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Legal Regulation of Autonomous Vehicles in China

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Abstract: This paper explores the legal regulation of autonomous vehicles in China. The article first introduces the current state of development of autonomous vehicles in China, categorizing it into three phases: the initial technological phase, the rapid development phase, and the commercial application phase. It is noted that China has already reached Level 4 (L4) autonomous driving capabilities. Next, the article analyzes the risks associated with autonomous vehicles, which include issues of liability determination, safety, information security, and ethical design risks. Additionally, the article provides an overview of the legislative experiences in Germany and California, USA, extracting insights that may inform China's legislative approach. Finally, the paper offers recommendations to improve the legal regulation of autonomous vehicles in China, such as refining the liability determination system for traffic accidents, optimizing safety protocols, establishing information security frameworks, and accelerating the legislative process. The article emphasizes that, with the rapid advancement of autonomous driving technology, continuous refinement of legal regulations is essential to ensure a balance between technological progress and the protection of public interest.

Keywords: Autonomous vehicles, Legal regulation in China, Liability determination risk, Information security risk.

1. Introduction

In recent years, autonomous driving technology has developed rapidly worldwide, becoming a key focus in the next generation of transportation and artificial intelligence technologies. Following years of extensive growth, China's autonomous driving technology has made significant advancements in both theoretical development and practical applications. Companies like "Robobus," for instance, have applied autonomous driving technology within the taxi industry and conducted trials in regions such as Wuhan, achieving substantial success and transforming everyday life for the public. Some scholars have presented models built on autonomous vehicle systems, highlighting the substantial impact of autonomous vehicles on the efficiency and structure of public transportation systems. At the same time, the development of autonomous vehicles has introduced numerous challenges for contemporary society, particularly in terms of legal construction and regulation. Issues such as how to effectively manage the risks posed by autonomous vehicles, how to allocate legal liability in the event of autonomous vehicle accidents, and how to protect user privacy remain unresolved. Against this backdrop, the government has introduced numerous policies to regulate and manage the operation of autonomous vehicles. Currently, scholars in China have put forward various suggestions regarding

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regulation and management. For example, some have proposed substituting corporate liability for individual liability. Nonetheless, numerous challenges persist within the realm of legal practice in autonomous driving, and China faces the predicament of autonomous vehicle development outpacing the establishment of corresponding regulatory frameworks. Therefore, it is essential to conduct a more in-depth study of the risks and legal regulation of autonomous vehicles. This paper will analyze the current development status and characteristics of autonomous vehicles, examining the associated development risks. By drawing on international experiences, it will review China's current legal regulation of autonomous vehicles, discussing the strengths and limitations of existing regulations, and providing relevant recommendations. The goal is to offer valuable insights for policymakers, legal researchers, and industry practitioners.

2. Current Development Status of Autonomous Vehicles in China

2.1. Development Status of Autonomous Vehicles

The development of autonomous vehicles in China can be divided into three phases. The first phase is the initial period of technological foundation and accumulation. In 1992, China manufactured its first autonomous vehicle through a collaboration between Harbin Institute of Technology, the National University of Defense Technology, and the Shenyang Institute of Automation, marking the beginning of autonomous vehicle technology in the country. Following this milestone, the efforts of numerous universities and research institutes have led to the accumulation of technical knowledge and practical experience in autonomous driving. The second phase is the period of rapid development. Since 2010, many enterprises have entered the autonomous vehicle industry. Technologies such as vehicle networking and large artificial intelligence models have progressed rapidly, with companies like Baidu and Changan achieving successful trials in autonomous vehicle experimentation. The third phase is the beginning of commercial application. In 2020, Baidu received approval to conduct autonomous vehicle trials in Changsha, and as of now, this has expanded to 11 cities, marking the start of commercial operations for autonomous vehicles. According to the classification standards established by the Society of Automotive Engineers (SAE), autonomous vehicles are divided into six levels, from L0 to L5. L0 represents no automation, where the driver controls the accelerator, brakes, and steering entirely. This is the most basic driving mode, where the vehicle only provides minimal assistance functions. L1 is known as assisted driving, where the system offers support under specific conditions, such as adaptive cruise control and anti-lock braking systems. L2 vehicles have partial automation, allowing the vehicle to control steering and acceleration/deceleration, but still require the driver to maintain attention. L3 is conditional automation, enabling the vehicle to drive autonomously under most conditions, with the driver expected to take over when necessary. At L4, vehicles are highly automated, capable of fully autonomous driving within specific areas but still requiring human intervention in certain situations. L5 represents the highest level of automation, in which the vehicle can drive completely autonomously under all conditions, with no human intervention needed. China's autonomous vehicle industry has now reached the L4 level. On May 15, 2024, Baidu Apollo released the first large model supporting L4 autonomous driving, known as Apollo ADFM, in Wuhan, Hubei [1]. Supported by this new model, Robobus has been better able to adapt to user needs and traffic conditions. As of May 2024, Robobus has completed six million trips, covering 11 cities, including Wuhan and Shanghai [2].

2.2. Characteristics of Autonomous Vehicles

Compared to traditional vehicles, autonomous vehicles have two notable characteristics. The first and primary characteristic of autonomous vehicles is the removal of human involvement, or automation. Although current autonomous vehicles still require human oversight due to technological limitations,

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it is undeniable that, as a tool traditionally perceived to rely on human operation, the importance of human presence in vehicle operation is gradually diminishing. Since the agricultural era, humankind has utilized animal power, and with the industrial era came the discovery of mechanical power. While both forms partially replaced human labor, they still required human operation and decision-making at the forefront. Now, however, artificial intelligence technology, as exemplified by autonomous vehicles, truly moves beyond direct human operation and decision-making, becoming a relatively autonomous, self-operating entity. This fundamental distinction from traditional vehicles suggests that autonomous vehicles will bring about a series of challenges to societal functioning. The absence of human involvement is inevitably causing public apprehension; for example, in Wuhan, 70,000 taxi drivers have collectively protested against the operation of autonomous vehicles, hoping to retain some space for their livelihoods [3]. While scientific and technological progress is an unstoppable force in societal development, how to resolve the conflict between public welfare and technological advancement remains a question. Additionally, this characteristic of "dehumanization" also severs the traditional legal link between taxi companies and their vehicles. One scholar suggests that "the autonomous actions of driverless vehicles disrupt the causal legal relationship between people; therefore, operational models should incorporate 'human-machine interaction,' decentering human involvement and establishing a legal relationship between humans and objects" [4]. The second characteristic of autonomous vehicles is their reliance on vehicle-to-network connectivity and artificial intelligence. Traditional vehicular systems are built upon objective traffic regulations, grounded in an ethical foundation that values human life. However, in a future transportation system where autonomous vehicles dominate, this foundation will be replaced by programming, code, and even autonomous decision-making by artificial intelligence. Although some scholars argue that the operational foundation of autonomous vehicles is an inherent, unconditional trust in these systems [5], there remains an unavoidable public apprehension regarding the replacement of ethical judgments with AI-driven decisions. Despite the issues outlined here, the advantages of autonomous vehicles remain undeniable; they liberate productivity, simplify daily life, and technological advancement will undoubtedly make our lives better.

3. Risks Associated with Autonomous Vehicles in China

3.1. Liability Determination Risks for Autonomous Vehicles

The first issue autonomous vehicles face is the difficulty in identifying the liable party. The operation of autonomous vehicles involves multiple parties, including vehicle manufacturers, software developers, and sensor suppliers. When an accident occurs, determining liability becomes complex. The current legal framework is primarily established for scenarios involving human drivers, and there is a lack of clear provisions for liability determination in autonomous vehicle cases, resulting in confusion in legal applications [6]. Some scholars argue that in cases where autonomous vehicles are involved in accidents due to their intelligent systems, traditional legal liability held by the vehicle owner or controller should shift to product liability borne by the manufacturer [7]. This approach may assist in resolving some issues in liability determination for autonomous vehicles, but further technological advancements are needed to develop a more refined judgment process. The second issue concerns the adaptability of current laws. The development of autonomous vehicles requires adaptive updates to the legal system. For instance, some scholars suggest that the testing and commercial application of autonomous vehicles need a clear legal framework for guidance and regulation [8]. The third issue pertains to the regulation of tort liability and product liability in autonomous vehicles. Various stages of autonomous vehicle manufacturing may encounter new issues, such as intellectual property challenges, which require adjustments and improvements to

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existing laws to align with the characteristics of autonomous vehicles. For example, liability in accidents involving autonomous vehicles may implicate the manufacturer's product liability [8].

3.2. Safety Risks of Autonomous Vehicles

Autonomous vehicles still face several safety risks today. The first risk is the unavoidable technical defects. Autonomous vehicles are still in the developmental stage, and some technologies are not yet fully mature. For instance, defects may exist in sensors, algorithms, and decision-making systems, which could impair the accurate recognition and response to traffic environments, thereby increasing the risk of accidents [9]. The second risk is the excessive reliance of passengers on autonomous systems. Passengers may overly depend on the autonomous driving system, neglecting the need to monitor the vehicle's operation, which could result in an inability to take control promptly in emergencies, posing significant safety hazards [6]. The final risk involves the decision-making system's performance under high-stress situations. In emergencies, autonomous vehicles need to make rapid decisions, which may involve moral and ethical dilemmas, such as deciding whom to protect in an unavoidable collision [10]. In such dilemmas, the judgment of the autonomous vehicle's decision-making system may be detrimental to individuals. For example, an incident in which a Robobus autonomous vehicle struck a pedestrian who ran a red light suggests that its decision-making system may exhibit deficiencies in handling ethical dilemmas of this nature.

3.3. Information Security Risks of Autonomous Vehicles

Autonomous vehicles operate based on vehicle-to-network (V2N) connectivity, and this high level of integration with information networks inevitably exposes them to numerous information security risks. The first risk is data leakage. Autonomous vehicles utilize V2N big data technology to provide passengers with a more intelligent service experience, which requires the collection and processing of substantial amounts of personal data during operation. If improperly managed, this data could be leaked, threatening personal privacy [11]. The second risk is the threat of malicious cyberattacks. Autonomous vehicles may become targets for hackers, who could control the vehicles through network attacks and cause safety incidents [11]. The final risk involves the opacity of decision-making algorithms. The decision-making algorithms in autonomous vehicles may be opaque and potentially biased, resulting in unjust and discriminatory outcomes. This lack of transparency can hinder the protection of certain groups' rights and may lead to legal disputes [12].

3.4. Ethical Design Risks of Autonomous Vehicles

The control of autonomous vehicles is primarily based on programming languages, with the artificial intelligence system making independent judgments. Consequently, the control system of autonomous vehicles must incorporate an ethical judgment framework to ensure the safety of human life. Some scholars suggest that the ethical judgment of current autonomous vehicles faces dilemmas rooted in utilitarianism versus deontology, the trolley problem, and prioritization issues between passengers and external parties [13]. If the ethical judgment aspect is not designed correctly, it could have severe negative impacts on the development of autonomous vehicles and public opinion.

4. Regulatory Experiences Abroad in Autonomous Vehicle Legislation

As a cutting-edge technology, the development and application of autonomous vehicles are influenced not only by technological maturity but also by the establishment and refinement of legal frameworks. From the legislative experiences of Germany and California, USA, we can derive some insights for the legislation of autonomous vehicles.

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4.1. Germany's Legislative Experience

As a leading automotive industry powerhouse, Germany's legislative experience in the field of autonomous driving serves as a valuable reference. In May 2021, Germany passed the "Autonomous Driving Law," amending the "Road Traffic Act" and the "Motor Vehicle Compulsory Insurance Act" to accommodate advancements in autonomous driving technology [14]. Key aspects of Germany's legislation are as follows: First, regulations on technical oversight and driving conditions. Germany's "Autonomous Driving Law" permits Level 4 autonomous vehicles to operate in designated areas on public roads, with specified technical and driving conditions. For example, vehicles must be equipped with appropriate technical systems that independently enable safe driving functionality. Second, the establishment of the technical supervisor system. Germany introduced a technical supervisor system, requiring the vehicle owner to appoint a qualified individual with expertise to serve as the technical supervisor, who remotely monitors the vehicle and intervenes in the autonomous driving system when necessary. This direct management approach enhances the safety of autonomous vehicles. Third, the safety assurance obligations of vehicle manufacturers. Vehicle manufacturers are required to ensure the proper functioning of all autonomous vehicle features and assume safety assurance responsibilities from the development to the operational stages. Regarding data storage, the new German law specifies the vehicle owner's obligation to store data and provides the traffic authorities with a legal basis for data processing. Regarding the handling of autonomous vehicle accidents, the "Autonomous Driving Law" supplements exceptions to the liability exemption for vehicle owners to ensure the protection of victims' interests. Germany has further expanded the scope of compulsory motor vehicle insurance. Through amendments to the "Motor Vehicle Compulsory Insurance Act," the range of insured parties in compulsory liability insurance has been extended, requiring technical supervisors to be covered and maintained under liability insurance. This change better facilitates the resolution of disputes arising from autonomous vehicles [14].

4.2. California's Legislative Experience

Unlike Germany's supportive and encouraging stance toward autonomous vehicles, California adopts a markedly more conservative and cautious approach, representing the opposite end of the spectrum in autonomous vehicle legislation. As a global center of technological innovation, California's legislative actions regarding autonomous vehicles also carry significant guiding value. Recently, California lawmakers proposed a bill prohibiting "driverless" autonomous vehicles from operating on public roads, reflecting concerns over the safety of autonomous vehicles [15]. The first aspect is the requirement for drivers of autonomous vehicles. The proposed bill in California mandates that autonomous vehicles weighing over 10,001 pounds must have a "trained" human driver to handle potential technical malfunctions or emergencies. This restriction on the conditions under which autonomous vehicles can operate aims to protect public safety. Although this policy may appear conservative, frequent incidents involving autonomous vehicles have led the public to question the technology's safety and feasibility, prompting legislators to adopt a more cautious stance.

4.3. Insights from Foreign Legislation

Examining both supportive and cautious legislative cases abroad, we can identify several key considerations for autonomous vehicle legislation. First, China should adopt a cautious approach toward autonomous vehicles, avoiding overly aggressive policies. Second, it is essential to balance technological advancement with public safety, as the development of autonomous vehicles inevitably encounters issues that pose risks to public safety. Achieving this balance within legal frameworks is a critical issue. Third, in terms of liability determination, legislation should emphasize the protection of public interests. Fourth, issues related to data oversight—such as the designation of regulatory

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authorities and the implementation of oversight measures—deserve close attention. Fifth, fostering a more democratic and scientifically-informed legislative process is crucial, encouraging a broader range of viewpoints in decision-making.

5. Legal Regulation of Autonomous Vehicles in China

5.1. Improving the Liability Determination System for Traffic Accidents Involving Autonomous Vehicles

As an emerging technology, autonomous vehicles present unique liability issues in practical applications, making liability determination a focal point in legal regulation. Therefore, it is recommended to amend the "Road Traffic Safety Law of the People's Republic of China" to establish specific rules for liability determination, as follows: First, when a traffic accident occurs while the vehicle's autonomous driving system is active, if the autonomous vehicle is found liable, the vehicle owner or manager should bear the compensation responsibility. This rule reflects the difference in liability between autonomous and traditional vehicles, emphasizing the responsibility of the technology user. Second, autonomous vehicles engaged in experimental activities should be equipped with a driver or safety operator to ensure that someone can take control of the vehicle when necessary, thus ensuring driving safety. The requirement for a safety operator not only enhances the safety of autonomous vehicles but also clarifies the operator's responsibility in specific situations. Third, after compensating the victim, the vehicle owner or manager may legally seek recourse from responsible parties such as the manufacturer or seller. This provision offers additional legal protection to autonomous vehicle users while imposing higher standards on producers and sellers.

5.2. Optimizing the Safety Framework for Autonomous Vehicles

Autonomous vehicles present several safety risks, and to facilitate their safer operation, the following measures are recommended: First, enhance vehicle safety technical requirements, emphasizing that autonomous vehicles must comply with national standards and technical specifications. They should be registered in accordance with the law, and autonomous vehicles should obtain a temporary license plate distinct from ordinary vehicles, allowing for more effective regulatory oversight. Second, establish a safety monitoring platform and a dynamic monitoring management system. Autonomous vehicles should be capable of transmitting critical operational status information in real time and automatically recording and storing relevant information in the event of an accident or autonomous system failure. Third, impose risk management and emergency preparedness requirements on industry practitioners involved with autonomous vehicles. Fourth, operators should promptly implement emergency response plans in the event of an accident and report to the relevant authorities as required by law in severe cases, in order to minimize accident risks and damages.

5.3. Establishing an Information Security Framework for Autonomous Vehicles

To address the information security risks of autonomous vehicles, it is recommended to establish a dedicated information security framework. With the increasing adoption of autonomous vehicles, the volume of data collected and processed by these vehicles will surge, highlighting information security concerns. First, emphasize that autonomous vehicle companies must legally establish robust data security and personal information protection management systems, perform data classification and graded protection, and conduct data security risk assessments. It should also be stipulated that companies must not unlawfully process personal information or collect data unrelated to vehicle operation and traffic safety. Second, outline cybersecurity management requirements for autonomous vehicle companies. These companies should be required to implement network security level

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protection in accordance with the law, establish network security management protocols, and develop emergency response plans for cybersecurity incidents to enhance network security protection and better safeguard user data. Third, stipulate the regulations for cross-border data transfers. Any cross-border transmission of autonomous vehicle data must comply with relevant national regulations. Fourth, establish mapping requirements for autonomous vehicles. Companies must obtain the necessary qualifications in accordance with the law and implement technical measures to ensure the security of geographic information data.

6. Conclusion

With the rapid development of autonomous driving technology, China has made significant progress in both theory and practice in this field. The commercialization and pilot applications of autonomous vehicles are gradually unfolding, bringing convenience to public life while also challenging existing social order and legal systems. This paper analyzed the current development status, characteristics, and risks associated with autonomous vehicles in China, explored the advantages and limitations of China's existing regulatory framework in light of international legislative experiences, and proposed corresponding recommendations for improvement. At this rapid development stage, issues such as technical defects, over-reliance on systems, and decision-making dilemmas in emergencies could lead to safety concerns. In terms of information security, challenges like data leakage, cyberattacks, and algorithmic opacity require urgent solutions. Therefore, to optimize and enhance the legal regulation of autonomous vehicles in China, several measures are recommended. First, improve the liability determination system by clarifying the liable parties in autonomous vehicle accidents, providing clear liability guidance for vehicle owners or managers, drivers, or safety operators. Second, strengthen safety technical requirements, ensuring that autonomous vehicles comply with national safety standards and implementing effective safety monitoring and dynamic management systems. Third, establish an information security framework to enhance data security and personal information protection, enforce network security level protection, regulate cross-border data transfers, and ensure the security of geographic information data. Finally, accelerate the legislative process, encouraging broader public participation and scientifically-informed legislation to keep pace with the rapid development of autonomous vehicle technology.

In summary, the development of autonomous vehicles is an inevitable trend that will profoundly change our modes of travel and daily habits. In addressing the challenges it brings, we must continually refine legal regulations to ensure a balance between technological progress and the protection of public interests.

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