passim;* G. Rathee-A. Sharma-R. Iqbal-M. Aloqaily-N. Jaglan-R. Kumar, *A blockchain framework for securing connected and autonomous vehicles,* in *Sensors,* vol. 19, no. 14, 2019, 3165; J. Grewal, *Blockchain-Powered Autonomous Automobiles Can be the Answer*, in *https://www.ibm.com/blogs/blockchain/2020/04/blockchainpowered-autonomous-automobiles-can-be-the-answer*, 2020; R. Shivers, M. A. Rahman-H. Shahriar, *Toward a secure and decentralized blockchain-based ride-hailing platform for autonomous vehicles*, 2019, vol. 68, no. 8, pp. 4734–4746, in *http://arxiv.org/abs/1910.00715;* M. Baza-M. Nabil-N. Lasla-K. Fidan-M. Mahmoud-M. Abdallah, *Blockchain-based firmware update scheme tailored for autonomous vehicles, in Proc. IEEE Wireless Commun. Netw. Conf. (WCNC), Apr. 2019, 1–7.*

However, it would be reductive to limit the potential of blockchain in the automotive sector to data storage. Suffice it to say that the Volkswagen Group is studying the best opportunities for using blockchain technology within the automotive industry[179]. More specifically, Volkswagen, in addition to developing the protection function that blockchain can provide, is testing two other concrete applications. The first concerns the connection of blockchain to car odometers, which would become very difficult to manipulate. The use of blockchain would make the second-hand market more transparent and secure and thus it would keep the value of cars higher.

Another function is being studied by Volkswagen Financial Services in Great Britain. The aim is to develop a system that would allow energy supplies to be paid for with the help of blockchain.

[179] For more information, please refer to: The future of blockchain is (also) in cars, of 11 September 2018, in https://modo.volkswagengroup.it.

The BMW Group is also developing solutions using blockchain technology in the automotive sector[180]. First of all, the BMW Group is experimenting with solutions that make it possible to create a kind of 'digital car passport' through which users will be able to know with a high degree of certainty the events that have marked the use of the car (e.g., number of accidents, kilometres driven, compliance with maintenance intervals).

In addition, according to the company, the use of such technology would make it possible to trace and document supply chains for components, spare parts and materials. Indeed, it is undoubtedly complex to trace and verify the source of certain raw materials such as cobalt and wolframite, as many supply chains involve numerous intermediaries, making it extremely complex to trace the origin. The BMW Group therefore implements pilot projects based on blockchain technology that make the path of minerals traceable.

[180] For more information, please refer to: Blockchain at the service of motorists, of 14 October 2019, at https://bmw.com.

In addition, the BMW Group is experimenting with innovative solutions that would allow cars to be recharged homogeneously, obviating the need for contracts with multiple operators. In this hypothesis, blockchain technology can be used successfully, as this would make it possible to recharge cars directly. In fact, the blockchain would ensure a decentralised recharging network and through so-called Smart Contracts with electricity suppliers, users could quickly recharge their cars. The blockchain model project supported by the BMW Group, called 'Charge Chain', aims to reduce the burden on the customer as much as possible, who will no longer have to worry about finding a particular provider and identifying it by means of a customer card.

This brief review allows us to state that blockchain is certainly a technology that will be widely used in the automotive sector. However, this brief review does not exhaust the application field of this technology. Therefore, in the following chapters, some of the aforementioned hypotheses will be analysed in more detail in order to highlight their legal corollaries.

Chapter V: Compulsory Insurance and Autonomous Driving

1. Introduction

It is reasonable to assume that the deployment of autonomous vehicles will lead to an increase in accidents caused by a vehicle defect. At present it is esteemed that road accidents caused by a vehicle defect account for less than 5% of the causes of road accidents[181]. However, it is possible that this percentage will increase even if it seems excessive to claim that all or almost all accidents caused by autonomous vehicles will be caused by a vehicle (or road) defect.

Indeed, part of the scholars has argued that the introduction of self-driving vehicles will lead to a shift of liability rules from the driver and/or owner to those of the manufacturer. In this way, all accidents caused by autonomous vehicles would be resolved by the rules on manufacturer's liability

[181] It should be remembered that currently 95 per cent of road accidents are due to human error. The remaining 5 per cent includes all other possible causes, such as poor infrastructure or vehicle conditions, force majeure, sole fault of the victim and vehicle defects.

under Directive 85/374/EEC concerning liability for defective products (hereafter: Directive 85/374/EEC or Product Liability Directive).

However, this is a simplistic solution since it cannot be assumed that all accidents will be due to a product defect. In fact, it seems reasonable to state that the road risk is not eliminated by the introduction of autonomous vehicles[182], even though everything suggests that accidents due to a product defect will increase, while those due to the road risk itself will decrease. In other words, it cannot be ruled out that accidents with a cause other than a vehicle defect will still occur. For this reason, a mechanism will be needed to enable victims to claim compensation.

Until it can be stated with certainty that all accidents caused by self-driving cars are the result of a defect in the vehicle, it seems necessary to maintain an alternative compensation system to the action against the manufacturer, based on

[182] E. Salazar (2020*), Vehículos autónomos. Desplazamiento de las reglas de responsabilidad civil del propietario al fabricante. Criticisms of the proposal. El riesgo de la circulación seguirá existiendo*, in SANTOS MORÓN-MERCADER UGUINA-DEL OLMO GARCÍA (Dir.), *Nuevos retos del derecho de daños en Iberoamérica,* 1st ed., Tirant lo Blanc, Valencia, 826-841.

driving or road risk. Victims will need a protection system that provides a compensatory remedy for accidents that are not caused by vehicle defects, such as force majeure or other.

In light of these considerations, the ideal compensation system for this purpose can only be the retention of compulsory insurance.

2. Italian insurance system

The Italian legal system underwent a profound and radical change when, on 24 December 1969, law no. 990 was issued, regulating the '*Compulsory insurance of civil liability arising from the circulation of motor vehicles and boats*'. In fact, the growing diffusion of cars and the correlated increase in the number of accidents had made evident the inadequacy of a compensation system based almost exclusively on direct action by the injured party against the owner and the driver, given also the limited success of optional insurance. Therefore, it had become indispensable to introduce regulatory provisions to ensure adequate compensation for motor vehicle damage[183].

In the course of the 1960s, damage caused by the circulation of vehicles gradually became the numerically most important non-contractual tort figure. However, the diffusion of the motor car among a public that was no longer elitist made recourse to Article 2054 of the Civil Code no longer effective, since the cases in which the damaging party's assets were not sufficient to compensate the damage caused to the injured party were increasingly frequent.

Therefore, the need to ensure adequate compensation for victims of road accidents and the enactment of the European Convention of Strasbourg of 20 April 1959, '*Compulsory Insurance for Civil Liability in respect of Motor Vehicles*'[184]

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[183] See law n. 990/1969, named "*Mandatory insurance for civil liability arising from the use of motor vehicles and watercraft*", at*:* *http://www.camera.it/_dati/leg04/lavori/stampati/pdf/41370001.pdf*. Among scholars, see: G. Gallone -G. B. Petti, *Il danno alla persona e alle cose nell'assicurazione per la R.C.A. - Tomo primo*, Torino, 2005, pp. 8 – 9.

[184] Art. 1, European Convention on Compulsory Insurance against Civil Liability in respect of Motor Vehicles: "*Each Contracting Party undertakes to ensure that, within six months of the date of entry into force of this Convention in respect of that Party, the rights of persons suffering damage caused by motor vehicles in its territory shall be protected through the introduction of a system of compulsory*

prompted the legislator to introduce the compulsory insurance system.

Article 1 of Law 990/1969 expressly stated that all mechanically propelled vehicles were required to carry insurance for '*third party liability as provided for in Article 2054 of the Civil Code*'. It is therefore evident that the legislator has retained the liability system based on the presumption of driver liability.

Moreover, the insurance system set up by the legislator clearly responds to solidaristic purposes, pursuing the aim of specifically protecting the injured party[185].

In fact, in Italy, the victim of an accident has the option of choosing whether to bring an action for damages against the author of the offence or directly against the insurance company of the damaging party's vehicle. Direct action is a faculty that was already provided for by article 18 of law no.

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insurance complying with the provisions annexed to this Convention", available at: *https://rm.coe.int/16800656cd*.

[185] C. Cost., 1 marzo 1973, n. 24, in *Foro It.*, 1973, I, 609; C. Cost., 29 marzo 1983, n. 77, in *Giust. civ.,* 1985, V, 1394.

990/1969, and which is now included in article 144 of legislative decree no. 209 of 7 September 2005, the so-called private insurance code. The second paragraph of this article states that: "*the insurance company cannot oppose to the injured party exceptions deriving from the contract, nor clauses providing for the insured party's possible contribution to compensation for the damage*". This demonstrates the complete autonomy of the third party's right against the insurer[186].

Nowadays the direct action is a substantial right of the injured party against the insurer. However, the insurer, in all cases where it could have refused to perform (e.g. in the event of non-payment of the insurance premium), has a right of recourse against the insured.

186 A. Donati, G. Volpe Putzolu, *Manuale di diritto delle assicurazioni - Undicesima edizione*, Giuffrè Editore, Milan, 2016, p. 230. The unenforceability of exceptions is now also imposed by Article 13 of Directive 2009/103/EC of 16 September 2009. It should be noted that jurisprudence, referring to the letter of article 144, which classifies as unenforceable only those exceptions arising from the contract, has identified as enforceable exceptions those relating to the non-existence or absolute nullity of the contract: see Civil cassation, section III, 7 October 1994, no. 8460, in Resp. civ. prev., 1995, II, 303, and more recently Civil cassation, section III, 30 June 2011, no. 14410, in *Foro it.*, 2011, I, 2668.

Therefore, the injured party's right to compensation would seem to derive directly from the law, the mere existence of an insurance contract - even a flawed one - being sufficient to protect the injured party.

The provisions dictated on direct action by the Italian legislature anticipated the provisions that were adopted at European level with Directive 2000/26/EC. In fact, Article 4 of Directive 2005/14/EC introduced this principle within the European framework[187].

In the event that the injured party does not have an insurance contract, the Italian legislator, with law no. 990/1969 (now Article 283 of the Private Insurance Code) established the Guarantee Fund for Road Victims.

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187 G. Pngelli, *Il risarcimento diretto nel codice delle assicurazioni*, Milano, 2011, pp. 29 ss.: "*La quarta direttiva assicurazione autoveicoli (direttiva 2000/26/CE del Parlamento europeo e del Consiglio, del 16 maggio 2000, concernente il ravvicinamento delle legislazioni degli Stati membri in materia di assicurazione della responsabilità civile risultante dalla circolazione di autoveicoli e che modifica le direttive 73/239/CEE e 88/357/CEE del Consiglio) era la penultima di un pacchetto di direttive di riavvicinamento legislativo in materia. L'ultima 2005/14/CE apportava a tutte queste dei correttivi*".

Article 19 of the 1969 law provided for the Fund to be operative first and foremost for accidents caused by uninsured or unidentified vehicles or craft, but also for cases in which the vehicle or craft was insured with a company that at the time of the accident was in a state of compulsory liquidation[188].

The mechanism set up by the Italian legislator does not provide for the Fund to compensate the victims directly, since this task is entrusted to certain private insurance companies, designated by Isvap.

The doctrine has long debated the legal nature of the Fund. The prevailing theory holds that the Fund performs the function of an autonomous centre of interests against which the insurance companies have the right of recourse after compensating the damage. It is the insurance companies that contribute economically to the formation and maintenance of its assets.

[188] G. Gallupi, *Il fondo di garanzia per le vittime della strada,* in *Dir. prat. ass.*, 1971, I, 278. This legislative initiative was probably due to the media clamour that the bankruptcy of the Compagnia Mediterranea di assicurazioni in 1964 caused.

The creation of this mechanism ensures that the risk caused by the total circulation is covered. In fact, this system makes it possible to prevent the blameless injured party from having to face the prejudicial consequences of the injury suffered by the damaging party.

In the traditional physiognomy of the insurance contract, the main obligation on the shoulders of the insurer is that of holding harmless the assets of the injured party, who, in return for this protection, pays the insurer a monetary consideration, called premium. Liability insurance, however, has its own peculiarities precisely because it aims to respond to precise needs of social solidarity[189]. In fact, the system set up by the Italian legislator clearly aims to protect the injured party rather than the injured party. Suffice it to think of the direct action of the injured party against the insurer of the other party (article 144 of the insurance code) which, in the Italian legal system, tends to be excluded since article 1917 of the civil code only refers to the insurer's right to pay the

[189] V.V. Cuocci, *Dall'assicurazione obbligatoria R.C. auto alla no-fault insurance. Uno studio comparato dei sistemi di* traffic accident compensation, Milano, 2013, p. 23.

indemnity due directly to the injured party and to the insured party's right to request a direct payment in favour of the injured party.

Similarly, direct compensation, introduced into the Italian legal system by the insurance code in articles 149 and 150, and subsequently by the regulation contained in Presidential Decree no. 254 of 18 July 2006, also pursues purely solidaristic purposes, contributing to the peculiarities that distinguish third party liability insurance. The institution provides for an *ope legis* substitution of the legitimated passive party in the action brought by the creditor. In particular, paragraph 3 of article 149, states that, under certain conditions, the victim's insurance company settles the claim "*on behalf of*" the insurance company of the injured party, without prejudice to the subsequent regulation of relations between the two insurance companies.

The protection afforded to the third party in the event of an accident is also a peculiarity of the third-party liability system. In fact, the second paragraph of article 122 of the insurance code - quoting article 1 paragraph 2 of law no. 990/1969 - states that "*insurance includes liability for* *personal injury sustained by persons transported, regardless of the title on the basis of which the transport is performed*".

2.1 The regulation of black boxes in the Private Insurance Code and the Smart Road Decree

Through the introduction of Article 132 *ter* of Legislative Decree no. 209 of 7 September 2005 (the so-called Private Insurance Code), the legislator has regulated the installation of the black box on the vehicle, providing that this leads to a reduction in the insurance premium in view of the reduction in the risk inherent in the insurance contract.

In fact, the introduction of such a tool provides greater protection to insurance companies, which would also be able to offer tailor-made policies, providing, for example, a premium related to the number of kilometres driven and the actual use of the vehicle.

However, the rule makes the reduction of the premium conditional on the implementation of regulations, which, as things stand, have only been partially adopted. A further obstacle to the widespread use of black boxes by users stems from the failure to regulate the processing of users' personal data collected by these devices. Indeed, in the absence of *ad hoc* regulation, the general rules on data processing can only apply. Nonetheless, it would seem most appropriate for these aspects to be regulated in a precise manner by the legislator in order to regulate the collection and limit the use of the data collected by the insurance company to the purposes strictly necessary to ensure the coverage under the contract.

Moreover, it cannot be overlooked that the lack of a precise definition of black box may lead to misunderstandings, since insurance companies could make use of different technologies, making the checks on users' movements more penetrating.

In fact, the Italian legislator had provided a definition of black box with the Ministerial Decree of 25 January 2013, adopted by the Ministry of Infrastructure and Transport in agreement with the Ministry of Economic Development. However, this decree was annulled by the Regional Administrative Tribunal of Lazio as it was deemed to be the source of an undue dominant position to the advantage of manufacturers of black boxes corresponding to the ministerial requirements and to the detriment of manufacturers of different technologies. The ruling of the Regional Administrative Court, which opens the door to technologies comparable to the black boxes identified by the Italian legislator, makes it particularly difficult to determine which equipment may result in a premium discount for the insured.

A further aspect that deserves further study concerns the special value of "legal proof" accorded to the findings of black boxes installed on vehicles. In fact, Article 145 *bis* of the Private Insurance Code states that the recordings are full evidence against all parties unless it is proven that the black box is not functioning or has been tampered with.

The aforementioned provision introduces a legal test by preventing the judge from freely assessing the probative value of the black box findings. Therefore, the only way for the party against whom the evidence is produced to challenge the validity of the black box's findings will be to carry out a party's technical expertise or to request the judge to entrust a court-appointed technical consultant with the analysis of the malfunctioning or tampering of the black box.

On the other hand, the prevailing orientation in doctrine and jurisprudence, before the introduction of Article 145 *bis* of the Private Insurance Code, assimilated the findings of black boxes to the mechanical reproductions referred to in Article 2712 of the Civil Code. According to the latter provision, the black box findings would be considered as documentary evidence and, more precisely, as mechanical reproductions, which the judge would be free to assess.

The importance that the Italian legislature attaches to the black box is made even more evident by the provisions of the so-called 'Smart Road decree', whereby operators interested in accessing the testing phase of autonomous vehicles on the road are required to accurately record the data concerning the tests. In fact, in this case, the black boxes perform the task of monitoring the proper functioning of autonomous driving systems, the correct reception of signals coming from infrastructures, and the interactions between the vehicle and the person in charge of monitoring (at least during the testing phase) the proper functioning of the vehicle.

It therefore appears evident that the installation of the black box is an essential and indispensable requirement for the proper functioning of autonomous driving cars. It is, therefore, foreseeable that the installation of black boxes on self-driving vehicles will become unavoidable and necessary for the proper monitoring of their operation, since greater control is a necessary consequence of the greater autonomy of self-driving vehicles.

3. Spanish insurance system

The Spanish motor vehicle insurance system is regulated by Royal Legislative Decree 8/2004, which approves the revised text of the Law on Civil Liability and Insurance in the Circulation of Motor Vehicles[190] (hereinafter, LRCSCVM). The LRCSCVM provides for a broad concept of traffic risk, which includes both traffic risks in the strict sense and those arising from vehicle defects or the condition of the installations[191].

[190] Royal Legislative Decree 8/2004, of 29 October 2004, approving the text of the law on civil liability and insurance in the circulation of motor vehicles (BOE no. 267, of 5 November 2004).

[191] These cases have been considered by the 3rd Chamber of the SC as traffic risks that established that they are not cases of force majeure: see STS, 3.ª, secc. 5.ª, no. 2551/2016 of 2 December, MP: Inés HUERTA GARICANO (RJ 2016, 6164) on the inadequate placement of a concrete sewer by the Administration or STS, 3. ª, secc. 6.ª, (no number recorded) of 31 January 2002, MP: José María ÁLVAREZ-CIENFUEGOS SUÁREZ (RJ 2002, 5055) on the fall of stones from the hillside onto the road.PORQUÉ EN MAYÚSCULAS SI TODOS LOS APELLIDOS ESTÁN EN MINÚSCULAS

Neither vehicle defects nor the breakage or failure of any of its parts or mechanisms are considered cases of force majeure. Therefore, accidents resulting from vehicle defects are also considered a consequence of the risk created by driving motor vehicles. The only thing that the law excludes from the concept of traffic risk is force majeure unrelated to driving and the exclusive fault of the victim[192].

However, it is well possible (although not frequent), that a road accident may be caused by the occurrence of a series of coincidences or unexpected circumstances. Indeed, it could be the case that an accident is caused by atypical and unforeseeable traffic-related circumstances that were not foreseen as a risk factor during the programming of the software and therefore cannot be considered to be defective.

As mentioned above, the LRCSCVM expressly considers accidents caused by unforeseeable circumstances. The

[192] Such as the sudden and unexpected irruption of a pedestrian onto the road. See: STS, 1.ª, núm. 25/2005 of 27 January, MP: Alfonso VILLAGÓMEZ RODIL (RJ 2005, 1828) in which the victim who suddenly bursts onto the road is considered to be exclusively at fault.

concept of traffic risks in the strict sense includes accidents caused by unforeseeable circumstances resulting from the traffic risk itself, such as accidents caused by brake failure[193], a tyre blowout[194], the presence of wild animals on the road[195], weather conditions such as frost, hail, snow or storm[196] or the intervention of third parties[197].

[193] STS, 1.ª, (no number recorded) of 21 November 1989, MP: Francisco MORALES MORALES (RJ 1989, 7897); "*in normal conditions of conservation, care and maintenance of a vehicle by its owner, the breakage of its brakes, occurring to it when it is in circulation, may, in strict civil doctrine, merit the concept of fortuitous event*".

[194] SAP de Jaén, secc. 1.ª, núm. 192/2019 de 22 de febrero (JUR 2019, 108521): "*(...) understanding that there would be an act of God and not force majeure, and, therefore, within the risks covered, those cases in which the damage is specific to the scope or internal sphere of said activity, such as the cases of an animal breaking into the road, the driver fainting, or the bursting of a tyre*".

[195] STSS, 1st Chamber, no. 50/2016 of 11 February, MP: Ángel Fernando PANTALEÓN PRIETO (RJ 2016, 247) or 3/2015 of 4 February, MP: Francisco Javier ARROYO FIESTAS (RJ 2015, 2075) on the liability of the driver who causes damage to third parties after hitting a herd of wild boars on the road. This is an eventuality not unrelated to the specific risk of the circulation of motor vehicles that does not constitute force majeure excluding civil liability, but rather a case of fortuitous event.

[196] STS, 1.ª, (no record number) of 26 October 1968 in which the vehicle fell down an embankment because the road was slippery or STS, 1.ª, (no record number) of 22 December 1992 (RJ 1992, 10639) in which the strong wind that caused the accident was classified as a fortuitous event.

[197] SAP of Madrid, sect. 21.ª, (no number recorded), of 9 February 1994 in which a third party improperly changed direction of traffic with which the plaintiff collided.

On the other hand, causes of force majeure unrelated to driving (not traffic risk)[198] are excluded from the concept of traffic risk because they are unforeseeable and unavoidable, such as the unexpected crossing of the road by an animal[199], the sudden entry of a pedestrian onto the road[200], the sudden blocking of the road by a vehicle[201] or the existence of an ice

198 The aforementioned STS, 1st, no. 3/2015 of 4 February, MP: Francisco Javier ARROYO FIESTAS (RJ 2015, 2075): "*The most authoritative doctrine distinguishes (...) whether the origin is external to the circle of activity in which the obligation takes place, or whether it is internal. That is to say, in the cases in which the force majeure can be considered as "proper", generated within, circle or specific sphere of the activity of the risk deployed, we would be dealing with a case of fortuitous event that would not be exonerating in the case of strict liability. For this reason, the doctrine distinguishes between force majeure, strictly speaking, as that which is extraneous to the specific risk being analysed and the fortuitous event as the internal force majeure, that is to say, inherent in the risk*".

199 STS, 1.ª, no. 245/2014 of 14 May, MP; Francisco Javier ARROYO FIESTAS (RJ 2014, 2729), on force majeure outside driving as a cause for exoneration of the liability of the insurer of the vehicle that collides with a herd of wild boars out of control that invade the road. The invasion of the herd, in this case, was considered by the Court unforeseeable and unavoidable.

200 STS, 1.ª, (no section or no. recorded) of 17 November 1989, MP; Mariano MARTÍN-GRANIZO FERNÁNDEZ (RJ 1989, 7889).) of 17 November 1989, MP; Mariano MARTÍN-GRANIZO FERNÁNDEZ (RJ 1989, 7889), on the force majeure extraneous to driving as a cause for exoneration of the liability of the insurer of the driver who was involved in an accident because a pedestrian entered the road four or five metres from the vehicle suddenly. The driver, who suddenly swerved to the left and braked in order not to hit the pedestrian, collided with another vehicle coming in the opposite direction, resulting in the death of the driver's wife.

201 SAP de Álava, secc. 1.ª, no. 232/2004 of 20 September (JUR 2004, 308866), on the force majeure extraneous to driving as a cause for exoneration of the liability of the insurer of the vehicle that rear-ends another vehicle that changes lanes to avoid an overturned car; SAP de Burgos, secc. 3.ª, no. 277/2001 of 31 May (JUR 2001,

patch[202]. In each case, these are circumstances beyond the control of the driver of the vehicle involved in the accident. According to the Supreme Court, fortuitous event is related to unforeseeability and force majeure to inevitability[203], for this reason only force majeure is considered a cause of exoneration from liability. Fortuitous event is not, since it is a force majeure endogenous to the risk of driving itself: it is therefore reserved for cases of unpredictability that are generated by driving and not by a circumstance extraneous to it[204].

In any case, it is foreseeable that autonomous vehicle technology will reduce the causes hitherto qualified as

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236201), on the force majeure extraneous to driving as a cause for exoneration of the liability of the insurer of the vehicle that rear-ends another vehicle that changes lanes to avoid an overturned car.

[202] SAP of Guadalajara, (no section or no. recorded) of 28 April 1994 (AC 1994, 581), regarding a vehicle that leaves the roadway due to the existence of a patch of ice and collides with another vehicle that is also off the roadway for the same reason.

[203] On the difference between force majeure and fortuitous event in traffic accidents, see. SSTS, 1st , (no record of section or number) of 21 July 1989, MP: Adolfo CARRETERO PÉREZ (RJ 1989, 5772) or (no record of section or number) of 17 November 1989, MP: Mariano MARTÍN-GRANIZO FERNÁNDEZ (RJ 1989, 7889). More recently, for example, SAP de Murcia, secc. 1.ª, no. 143/2012 of 15 March (JUR 2012, 140737). Vid. BADILLO ARIAS (2016), *La responsabilidad civil automovilística. El hecho de la circulación, Aranzadi*, Cizur Menor, p. 180.

[204] SAP of Córdoba, sect. 3.ª, no. 82/2000 of 17 March (AC 2000, 3732) on the fortuitous event as a cause for exoneration of civil liability in matters of traffic accidents involving motor vehicles when this is unrelated to the risk created by driving.

chance[205] or force majeure, since vehicles should be able, at least in theory, to detect and thus avoid brake or wheel failure, collisions with pedestrians or with animals[206]. Nevertheless, it is equally obvious that autonomous driving vehicles, even if equipped with sophisticated state-of-the-art technology, will not be able to anticipate events that are not related to driving but fall within the realm of fortuitous events or force majeure, such as an accident caused by the sudden fall of a tree on the road due to bad weather[207].

Thus, accidents of both types will continue to occur, and it will be up to the courts to interpret and decide on a case-by-case basis, as they have done so far, whether it is a case of

[205] Accidents caused by a driver who falls asleep at the wheel (SAP of Valencia, 8th section, no. 501/2013 of 18 November [JUR 2014, 172403]) or who suffers a myocardial infarction causing sudden fainting to have been classified as fortuitous events. 501/2013 of 18 November [JUR 2014, 172403]) or who suffers a heart attack causing sudden fainting (SAP of Barcelona, 11th section, no. 354/2019 of 6 June [JUR 2019, 190910] or SAP of Murcia, 1st section, no. 224/2004 of 8 July [JUR 2005, 25131]).

[206] See the video "*Tesla Autopilot avoiding a crash with a pig crossing the road*" in which a Tesla level 2 SAE vehicle avoids colliding with an animal in the middle of the road. Available at https://www.youtube.com/watch?v=KyRhU5mVMzc.

[207] SAP of Girona, section 1, no. 138/2005 of 7 April (JUR 2005, 123936), SAP of Vizcaya, section 4, no. 485/2003 of 18 July (JUR 2003, 213565), SAP of Vizcaya, section 3, no. 410/2003 of 10 July (JUR 2003, 212963), SAP of Cantabria, section 2, no. 501/2002 of 20 November (JUR 2003, 42781, among others), and SAP of Cantabria, section 2, no. 501/2002 of 20 November (JUR 2003, 42781). 410/2003 of 10 July (JUR 2003, 212963), SAP of Cantabria, 2nd section, no. 501/2002 of 20 November (JUR 2003, 42781).

force majeure unrelated to driving or a traffic hazard. One might even think that the delimitation of the concept of road risk should be made in a negative sense, meaning by road risk everything that cannot be classified as force majeure unrelated to driving. Emphasising the importance of this distinction in the Spanish legal system where only force majeure is a cause for exoneration from civil liability in road accidents, pursuant to Article 1 LRCSCVM.

From what has been said so far, it seems easy to state that road risk will continue to exist with autonomous vehicles and that victims will need a protection system that provides compensation for damages suffered.

Therefore, it seems reasonable to maintain an alternative damage compensation system to an action against the manufacturer for accidents with a cause other than a defect. It follows that it is necessary to resort to the compulsory motor vehicle insurance (hereinafter referred to as SOA) governed by Directive 2009/103/EC[208] on insurance against

[208] Directive 2009/103/EC of the European Parliament and of the Council of 16 September 2009 relating to insurance against civil liability in respect of the use of motor vehicles, and the

civil liability in respect of the use of motor vehicles (hereinafter referred to as SOA Directive 2009/103/EC, SOA Directive or Insurance Directive, interchangeably). The European Union, which is working on a reform of this directive, has expressly indicated its interest in ensuring that the OAS remains compatible with the circulation of autonomous[209].

The current SOA system has been in place for many years, as European Union law has required all vehicle owners to take out compulsory motor insurance since the 1960s[210]. Like Italy,

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enforcement of the obligation to insure against such liability. The Directive is mandatory in the European Economic Area, which includes all member states of the European Union, Norway, Liechtenstein and Iceland.

[209] EUROPEAN PARLIAMENT (2019), "*Motor insurance. Amendments adopted by the European Parliament on 13 February 2019 on the proposal for a Directive of the European Parliament and of the Council amending Directive 2009/103/EC of the European Parliament and of the Council of 16 September 2009 relating to insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability [COM(2018)0336 - C8-0211/2018 - 2018/0168(COD)]*", P8_TA-PROV(2019)0110, 1-43. Previously, EUROPEAN COMMISSION (2018), "*Proposal for reform of the Directive of the European Parliament and of the Council amending Directive 2009/103/EC of the European Parliament and of the Council of 16 September 2009 relating to insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability*", COM (2018) 336 final, 2018/0168 (COD), 1-23.

[210] The obligation to ensure motor vehicles is currently provided for in Article 3 of Directive 2009/103/EC. In the Spanish legal system, the duty of the vehicle owner to take out compulsory insurance is regulated in Article 2 of the LRCSCVM.

the owner of a motor vehicle in Spain is therefore obliged to take out compulsory motor insurance to protect the victim and to take out insurance to cover damage caused to third parties by the use of the vehicle. This obligation arises from the mere ownership of the vehicle, although this does not prevent other parties, such as the owner, the regular user, from being insured.

This is a very protectionist system for the victim and also for the insured, since Member States must ensure an insurance system that allows the victim to bring a direct action against the insurance company with very generous minimum limits of cover[211], which are still to be extended[212]. This is without

[211] Under Art. 9 of the Directive, for personal injury, a minimum amount of cover of €1,000,000 per victim or €5,000,000 per claim, whatever the number of victims, and for damage to property, €1,000,000 per claim, whatever the number of victims, without prejudice to any higher guaranteed amounts prescribed by the Member States. Spain raised the limits to €70,000,000 for damage to persons, whatever the number of victims, and to €15,000,000 for damage to property, according to art. 4 of the LRCSCVM.

[212] The European Parliament, in the proposal for amendment of the Directive, (Amendments 31 and 32) extends these limits: *"(a) in respect of personal injuries: €6,070,000 per accident, whatever the number of injured parties, or €1,220,000 per injured party; (b) in respect of damage to property: €1,220,000 per accident, whatever the number of injured parties". In this sense, if the proposal for a Regulation on civil liability for the operation of artificial intelligence systems (vid. n. 272) were applicable to autonomous vehicles, non-material damage would have to be included as compensable under Article 5.1. a) which states that the Regulation shall compensate: "up to a maximum amount of EUR 1 million in case of significant non-*

prejudice to the insurer's right of recourse against a liable third party such as, for example, the producer.

Since this system has proven to be functional, it would seem appropriate to extend it also to accidents triggered by autonomous vehicles.

A further advantage of retaining the current SOA system is its compatibility with product liability rules, since the victim collects compensation directly from the insurer, which, if the conditions are met, will be able to make a claim against the manufacturer. However, it is rare for insurance companies to file a claim against manufacturers for defective products. With the introduction of autonomous vehicles, it can be expected that insurance companies will exercise this right more frequently, as vehicle defects will increase as a cause of road accidents in proportion to all accidents.

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material damage resulting in verifiable economic loss or damage to property, including where different property owned by an affected person is damaged as a result of a single operation of a single high-risk AI system; where the affected person also has a right to claim for contractual liability against the operator, no compensation shall be paid under this Regulation if the total amount of the material damage or non-material damage is less than [EUR 500]'.

In order to be able to apply the LRCSCVM it is necessary that the accident is caused by a motor vehicle during its use on the road. Only when these two elements, defined in Royal Decree 1507/2008 that approves the Regulation on liability insurance for the circulation of motor vehicles (hereinafter RD 1507/2008), are present, the aforementioned law shall be applied.

Article 1 of RD 1507/2008 establishes that motor vehicles are considered to be all vehicles that are suitable for circulation on the surface of the land and are propelled by a motor, including mopeds, special vehicles, trailers and semi-trailers.

Considering that autonomous vehicles are suitable for use on the surface of the land, they are motor-driven and their use requires administrative authorisation, the content of which is specified in the Law on Traffic, Circulation of Motor Vehicles and Road Safety14, it is possible to conclude that automated vehicles and autonomous vehicles may fall within the definition of "motor vehicles" given by article 1 of RD 1507/2008.

Article 2 of RD 1507/2008 establishes that traffic incidents are understood to be those arising from the risk created by the driving of motor vehicles. This definition explicitly refers to the risk arising from the action of driving.

A strict literal interpretation of the provision would lead to the exclusion of self-driving vehicles from its scope of application because they are driverless. However, the act of driving has been widely interpreted and it includes not only the case where there is a person driving a car, but rather refers to the driving of the vehicle.

In fact, accidents caused by a vehicle with the engine switched off have been included in the concept of traffic risk, even if at the time of the accident the activity of driving was not being carried out. There is also a case law stating that an accident caused by a parked vehicle is a traffic incident when the parking is part of a journey which has not yet been completed.

That being the case, there would seem to be no obstacle to the application of the LRCSCVM to self-driving vehicles.

3.1 Compensable damage

According to the LRCSCVM, personal injuries suffered by the driver causing the accident are excluded from the coverage of the policy (art. 5.1).

Nevertheless, it reasonable to believe that after the driver disappearance with the circulation of autonomous vehicles, the personal injuries of all passengers in the vehicle could be covered by the civil liability insurance policy, including those of the owner-passenger of the vehicle.

As of today, civil liability insurance covers damages suffered by third parties and not those of the insured himself, according to Article 73 of the Insurance Contract Law (hereinafter LCS)[213].

Indeed, the exclusion of the driver's personal injuries foreseen in article 5.1 of the LRCVCVM is understandable,

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[213] See: Law 50/1980, of 8 October 1980, on Insurance Contracts (BOE no. 250, of 17/10/1980). In literature, S. CALERO (Dir.) (2010), Ley de Contrato de Seguro. Comentarios a la Ley 50/1980, de 8 de octubre, y a sus modificaciones, Aranzadi, Cizur Menor, pp. 1.589 and ff.

since it is the driver the one causing the damage. However, with the introduction of autonomous vehicles, the figure of the driver will disappear, and the liable party will be the owner. He/she will not be liable for another person's fault as currently under Article 1.3 of the LRCSCVM, but for his/her own fault.

However, maintaining a rule such as the one in article 5.1 of the LRCSCVM and replacing the word "owner" with "driver", would leave the personal injuries of owners who have not caused the accident without any cover[214]. If this approach is pursued, it is plausible to assume that accident underwriting will decrease, since the personal injuries of the owner-insured will be covered by the road accident policy.

Therefore, damage to the property of the owner and passengers of the vehicle causing the damage, as well as damage to the insured vehicle itself, would also be excluded from the coverage, as is currently the case, by virtue of Article

[214] See, *ex multis*, STS, 1.ª, no. 35/2019 of 17 January, MP: Antonio SALAS CARCELLER (RJ 2019, 75), in which compensation is recognised, to be paid by the insurance company itself, for the damages suffered by the owner of the vehicle who was travelling as co-pilot.

5.2 LRCSCVM. The main reason for excluding damage to the property of the passengers is to avoid fraudulent accidents and defrauding insurance companies.

However, considering that autonomous vehicles will allow to reconstruct the circumstances of the accident, they could also provide information on the state of passengers' property before and after the accident (e.g. by means of in-vehicle cameras). For these reasons, it would be advisable to expand the scope of the insurance cover to also include damage to the property of the owner and passengers of the vehicle causing the damage, as well as damage to the insured vehicle itself.

As of today, according to the current wording of Article 5 of the LRCSCVM, these damages will be excluded and in order to be covered, the owner will have to take out his own property damage insurance, as is currently the case[215].

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[215] According to the Unión Española de Entidades Aseguradoras y Reaseguradoras, UNESPA (2019), "*Informe estamos seguros*", 1-290, p. 98, approximately 32.1% of all insured vehicles in Spain in 2018 had taken out a voluntary own vehicle damage policy. See also G. POMAR (2019), *La posición del Tribunal Supremo sobre el coste de los accidentes de tráfico y la incertidumbre*, InDret 3/2019, 1-11, p. 8: «la decisión por parte del propietario de un vehículo de contratar o no un seguro de daños propios no es exógena al régimen jurídico

Nevertheless, sometimes insurance companies provide full cover for damage caused by and to self-driving vehicles are beginning to appear.

By way of example, we can mention the insurer "ADRIAN FLUX INSURANCE SERVICES" that offers a special motor insurance policy for autonomous vehicles[216] which allows additional cover to be taken out in relation to property damage to the autonomous vehicle itself. However, it is a cover that it is only applicable if explicitly taken out[217].

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de los daños en el vehículo y a la existencia de potenciales responsables (...), los propietarios de vehículos son mucho más proclives asegurar (voluntariamente) daños en las lunas del vehículo o por incendio del mismo que un seguro más amplio de daños propios del coche. Una explicación de esta divergencia puede venir dado por el hecho de que los costes que sufre el propietario del vehículo por incendio o rotura de lunas difícilmente puede esperarse que se "trasladen" sobre otros conductores y su cobertura de responsabilidad, mientras que otros daños en el vehículo –por colisiones, entre otros–pueden tratar de desplazarse sobre otros (...) Lo anterior hace pensar aún más en un cierto comportamiento estratégico de los propietarios de vehículos que se traducen en la falta de aseguramiento contra daños propios con la expectativa de una cierta probabilidad de poder cobrarlos de otros conductores».

[216] See the full text of the policy in TRINITY LANE INSURANCE COMPANY, "*Driverless car policy document*", available at https://www.adrianflux.co.uk/pdfs/documents/driverless-car-insurance-policy-document.pdf.

[217] See Section 6, named "Fire and theft cover": «Loss or damage to your vehicle by fire or theft. What we cover: This section applies to your vehicle only. We will cover you under this section if the loss or damage to your vehicle is caused by fire, theft or attempted

3.2 The insurer's right of reimbursement

Similar to what happens in the Italian legal system, the victim can bring the action against the insurer by virtue of Article 7.1 of the LRCSCVM, without prejudice to the insurer's subsequent recourse against the liable third party. This system makes it easier for the victim to collect the compensation, since the insurance company is usually more solvent than the driver or owner of the vehicle causing the damage (against whom the action can be brought alternatively, by virtue of article 1).

However, the insurer, after having paid the victim, may recourse pursuant to Article 10 LRCSCVM against the driver, the owner of the vehicle that caused the damage and the insured person, if the damage caused was due to the

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theft, hacking or attempted hacking of an operating system, authorised software or navigation system (less any excess which applies). We will also provide cover for damage to accessories while fitted to your vehicle or while they are in your locked private garage. We will not pay more than £500 (less any excess which applies) for damage to accessories while they are in your locked private garage. The value of the accessories must be within the maximum amount we pay. We will not pay under this section for loss or damage more specifically covered under section 7 of this insurance [Section 7 – Loss of or damage to in-vehicle entertainment and navigation equipment] ».

fraudulent conduct of any of them or if they were driving under the influence of alcoholic drinks or toxic drugs, narcotics or psychotropic substances, or against any third party responsible for the damage[218].

Nevertheless, some of the cases mentioned in Article 10 of the LRCSCVM are not applicable in relation to autonomous vehicles. This is the case of section a) and section c), on driving under the influence of alcoholic beverages or narcotics or psychotropic substances and the lack of a driving licence.

Article 6 of the LRCSCVM[219] identifies the causes for which the insurer cannot refuse to compensate the victim and

[218] Art. 10 LRCSCVM «Artículo 10. Facultad de repetición de la LRCSCV. El asegurador, una vez efectuado el pago de la indemnización, podrá repetir: a)Contra el conductor, el propietario del vehículo causante y el asegurado, si el daño causado fuera debido a la conducta dolosa de cualquiera de ellos o a la conducción bajo la influencia de bebidas alcohólicas o de drogas tóxicas, estupefacientes o sustancias psicotrópicas. b) Contra el tercero responsable de los daños. c) Contra el tomador del seguro o asegurado, por las causas previstas en la Ley 50/1980, de 8 de octubre, de Contrato de Seguro, y, conforme a lo previsto en el contrato, en el caso de conducción del vehículo por quien carezca del permiso de conducir. d) En cualquier otro supuesto en que también pudiera proceder tal repetición con arreglo a las leyes. (...)».

[219] Article 6 of the LRCSCVM: «Artículo 6. Inoponibilidad por el asegurador. El asegurador no podrá oponer frente al perjudicado

subsequently repeat against the liable party. Similarly to Article 10 of the LRCSCVM, some of the causes foreseen are no longer applicable with the circulation of autonomous vehicles.

In fact, with the introduction of self-driving vehicles, some of the provisions of Article 6 will no longer be relevant. Article 6 does not allow the insurer to obtain indemnity exclusions for the victim if the driver does not have a driving licence or if the driver of the vehicle was under the influence of alcohol or another intoxicating substance at the time of the accident. It is clear that these provisions will cease to be effective with the introduction of self-driving vehicles.

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ninguna otra exclusión, pactada o no, de la cobertura distinta de las recogidas en el artículo anterior. En particular, no podrá hacerlo respecto de aquellas cláusulas contractuales que excluyan de la cobertura la utilización o conducción del vehículo designado en la póliza por quienes carezcan de permiso de conducir, incumplan las obligaciones legales de orden técnico relativas al estado de seguridad del vehículo o, fuera de los supuestos de robo, utilicen ilegítimamente vehículos de motor ajenos o no estén autorizados expresa o tácitamente por su propietario. Tampoco podrá oponer aquellas cláusulas contractuales que excluyan de la cobertura del seguro al ocupante sobre la base de que éste supiera o debiera haber sabido que el conductor del vehículo se encontraba bajo los efectos del alcohol o de otra sustancia tóxica en el momento del accidente. El asegurador no podrá oponer frente al perjudicado la existencia de franquicias. No podrá el asegurador oponer frente al perjudicado, ni frente al tomador, conductor o propietario, la no utilización de la declaración amistosa de accidente».

On the other hand, the aforementioned Article 6 will have to be profoundly modified or read in accordance with the new requirements that will emerge in correspondence with the introduction on the market of self-driving vehicles.

In fact, Article 6 also mentions non-compliance with the technical-legal obligations laid down by the law in force. Therefore, it could be considered that this circumstance could be equated with a lack of maintenance obligations on the part of the owner of the autonomous vehicle[220].

Suffice it to consider, for example, that Regulation 2019/2144 on type-approval requirements for motor vehicles proposes that new vehicles placed on the European market as from 2022 be equipped with a "*tyre pressure monitoring*

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[220] According to data from the DIRECCIÓN GENERAL DE TRÁFICO (2018), "*Anuario estadístico de accidentes*", p. 206, in 2017, on interurban roads, 52 passenger cars involved in accidents with casualties had badly worn or defective tyres, 9 previous steering anomalies and 27 previous brake anomalies. Nevertheless, it does not provide any information on the correlation between the condition of the vehicle and the cause of the accident. In literature, see: Castellis I Marqués (2017), *Vehículos autónomos y semiautónomos*, in S. Navas Navarro, *Inteligencia artificial. Tecnología y derecho*, 1.ª. ed., Tirant Lo Blanch, Valencia, 101-121, p. 114; A. Kock (2018), *Product liability 2.0 - Mere update or new version*?, in Lohsse – Schulze – Staudenmayer (eds.*), Liability for artificial intelligence and the internet of things*, 1ª ed., Nomos Verlagsgesellschaft, Baden-Baden, 99-116, pp. 101-102.

system", defined in Article 3 as "*a system installed on a vehicle that is capable of assessing the tyre pressure or its variation over time and transmitting the relevant information to the user while the vehicle is in motion*".

If the vehicle owner ignores the warning signals of the tyre monitoring system and due to his negligence, the car is involved in an accident, the insurance company could not refuse to compensate the victim.

3.3 Further potential developments in the Spanish insurance system

It is reasonable to assume that the introduction of autonomous vehicles on the market will lead to further developments in the Spanish insurance system. By way of example, suffice it to say that the circulation of autonomous vehicles will make certain cases for which, as of today, the Consorcio de Compensaciòn de Seguros is obliged to indemnify completely obsolete.

In fact, since the identification of vehicles will be easier thanks to electronic devices such as cameras or GPS localisation systems, the hypotheses governed by Article 11.1.a)234 of the LRCSCVM relating to damage caused by an unknown vehicle will diminish considerably.

Similarly, in light of the highly advanced and interconnected technological devices that will be installed in autonomous vehicles, it should be easier to prevent uninsured vehicles from circulating on the roads, making the provision in Art. 11.1.b)235 of the LRCSCVM regarding damage caused by an uninsured vehicle completely obsolete.

In this respect, it is worth mentioning an interesting proposal by the European Parliament where it is proposed to give a new function to bodies assimilated to the CCS, which are required to compensate for damage caused by a motor vehicle used as a means of committing intentional crimes against persons or property, without prejudice to the possibility for the body to claim against the liable party242.

This proposal is contrary to Article 2.3 of RD 1507/2008, which excludes the use of a motor vehicle as an instrument for the commission of intentional offences against persons and property from the concept of road traffic offences. Consequently, Spain will have to adapt to the European indications by amending or deleting Article 2.3.

4. The UK insurance system for Automated vehicles

In 2018, the United Kingdom enacted insurance liability legislation applicable to vehicles that move either fully or partially automatically, as long as those vehicles are on an appropriate list. This legislation is contained in the Automated and Electric Vehicle Act 2018 (hereinafter also Aeva 2018), in force since July of that year[221].

[221] Automated and Electric Vehicles Act 2018, which was given royal seal on 19 July 2018, after it had been approved by the Westminster Parliament under No. 18, at https://www.legislation.gov.uk/ukpga/2018/18/contents/enacted . In literature, see J. Marson-K. Ferris-J. Dickinson, The Automated and Electric Vehicles Act - Part I and Beyond: A Critical Review, 2020, p. 395 ss.; M. Channon, Automated and Elecrtic, Vehicles Act 2018: An Evaluation in light of Proactive Law and Regulatory Disconnect, in European Journal of Law and Technology, 2019, online; A. Glassbrook, An A to Z of automated and electric vehicle law, in Journal of Personal Injury Litigation, n. 3/2021, pp. 140-150; T. Mulder-N. E. Vellinga, Exploring data protection challengers of automated driving, in Computer Law & Security Review, n. 40/2021; N. Goltz-J. Zeleznikow-T. Dowdeswell, From the Tree of Knowledge and the golem of Prague to kosher autonomous cars: the ethics of artificial intelligence through Jewish eyes, in Oxford Journal of Law and Religion, n. 1/2020, pp. 132-156; P. de Gioia Carabellese, Unmanned vehicles e rischi legali ed assicurativi. Una visuale dal Regno Unito della disciplina della responsabilità dei

The Aeva 2018 stipulates that Connected and Autonomous Vehicles, namely vehicles that move on their own, either totally or partially, must be covered by an insurance contract. In light of this, if an accident is caused by a self-driving vehicle, the insurer is obliged to indemnify the third party, without prejudice to its recourse action against the manufacturer of the self-driving vehicle, i.e. the person responsible for the accident[222].

A brief introduction should be made. It should be noted that the Anglo-Saxon insurance system for ordinary cars is almost

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veicoli senza guidatore, in Diritto e politica dei trasporti, n. 1/2021, p. 1 ss.; C. Darling, Autonomous vehicles consultation; are we in the right lane? In Computer & Law, 2021, pp. 70-72; A. Bertolini-M. Riccaboni, Grounding the case for a European approach to the regulation of automated driving: the technology-selection effect of liability rules, in European Journal of Law & Economics, n. 2/2021, pp. 243-284; W. Gill-M. Taylor, Smart roads, in Computer and Telecommunications Law Review, n. 2/2021, pp. 36-37; J. Marson-K. Ferris-J. Dickinson, The Automated and Electric Vehicles Act 2018 Part 1 and beyond: a critical review, in Statute Law Review, n. 3/2020, pp. 395-416; S. Aron-S. Murarka, Autonomous vehicles at the antitrust crossroads, in European Competition Law Review, n. 11/2020, pp. 564-570; E. Salami, Autonomous transport vehicles versus the principles of data protection law: in compatibility really an impossibility? In International Data Privacy Law, n. 4/2020, pp. 330-345.

[222] It should be pointed out that in the United Kingdom, in relation to conventional vehicles, the Road Traffic Act 1988 prescribes that the user of a vehicle (the user) must take out an insurance contract to cover his liability to third parties for damage caused by his negligence. If the injured party does not have an insurance contract, the Motor Insurers' Bureau will compensate the victim.

similar to the one in force in Europe. In the event of an accident, the owner who has taken out an insurance policy calls the insurer as collateral. The owner's liability to the person who has suffered the damage derives from the general principles, and in particular from the historic Scottish case of Donoghue v. Stevenson[223], which was also assimilated by Anglo-Saxon law.

Even in the absence of a contract or contractual relationship between the owner/driver and the injured party - for which no legal action of a civil law nature, which presupposes the existence of a contract, would be conceivable - the injured party can still sue the damaging party, on the basis of the violation of a duty of care, an obligation of diligence that, regardless of existing contractual relationships, is incumbent on anyone who performs a certain activity, which causes damage to others.

Indeed, in English common law, the summoning of the third-party insurer represents an exception to the principle of privity of contract, according to which the contract has no

[223] J.C. Smith-P. Burns, Donoghue v. Stevenson: The Not so Golden Anniversary, in The Modern Law Review, 1983, p. 147 ss.

effect towards third parties and has effect only between the contracting parties [224]. Thus, the insurance contract represents one of the few exceptions to the principle of privity of contract.

Although there is no *ad hoc* definition of the insurance contract in Anglo-Saxon law, there are 'legislative', and not jurisprudential, definitions of the insurance contract in certain disciplines relating to specific sectors. Reference is made to the Consumer Insurance Act 2012, which regulates consumer insurance contracts. In that act, the consumer insurance contract is defined as a contract in which an individual enters into a contract exclusively or primarily for purposes unrelated to his or her self-employment, business or profession. The counterparty, on the other hand, is the entity engaged in the business of insurance on a professional basis, i.e. the insurance company[225].

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[224] See R. Taylor-D. Taylor, Contract Law6, Oxford, 2017, p. 336 ss.: "No party can act upon a contract unless they are a party to it". Relevant precedents: Tweddle v Atkinson [1861]; Dunlop Pneumatic Tyre Co Ltd v Selfridge Ltd [1915]; Beswick v Beswick [1968].

[225] Consumer Insurance (Disclosure and Representations) Act 2012, 8 March 2012, 1. Main Definition: "*In this Act—"consumer insurance contract" means a contract of insurance between — (a) an individual who enters into the contract wholly or mainly for purposes unrelated to the individual's trade, business or profession,*

Similarly, the Marine Insurance Act 1906 also defines the marine insurance contract: "*a contract by which an insurer undertakes to indemnify the insured, in the manner and to the extent agreed, against losses of a marine nature, more precisely, losses affecting maritime activity (marine adventure)*"[226].

Having said this, the fundamental pillar of the Aeva is section 2, sub-section 2. To this end, section 2 states that there is liability of insurers: *"(1) Where — (a)an accident is caused by an automated vehicle when driving itself on a road or other public place in Great Britain, (b)the vehicle is insured at the time of the accident, and (c) an insured person or any other person suffers damage as a result of the accident, the insurer is liable for that damage".*

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and (b) a person who carries on the business of insurance and who becomes a party to the contract by way of that business (whether or not in accordance with permission for the purposes of the Financial Services and Markets Act 2000); "consumer" means the individual who enters into a consumer insurance contract, or proposes to do so; "insurer" means the person who is, or would become, the other party to a consumer insurance contract", at https://www.legislation.gov.uk/ukpga/2012/6.

[226] The Marine Insurance Act is a piece of legislation that codified, in section 17, the jurisprudential principle of utmost good faith, attributable to Lord Mansfield in Carter v Boehm (1766) 3 Burr. 1905. In doctrine cfr. J. Birds, Birds'Modern Insurance Law, London, 2010.

The precept of sub-section 6 of Section 2 is very important, since it states that, except in specific cases covered by Section 4, "*liability under this section may not be limited or excluded by a term of an insurance policy or in any other way*". More specifically, section 4 provides for an exclusion or limitation of liability for damages suffered as a result of an accident where such accident is the result of an alteration of software or a failure in the manner in which strategic equipment should have been installed and updated[227].

According to subsection, it is stipulated that the imposition of liability on the insurer or the vehicle does not affect the liability of any other person in connection with the accident[228].

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[227] Automated and Electric Vehicles Act 2018, Section 4, *Accident resulting from unauthorised software alterations or failure to update software*: *"(1)An insurance policy in respect of an automated vehicle may exclude or limit the insurer's liability under section 2(1) for damage suffered by an insured person arising from an accident occurring as a direct result of — (a)software alterations made by the insured person, or with the insured person's knowledge, that are prohibited under the policy, or (b)a failure to install safety-critical software updates that the insured person knows, or ought reasonably to know, are safety-critical".*

[228] Automated and Electric Vehicles Act 2018, Section 2, Subsection 7: "*The imposition by this section of liability on the insurer or vehicle owner does not affect any other person's liability in respect of the accident".*

In subsection 3, a notion of damage is given, which is particularly useful for judges also for the purpose of defining the allocation of liability. Damage means "*death or personal injury, and any damage to property other than— (a)the automated vehicle, (b)goods carried for hire or reward in or on that vehicle or in or on any trailer (whether or not coupled) drawn by it, or (c)property in the custody, or under the control, of— (i)the insured person (where subsection (1) applies), or (ii)the person in charge of the automated vehicle at the time of the accident (where subsection (2) applies*)."

Section 3 then states that if an insurer or vehicle is liable under Section 2 to the person (the offended party) in connection with an accident and the accident or damage is partly due to the offended party, then its liability will be subject to the limitation under the Law Reform (Contributory Negligence) Act 1945[229].

[229] Automated and Electric Vehicles Act 2018, Section 3. Contributory negligence etc.: *"(1)Where— (a)an insurer or vehicle owner is liable under section 2 to a person ("the injured party") in respect of an accident, and (b)the accident, or the damage resulting from it, was to any extent caused by the injured party, the amount of the liability is subject to whatever reduction under the Law Reform (Contributory Negligence) Act 1945 would apply to a claim in respect of the accident brought by the injured party against a*

In addition, section 3 - subsection 2 states that the insurer or owner is not liable to the person in control of the vehicle if the accident is caused by the negligence of that same person who allowed the vehicle to initiate automatic driving in circumstances where this was not permitted.

The rule aims above all to protect the owner and insurer in the event that a third party decides, in violation of protocols or internal orders, to initiate automatic driving of the car.

In conclusion, the Anglo-Saxon system provides that, without prejudice to the manufacturer's general liability for damages caused by the automatic machine, since he has set up the vehicle to operate autonomously, the owner's liability remains for failure to adapt the software (first and foremost, the installation of updates) or for altering it.

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person other than the insurer or vehicle owner. (2) 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".

5. Further potential developments in the European insurance system: the importance of black boxes

It has already been mentioned in the previous paragraphs that EU Regulation 2019/2144 has mandated the installation of so-called Advanced Driver Assistance Systems (ADAS) in all vehicles, which will also become effective for passenger cars on the market as of July 2024. In addition to ADAS systems, the Regulation made it mandatory to install an 'Event Data Recorder' that stores information before, during and after an accident. More specifically, Article 6 of the Regulation indicates the minimum requirements that Event Data Recorders must meet, stipulating, *inter alia*, that this device cannot be disconnected from the driver.

With regard to data processing, differently from what is found in Italian law, the Regulation provides an initial set of rules applicable to the data collected by Event Data Recorders, establishing that data recording is limited exclusively to the period immediately before, during and immediately after a collision. It follows that further information collected from the vehicle may not be stored.

Furthermore, the Regulation requires that the data recorded in the black box be '*anonymised and protected from manipulation and abuse*'. Furthermore, the regulation specifies that data collected by black boxes can be made available to national authorities via a standardised interface.

It is clear, therefore, that the black box, already provided for in the Italian Private Insurance Code, becomes mandatory for latest-generation vehicles precisely on the basis of European legislation.

UNECE Regulation no. 157 also states that autonomous driving vehicles must be fitted with a black box that monitors the behaviour of the system and that of the user, establishing the need to install a Data Storage System for Automated Driving (DSSAD) [230]. The regulation also establishes that in all situations in which this safety component is not fully

[230] See Art. 8.1, UN Regulation No. 157 – *Uniform provisions concerning the approval of vehicles with regards to Automated Lane Keeping Systems* [2021/38]: "*Each vehicle equipped with ALKS (the system) shall be fitted with a DSSAD that meets the requirements specified below. The fulfilment of the provisions of paragraph 8 shall be demonstrated by the manufacturer to the technical service during the inspection of the safety approach as part of the assessment to Annex 4. This Regulation is without prejudice to national and regional laws governing access to data, privacy and data protection*".

operational and functioning, the vehicle may only be driven in manual mode.

In light of these latest regulatory interventions, it does not seem unreasonable to assume that self-driving vehicles will be equipped with black boxes to monitor their use. Nevertheless, there do not seem to be any more precise indications as to the characteristics of these systems at present. However, it seems reasonable to hope for a more comprehensive regulatory intervention to make it compensable and to reduce the insurance premium paid by users who install such a device.

Chapter VI: Environment and Autonomous Driving

1. The necessity to ensure environmental protection

This chapter analyses the ecological improvement that the introduction of autonomous driving will lead. Indeed, the first chapter will be focused on the environmental impact and the contribution in the fight against pollution and CO2 that autonomous vehicles could led.

Environmental issues are an increasing and frequently debated topic. Although the objective of '*Protecting and improving the environment for present and future generations*' has been an international goal since the Stockholm Declaration of 1972[231], it is only in recent years that national legislators have begun to take the threat posed by global warming and environmental pollution seriously.

[231] United Nations Declaration on the Human Environment, Conference on the Human Environment, held in Stockholm 5-16 June 1972.

In the following, therefore, European policies will be highlighted, emphasising the peculiarities of the environmental policies adopted by Spain and Italy. More specifically, it can already be observed that there is a tendency to conceive the environment 'as a good' according to a holistic approach, thus considering it a value in itself[232]. In this scenario, it seems useful to observe how the use of self-driving cars and the divestment of fossil fuels is one of the main objectives, shared by almost all European countries.

1.1 Environmental protection in the European legal system

The Treaty on the Functioning of the European Union (hereafter 'TFEU') does not provide a definition of 'environment', limiting itself to the definition of 'ecosystem', which is understood as a dynamic ecosphere in which flora and fauna interact with the environment in multiple series of reciprocal interactions.

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[232] See: Caravita, *Diritto pubblico dell'ambiente,* Bologna, 2001; Cecchetti, *Principi costituzionali per la tutela dell'ambiente,* Milano, 2000; Spatigati, *Le categorie necessarie per lo studio del diritto dell'ambiente,* in *Riv. Giur. Amb.,* 1999, 228.

It must be premised, in fact, that at least at the time when the founding treaties of the European Communities[233] were drafted, the protection of the environment had not yet become an issue of particular urgency. In fact, it is with the economic and social development that has taken place since the 1970s that the need to develop a common environmental policy has been increasingly felt[234].

In fact, it was in the 1970s that the debate on environmental protection began to develop. In 1972, the United Nations Stockholm Conference on the Human Environment took place, in which the European Commission also participated. The conference led to the issuing of a United Nations Declaration in which 26 principles concerning human rights, duties and responsibilities towards the environment were affirmed. On the basis of the Stockholm Declaration, the heads of state recognised the importance of adopting an EU environmental policy as soon as possible.

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[233] The reference is to the Treaties of Rome of 25 March 1957, marking the birth of the then European Economic Community (EEC) and the European Atomic Energy Community (Euratom).

[234] Not even the European Convention on Human Rights, adopted in 1950, expressly mentions the environment as a good worthy of protection.

About a decade later, with the Single European Act of 1987, Title XX on the Environment was introduced into the Community Treaty. Thus, the European Community officially recognised the importance of acting proactively with a view to ensuring the protection of the environment, preserving human health and ensuring the rational use of natural resources.

Subsequently, during the Rio de Janeiro Conference in 1992, the first world conference on the environment (also called the 'Earth Summit'), issues concerning the development of an environmental policy in order to safeguard the environment were extensively dealt with. In particular, the Rio Conference produced Agenda 21, which highlighted the reasons why human societies should start addressing environmental issues in a more serious and respectful manner.

As a result of the Rio Conference, the European Community introduced the concept of '*sustainable development*' into the Maastricht Treaty, in order to ensure a form of economic and social development that respects the environment and is aimed at not precluding a healthy environment for future generations. More specifically, the Maastricht Treaty introduced, as is well known, the co-decision procedure in the area of the European Community's environmental policies, requiring qualified majority voting in the Council.

The EU's decision to adopt measures to ensure a more meaningful protection of the environment was made even more manifest with the Lisbon Treaty[235], which expressly stated in Art. 3(3) that the EU shall promote: "*the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress, and a high level of protection and improvement of the quality of the environment*".

More specifically, with the introduction of the Lisbon Treaty, the EU's shared competence with the member states in dealing with environmental issues was formalised (Art. 4(2)(e) TFEU).

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[235] Treaty of Lisbon, 13 December 2007, consisting of the Treaty on European Union (TEU) and the Treaty on the Functioning of the European Union (TFEU).

More recently, in its Communication to the European Parliament[236], the Council, the European Economic and Social Committee and the Committee of the Regions, the European Commission highlighted the importance of pursuing '*sustainable environmental development*' that '*meets the needs of today without compromising the ability of future generations to meet their own needs*'. Among the many goals set, the reduction of carbon emissions stands out in importance.

Most recently, the EU reaffirmed these principles in the European Green Deal, in which the EU expressly stated that it aims to reduce climate-altering gases by 2030[237].

In order to make the political commitments adopted with the Green Deal binding, the European Climate Act was passed with the aim of achieving climate neutrality by 2050. The legislation pursues the goal of reducing pollutant emissions

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[236] Communication from the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *Europe's sustainable future: next steps. European action for sustainability,* Strasbourg, 22 November 2016.

[237] Communication from the European Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *The European Green Deal,* COM(2019) 640 final, 11 December 2019.

from 40% to 55% by 2030. In particular, the EU specifies that in order to achieve this goal, it is necessary to involve all sectors of the economy, expressly including the transport and mobility sector More specifically, the EU aims to develop intelligent and, above all, eco-friendly transport and mobility systems capable of ensuring a significant decrease in CO2 emissions and, more generally, in global pollution. Therefore, it is clear that the EU is promoting the use of self-driving cars that will hopefully gradually replace ordinary cars.

In order to achieve the goal of climate neutrality by 2050, the EU has taken specific measures to reduce car emissions. The EU aims to reduce emissions from cars by 55 per cent and from vans by 50 per cent by 2030, compared to 2021, in order to achieve zero emissions for new cars and vans by 2035.

For this reason, EU Regulation 2023/851 was adopted on 19 April 2023, amending Regulation (EU) 2019/631 with regard to strengthening the CO2 emission performance standards for new passenger cars and light commercial vehicles, in line with the Union's increased climate ambition[238].

The regulation stipulates that from 2035 onwards, all new cars coming onto the market must be CO2-neutral, in order to ensure that the transport sector can become zero-emission by 2050.

It is therefore clear that the introduction of self-driving vehicles fits in well with the EU's desire to significantly reduce CO2 emissions, and it is therefore possible to assume that the process of bringing such vehicles onto the market will be accelerated.

The implications of environmental, social and regulatory policies (Environmental, Social and Governance) aimed at countering the effects of climate change in both Italian and Spanish law will be analysed more specifically below.

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[238] REGULATION (EU) 2023/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 April 2023 amending Regulation (EU) 2019/631 as regards strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition, see: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R0851.

2. ESG: state of the art and regulatory perspectives in Italian and Spanish law

The growing attention given to environmental issues and the need to identify instruments through which to ensure 'sustainable' economic growth have led to the conception of a model based on the full integration of environmental, social and governance factors. In fact, the syntagm ESG (Environmental, Social and Governance) alludes to a financial system aimed at ensuring the implementation of policies to counter the effects of climate change [239].

In this regard, it is necessary, on the one hand, that practices are developed to identify, measures and avert the occurrence of such risks, and on the other hand, it is important that companies equip themselves with an operating model to

[239] M. Stella Richter jr., Long-Termism, in Riv. Soc., I, 2021, 16 ss., which highlights how the ESG relates to three factors that are inhomogeneous and inconsistent from the point of view of the conception of social interest that they presuppose. Hence their contradictory nature at least on a conceptual level'.

prevent unfair practices (e.g. greenwashing) that would hinder the development of sustainable finance[240].

Italy lacks a specific body of legislation on ESG. However, it is possible to identify provisions aimed at protecting the environment and preserving the ecosystem or enacted with the primary purpose of improving environmental and social sustainability and corporate governance. In this framework, it is important to highlight the compliance of AV regulation to those rules. In order to do so, it is necessary to analyse the Italian legislation related to ESG[241].

[240] M. Stella Richter jr, cit., according to which it is not necessarily the case that pursuing socio-environmental and governance sustainability in the choice of investment makes the investment itself sustainable for the same reasons that economic-financial sustainability may not go (id est: does not necessarily go) hand in hand with socio-environmental sustainability.

[241] With regard to environmental protection, the main dispositions are the following: the EU Directive 2004/35/EC on environmental liability, Article 2043 of the Civil Code, which sanctions conduct that causes damage to the environment, legislative decree 152/2006, which contains the main rules governing environmental regulations, legislative decree 231/2001 on the criminal liability of entities for crimes committed by managers and supervisors in the interest or to the advantage of the entity (including environmental crimes), Law 221/2015 on environmental measures to promote the green economy and to curb the use of natural resources, Decree-Law 111/2019, on 'Urgent measures to comply with the obligations under Directive 2008/50/EC on air quality'.

With regard to social sustainability, the main dispositions are the following: legislative decree 81/2008 on the protection of workers' health and safety in the workplace and law 199/2016 on combating 'caporalato' (forced labour) are worth mentioning.

In 2021 the Second National Action Plan on Business and Human Rights for the period 2021-2026 was adopted[242], where the Italian legislature '*implements the recommendations addressed to Italy on the occasion of the third cycle of the Universal Periodic Review (2019-2020) concerning the prevention and management of the risk - in terms of policies, legislative and administrative measures - of business involvement in potential human rights violations in conflict situations, and the support to businesses in the implementation of legislative measures to combat forms of labour exploitation in the agricultural sector*'.

In this regard, in the *"Afterword by the Undersecretary for Foreign Affairs and International Cooperation"* it can be read

Finally, with regard to governance policies, the main dispositions are the following: Articles 2086 and 2391 of the Italian Civil Code come to the fore, Law 190/2012 which identifies the conditions that companies owned or controlled by the Italian State must comply with in order to adopt anti-corruption models, EU Regulation 2088/2019 on sustainability disclosure in the financial services sector, EU Directive 2021/1269 on the integration of sustainability factors into product governance obligations, EU Regulation 2021/1253 on the integration of sustainability factors, sustainability risks and sustainability preferences into certain organisational requirements and conditions of operation of investment firms' activities.

[242] See: *https://cidu.esteri.it/ComitatoDirittiUmani/resource/doc/2021/12/secondo_pan_bhr_ita.pdf*

that: "*relevant in the Plan is the treatment of issues and practices related to the protection of the environment, health, decent work and 'Human Rights Defenders*', *in the face of the new challenges posed by the gig economy and in the context of the National Recovery and Resilience Plan (NRP), in correlation with the opportunities offered in the perspective of post-pandemic reconstruction. It also seems necessary to investigate new issues related to technological development and artificial intelligence, in order to highlight their possible impact on the enjoyment of human rights*'.

It is evident that the Italian government purpose is to implement the technological development and the use of A.I. in the next future in order to protect the environment, improve health standards and increase economic competitiveness. In this regard, it is clear that the use of AVs could be extremely helpful and propitious.

Having said that, it is important to analyse the Spanish regulation too in this field. In this regard, the Spanish Parliament and the Central Government have enacted specific provisions, to which are added in some cases - especially in the environmental and social sectors - regulations issued by some regional authorities. It is clear from this review that the ESG regulatory framework in Spain is composed of hard regulation and soft codes[243].

It is important to highlight the compliance of Spanish and Italian AV regulation to those rules. In order to do so, it is necessary to analyse the Italian and Spanish legislation related to ESG.

2.1 Environmental: violation of regulations

[243] Among the ESG regulations issued at the national level, it is worth mentioning Law 11/2018, which implemented the NFRD in Spain; and Law 5/2021, which implemented the SRD2 in Spain.
With regard to the provisions enacted on the environment, they mainly focus on the energy transition and include Law 26/2007 on environmental responsibility; Law 22/2011 on waste and contaminated soil; Royal Decree 564/2017 on energy efficiency certification of buildings; Royal Decree 617/2017 on alternative energy vehicles; Royal Decree-Law 15/2018 on urgent measures for energy transition and consumer protection; and Law 7/2021 on climate change and energy transition.
Statutes relating to the social sphere, which focus mainly on equality, non-discrimination and reconciliation, include Royal Decree-Law 6/2019 on urgent measures to ensure equal treatment and opportunities for women and men in employment and work; Royal Decree-Law 28/2020 on remote working; Royal Decree-Law 901/2020 on equality plans and their registration; Royal Decree-Law 902/2020 on equal pay for women and men; Royal Decree-Law 10/2021 on remote work; Royal Decree-Law 4/2022 on the protection of consumers and users in situations of social and economic vulnerability; and Organic Law 6/2022 on equal treatment and non-discrimination. Governance-related statutes, which focus on governance and long-term shareholder engagement, include Law 11/2018; and Royal Legislative Decree 1/2020 approving the consolidated text of the Companies Law.

The automotive industry is a major source of air pollution that contributes to the modification of the normal composition of the atmospheric air by fumes, gases, dust, odours and numerous other pollutants that alter the healthiness of the environment.

Much of the air pollution is caused by car emissions. In fact, car exhausts put into the air: carbon monoxide which is an odourless and colourless gas that is very poisonous, sulphur oxide which is equally toxic and polluting, and nitrogen oxide which contributes to the formation of ozone.

The effects of the massive introduction of these substances into the atmosphere are now well known. In recent years, there has been a general rise in global temperature (the so-called greenhouse effect), there has been a considerable increase in smog, and acid rain is becoming increasingly frequent, causing tangible damage to people's health.

Climate change is producing increasingly evident effects that directly affect the lives of individuals. As a result, there is an exponential increase in the number of legal actions brought by individuals or representative associations against states or corporate groups operating in the energy sector in order to obtain compensation, stop damaging behaviour and restore (where possible) the status *quo ante*.

At the international level, there are numerous rulings on the subject. In this regard, it is worth mentioning the ruling of 24 March 2021 by the German Constitutional Court[244], where it was affirmed that the national regulations governing emissions are in conflict with the fundamental rights enshrined in the Constitution. No less important is the ruling in which the District Court of The Hague ordered Royal Dutch Shell PLC to reduce emissions by 45% compared to 2019 by 2030[245].

Similarly, the Dutch Court of Cassation upheld the Dutch order to reduce greenhouse gas emissions by 25% compared to 1990 levels[246].

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[244] See: German Constitutional Court, 24 March 2021, at https://www.bundesverfassungsgericht.de.

[245] See Corte distrettuale de L'Aja, ECLI:NL:RBDHA:2021:5339, 26 may 2021.

[246] Corte distrettuale de L'Aja, Urgenda v The State of the Netherlands, ECLI:NL:RBDHA:2015:7145, 24 giugno 2015; Corte

Although the international scene is teeming with 'climate justice'[247] pronouncements in Italy, no significant 'climate litigation' has yet developed. In this regard, it should be pointed out that the Italian state has been sued by a consumer association, which is demanding that it be ordered to reduce greenhouse gas emissions by 92% compared to 1990, by 2030[248].

That said, one must ask whether the current physiognomy of the Italian civil process can offer solutions to the growing demand for access to (climate) justice. In fact, the Italian legal system provides a specific discipline only for environmental damage, while climate litigation can be defined as still an unexplored ground. Therefore, before considering such litigation admissible, it is necessary to reflect on the

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d'appello de L'Aja, Urgenda v The State of the Netherlands, ECLI:NL:GHDHA:2018:2591, 8 ottobre 2018; Corte di cassazione, ECLI:NL:HR:2019:2007, 13 gennaio 2020.

[247] Sul tema della giustizia climatica, cfr. Dryzek-Norgaard-Schlosberg, The Oxford Handbook of Climate Change and Society, Oxford, 2011; Jafry, Routledge Handbook of Climate Justice, New York, 2019; Jean-Baptiste-Abate-Tigre-Ferreira, Burns, Recent Developments in Climate Justice, in Environmental Law Reporter News & Analysis, vol. 47, no. 12, 2017, pp. 11005-11017.

[248] See: *https://giudiziouniversale.eu/.* On this point, see: Viviani, Climate change litigation: what liability for the omission of appropriate measures to combat climate change?, in *Amb. & svil.*, 2020, 599 ff.

existence of the requirements of the action[249] and the constituent elements of the claim.

Although there seems to be no doubt about the abstract admissibility of a claim for damages, the admissibility of such an injunction claim before the Italian courts may be questioned[250].

In the Spanish legal system, on 15 September 2020, Greenpeace Spain, Oxfam Intermón and Ecologistas en Acción filed a motion to notify the Supreme Court of their intention to sue the Spanish government, arguing that it had failed to take adequate action on climate change.

According to the plaintiffs' prospectus, Spain had allegedly violated Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on

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[249] G. Ghinelli, *Le condizioni dell'azione nel contenzioso climatico: c'è un giudice per il clima?,* in *Riv. trim. proc. civ.*, IV, 2021, 1273 ss.
[250] On 30 September 2020, the Supreme Court admitted the claim and requested the Ministry of the Presidency to submit its administrative file within 20 days. After the government submitted its file, the claimants asked the Court to order an extension of the file, arguing that the file submitted by the government was incomplete. The Court rejected this request and the plaintiffs appealed.

Energy Union Governance and Climate Action. Furthermore, according to the plaintiffs, by December 2019 Spain should have approved a National Energy and Climate Plan with climate targets for 2030 and a Long-Term Strategy with targets for 2050, but the draft plan would not be consistent with the Paris Agreement and the IPCC recommendations to keep global warming at 1.5 degrees Celsius.

In the meantime, on 3 November 2020, the Spanish Council of Ministers approved a Long-Term Decarbonisation Strategy for 2050, and for this reason, the State Attorney's Office filed a motion to dismiss the plaintiffs' claims regarding the Long-Term Strategy.

Subsequently, and more precisely on 15 December 2020, the plaintiffs filed the case in the Supreme Court, claiming that Spain has unlawfully failed to produce a National Energy and Climate Plan with climate targets for 2030, in violation of national law, EU regulations and obligations under the Paris Agreement.

In March 2021, the government approved the National Energy and Climate Plan and, therefore, the defendants filed a pleading requesting that the case be dismissed for lack of subject matter jurisdiction. The plaintiffs filed their response on 26 May 2021. Meanwhile, the plaintiffs filed another lawsuit challenging the National Energy and Climate Plan.

The Supreme Court dismissed the defendants' motion to dismiss for lack of subject-matter jurisdiction. The Court held that the approval of the National Energy and Climate Plan did not exhaust the plaintiffs' claims, as their demands were broader than simply approving the Plan. On the contrary, they demanded that the Plan be ordered to be more ambitious to be aligned with the goals of the Paris Agreement.

On 20 June 2023, the Supreme Court issued its final decision on the case Greenpeace v. Spain I, known as the climate trial ('*el juicio por el clima*')[251]. The decision was notified to the parties, ruling in favour of the Spanish government and against environmental and human rights organisations.

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[251] Greenpeace v. Spain I, available at: https://climatecasechart.com/non-us-case/greenpeace-v-spain/#:~:text=On%20December%2015%2C%202020%2C%20plaintiffs,obligations%20under%20the%20Paris%20Agreement.

Specifically, the plaintiffs claimed that the National Energy and Climate Plan 2021-2030 (PNIEC) approved by the Spanish government was not ambitious enough to meet the temperature targets of the Paris Agreement. Spain's Energy and Climate Plan 2021-2030 is the main Spanish instrument that defines greenhouse gas emission reduction targets, sets renewable energy and energy efficiency targets for the period 2021-2030.

In fact, the Supreme Court's decision holds that the Spanish government acted in accordance with the Paris Agreement and cannot be held liable for non-compliance.

The Supreme Court emphasises that, although the Paris Agreement and subsequent EU commitments and adopted regulations constitute the minimum limit for Member States to adopt their own regulations, it cannot be concluded that the Spanish government failed to adopt a regulation when the approved regulation is aligned with the EU commitments to which the Spanish state is party, such as the Paris Agreement.

2.2 **Social: prevention and implications**

Relevant issues from a social point of view include those relating to the safety of the company's workers. In this respect, of particular relevance in the Italian landscape is Legislative Decree 231/2001, which, by regulating the liability of entities, requires companies to have an organisational model designed to prevent criminal conduct by directors or employees.

Legislative Decree 231/2001 establishes that a company cannot be sanctioned if, prior to the occurrence of the offence, it has adopted and effectively implemented systems of organisation, risk management and control (the '231 Model'), aimed at preventing this type of offence and has set up a body to supervise their operation and compliance (the '231 Body').

Although the 231 Model is normally used to avert risks related to environmental, social and governance issues, Legislative Decree 231/2001 does not introduce an obligation to prepare measures to specifically prevent ESG risks or to develop a strategy to prevent the occurrence of such risks.

It is possible to believe that an implementation of these provisions could have prevented the events that occurred at the former Ilva plant in Taranto, which turned into a tortuous judicial affair[252]. It will be recalled, in fact, that the polluting emissions of Ilva's largest plant (located in Taranto) caused the death of many workers and that the company's top management was indicted for the crimes of culpable and intentional disaster, poisoning of foodstuffs, intentional omission of precautions against accidents at work, aggravated damage to public property, throwing and spilling of hazardous substances and atmospheric pollution.

In a similar vein, it is worth mentioning the judgment of the Court of Appeal of Ancona[253], which dealt with the claims brought against Fincantieri by the family of a worker, who

[252] In particular see: Corte App. Lecce, sez. pen. dist. Taranto, 23 June 2017, no. 563, with note by Jann V., Amianto nello stabilimento ILVA di Taranto: le motivazioni della sentenza di appello del processo a carico di ventisette ex dirigenti della società, in Dir. pen cont., fasc. 12/2017.

[253] App. Ancona, 26 May 2020, no. 70.

died as a result of exposure to asbestos, because he was forced to work without individual protection tools and in a contaminated environment.

In a similar perspective, such a regulation could be extended to AVs producers in order to prevent their liability when damages occur. Indeed, an implementation of Legislative Decree 231/2001 could lead to a more protective scenario for both producers and users, since the compliance of some requirements could lead to avoid similar risks.

Spanish regulation is very similar to Italian one[254]. Indeed, in 2010 the Spanish legislator modified the Spanish Criminal Code regulating the liability of entities. More specifically, the

[254] It is important to note that there are several law provisions in the Spanish jurisdiction related to social considerations. In the following, there are some examples: Royal Decree 193/2023, of March 21, which states the basic conditions of non-discrimination of people with disabilities; Law 4/2023, of February 28, for the equality of trans people and for the guarantee of the rights of LGTBI people; Organic Law 10/2022, of September 6, on the comprehensive guarantee of sexual freedom; Law 15/2022, of July 12, regarding the equal treatment and non-discrimination; Royal Decree 901/2020, of 13 October, regulating equality plans and their registration; Royal Decree 902/2020, of 13 October, on Equal Pay for Women and Men.

liability of legal entities was introduced for the first time in the Criminal Code in the 2010 reform, with article 31 *bis*[255].

[255] Artículo 31 bis Codigo Penal: "*1. En los supuestos previstos en este Código, las personas jurídicas serán penalmente responsables: a) De los delitos cometidos en nombre o por cuenta de las mismas, y en su beneficio directo o indirecto, por sus representantes legales o por aquellos que actuando individualmente o como integrantes de un órgano de la persona jurídica, están autorizados para tomar decisiones en nombre de la persona jurídica u ostentan facultades de organización y control dentro de la misma. b) De los delitos cometidos, en el ejercicio de actividades sociales y por cuenta y en beneficio directo o indirecto de las mismas, por quienes, estando sometidos a la autoridad de las personas físicas mencionadas en el párrafo anterior, han podido realizar los hechos por haberse incumplido gravemente por aquéllos los deberes de supervisión, vigilancia y control de su actividad atendidas las concretas circunstancias del caso.*
2. Si el delito fuere cometido por las personas indicadas en la letra a) del apartado anterior, la persona jurídica quedará exenta de responsabilidad si se cumplen las siguientes condiciones: 1.ª el órgano de administración ha adoptado y ejecutado con eficacia, antes de la comisión del delito, modelos de organización y gestión que incluyen las medidas de vigilancia y control idóneas para prevenir delitos de la misma naturaleza o para reducir de forma significativa el riesgo de su comisión; 2.ª la supervisión del funcionamiento y del cumplimiento del modelo de prevención implantado ha sido confiada a un órgano de la persona jurídica con poderes autónomos de iniciativa y de control o que tenga encomendada legalmente la función de supervisar la eficacia de los controles internos de la persona jurídica; 3.ª los autores individuales han cometido el delito eludiendo fraudulentamente los modelos de organización y de prevención y 4.ª no se ha producido una omisión o un ejercicio insuficiente de sus funciones de supervisión, vigilancia y control por parte del órgano al que se refiere la condición 2.ª En los casos en los que las anteriores circunstancias solamente puedan ser objeto de acreditación parcial, esta circunstancia será valorada a los efectos de atenuación de la pena.
3. En las personas jurídicas de pequeñas dimensiones, las funciones de supervisión a que se refiere la condición 2.ª del apartado 2 podrán ser asumidas directamente por el órgano de administración. A estos efectos, son personas jurídicas de pequeñas dimensiones aquéllas que, según la legislación aplicable, estén autorizadas a presentar cuenta de pérdidas y ganancias abreviada.
4. Si el delito fuera cometido por las personas indicadas en la letra b) del apartado 1, la persona jurídica quedará exenta de

According to the provisions of the Criminal Code, in certain cases no liability of entities can arise. In order to be exonerated from any liability consequences, companies are required to have an organisational model designed to prevent criminal conduct by directors or employees.

It is necessary an implementation of the existing legislation in order to prevent any risks related to AVs deployment.

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responsabilidad si, antes de la comisión del delito, ha adoptado y ejecutado eficazmente un modelo de organización y gestión que resulte adecuado para prevenir delitos de la naturaleza del que fue cometido o para reducir de forma significativa el riesgo de su comisión. En este caso resultará igualmente aplicable la atenuación prevista en el párrafo segundo del apartado 2 de este artículo.
5. Los modelos de organización y gestión a que se refieren la condición 1.ª del apartado 2 y el apartado anterior deberán cumplir los siguientes requisitos: 1.º Identificarán las actividades en cuyo ámbito puedan ser cometidos los delitos que deben ser prevenidos. 2.º Establecerán los protocolos o procedimientos que concreten el proceso de formación de la voluntad de la persona jurídica, de adopción de decisiones y de ejecución de las mismas con relación a aquéllos. 3.º Dispondrán de modelos de gestión de los recursos financieros adecuados para impedir la comisión de los delitos que deben ser prevenidos. 4.º Impondrán la obligación de informar de posibles riesgos e incumplimientos al organismo encargado de vigilar el funcionamiento y observancia del modelo de prevención. 5.º Establecerán un sistema disciplinario que sancione adecuadamente el incumplimiento de las medidas que establezca el modelo. 6.º Realizarán una verificación periódica del modelo y de su eventual modificación cuando se pongan de manifiesto infracciones relevantes de sus disposiciones, o cuando se produzcan cambios en la organización, en la estructura de control o en la actividad desarrollada que los hagan necesarios”.

2.3 Governance: the directors liability

In order to give a full picture of the state of art of ESG regulation is important to analyse also the aspect related to companies' governance that, in the future, will affect also AVs producers.

In December 2021, the Report on the Evolution of Corporate Governance in Listed Companies was published, incorporating the Ninth Report on the Application of the Corporate Governance Code in Italy.

It should be pointed out that the adoption of the principles of the Self-Regulatory Code by Italian listed companies is not mandatory but subject to the will of the individual companies. However, once the individual company decides to comply with these rules, it will be bound by them, in accordance with the 'comply or explain' rule.

In particular, the Italian Court of Cassation, in its rulings No. 5 of 3 January 2019 and No. 301 of 9 January 2019, stated that directors are required to comply with the voluntary code adopted by the company they administer[256].

Furthermore, the Court of Rome, in a ruling of 8 April 2020, ruled that directors may not unreasonably deviate from voluntarily adopted self-regulatory codes [257].

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[256] Cass. 3 January 2019 no. 5: "*The correct application of the principles just referred to requires that the self-regulatory rules provided for by internal provisions must also be considered binding for the company, even if they are more stringent than the general provisions laid down by law, regulatory sources or self-regulatory codes. When the company, as the result of an entirely free choice, decides to adopt rules of business conduct and to express this decision to the market, it is in fact bound to comply with them, the above choice representing a voluntary self-restraint on the part of the market operator*".

[257] Trib. Rome, Corporate Chamber, 08 April 2020: "*The meaning and limits of the business judgement rule also apply to the directors' organisational choices. The organisational function always falls within the broader sphere of corporate management and must necessarily be exercised employing an irrepressible margin of freedom, so that the decisions relating to its performance are included among the strategic decisions. Moreover, the preparation of an organisational structure does not constitute the object of an obligation with specific content, but, on the contrary, of an obligation that is not predetermined in its content, which acquires concreteness only having regard to the specificity of the business exercised and of the moment in which that organisational choice is made. This organisational obligation can be effectively discharged by looking not so much at rigid regulatory parameters (since a model of organisation that is useful for all situations cannot be deduced from the code), but rather at the principles elaborated by the corporate sciences or by trade associations or self-regulatory codes*".

Among the companies that have complied with ESG principles in Italy it is worth to mention Snam S.p.A. ('Snam'), which has updated its articles of association to expressly pursue “sustainable success"[258].

However, it should be noted that there are no legal rules in Italian law that expressly require directors to comply with ESG principles. In fact, under Italian law, there is no duty for directors to change the company's strategy to address ESG risks. This does not exclude that if an ESG issue triggers a potential breach of applicable legislation (e.g. on waste management and environmental protection or the obligation to pay social security contributions to employees), liability of directors (both civil and criminal) would arise in the event of omissive behaviour.

The new Article 2086 of the Italian Civil Code (originally included in Article 375 of the new Crisis Code) has introduced new obligations for entrepreneurs and directors,

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[258] See: *https://www.snam.it/repository/file/investor_relations/bilanci_relazioni/bilanci_annuali/2020/sosten-indicizzati-2020/01-Purpose-SDGs.pdf*

including that of having organisational, administrative and accounting structures appropriate to the size and nature of the business.

This provision stipulates that director must apply best governance practices in order to minimise financial risks (which directly affect the company's economic-financial equilibrium) and non-financial risks, as well as factors that could jeopardise the company's ability to continue as a going concern.

It follows that an enhancement of this provision in the interpretation could lead to an implementation of the duties incumbent on directors in relation to the implementation of best governance practices, among which it is possible to include those relating to environmental and social issues.

In the Spanish framework, there are several provisions regulating this field[259]. In this regard, it worths to mention

[259] See: Law 2/2023, of February 20, that protect people who report regulatory infractions and the fight against corruption; Law

Law 11/2018 that covers the majority of all ESG aspects. The advantages of following such provisions implies an improvement in the reputation of the company, the possibility to access to new markets and to save costs by implementing environmental measures[260].

Even if the regulatory frameworks seem similar to Italian one, there has been no material litigation comparable to Italian ones with respect to ESG issues, although there have been some ESG related disputes. Nevertheless, it is reasonable to think that in the next future there will be an increasing number of disputes ESG related.

2.4 Sustainable finance and possible developments in litigation and dispute resolution

1/2023, of February 20, on Cooperation for Sustainable Development and Global Solidarity; Law 11/2018, of 28 December, approving the Code of Commerce ("Law 11/2018"); the revised text of the Capital Companies Act approved by Royal Legislative Decree 1/2010, of 2 July; The Corporate Enterprises Act (Ley de Sociedades de Capital, or "LSC"), modified by Law 11/2018.

[260] For more information, please see I. Cisneros – C. Eguiraun – A. Tallulah Jones, in *Environmental, Social & Governance Law 2024*, 201 ff., available at: *https://www.rocajunyent.com/sites/default/files/content/file/2024/03/07/1/esg24_chapter-26_spain_e-version.pdf.*

The rising attention given to environmental issues also involves the topic of sustainable finance. In fact, the European Union aims to spread a sustainable economy model across Europe by introducing a regulatory framework aimed at steering the investment and financing choices of financial sector operators towards sustainable investments.

The European project to achieve a sustainable economy began with the publication of the 'Action Plan for Sustainable Finance' in March 2018. Subsequently, the European Commission published the so-called Green Deal, by which a detailed action plan was drawn up with the aim of achieving climate neutrality in 2050. Among the main objectives the Green Deal aims to achieve is the promotion of sustainable investment and finance through the introduction of a common taxonomy of labelling and disclosure requirements and rules of conduct. The aim is to foster the emergence of a common market for 'green' products and, at the same time, to strengthen investor confidence in sustainable finance.

It is clear that AVs are among the so called “green products” that the EU policy is encouraging to adopt. The reasons is quite simple: the massive use of AVs would reduce drastically the environmental pollution.

On 18 June 2020, the Taxonomy Regulation was issued, which, as seen above, aims to implement sustainable investments by discouraging unfair business practices (e.g. greenwashing). Also worth mentioning is the EU Regulation 2019/2088 of 27 November 2019 on Sustainability-Related Disclosures in the Financial Sector ("SFDR Regulation").

In this regard, it should be noted that the investments aimed at achieving climate neutrality in 2050 include the automotive sector since, as we have seen, this is an industry of strategic importance for achieving the climate neutrality goals pursued at European level.

3. Autonomous vehicles and their environmental impact

In recent years, several important research regarding the environmental impact of AVs have been conducted[261]. In these studies, it has been highlighted that the benefits of the introduction of autonomous vehicles is not limited to the reduction of CO2 emissions.

Indeed, the environment could benefit from AVs' spread registering a valuable decreasing of noise, light pollution and traffic congestion.

Nevertheless, it has been pointed out that AVs could also have a negative impact on the traffic jam, cause the number of people able to use a car will be exponentially increased and also the kilometers that those vehicles will be able to drive is

[261] Massar - Reza -Rahman - Abdullah - Jamal - Al-Ismail, *Impacts of Autonomous Vehi-cles on Greenhouse Gas Emissions-Positive or Negative?,* in *Int. J. Environ Res Public Health*, 2021, 18. The text is available at the following link: *https:/www.mdpi.com/1660-4601/18/1/5567*; Silva - Cordera - Gonzales-Gonzales - Nogues, *Environmental impacts of autonomous vehicles: A review of the scientific literature,* in *Science of The Total Environment*, 2022, 830. The text is available at: *https://www.sciencedirect.com/science/article/pil S0048969722017089;* Alexander - Kearns - Peterson - Cassady, *The Impact of Vehicle* Automation *on Carbon Emissions,* in *Centre for American Progress*, 18 November 2016, at: *<https://www.american-progress.org/issues/green/reports/2016/11/18/292588/the-impact-of-vehicle-automation-on-car- bon-emissions-where-uncertainty-ies/.*

destined to boost. Some scholars, talk about it as "environmental ambivalence"[262].

In this light, the use of AVs could have even a negative impact on the environment. Indeed, it is possible to imagine that those vehicles will allow to a wider public to use this technology. The immediate consequence is a rise of the number of users and an increase of the distance potentially driven.

For this reason, it is important to implement guidelines and policies in order to prevent those scenarios. In this case, the role of EU and national legislators is essential.

With this in mind, the following chapter will highlight further implications that arise with regard to ethical issues and the case where an autonomous vehicle commits a road accident by applying the lessons learned autonomously through deep learning software.

[262] This issue is clearly explained by L. Butti, *Auto a guida autonoma e impatto ambientale,* in AA.VV., *Veicoli a guida autonoma e veicoli a impatto zero*, edited by G. Cassano e L. Picotti, Pisa, 2023, 49.

Chapter VII: Autonomous vehicles and machine learning

1. AI, Self-driving cars and deep learning

In the previous paragraphs, the need for uniform legislation on this point has already been highlighted. However, regulating technology is very difficult. In fact, the principle of technological neutrality, which has been affirmed in the drafting of UNCITRAL (United Nations Commission on International Trade Law), states that law should remain neutral with respect to technology, refraining from enacting rules to regulate technical issues [263]. According to this principle, therefore, the legislator should limit its work to identifying goals to be achieved.

In order to understand the heterogeneity of the phenomenon, it should be pointed out that the regulatory measures currently in force do not seem adequate to resolve the numerous legal issues that may arise.

[263] The principle of technological neutrality has been expressly adopted by the European legislator. Take, for instance, Regulation (EU) No 910/2014, the so-called e-IDAS Regulation, when it introduced definitions of electronic signature and advanced electronic signature not referring to specific technologies.

Indeed, A.I. technology has experienced an impressive development in recent years, to the point of influencing social life and the global economy. In the light of the above, an analysis of the interaction between autonomous vehicles and artificial intelligence is now possible. In particular, the technology of deep learning and its use on self-driving vehicles will be described[264].

From the discussion so far and considering the SAE parameters, it has become clear that the only fully autonomous cars are those of level 5, according to the SAE scale. As already noted, these cars drive themselves without no need for human action, but for this to be possible, the car must be equipped with an Artificial Intelligence system[265]. A.I. models aim to mechanically reproduce the functions of

[264] Deep learning is an artificial intelligence (AI) method that teaches computer to process data in a way that is inspired by the human brain.

[265] See: J. McCarthy, Artificial Intelligence, Dartmouth, 1965, passim; M. Solmavico-F. Amigoni-V. Schiaffonati, La grande scienza. Intelligenza artificiale, in Storia della Scienza, 2003; B. Cappiello, "A.I. in a Vehicle": extra-contractual liability issues, in Giur. comm., (2021), 1127 ff; Sul tema v. U. Ruffolo, Per i fondamenti di un diritto self-learning; dalla machinery produttiva all'auto driverless: verso una "responsabilità da algoritmo"?, in Intelligenza artificiale e responsabilità, Milano, 2017, 2 ff.

human brain, trying to simulate every aspect of learning or any other feature of intelligence.

For this reason, hardware and software systems are designed with certain characteristics that are considered typically human, such as, for example, visual, spatio-temporal, and decision-making perceptions.

In fact, those systems have been refined to the point of creating machines capable of learning by themselves from reality, just like humans[266]. Thus, the machine will be able to learn to perform certain tasks by improving, through experience, its own responses, and functions.

Before continuing with the analysis, it is important to note that two branches of A.I. can be distinguished: the first one transforms real-world phenomenon in a language

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[266] This phenomenon is known as "Machine learning", that could be defined as: «a form of artificial intelligence that allows computer systems to learn from examples, data, and experience. Through enabling computers to perform specific tasks intelligently, machine learning systems can carry out complex processes by learning from data, rather than following pre-programmed rules», The Royal Society, in *www.royalsociety.org*. See also: S. Haddadin-D. Knobbe, *Robotics and Artificial Intelligence: The present and future visions,* cit., 21 ff.

understandable from a computer, while the second area inheres the machine learning software[267].

Machine learning systems use different algorithms and, depending on the type of algorithm used to enable the robot's learning, it is possible to retrace three different machine learning systems: supervised learning; unsupervised learning and reinforcement learning.

In case of supervised learning a database of information and examples is provided to the machine. When it is faced with a problem, it draws on the experiences in its system and works out answer because of these.

In unsupervised systems, the information entered the system is not encoded. In this hypothesis the machine draws on it without having knowledge of the expected results depending on the choice made. Therefore, the machine must catalogue all the information in its possession, organise it and learn what it means and the result it leads to.

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[267] See: M. Navarro-Michel, *Vehìculos automatizados y responsabilidad por producto defectuoso,* in Revista *de Derecho Civil*, vol. VII, núm. 5 (2020), 191 ff.

Machines with reinforcement learning algorithm are provided with support elements such as GPS, sensors, cameras and other devices that allow it to detect what is happening in its environment and then make choices according to the best adaptation to it[268].

Those algorithms are used by self-driving cars that are capable of processing the data that are detected by the countless sensors' cameras and radars in the vehicle. Thanks to the technologies of deep learning[269] automated vehicles have the capacity to process twenty billion operations per second. In this regard, a computer vision system is installed on self-driving car, which mimics human vision, recognising the environment in which it is located.

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[268] C. Domeniconi-M. Jordan, Discorsi sulle reti neuronali e l'apprendimento, Milano, 2001.

[269] See: B. Marr, What Is the Difference Between Deep Learning, Machine Learning and AI? in www.forbes.com, 8 December 2016, who states that: «Deep Learning involves feeding a computer system a lot of data, which it can use to make decisions about other data. This data is fed through neural networks, as is the case in machine learning. These networks – logical constructions which ask a series of binary true/false questions, or extract a numerical value, of every bit of data which pass through them, and classify it according to the answers received».

After this brief description, it is clear that the application of deep learning technology to autonomous vehicles could lead to scenarios where these vehicles will be able to decide autonomously what to do when something happens. It could be an innocent decision (i.e. choosing a particular itinerary instead of another one) or a more significative one (i.e. decide if sacrifice itself and its passenger or hurt pedestrians).

In the following, the ethical implications related to autonomous vehicles implemented with deep learning technology will be analysed.

2. Ethics and Autonomous Driving: The ethical dilemma

In this paragraph ethical issues regarding autonomous road vehicles will be highlighted[270]. First of all, it is important to explain the real content of Asimov's laws[271], known as the rules of robotics.

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[270] See. P. Lin, *Why Ethics Matters for Autonomous Cars,* in *Autonomous Driving,* edited by M. Maurer-J. C. Gerdes – B. Lenz - Hermann Winner, Springer, 2016, 69 ff.

[271] The three laws are: I Law of Robotics: “A robot cannot harm a human being and cannot allow a human being to be harmed by its failure to act”. II Law of Robotics: “A robot must obey orders given by humans as long as those orders do not contravene the First Law”. III Law of Robotics: “A robot must protect its own existence,

Asimov's laws appeared for the first time in 1942 in Isaac Asimov's short story 'Roundabout'[272]. These rules must be obeyed by robots in order to avoid attacks to humans and to assure the safety of human race.

The analysis of Asimov's laws in relation to autonomous vehicles is particularly interesting with regard to the so called '*dilemma situations*', i.e. situations in which a decision has to be made on how best to act ethically. In 2017, the German Ethics Commission was set up with the aim of formulating a document containing ethical rules relating to robotics applied to '*automated and connected cars*'[273]. The Commission analysed, inter alia, a scenario where highly automated car detects the presence of children on the road.

The driver of a non-autonomous car would have the choice of either sacrificing his own life by going off-road or putting the children's lives at risk by continuing to drive on the road on

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as long as its self-defence does not contravene the First or Second Law". In 1950, Asimov developed a further rule, namely the zero law. 0 Law of Robotics: "A robot cannot harm mankind and cannot allow mankind to be harmed as a result of its failure to act".

[272] I. Asimov, Girotondo, in Astounding Science Fiction, 1942.

[273] Ethics Commision, Automated and connected driving, report June 2017.

which they are playing. Assuming the car in question is a self-driving car, it would be the autonomous driving system that would have to decide which choice to make in this situation. If the driverless car decided to continue in the direction in which the children are, it would be breaking Asimov's first rule, both because it would be harming the children and because it would be failing in its duty to intervene in the event of danger. At the same time, however, if the AV abruptly changed direction, it would be endangering the life of his passenger, having obeyed the third law, but violating the first.

In any case, there are many actual and hypothetical scenarios that could involve issues about ethics and autonomous vehicles.

One of the scenarios that is possible to imagine is those where the autonomous car encounters a terrible choice that determine, in any case, a pedestrian murder. Indeed, it could happen that an autonomous vehicle, in front of an obstacle, is forced to choose to swerve left and strike an eight-year-old girl or swerve right and strike an 80-year-old grandmother, or do not swerve and kill both victims.

In a similar scenario it is legitimate to wonder what is (and if there is) a ethically correct decision. On one hand, it could be possible thinking that striking the old woman could be the most acceptable solution, considering the age difference between the two potential victims (the girl still has her entire life in front of her, while the grandmother has already had a full life.

On the other hand, the age of the older woman does not preclude her right to life. This statement implies that either choice is ethically incorrect, according to the relevant professional codes of ethics. First, to treat individuals differently on the basis of their age, when age is not a relevant factor, seems to be exactly the kind of discrimination the IEEE prohibits[274]. Indeed, the Institute of Electrical and Electronics Engineers (IEEE), for instance, commits itself and its members "*to treat fairly all persons and to not engage in acts of discrimination based on race, religion, gender, disability, age,*

[274] N. J. Goodall, *Vehicle automation and the duty to act, in Proceedings of the 21st World Congress on Intelligent Transport Systems*, 7-11 September 2014, Detroit, Michigan.

national origin, sexual orientation, gender identity, or gender expression"[275].

Moreover, it cannot be ignored that the right to life is protect in the EU jurisdiction and, more generally, in all occidental countries. This means that it is difficult to see how law could even allow a company to create a product that is capable to making such an apparently illegal choice.

If, from an ethical perspective, it is not possible to choose a path forward, the only possible solution is to refuse to make a swerve decision, allowing both victims to be struck. Nevertheless, it is evident that, even if ethically correct, this solution seems much worse because it would cause two victims.

This is a dilemma that is not easily solvable and therefore it demonstrates the importance of ethics in developing autonomous cars. In this regard, it would be important that the European legislator would enact at least some guidelines

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[275] IEEE: IEEE code of ethics. http://www.ieee.org/about/corporate/governance/p7-8.html (2014).

on this topic, in order to allow producer to settle software in a predictable and uniform way. Indeed, the lack of similar regulations could lead to unpredictable scenarios that could cause just more confusion between scholars.

In other words, automated vehicles need to be able to operate responsibly and take complicate decision replicating - or improving - human decision-making process. In order to do that, the rule making should codify “ethical issues”, introducing *ad hoc* rules to be followed universally. Indeed, algorithms should be programmed according to those rules.

Scenarios similar to the ones represented above should be faced with transparency and effectiveness. Programmers should need to design a cost-functions algorithms that estimate the expected cost and benefits of various possible scenarios and determine who gets to live and who gets to die in such extremal situations. Even though making similar choices could appear ethically incorrect, it is undeniable that not choosing would cost even more in terms of life and consequences. Indeed, thinking in advance about ethical design and policies could lead to face responsibly the unknown scenarios will happen.

Having said that, the following chapter will stress the importance of regulating A.I. and machine learning in the process of automation of vehicles.

3. AI Act

Beyond the ethical issues, the use of machine learning technology raises further problems. In fact, the possibility of vehicles being able to make choices pose the question of who is liable if that choice causes damages.

The fears rise by the possibility that artificial intelligence systems may take decisions autonomously and may cause harm to human beings lead the EU to adopt a particular regulation in order to regulate these cases.

In order to handle a such challenging lack of regulation, the European Union has recently adopted a specific provision on this matter. Indeed, last march a proposal for a European Regulation on Artificial Intelligence has been approved. The

Artificial Intelligence Act[276] pursues precisely the strategic objective: "*to improve the functioning of the internal market by laying down a uniform legal framework in particular for the development, the placing on the market, the putting into service and the use of artificial intelligence systems (AI systems) in the Union, in accordance with Union values, to promote the uptake of human centric and trustworthy artificial intelligence (AI) while ensuring a high level of protection of health, safety, fundamental rights as enshrined in the Charter of fundamental rights of the European Union (the 'Charter'), including democracy, the rule of law and environmental protection, against the harmful effects of AI systems in the Union, and to support innovation*"[277].

[276] See: *European Parliament legislative resolution of 13 March 2024 on the proposal for a regulation of the European Parliament and of the Council on laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union Legislative Acts (COM(2021)0206 – C9-0146/2021 – 2021/0106(COD)),* available at: *https://www.europarl.europa.eu/doceo/document/TA-9-2024-0138_EN.pdf*

[277] See: G. Alpa, *Quale modello normativo europeo per l'intelligenza artificiale?,* in *Contr. e impr.,* 2021, 1003-1026; M. Ebers, *Standandizing AI - The Case of the European Commission's Proposal for an Artificial Intelligence Act*, in Di Matteo-Cannarsa-Poncibò (edited by), *Handbook of Artificial Intelligence: Global Perspectives on Law and Ethics*, Cambridge, 2022; Floridi, *The European Legislation on AI: a Brief Analysis of its Philosophical Approach,* in *Philos. Technol*, 2021, 215-222; MacCarthy-Propp, *Machines learn that Brussels writes the rules: The EU's new AI regulation. Editor's Note,* in *Brookings.edu*, 2021; G. Finocchiaro, *La Proposta di Regolamento sull'Intelligenza Artificiale: il modello europeo basato*

This is a very articulate measure, which consists of 12 main titles. In the following, the most relevant and innovative measures will be stressed.

The first chapter provides general provisions regarding the purpose of the regulation, stressing the importance of ensuring: *"a high level of protection of health, safety, fundamental rights enshrined in the Charter, including democracy, the rule of law and environmental protection, against the harmful effects of AI systems in the Union and supporting innovation"*.

Article 2 identifies the subject to who the regulation is addressed. More precisely, providers of AI systems, deployers of AI systems, importers and distributors of AI systems are among the figures to which this regulation shall apply.

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sulla gestione del rischio, in *Diritto dell'Informazione e dell'Informatica* , 2022, 303 ff.; Mcfadden-Jones-Taylor-Osborn, *Harmonising Artificial Intelligence; The role of standards in the EU AI Regulation Harmonising Artificial Intelligence*, Oxford Commission on AI & Good, Oxford Information Labs, 2021; Veale-Borgesius, *Demystifying the Draft EU Artificial Intelligence Act,* in *Computer Law Review International,* 2021, 97-112.

In other words, this provision offers a regulatory approach concerning high-risk AI systems, listed in Article 6[278] and Annex III.

The definition of artificial intelligence, consistent with this approach, is deliberately general[279]. It is evident, then, that the model adopted by the Commission is a risk-based model.

The legislator, in Art. 5 of the regulation, expressly prohibits certain applications of artificial intelligence systems such as,

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[278] *European Parliament legislative resolution of 13 March 2024 on the proposal for a regulation of the European Parliament and of the Council on laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union Legislative Acts (COM(2021)0206 – C9-0146/2021,* Art. 6: "*1. Irrespective of whether an AI system is placed on the market or put into service independently of the products referred to in points (a) and (b), that AI system shall be considered to be high-risk where both of the following conditions are fulfilled:*
(a) the AI system is intended to be used as a safety component of a product, or the AI system is itself a product, covered by the Union harmonisation legislation listed in Annex I;
(b) the product whose safety component pursuant to point (a) is the AI system, or the AI system itself as a product, is required to undergo a third-party conformity assessment, with a view to the placing on the market or the putting into service of that product pursuant to the Union harmonisation legislation listed in Annex I", available at: *https://www.europarl.europa.eu/doceo/document/TA-9-2024-0138_EN.pdf*.

[279] Article 3: *'For the purposes of this Regulation, the following definitions apply: (1) 'AI system' means a machine-based system that is designed to operate with varying levels of autonomy and that may exhibit adaptiveness after deployment, and that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments;'*.

for example, the commissioning of systems that use subliminal techniques, as well as the commissioning of systems that exploit the vulnerabilities of a group of people[280]. This provision pursues the scope of ensuring safety

[280] In particular, Art. 5, 1st paragraph: " 1. The following AI practices shall be prohibited: *(a) the placing on the market, the putting into service or the use of an AI system that deploys subliminal techniques beyond a person's consciousness or purposefully manipulative or deceptive techniques, with the objective, or the effect of materially distorting the behaviour of a person or a group of persons by appreciably impairing their ability to make an informed decision, thereby causing them to take a decision that they would not have otherwise taken in a manner that causes or is reasonably likely to cause that person, another person or group of persons significant harm; (b) the placing on the market, the putting into service or the use of an AI system that exploits any of the vulnerabilities of a natural person or a specific group of persons due to their age, disability or a specific social or economic situation, with the objective, or the effect, of materially distorting the behaviour of that person or a person belonging to that group in a manner that causes or is reasonably likely to cause that person or another person significant harm; (c) the placing on the market, the putting into service or the use of AI systems for the evaluation or classification of natural persons or groups of persons over a certain period of time based on their social behaviour or known, inferred or predicted personal or personality characteristics, with the social score leading to either or both of the following: (i) detrimental or unfavourable treatment of certain natural persons or groups of persons in social contexts that are unrelated to the contexts in which the data was originally generated or collected;*
(ii) detrimental or unfavourable treatment of certain natural persons or groups of persons that is unjustified or disproportionate to their social behaviour or its gravity; (d) the placing on the market, the putting into service for this specific purpose, or the use of an AI system for making risk assessments of natural persons in order to assess or predict the risk of a natural person committing a criminal offence, based solely on the profiling of a natural person or on assessing their personality traits and characteristics; this prohibition shall not apply to AI systems used to support the human assessment of the involvement of a person in a criminal activity, which is already based on objective and verifiable facts directly linked to a criminal activity; (e) the placing on the market, the putting into

and security when AI technology is used. Nevertheless, it should be noted that the provided definition is too wide.

The second paragraph regulates the use of 'real-time' remote biometric identification systems in publicly accessible spaces for law enforcement purposes. It is permitted in specific

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service for this specific purpose, or the use of AI systems that create or expand facial recognition databases through the untargeted scraping of facial images from the internet or CCTV footage;
(f) the placing on the market, the putting into service for this specific purpose, or the use of AI systems to infer emotions of a natural person in the areas of workplace and education institutions, except where the use of the AI system is intended to be put in place or into the market for medical or safety reasons; (g) the placing on the market, the putting into service for this specific purpose, or the use of biometric categorisation systems that categorise individually natural persons based on their biometric data to deduce or infer their race, political opinions, trade union membership, religious or philosophical beliefs, sex life or sexual orientation; this prohibition does not cover any labelling or filtering of lawfully acquired biometric datasets, such as images, based on biometric data or categorizing of biometric data in the area of law enforcement;
(h) the use of 'real-time' remote biometric identification systems in publicly accessible spaces for the purposes of law enforcement, unless and in so far as such use is strictly necessary for one of the following objectives: (i) the targeted search for specific victims of abduction, trafficking in human beings or sexual exploitation of human beings, as well as the search for missing persons; (ii) the prevention of a specific, substantial and imminent threat to the life or physical safety of natural persons or a genuine and present or genuine and foreseeable threat of a terrorist attack; (iii) the localisation or identification of a person suspected of having committed a criminal offence, for the purpose of conducting a criminal investigation or prosecution or executing a criminal penalty for offences referred to in Annex II *and punishable in the Member State concerned by a custodial sentence or a detention order for a maximum period of at least four years. Point (h) of the first subparagraph is without prejudice to Article 9 of Regulation (EU) 2016/679 for the processing of biometric data for purposes other than law enforcement".*

cases and just to confirm the identity of the specifically targeted individual[281].

The European regulation, from Article 6 onwards, identifies high-risk artificial intelligence systems, stipulating that the manufacturer of high-risk systems, when placing them on the market, must fulfil a series of requirements and carry out an *ex ante* conformity assessment[282].

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[281] Art. 5, par. 2: "*2. The use of 'real-time' remote biometric identification systems in publicly accessible spaces for the purposes of law enforcement for any of the objectives referred to in paragraph 1, first subparagraph, point (h), shall be deployed for the purposes set out in that point only to confirm the identity of the specifically targeted individual, and it shall take into account the following elements: (a) the nature of the situation giving rise to the possible use, in particular the seriousness, probability and scale of the harm that would be caused if the system were not used; (b) the consequences of the use of the system for the rights and freedoms of all persons concerned, in particular the seriousness, probability and scale of those consequences. In addition, the use of 'real-time' remote biometric identification systems in publicly accessible spaces for the purposes of law enforcement for any of the objectives referred to in paragraph 1, first subparagraph, point (h), of this Article shall comply with necessary and proportionate safeguards and conditions in relation to the use in accordance with the national law authorising the use thereof, in particular as regards the temporal, geographic and personal limitations. The use of the 'real-time' remote biometric identification system in publicly accessible spaces shall be authorised only if the law enforcement authority has completed a fundamental rights impact assessment as provided for in* Article 27 *and has registered the system in the EU database according to* Article 49*. However, in duly justified cases of urgency, the use of such systems may be commenced without the registration in the EU database, provided that such registration is completed without undue delay".*

[282] Art. 6, § 1: "*1. Irrespective of whether an AI system is placed on the market or put into service independently of the products referred to in points (a) and (b), that AI system shall be considered*

It appears clear, then, that those provisions would be applicable to AVs vehicles too, since the definition of High-Risk AI system is wide enough to include AVs. In this case, the provisions described below would be applicable to autonomous vehicles.

Articles 8 et seq. identify the obligations and requirements that a high-risk AI system must meet. First of all, Article 9 establishes that: "*a risk management system shall be established, implemented, documented and maintained in relation to high-risk AI systems*". The provision states that: "*a continuous iterative process, carried out throughout the entire life cycle of the high-risk AI system*", which includes the identification and analysis of known and foreseeable risks associated with the system, the estimation and evaluation of the risks that may emerge when the high-risk AI system is used in accordance with its intended purpose, and under

to be high-risk where both of the following conditions are fulfilled: (a) the AI system is intended to be used as a safety component of a product, or the AI system is itself a product, covered by the Union harmonisation legislation listed in Annex I; (b) the product whose safety component pursuant to point (a) is the AI system, or the AI system itself as a product, is required to undergo a third-party conformity assessment, with a view to the placing on the market or the putting into service of that product pursuant to the Union harmonisation legislation listed in Annex I".

conditions of reasonably foreseeable misuse, the evaluation of any other risks arising from the analysis of data collected by the post-market monitoring system, and the adoption of appropriate risk management measures.

Article 10 regulates the use of data[283] and data governance. The provision establishes that: "*High-risk AI systems which make use of techniques involving the training of AI models with data shall be developed on the basis of training, validation and testing data sets that meet the quality criteria referred to in paragraphs 2 to 5 whenever such data sets are used*".

The quality criteria mentioned above includes relevant design choices, data collection processes, relevant data-preparation processing operations, formulation of assumptions, assessments of the availability, quantity and suitability of the data sets that are needed, examination of possible biases that are likely to affect the health and safety of persons[284].

[283] According to the definitions in Art. 3, § 29, "*training data means data used for training an AI system through fitting its learnable parameters*", while according to Art. 3, § 30: "*'validation data' means data used for providing an evaluation of the trained AI system and for tuning its non-learnable parameters and its learning process in order, inter alia, to prevent underfitting or overfitting*".
[284] See Article 10, § 2, AI Act.

In other words, these data sets must be subject to specific governance and management practices and be relevant, representative, error-free, complete and statistically appropriate.

Furthermore, it is required that, prior to the high-risk AI system being placed on the market or put into service, the relevant technical documentation must be drawn up, aimed at demonstrating that the high-risk AI system complies with the requirements set forth in AI Act[285].

Moreover, the AI Act expressly provides that high-risk AI systems must be designed and developed in such a way as to guarantee, through the automatic recording of events and throughout their life cycle, traceability of the functioning of a high-risk AI system[286].

[285] See Article 11, which refers to Annex IV of the AI Act for the identification of the minimum content of the technical documentation.

[286] See, Article 12: "*1. High-risk AI systems shall technically allow for the automatic recording of events (logs) over the lifetime of the system. 2. In order to ensure a level of traceability of the functioning of a high-risk AI system that is appropriate to the intended purpose of the system, logging capabilities shall enable the recording of events relevant for: (a) identifying situations that may result in the high-risk AI system presenting a risk within the meaning of Article*

This provision, in particular, seem to valorise the hypothesis according to which all the autonomous vehicles will be equipped with black boxes, able to record the functioning (but also the malfunctioning) of self-driving cars.

The exigence to ensure transparency is pursued also requiring, for all high-risk AI systems, instructions for use, in a digital or non-digital format, which include concise, complete, correct, clear and relevant information that is accessible and comprehensible to users[287].

79(1) or in a substantial modification; (b) facilitating the post-market monitoring referred to in Article 72; and (c) monitoring the operation of high-risk AI systems referred to in Article 26(5). 3. For high-risk AI systems referred to in point 1 (a) of Annex III, the logging capabilities shall provide, at a minimum: (a) recording of the period of each use of the system (start date and time and end date and time of each use); (b) the reference database against which input data has been checked by the system; (c) the input data for which the search has led to a match; (d) the identification of the natural persons involved in the verification of the results, as referred to in Article 14(5)".

[287] Art. 13 states that, among the information to be provided to the user, includes: the identity and contact details of the provider and, where applicable, its authorised representative; the characteristics, capabilities and performance limitations of the high-risk AI system, including its intended purpose; the level of accuracy, robustness and cybersecurity against which the high-risk AI system has been tested and validated and can be expected; any known or foreseeable circumstances that may impact the expected level of accuracy, robustness and cybersecurity any known or foreseeable circumstances related to the use of the high-risk AI system in accordance with its intended purpose or under conditions of reasonably foreseeable misuse that may pose risks

High-risk AI systems shall be designed and developed with human-machine interface tools that allow for their effective supervision by natural persons, aimed at preventing or minimising risks to health, safety or fundamental rights[288]

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to health and safety or fundamental rights; its performance with respect to the persons or groups of persons on whom the system is intended to be used; where appropriate, specifications for input data or any other relevant information in terms of training, validation and testing datasets, taking into account the intended purpose of the AI system.

[288] Article 14 establishes that: "*1. High-risk AI systems shall be designed and developed in such a way, including with appropriate human-machine interface tools, that they can be effectively overseen by natural persons during the period in which they are in use. 2. Human oversight shall aim to prevent or minimise the risks to health, safety or fundamental rights that may emerge when a high-risk AI system is used in accordance with its intended purpose or under conditions of reasonably foreseeable misuse, in particular where such risks persist despite the application of other requirements set out in this Section 3. The oversight measures shall be commensurate with the risks, level of autonomy and context of use of the high-risk AI system, and shall be ensured through either one or both of the following types of measures: (a) measures identified and built, when technically feasible, into the high-risk AI system by the provider before it is placed on the market or put into service; (b) measures identified by the provider before placing the high-risk AI system on the market or putting it into service and that are appropriate to be implemented by the deployer. 4. For the purpose of implementing paragraphs 1, 2 and 3, the high-risk AI system shall be provided to the deployer in such a way that natural persons to whom human oversight is assigned are enabled, as appropriate and proportionate: (a) to properly understand the relevant capacities and limitations of the high-risk AI system and be able to duly monitor its operation, including in view of detecting and addressing anomalies, dysfunctions and unexpected performance;*
(b) to remain aware of the possible tendency of automatically relying or over-relying on the output produced by a high-risk AI system (automation bias), in particular for high-risk AI systems used to provide information or recommendations for decisions to be taken by natural persons; (c) to correctly interpret the high-risk AI

and, finally, they must be designed and developed in such a way as to achieve, in light of their purpose, an adequate level of accuracy, robustness and cybersecurity, which lasts for the entire life cycle of the system[289].

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system's output, taking into account, for example, the interpretation tools and methods available; (d) to decide, in any particular situation, not to use the high-risk AI system or to otherwise disregard, override or reverse the output of the high-risk AI system; (e) to intervene in the operation of the high-risk AI system or interrupt the system through a 'stop' button or a similar procedure that allows the system to come to a halt in a safe state. 5. For high-risk AI systems referred to in point 1(a) of Annex III, the measures referred to in paragraph 3 of this Article shall be such as to ensure that, in addition, no action or decision is taken by the deployer on the basis of the identification resulting from the system unless that identification has been separately verified and confirmed by at least two natural persons with the necessary competence, training and authority. The requirement for a separate verification by at least two natural persons shall not apply to high-risk AI systems used for the purposes of law enforcement, migration, border control or asylum, where Union or national law considers the application of this requirement to be disproportionate".

[289] According to Article 15, paragraph 4, high-risk IA systems must also be resilient with respect to errors, failures or inconsistencies that may occur within the system or in the environment in which it operates, in particular due to their interaction with natural persons or other systems. Moreover, Article 15, paragraph 5, high-risk IA systems shall also be resilient against attempts by unauthorised third parties to alter their use, outputs or performance by exploiting system vulnerabilities. In this case, the provision expressly requires technical solutions aimed at ensuring cybersecurity and to provide with an evaluation of the relevant circumstances and risks, including: *"measures to prevent, detect, respond to, resolve and control for attacks trying to manipulate the training data set (data poisoning), or pre-trained components used in training (model poisoning), inputs designed to cause the AI model to make a mistake (adversarial examples or model evasion), confidentiality attacks or model flaws"*.

Article 15 closes Chapter 2 of the proposal, which is expressly devoted to the requirements for high-risk AI systems.

Further obligations and requirements for high-risk AI systems are prescribed by the provisions addressed to those involved in the chain of creation and use of such systems.

According to Article 16, the provider of a high-risk AI system is first and foremost called upon to ensure that the system complies with the requirements described above[290]. In the event of non-compliance, the provider has to immediately take the necessary corrective measures, recall it or withdraw the high-risk AI system from the market, as appropriate, informing the distributors and, where applicable, the importer[291].

The conformity of the high-risk AI system with the Regulation shall also be certified through an assessment procedure, which the provider shall ensure and carry out before it is placed on the market or put into service. Only if the

[290] See Art. 16(1)(a).
[291] See Art. 16(1)(j) and Art. 20.

aforementioned conformity assessment procedure has a positive outcome may the provider draw up a declaration of conformity and affix the CE marking[292]. In any event, the provider must demonstrate the conformity of the high-risk AI system with the requirements of the Regulation when requested to do so by a competent national authority[293]. In addition, the provider is required to set up a post-market monitoring system that, depending on the risks posed by the AI system, enables him to assess its continued compliance[294].

Furthermore, the provider is obliged to establish a quality management system that, by means of written policies, procedures and instructions, guarantees the conformity of the AI system with the Regulation[295].

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[292] See Art. 16(1)(g) - (h) and Art. 47 and 48.
[293] See Art. 16(1)(k).
[294] See Art. 16(1)(l).
[295] Thus Art. 17, according to which the quality management system shall be include at least the following elements: "*(a) a strategy for regulatory compliance, including compliance with conformity assessment procedures and procedures for the management of modifications to the high-risk AI system; (b) techniques, procedures and systematic actions to be used for the design, design control and design verification of the high-risk AI system; (c) techniques, procedures and systematic actions to be used for the development, quality control and quality assurance of the high-risk AI system; (d) examination, test and validation procedures to be carried out before, during and after the development of the high-risk AI system, and the frequency with which they have to be carried out; (e) technical specifications, including standards, to be applied and, where the relevant harmonised standards are not*

Moreover, importers, before placing a high-risk AI system on the market, shall ensure that the provider has carried out the appropriate conformity assessment procedure and drawn up the relevant technical documentation.

Importers also ensure that the system bears the required conformity marking and is accompanied by the necessary documentation and instructions for use[296]. Furthermore, if the importer considers or has reason to believe that a high-risk AI system is not in conformity with the regulation, he is obliged not to place it on the market until it has been brought

applied in full or do not cover all of the relevant requirements set out in Section 2, the means to be used to ensure that the high-risk AI system complies with those requirements; (f) systems and procedures for data management, including data acquisition, data collection, data analysis, data labelling, data storage, data filtration, data mining, data aggregation, data retention and any other operation regarding the data that is performed before and for the purpose of the placing on the market or the putting into service of high-risk AI systems; (g) the risk management system referred to in Article 9; (h) the setting-up, implementation and maintenance of a post-market monitoring system, in accordance with Article 72; (i) procedures related to the reporting of a serious incident in accordance with Article 73; (j) the handling of communication with national competent authorities, other relevant authorities, including those providing or supporting the access to data, notified bodies, other operators, customers or other interested parties; (k) systems and procedures for record-keeping of all relevant documentation and information; (l) resource management, including security-of-supply related measures; (m) an accountability framework setting out the responsibilities of the management and other staff with regard to all the aspects listed in this paragraph".

[296] See Art. 23(1).

into conformity and, if the system presents a risk to health, safety or the protection of the fundamental rights of persons, he must inform the provider and the market surveillance authorities thereof[297].

Similar obligations also fall to the distributor, who, before making a high-risk AI system available on the market, is obliged to check that the system bears the CE marking, that the technical documentation is in conformity and that there are adequate instructions for use, and, more generally, that the provider and the importer have complied with the obligations of the regulation[298].

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[297] See Art. 23(2): "2. *Where an importer has sufficient reason to consider that a high-risk AI system is not in conformity with this Regulation, or is falsified, or accompanied by falsified documentation, it shall not place the system on the market until it has been brought into conformity. Where the high-risk AI system presents a risk within the meaning of Article 79(1), the importer shall inform the provider of the system, the authorised representative and the market surveillance authorities to that effect*".

[298] Thus Article 24, under which the distributor that "*considers or has reason to consider, on the basis of the information in its possession, a high-risk AI system which it has made available on the market not to be in conformity with the requirements set out in Section 2, shall take the corrective actions necessary to bring that system into conformity with those requirements, to withdraw it or recall it, or shall ensure that the provider, the importer or any relevant operator, as appropriate, takes those corrective actions. Where the high-risk AI system presents a risk within the meaning of Article 79(1), the distributor shall immediately inform the provider or importer of the system and the authorities competent for the high-risk AI system concerned, giving details, in particular, of the non-compliance and of any corrective actions taken*".

Prudential obligations also apply to users, who are required to use high-risk AI systems in accordance with the instructions for use, to monitor the operation of the system and to inform the provider or distributor, and to suspend use of the system if they have reason to believe that it presents a risk to the health, safety or protection of the fundamental rights of persons, or if they detect a serious accident or malfunction[299]. Failure to observe such precautions could lead to contributory negligence on the part of the user in the damage caused by the high-risk AI system.

The introduction of such a provision is undoubtedly to be welcomed, even though it might be desirable to extend the scope of its application also to systems that do not strictly belong to the group of high-risk AI systems. This in order to

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[299] Thus Art. 26, according to which: "*Deployers of high-risk AI systems shall keep the logs automatically generated by that high-risk AI system to the extent such logs are under their control, for a period appropriate to the intended purpose of the high-risk AI system, of at least six months, unless provided otherwise in applicable Union or national law, in particular in Union law on the protection of personal data. Deployers that are financial institutions subject to requirements regarding their internal governance, arrangements or processes under Union financial services law shall maintain the logs as part of the documentation kept pursuant to the relevant Union financial service law*".

avoid possible issues related to the discipline applicable to medium- or low-risk AI systems.

4. Next step: connected cars

The debate on autonomous cars and artificial intelligence has gradually shifted from technical and ethical issues to internet connected cars[300], that are vehicles with systems that allow them a connection (automatic or voluntary) with the outside world (to other vehicles, infrastructures, the manufacturer, suppliers, insurance companies, rescue centers, etc.), for the purpose of transmission, reception and sharing of digital data[301]. The ongoing experimentation of autonomous cars has shown that the problems of traffic safety of these vehicles have not yet been resolved. Although the use of connected

[300] See: G.F. Simonini, La vettura connessa: un oggetto con qualità che cambiano continuamente ed al quale si applicano le regole della compravendita, in Danno e resp., 2022, 192 ff. See also: Dir. 40/2010/Ue; 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 the mobility of the future, 2018, Brussels; ACEA, Connected and Automated Driving, Brussels, 2018; ACEA, Connected vehicles and personal data, Brussels, 2017; ACEA, Strategy paper on connectivity, Brussels, 2016; BEUC, Data access and control in the era of connected devices, Brussels, 2018.
[301] For an in-depth analysis about the so-called *Internet of Things*, see: S. Navas Navarro*, Smart Robots y otras máquinas inteligentes en nuestra vida cotidiana*, in *Revista CESCO de Derecho de Consumo,* n. 20, 2016, 82 ff.

cars has improved data processing capacity[302], it has not allayed the concerns about security and software protection.

More recently, the Commission issued Delegated Regulation (EU) 2022/545[303], which supplements and amends Delegated Regulation (EU) 2019/2144. In particular, this Regulation not only updates and supplements the provisions contained in Delegated Regulation (EU) 2019/2144, but also provides specific guidance in relation to data security.

Article 3 of EU Regulation 2022/545 states that compliance with the technical requirements and transitional provisions of UN Regulation No. 155 guarantees protection against possible data manipulation. UN Regulation No. 155, on the other hand, stipulates that in order to be granted type approval with regard to cyber security, the vehicle manufacturer must prove that he has taken all measures to

[302] For more information about data processing see: A.C. Di Landro, *Big Data. Rischi e tutele nel trattamento dei dati personali,* Napoli, 2020.
[303] COMMISSION DELEGATED REGULATION (EU) 2022/545 of 26 January 2022 supplementing Regulation (EU) 2019/2144 of the European Parliament and of the Council by laying down detailed rules on test procedures and specific technical requirements for the type-approval of motor vehicles with regard to event data recorders and for the type-approval of such systems as separate technical units, and amending Annex II thereto, available at: https://eur-lex.europa.eu/.

prevent cyber-attacks[304]. The need to ensure elevated levels of protection and prevent possible cyber-attacks has led the industry to promote the use of blockchain technology (see Chapter IV).

In the following, therefore, the risks related to the use of connected cars will be analysed.

5. Possible risks: abusive accesses to autonomous vehicles' software in UE

One of the worst possible scenarios regarding autonomous vehicles concerns the hacking of their informatic system. This implies that an abusive access to the vehicle's software

[304]Regulation No. 155 of the Economic Commission for Europe of the United Nations (UN/ECE) - Uniform provisions concerning the approval of vehicles with regard to cybersecurity and cybersecurity management systems [2021/387], Par. 5.1.1: "The approval authority or technical service shall verify, by means of documentary checks, that the vehicle manufacturer has taken the relevant measures for the vehicle type in order to: (a) collect and verify the information required under this Regulation along the supply chain in order to demonstrate that supplier-related risks are identified and managed; (b) document the risk assessment (carried out during the development phase or retrospectively), test results and mitigation measures applied to the vehicle type, including design information supporting the risk assessment (c) implement appropriate cybersecurity measures in the design of the vehicle type; (d) detect and respond to possible cybersecurity attacks; (e) record data in a log to aid in the detection of cyber-attacks and have data processing capabilities to analyse attempted or successful cyber-attacks."

is perpetrated illegally by an unknown individual in order to stole data or, worse, to perpetrate a more serious crime (i.e. kidnapping, murder, terrorist attack).

Indeed, the risk generated by a cyber-attack constitutes one of the main risks (if not the worst) related to the introduction of self-driving vehicles on the market. In fact, the European Parliament, in its report on defence against cyber-attacks of 25 May 2018, expressly addressed the issue of possible attacks through unlawful access to the computer programming system of self-driving vehicles (more specifically, of self-driving aircraft), stating in point 15 and 16 that the European Parliament: "*underlines the growing role of artificial intelligence in both cyber offence as well as defence; urges the EU and the Member States to pay special attention to this area, both in the course of research and in the practical development of their cyber defence capabilities*;" and that *"strongly emphasises that with the deployment of unmanned aerial vehicles, whether armed or not, additional* *measures should be taken to reduce their potential cyber vulnerabilities*"[305].

The European Union, moreover, has been pursuing a policy to fight cybercrime since 2013. In fact, with the communication of the European Parliament, the Council, the European Economic and social committee and the Committee of the Regions in 2013, strategic goals and actions were set to counter and reduce cybercrime[306]. Subsequently, the European Union Network and Information Security Agency (ENISA) was mandated to monitor the security of computer networks[307]. Furthermore, the EU adopted the Network and

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[305] European Parliament, report on cyber defence, 25 May 2018, (2018(/2004(INI)), relating to European Parliament motion for resolution on cyber defence (A8-0189/2018.

[306] Joint communication of the European Parliament, the Council, the European Economic and social committee and the Committee of the Regions, *Cybersecurity Strategy of the European Union: An Open, Safe and Secure Cyberspace*, where it is stated that: "*Cybersecurity can only be sound and effective if it is based on fundamental rights and freedoms as enshrined in the Charter of Fundamental Rights of the European Union and EU core values. Reciprocally, individuals' rights cannot be secured without safe networks and systems. Any information sharing for the purposes of cyber security, when personal data is at stake, should be compliant with EU data protection law and take full account of the individuals' rights in this field*", p. 4, at: https://edps.europa.eu/sites/default/files/publication/13-02-07_communication_join_cyber_sec_en.pdf

[307] Regulation (EU) No 526/2013 of the European Parliament and of the Council of 21 May 2013 concerning the European Union Agency for Network and Information Security (ENISA) and repealing Regulation (EC) No 460/2004 that: "*establishes a European Union*

Information Systems Security Directive (NIS Directive) to implement measures for a common high level of network and information system security in the Union[308]. In particular, with the NIS directive, the EU called on all actors potentially threatened by cyber threats to take measures to appropriately manage security risks[309].

Agency for Network and Information Security (ENISA, hereinafter 'the Agency') to undertake the tasks assigned to it for the purpose of contributing to a high level of network and information security within the Union and in order to raise awareness of network and information security and to develop and promote a culture, of network and information security in society for the benefit of citizens, consumers, enterprises and public sector organisations in the Union, thus contributing to the establishment and proper functioning of the internal market" (art. 1(I)), at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0526.

[308] Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union (also known as NIS Directive), at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L1148.

[309] See par. 1 of Directive (EU) 2016/1148: "*This Directive lays down measures with a view to achieving a high common level of security of network and information systems within the Union so as to improve the functioning of the internal market.*
2. To that end, this Directive: (a) lays down obligations for all Member States to adopt a national strategy on the security of network and information systems; (b) creates a Cooperation Group in order to support and facilitate strategic cooperation and the exchange of information among Member States and to develop trust and confidence amongst them; (c) creates a computer security incident response teams network ('CSIRTs network') in order to contribute to the development of trust and confidence between Member States and to promote swift and effective operational cooperation (d) establishes security and notification requirements for operators of essential services and for digital service providers; (e) lays down obligations for Member States to designate national competent authorities, single points of contact and CSIRTs with

The EU's work to fight cybercrime continued with the issuance of a Communication on the need to strengthen cyber resilience and competitiveness in the area of innovation and cyber security. For this reason, EU Reg. No. 526/2013 was replaced by EU Reg. 2019/881, which established the objectives, tasks and organisational aspects relating to ENISA[310].

In fact, a particularly relevant role is played by ENISA, which is mandated to contribute to the development of a robust and effective policy in the area of cyber security[311].

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tasks related to the security of network and information systems"; and par. 6: "*This Directive is without prejudice to the actions taken by Member States to safeguard their essential State functions, in particular to safeguard national security, including actions protecting information the disclosure of which Member States consider contrary to the essential interests of their security, and to maintain law and order, in particular to allow for the investigation, detection and prosecution of criminal offences*".

[310] Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communications technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act), at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0881.

[311] It is important to highlight that on 16 January 2023, the Directive (EU) 2022/2555 (known as NIS2) entered into force, replacing Directive (EU) 2016/1148. NIS2 improves the existing cyber security status across EU creating the necessary cyber crisis management structure (CyCLONe); increasing the level of harmonization regarding security requirements and reporting

It is worth mentioning that maritime transport operators are preparing Guidelines aimed at preventing and suppressing cyber-attacks on fleets. In fact, modern ships make massive use of technological tools such as sensors, software, and control networks for on-board systems. For this reason, the guidelines urge operators to prevent cyber risk *ex ante*, by setting up IT systems capable of continuing to operate even in the event of cyber-attacks or capable of retaining a margin of autonomy despite the attack.

The International Maritime Organisation (IMO) has issued guidelines on cyber risk management in maritime shipping to raise operators' awareness of cyber risks and threats[312].

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obligations; encouraging Members States to introduce new areas of interest such as supply chain, vulnerability management, core internet and cyber hygiene their national cybersecurity strategies. Moreover NIS2 assigns to ENISA a number of significant new tasks such as the development and maintenance of a European vulnerability registry; the publication of an annual report on the state of cybersecurity in the EU; the creation and maintenance of a registry for entities providing cross-border services e.g DNS service providers, TLD name registries, entities providing domain name registration services, cloud computing service providers and data centre service providers.

[312] The International Maritime Organisation (IMO), *Guidelines on Cyber Risk Management*, 7 June 2022, at https://wwwcdn.imo.org/localresources/en/OurWork/Security/Documents/MSC-FAL.1-Circ.3-Rev.2%20-%20Guidelines%20On%20Maritime%20Cyber%20Risk%20Management%20(Secretariat)%20(1).pdf.

This is a first step that undoubtedly constitutes a good practice that will hopefully also be followed by the respective authorities in the transport sector. In fact, the need to effectively protect computer systems from possible attacks and to implement a prevention system capable of averting possible risks.

The need to prevent such attacks is made even more manifest by the fact that traditional insurance policies tend to exclude from insurance cover the risks associated with a possible hacker attack. This means that the coverage of such a risk will, in most cases, require a special policy.

ENISA (European Agency for Network and Information Security) has outlined good practices and recommendations aimed at vehicles with advanced technology, but expressly excluding self-driving vehicles from its scope.

This exclusion makes the need for a set of rules to ward off cyber-attacks even more evident, and for appropriate insurance policies to cover possible hacker attacks. Threats to the computer system can arise from bugs in the system or fraudulent acts carried out in order to cause damage.

5.1 The protection of third parties

The risks described above are strictly connected to those related to autonomous decisions made by autonomous vehicles because of the machine learning algorithm.

In both cases, it emerges the need to assure an adequate protection to third parties. Indeed, producers and software developers will be valued and chosen by consumers in order to the degree of safety they will be able to reach.

If the risk evaluation is a scientific activity, the risk handling is a discretional activity that it is based on the level of trust, accountability and transparency. Even if the introduction of the AI Act represents a considerable progress, it is clear that the lack of system that allows to remunerate adequately consumers if a mistake is made would be an element that will discourage consumers to adopt the new technology.

Moreover, it should made be clear who is the subject liable in case some critical events happen. As already said, AI Act is a progressive provision, but it does not regulate meticulously the liability regime.

For instance, in case of a damage caused by a defect in software program, it is possible to consider the developer liable for it. At the same time, in case the abusive access to the software is caused by an insufficient protection of it, the developers could be considered liable.

Nevertheless, addressing all the liability charges to the developer would imply a significative slowdown in terms of innovation because developers could be afraid to be considered liable in case a damage occur.

Indeed, some scholars have suggested solving the issue by allocating the risk to pre-established funds financed by the car manufacturers, which would allow compensation to be paid to injured and transported third parties in such cases[313].

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[313] G. Calabresi – E. Al Mureden, *Driverless cars. Intelligenza artificiale e futuro della mobilità*, cit., *passim*.

In fact, it would seem that this hypothesis would not be so different from an insurance system that cover producers and developers' risks. By the contrary, it would be appropriate to allocate the risk to autonomous vehicle itself in order to facilitate the innovation and, at the same time, protect third parties that could be damaged.

The idea is to reproduce a liability regime comparable to the one created for legal entities. In other words, an autonomous vehicle should be considered liable in case its autonomous decision (or the command of a hacker) causes a damage to someone or something. In order to do so, autonomous vehicles should be insured with a standard policy that cover this kind of risk with no temporal limitation. The current systems should be implemented from the legislators following this direction.

Chapter VIII. Conclusions

It has been shown that the introduction of autonomous vehicles is no more an imaginative idea, but it is just matter of time. It is sufficient to think that, according to EU prediction, the earlier roll-out of AVs worths $148 billion[314].

In previous chapters, it was pointed out that the idea of an autonomous driving vehicle is far from being a recent one. Therefore, already in the early 1920s, the idea of a self-driving vehicle began to spread, especially in the United States. Indeed, the potential advantages of this technology were immediately evident. Nevertheless, it did not take long before it was clear that the spread of self-driving vehicles entailed new potential risks.

A recent study confirmed that the spread of AVs among consumers would favour a safer road transport network, considering that over 95% of traffic accidents are caused by

[314] European Parliament, A Common EU approach to liability rules and insurance related for Connected and Autonomous Vehicles, European Added Value Assessment, (2018), 37.

human errors[315]. At the same time, the favorable impact on the environment has been stressed, highlighting how autonomous vehicle could contribute to a massive reduction of CO2 emissions.

Nevertheless, it has been pointed out that AVs entail also new potential risks. In order to prevent these occurrences, it has been proved that a proper regulation is needed. It has also been noted that one of the worst possible scenarios regarding automated cars concerns the hacking of informatic system of the vehicles or the case of a damage caused by an autonomous decision, made on the basis of machine learning algorithm, of automated vehicles.

Indeed, a coherent and effective normative framework is still missing. This is because, as it has already been observed in the previous chapters, there are still many unresolved legal issues and the speed at which technology is evolving makes it difficult to establish fixed points on which adequate regulatory measures can be built. It is inevitable that, for

[315] See: EC Communication on the Road to automated mobility: an EU strategy for mobility of the future, Brussels, 17 May 2018, COM(2018)283, in *https://ec.europa.eu*.

regulatory measures to be enacted that take into account the incessant technological developments, the legislator will necessarily have to make use of the input of other sciences such as computer science and mechanical engineering.

In this regard, a cooperation among different branches and industries is necessary in order to enact appropriate measures that will take into consideration different perspectives. In other words, it is important to implement the existent legislation with the cooperation of technicians that will be able to advice the law maker about the appropriateness of the provision.

It was also noted in the previous chapters that, as of today, there are elements of incompatibility between the definition of vehicle under the current system and the nature of self-driving vehicles, as well as between the figure of the driver and that of the user. In addition, it has clearly emerged that the regulatory system of liability for production defects, as currently structured, has elements that allow the manufacturer or producer – the unique individual able to intervene at the lowest cost to prevent the occurrence of an accident or minimise the damage - not to be held liable for damage caused to third parties.

On the other hand, such exemptions do not exist for the user and owner of the vehicle, who, even if they were unable to prevent an accident from occurring, could still be held liable.

This circumstance could have particularly harmful consequences from both a legal-economic and a social point of view. Indeed, such a liability regime could significantly affect the decision of users to use self-driving cars, since they could be considered liable for damages of an accident caused by circumstances beyond their control.

Although the liability system outlined by the PLD in order to identify the car manufacturer and the programmer of the driving software (figures that are likely to overlap more and more in the future) as the liable parties for manufacturing defects and malfunctions of self-driving cars is inadequate, a substantial reform of the PLD may not be an efficient solution.

It cannot be forgotten that the liability regime introduced by the PLD in fact applies to all types of goods in the market and for most of them does not entail similar problems to those identified in relation to self-driving vehicles and other highly automated products. It follows that, rather than amending the aforementioned regulation, it would be appropriate to introduce a new *ad hoc* liability regime at EU level for highly or fully automated vehicles resulting from the latest technological developments.

Moreover, it would be also appropriate to introduce a standardised European insurance or warranty system that would allow the manufacturer of an autonomous driving vehicle to be liable to the purchaser, within certain limits and circumstances, for any malfunction or anomaly of the software or mechanical parts of the vehicle that is not due to wear and tear, failure to update, unauthorised modifications or improper use[316].

[316] By way of illustration, reference is made to paragraph 59 of the European Parliament Resolution of 16 February 2017 (2018/C 252/25), according to which the European Parliament: "*calls on the Commission to explore, examine and assess, as part of the impact assessment of its future legislative instrument, the implications of all possible legal solutions, including: (a) the establishment of a compulsory insurance scheme, where relevant and necessary for specific categories of robots, whereby, as is already the case for cars,*

In this regard, it has been pointed out that some Stated have already adopted a sort of regulation. Since 2018, the United Kingdom enacted the Automated and Electric Vehicle Act 2018 extending the insurance liability legislation to vehicles that move either fully or partially automatically, as long as those vehicles are on an appropriate list.

Nevertheless, a more comprehensive and homogeneous regulation is still missing. For this reason, it is important to adjust the liability regime currently in place and extend the liability regime created for legal entities to autonomous vehicles. If such modification would be receipted, an autonomous vehicle would be considered liable in case its autonomous decision (or the command of a hacker) causes a damage to someone or something.

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manufacturers and owners of robots would be required to take out insurance cover for damage potentially caused by their robots; (b) the setting up of a compensation fund not only to guarantee compensation when the damage caused by the robot is not insured; (c) the possibility for the manufacturer, programmer, owner or user to benefit from limited liability if they set up a compensation fund as well as if they jointly take out insurance guaranteeing compensation in the event of damage caused by a robot; [. ..] ". However, this topic will be discussed deeply in Section III.

The implementation of this liability system requires a legislative intervention that introduce a standard policy that cover this kind of risk with no temporal limitation.

In conclusion, even if the current legislation in Europe (and, in particular in Spain and Italy) is partially extensible to autonomous vehicles, a more comprehensive and homogenous legislative intervention is needed.

Hopefully, such an intervention could implement the diffusion of this new technology and prevent the risks that the introduction of a new technological product inevitably entails.

In other words, while AV technology continues to improve before becoming an ordinary tool on the market, the collaboration between legal scholars, policymakers, and technologists will be essential to navigate the complex landscape of autonomous vehicles and law.

RESUMEN

Esta tesis se ha redactado utilizando una metodología exhaustiva e interdisciplinaria para investigar las implicaciones legales que plantea el despliegue de vehículos autónomos. De hecho, se ha demostrado que la introducción de vehículos autónomos ya no es una idea imaginativa, sino que es solo cuestión de tiempo y , según las previsiones de la UE, el despliegue temprano de los vehículos autónomos tendrá un valor de 148 mil millones de dólares.

La tesis se divide en ocho capítulos, cada uno de los cuales analiza una cuestión concreta relacionada con el despliegue de los vehículos autónomos.

La metodología adoptada incluye el análisis de diversas fuentes y materiales, como la investigación doctrinal, el análisis legal comparativo, estudios de casos, investigación empírica y enfoques interdisciplinarios.

En particular, se ha llevado a cabo una revisión exhaustiva de la literatura legal existente sobre vehículos autónomos, examinando algunos de los artículos académicos más

importantes sobre el tema, comentarios legales e informes de la industria.

La investigación incluyó el análisis de estatutos, regulaciones y directrices europeas e internacionales relacionadas con los vehículos autónomos, centrándose en áreas como las leyes de tráfico, los estándares de seguridad, la responsabilidad civil y de productos, los seguros y la protección de datos.

En particular, se analizaron las legislaciones existentes en España e Italia para resaltar los elementos de incompatibilidad entre la definición de "vehículo" bajo el sistema actual y la naturaleza de los vehículos autónomos, así como entre la figura del conductor y la del usuario.

El uso de esta metodología de análisis es especialmente evidente en los capítulos II y III. El segundo capítulo está dedicado al examen de la normativa ya promulgada relacionada con la responsabilidad civil en caso de accidente, con especial atención a la legislación italiana y española.

En particular, tras analizar la normativa promulgada a nivel europeo en materia de responsabilidad civil, se describen los ordenamientos jurídicos italiano y español, destacando las similitudes y diferencias, así como las medidas legislativas adoptadas en estos dos sistemas jurídicos en relación con las pruebas en carretera de los vehículos de conducción autónoma.

El tercer capítulo, de manera similar, describe el régimen de responsabilidad por productos defectuosos, con especial atención a la legislación italiana, española y estadounidense. En este capítulo se analizan las posibles consecuencias en caso de que se comercialice un vehículo defectuoso que cause daños a sus ocupantes o a terceros (es decir, peatones o pasajeros de otros vehículos).

Para ofrecer un análisis integral del tema, también se ha tenido en cuenta la revisión de la jurisprudencia. De hecho, se han examinado las decisiones judiciales más relevantes relacionadas con los vehículos autónomos, con el fin de entender cómo los tribunales interpretan las leyes existentes en el contexto de las tecnologías emergentes.

Por ejemplo, en los capítulos V y VI se analizan las principales y más relevantes sentencias de la jurisprudencia italiana y española en materia de seguros e impacto ambiental.

En el capítulo V, se examina la regulación de los seguros para determinar si la normativa actual es aplicable a los vehículos automatizados.

En primer lugar, este capítulo describe el sistema de seguros italiano, con especial atención a la regulación de las cajas negras en el Código de Seguros Privados y en el Decreto Smart Road, así como al enfoque jurisprudencial sobre esta cuestión.

A continuación, se describe el sistema de seguros español, destacando, entre otros aspectos, las posibles implicaciones de un rápido despliegue de los vehículos de conducción autónoma. Del mismo modo, se examina el enfoque jurisprudencial en España.

El VI capítulo se centra en el impacto medioambiental de los vehículos automatizados, con el objetivo de comprender si la introducción de esta tecnología podría generar beneficios considerables para el ambiente, analizando también el enfoque judicial actual. En concreto, este capítulo examina las posibles repercusiones positivas que la introducción de los coches autónomos puede tener sobre el entorno. Sin embargo, el análisis revela que, además de los posibles beneficios, también podrían existir riesgos asociados con un aumento considerable en el número de vehículos autónomos.

Como ya se ha mencionado, la tesis adopta un enfoque de análisis legal comparativo. Utilizando esta metodología, se han estudiado en profundidad los sistemas legales español e italiano, destacando sus fortalezas y debilidades, así como las similitudes y diferencias entre estos marcos normativos. Además, se consideró útil y pertinente resaltar algunas peculiaridades de los sistemas legales británico y estadounidense para identificar mejores prácticas y posibles riesgos.

Para llevar a cabo un análisis legal comparativo completo, fue esencial, en primer lugar, seleccionar una muestra representativa de jurisdicciones que hayan hecho avances significativos en la regulación de los vehículos autónomos. Esta es la razón por la que se incluyó a los Estados Unidos.

Como se mencionó previamente, la legislación estadounidense sobre responsabilidad por productos defectuosos fue examinada en el Capítulo III.

En segundo lugar, se estableció una matriz comparativa para comparar y contrastar de manera sistemática los enfoques legales de diferentes jurisdicciones. La comparación se realizó tras examinar estudios de casos, recopilar datos de múltiples fuentes y revisar la literatura principal relacionada con los vehículos autónomos.

Finalmente, se destacaron los resultados del análisis, identificando mejores prácticas y lecciones aprendidas del análisis legal comparativo, sintetizando los hallazgos para extraer conclusiones más amplias sobre las implicaciones legales del despliegue de vehículos autónomos.

Tampoco se ha pasado por alto el contexto histórico. De hecho, se ha destacado que la idea de un vehículo autónomo está lejos de ser reciente. Ya a principios de la década de 1920, la idea de un vehículo sin conductor comenzó a difundirse, especialmente en los Estados Unidos.

En particular, el primer capítulo se remonta a finales del siglo XIX, cuando Carl Benz registró la patente nº 37435, describiéndola como «vehículo con funcionamiento por motor de gas». Tras trazar la historia del automóvil y los primeros intentos (aunque todavía rudimentarios) de desarrollar un coche autónomo, se analizò el estado actual de la tecnología.

Asimismo, se profundizò en las posibles ventajas de esta tecnología, así como en los nuevos riesgos potenciales que implica la expansión de los vehículos autónomos.

Por ejemplo, se incluyeron estudios estadísticos que confirman que la adopción de vehículos autónomos entre los consumidores podría favorecer una red de transporte por carretera más segura, considerando que más del 95% de los accidentes de tráfico son causados por errores humanos.

Al mismo tiempo, se destacó el impacto positivo en el medio ambiente, subrayando cómo estos vehículos podrían contribuir a una reducción significativa de las emisiones de CO2.

Como se mencionó, un análisis exhaustivo del tema también requirió la evaluación de los nuevos riesgos potenciales. Para mitigar estos riesgos, se ha demostrado que es necesaria una regulación adecuada. Asimismo, se señaló que uno de los peores escenarios posibles relacionados con los coches automatizados se refiere al pirateo de su sistema informático o al daño causado por una decisión autónoma tomada por un algoritmo de aprendizaje automático.

Además, como ya se ha mencionado, fue necesario profundizar en el tema de los seguros para comprender si los sistemas actualmente vigentes en Italia y España están preparados para cubrir los nuevos riesgos generados por la introducción de los vehículos autónomos.

En este sentido, se señaló que algunos estados ya han adoptado regulaciones específicas. Desde 2018, el Reino Unido promulgó la Ley de Vehículos Automatizados y Eléctricos, extendiendo la legislación de responsabilidad de seguros a los vehículos que se mueven de forma total o parcialmente automática, siempre que dichos vehículos estén incluidos en una lista adecuada.

Dada la complejidad de los vehículos autónomos, se requirió un enfoque interdisciplinario para considerar las contribuciones científicas de disciplinas no jurídicas. De hecho, se examinaron artículos de ingeniería para comprender completamente la tecnología detrás de los vehículos autónomos. De manera similar, se abordaron cuestiones éticas relacionadas con estos vehículos, como el proceso de toma de decisiones y los posibles sesgos.

En este sentido, se analizó la tecnología detrás de los vehículos autónomos, su funcionamiento y los distintos niveles de automatización. Se examinó la tecnología innovadora que sustenta los sistemas de conducción automatizada, destacando que estos vehículos están equipados con sofisticados sistemas de asistencia al conductor, conocidos como «ADAS» (Sistemas Avanzados de Asistencia al Conductor).

Una vez analizado el estado actual de la tecnología, se presentaron los seis niveles de conducción autónoma elaborados por la SAE (Society of Automotive Engineers), los cuales son aceptados globalmente para clasificar e identificar los grados de automatización de los vehículos.

El IV capítulo, por ejemplo, se centra en la interacción entre *blockchain* y los vehículos automatizados. Tras destacar las principales características de la tecnología blockchain, se analizaron los potenciales que la interacción entre ambas tecnologías podría tener a largo plazo.

Además, se profundizó en el análisis de la tecnología de *deep learning* y en las ciencias éticas y sociológicas. En el capítulo VII, se examinò el uso del *deep learning* y su interacción con los vehículos autónomos, analizando las implicaciones éticas y abordando el llamado «dilema ético».

Tampoco se ha descuidado el impacto socioeconómico de la llegada de esta nueva tecnología. De hecho, se profundizó en el potencial de los vehículos autónomos para transformar los sistemas de transporte público.

Con base en lo anterior, está claro que investigar las implicaciones legales de los vehículos autónomos requirió un enfoque multifacético, que combinara investigación doctrinal, análisis legal comparativo, estudios de casos y un enfoque interdisciplinario.

Esta metodología garantizó una comprensión integral de los desafíos y oportunidades que presentan los vehículos autónomos en Europa, particularmente en Italia y España.

De este estudio se concluye que, sin embargo, aún falta una regulación más integral y homogénea. Por esta razón, es importante ajustar el régimen de responsabilidad vigente en España e Italia.

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