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The Impasse and Solutions for Product Liability in the Field of Autonomous Vehicles

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Abstract

Currently, autonomous driving technology is transitioning from technical testing to large-scale commercial application. Compared to traditional industrial products, autonomous driving technology is characterized by both complexity and autonomy, making it difficult to adapt to traditional product liability standards. This not only affects the effective remedy of the legitimate rights and interests of victims but also hinders the innovative development of the industry. This paper takes the application of product liability for autonomous vehicles as its research object, combining relevant legal provisions and practical cases to analyze the application dilemmas of autonomous vehicles in terms of the scope of product liability subjects, defect identification, and the difficulty in proving causation, and provides corresponding solutions.

Keywords

Autonomous Vehicles, Product Liability, Defect Determination, Causation.

1. Introduction

In recent years, with the continuous innovation of artificial intelligence technology, the autonomous vehicle industry has developed rapidly. At the departmental regulatory level, in November 2023, the Ministry of Industry and Information Technology, together with several other departments, issued the "Notice on Carrying Out Pilot Work on Access and Road Traffic of Intelligent Connected Vehicles," officially launching pilot work on the access and road traffic of mass-produced intelligent connected vehicles based on L3/L4 level autonomous driving functions [1] . At the local regulatory level, Shenzhen took the lead in legislating for autonomous vehicles, promulgating the "Regulations on the Management of Intelligent Connected Vehicles in the Shenzhen Special Economic Zone." Beijing, Shanghai, Wuhan, and other places have also actively carried out relevant legislation and road tests. China's autonomous vehicle industry is shifting from early technology testing and regional demonstrations to the construction of a systematic system aimed at large-scale commercial application.

At the same time, the commercialization of autonomous vehicles is accompanied by certain risks. Globally, there have been numerous accidents and fatalities related to autonomous driving. Examples include the 2016 Tesla Autopilot fatal accident, the 2018 Uber self-driving car fatality, and the 2019 Los Angeles Tesla Auto Pilot crash. These incidents not only expose the need for technological improvements in autonomous vehicles but also highlight the inadequacies of the existing legal system in addressing such issues.[2]

Accidents involving autonomous vehicles involve multiple parties with varying degrees of responsibility, as well as inherent issues with autonomous driving technology itself, making them significantly different from the tort liability determinations for traditional vehicles. Furthermore, the current provisions on product liability in the Civil Code and Product Quality Law present difficulties in resolving the determination of product defects and proving causation in such cases.

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2. Problem Statement

2.1. The Traditional “Producer-seller" Responsibility System is in Trouble

The development of autonomous driving technology is driving the automotive industry from mechanical control to intelligent systems driven by algorithms, data, and the cloud. This fundamental shift poses a serious challenge to the traditional product liability system centered on "physical component defects" and "producer-seller" relationships [3] . On the one hand, the traditional liability chain is relatively simple, mainly revolving around car manufacturers and dealers. However, an autonomous driving system is a complex system encompassing hardware, software algorithms, and data services, and defects in any link can lead to serious safety accidents. This means that potential liable parties are no longer limited to traditional automakers but also extend to autonomous driving algorithm companies, high-precision map providers, and data service providers. After an accident, accurately pinpointing which "defect" caused the damage makes technical attribution extremely difficult [4] . On the other hand, in the profit distribution of the autonomous driving industry, developers of core technologies (such as algorithm companies) reap considerable profits by providing the intelligent "soul," but may not directly face end consumers and bear the corresponding product liability risks. While traditional vehicle manufacturers and sellers act as the responsible interface to users, they have limited control over highly specialized algorithmic or data defects in their upstream supply chain. This misalignment between risk bearers and beneficiaries creates an imbalance of rights and responsibilities. It may unreasonably increase the liability burden of traditional automakers; at the same time, core technology providers may lack sufficient motivation to continuously improve safety due to their "isolation" from responsibility.

2.2. Difficulty in Identifying Defects in Autonomous Driving Products

China's Product Quality Law, when determining whether an infringing product is defective, advocates relying on the "unreasonable danger standard" and "national standards and industry standards." Firstly, regarding the "unreasonable danger" standard adopted in Article 46 of the Product Quality Law, judicial practice typically uses the consumer's reasonable expectation standard and the risk-utility standard for specific assessment. [5] However, both standards show shortcomings when applied to autonomous vehicles. On the one hand, the consumer's reasonable expectation standard is highly subjective. This standard states that if a product cannot meet consumers' reasonable expectations for safety, it constitutes a defect [6]. However, autonomous driving systems are highly specialized, and their operational logic and limitations far exceed the understanding of ordinary consumers. Consumers may expect the system to be able to completely handle complex road conditions based on automakers' "autonomous driving" claims, but whether such expectations are "reasonable" is difficult to define. On the other hand, the application of the risk-utility standard faces obstacles. The prerequisite for using the risk-utility standard in product defect determination is that the injured party can provide an alternative solution; its focus is on how to weigh the product's risks and benefits. Generally, a product is considered defective when the benefits of improvement outweigh the costs, suggesting the existence of a reasonable alternative design. Conversely, if no reasonable alternative exists, the existing product is not legally defective [7] . However, many aspects of autonomous driving systems, algorithms, and technologies are trade secrets, making them difficult for victims to access and for them to propose effective alternatives. Even if algorithmic information is obtained through legal proceedings, determining the rationality of the design heavily relies on professional technical assessment, significantly increasing the cost of pursuing legal action. [8]

Secondly, regarding the "national and industry standards" established by the Product Quality Law, China has initially established a standard framework, formulating and issuing relevant

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standards such as "Intelligent Connected Vehicle Automated Driving Data Recording System" (GB 44497-2024), "Technical Requirements for Information Security of Automobiles" (GB 44495-2024), and "Classification of Driving Automation for Automobiles" (GB/T 40429-2021). However, the system is still incomplete, and a unified industry standard has not yet been formed. Current standards mostly focus on basic general areas (such as automation classification) and baseline safety requirements (such as data recording and information security), but lack detailed and operational evaluation standards for the most critical aspects of identifying product defects, such as algorithm decision safety, specific quantitative criteria for Safety in Expected Functions (SOTIF), and system performance boundaries in complex scenarios. This results in a lack of clear and unified technical basis when determining whether algorithm decisions constitute "unreasonable dangers."

2.3. Dilemmas in Applying Causation

Causation is a crucial element in product liability, and it plays a vital role in assigning product liability for damages caused by autonomous vehicles [9] . In the legal logic of product liability, causation is the indispensable bridge connecting "product defect" and "damage," and is key to determining whether a manufacturer should bear liability for compensation. While the Civil Code and other laws do not provide specific provisions for determining causation in product liability, the injured party still bears the burden of proof regarding the causal chain in the case; failure to provide such proof will result in adverse litigation consequences. However , proving causation presents the following challenges :

First, the general social experience approach presents challenges in determining causation. Regarding the general rules for determining causation in product liability cases, China primarily adopts the "theory of adequate causation," which requires a presumption of probability based on general social experience and scientific findings [10] . However, autonomous vehicles involve a combination of algorithms, data, computing power, and other hardware and software aspects, resulting in a lack of corresponding social experience to determine the causal relationship between defects and damage.

Secondly, victims face difficulties in providing evidence. The highly technical nature of autonomous driving systems, the black-box nature of their algorithms, and the concentration of data control in the hands of manufacturers make it difficult for ordinary victims to effectively obtain, interpret, and preserve technical evidence related to accidents. For non-professionals, proving key facts such as malfunctions, algorithmic defects, data deviations, or design flaws in autonomous driving systems is not only technically challenging but also requires significant investment . This severe imbalance between information and capability makes the traditional "whoever asserts must prove" rule difficult to apply fairly and poses a serious challenge to the remedial function of existing product liability and tort liability systems. Overly strict standards for determining causation may be detrimental to protecting consumer rights and ultimately inhibit the acceptance of autonomous vehicles. Conversely, relatively lenient standards could easily lead to liability for manufacturers and developers of autonomous vehicles, which would stifle industrial innovation and development [11] . Finding a balance between industrial innovation and rights protection is the key issue.

3. Constructing a Systematic Approach to Product Liability for Autonomous Vehicles

3.1. Expanding the Scope of Product Liability Entities

In the traditional automotive industry chain, the main responsible parties are vehicle hardware manufacturers and car sellers. However, the risks of autonomous vehicles have shifted from hardware to software and data. If only manufacturers or sellers bear full product responsibility,

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it is insufficient to reasonably constrain the new risk sources, namely software designers and maintainers. The designers of autonomous driving systems and data providers should be included in the scope of product liability. This approach aligns with the needs of current development and strengthens consumer protection. Furthermore, holding those truly at fault liable aligns with the modern legal principle of "whoever benefits, bears the responsibility; whoever controls the risk, bears the responsibility." System designers and data providers are the primary beneficiaries of the technology and the actual controllers of the risk sources; they should bear corresponding responsibility within the scope of their benefits and control. This directly incentivizes them to invest more resources in ensuring algorithm security and improving data quality, thus promoting the healthy development of autonomous driving technology.

3.2. Improve the Standard System for Identifying Defects in Autonomous Driving Products

(1) Optimize the specific criteria for judging "unreasonable danger" to resolve the application dilemmas of the consumer reasonable expectation standard and the risk utility standard. Addressing the subjectivity of the consumer reasonable expectation standard, construct an "objective reasonable expectation standard," comprehensively judging whether consumer expectations are reasonable by considering factors such as the prevalence of autonomous driving technology, the manufacturer's promotional content, and the general technical level of the industry. Simultaneously, clarify that algorithm companies and vehicle manufacturers have an obligation to provide algorithm design documents, test data, and other relevant materials. Regarding the issue of "difficulty in obtaining alternative solutions" in the application of the risk utility standard, if the victim cannot propose an effective alternative algorithm design, they can apply to the People's Court to entrust a professional autonomous driving technology appraisal institution to assess the reasonableness of the existing algorithm design and determine whether a safer and more reasonable alternative design exists.

(2) Accelerate the improvement of national and industry standards related to autonomous driving, filling the standard gaps in core areas such as algorithm safety and expected functional safety. At the same time, clarify the supplementary status of "national and industry standards," rejecting the absolutist view that "compliance equals no defects." Emphasize that technical standards are the minimum requirements for product safety, not the only requirements. Even if an autonomous vehicle fully complies with current technical standards, if it still poses an unreasonable danger to personal safety or property, it should still be considered a product defect. For example, an autonomous vehicle may comply with current information security standards, but due to a hidden vulnerability in its algorithm, it may experience perception failure under certain weather conditions. In this case, even if the vulnerability is not covered by current standards, the product should still be considered defective.

3.3. Optimize the Rules for Determining Causation and the Allocation of the Burden of Proof

(1) Introduce the presumed causation rule to reduce the burden of proof for victims. In environmental and resource tort disputes, victims often face difficulties proving the connection between the tortious act and the resulting damage. China's Civil Code, in its Tort Liability section, stipulates a reversed burden of proof and a presumed causal relationship system. [12] In autonomous vehicle tort cases, the asymmetry of information between the plaintiff and defendant continues, making it difficult for victims to prove the causal chain. Therefore, the approach used in environmental pollution cases can be adopted to address autonomous vehicle torts. This means that victims of autonomous vehicle accidents can prove a certain causal link between the product defect and the damage. The standard of proof for this causal link is lower than the high probability; it is sufficient to prove that the infringing act "may have caused" the

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damage, without requiring a strict causal chain argument. After the victim's initial evidence presentation, if the infringer cannot prove that the product defect and the damage are not causally related, a presumed causal relationship is established. This effectively alleviates the burden of proof difficulties faced by victims due to technical barriers and informational obstacles.

(2) To address the challenge of establishing causal relationships due to the "black box" nature of algorithms, the requirement of "algorithm explainability" is introduced. This clarifies that algorithm companies have an obligation to explain their algorithm decision-making process and prove the rationality of their decision-making logic. After an accident, algorithm companies must provide judicial authorities and appraisal institutions with relevant materials such as algorithm design documents, decision-making flowcharts, training data, and test reports to explain the algorithm's decision-making process at the time of the accident, proving that its decision-making behavior complies with safety standards and ethical norms. If the algorithm company cannot provide a reasonable explanation of the algorithm's decision-making process or prove that its decision-making logic is free of defects, it is presumed that the algorithm is defective, and that a causal relationship exists between this defect and the damage. Simultaneously, a professional technical appraisal system will be established to provide technical support for causal relationship determination and defect identification. A national-level autonomous driving accident technical appraisal center will be established, while local governments are encouraged to establish regional appraisal institutions, cultivating a composite appraisal team that understands both law and autonomous driving technology (algorithms, sensors, data processing, etc.).

4. Conclusion

The emergence of autonomous driving technology has transformed transportation from "mechanical carriers" to "intelligent systems," posing profound challenges to the product liability system built upon traditional industrial products. Traditional product liability law is based on the "physical defect" and "producer-seller" binary structure. However, in the era of autonomous driving, the source of risk has shifted from tangible hardware failures to intangible algorithmic decisions. The decision-making patterns learned by algorithms from massive amounts of data-patterns that even developers struggle to fully predict-make it difficult to apply a liability system based on causal certainty. At the heart of these dilemmas lies the mismatch between the logic of technological risk allocation and the fairness and remedial functions of the law-the unexplainability of the algorithmic black box, the unequal control over data, and the lag in technological standards collectively undermine the traditional legal principles of "equal risk and benefit" and "balance between rights and obligations" in product liability.

This article argues that resolving this dilemma should not involve simple patching of existing rules, but rather a reconstruction of product liability logic adapted to the intelligent era, based on the core principles of "risk controllers bearing responsibility" and "priority of rights remedies." Technology knows no boundaries, but law has a human touch. As autonomous driving technology continues to iterate, new technological scenarios will continue to challenge the existing legal framework. In the future, it is necessary to continuously deepen the interdisciplinary integration of law with artificial intelligence and automotive engineering, seeking a dynamic balance between technological development and legal regulation, and laying a solid legal foundation for the healthy and orderly development of the intelligent transportation industry.

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[12] Article 1230 of the Tort Liability Law of the People's Republic of China stipulates that in the event of a dispute arising from environmental pollution or ecological damage, the actor shall bear the burden of proof regarding the circumstances under which the law provides for exemption from or mitigation of liability, and the absence of a causal relationship between the actor's conduct and the damage.