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Autonomous Vehicles: Legal Governance of Civil Liability Risks

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Abstract: The advancement of artificial intelligence (AI) technologies has driven transformative shifts in transportation, evidenced by the accelerated transition of autonomous vehicles from controlled trials to large-scale public implementation. However, this technological evolution has exposed unprecedented civil liability risks that surpass the governance capacity of conventional traffic legal frameworks. This urgency calls for establishing a systematic legal governance framework focused on liability allocation rules, designed to address the unique challenges of civil liability risks in autonomous driving systems. This paper systematically examines international and domestic autonomous vehicle classification standards alongside Chinese current legislative landscape governing autonomous vehicle technologies. It analyses accountability dilemmas arising from "human-machine shared control" in advanced driving assistance system, progressing to imputation challenges triggered by the "full delegation of operational control" in autonomous driving systems. To address distinct technological phases, we propose a layered governance model: for driver-assist vehicles, a technical intervention audit mechanism under the fault liability framework; for autonomous vehicles, a tripartite liability hierarchy involving end-users, owners, and manufacturers.

Keywords: autonomous vehicles, traffic accidents, tort liability, product liability

1. Introduction

The advancement of AI has positioned autonomous vehicles at the forefront of technological discourse, with nations globally enacting legislation to accelerate their integration into mainstream societal adoption.

Although Chinese autonomous vehicle industry commenced later than its global counterparts, it has demonstrated accelerated governmental prioritization in recent years. Exemplifying this trend, the Regulation of the Beijing Municipality on Autonomous Vehicles enacted on April 1, 2025, has injected renewed momentum into technological advancement and societal integration of autonomous vehicles. The Regulation has drafted and enacted the legislation, which not only consolidates local practical experience but also provides solutions to the bottlenecks and challenges in the innovative application of autonomous vehicles[1].

In the evolutionary process of automotive automation technologies, a fundamental distinction exists between Advanced Driver Assistance Systems and Automated Driving Systems: the former retains human drivers as the primary agents of operational control, while the latter transfers vehicular control authority to AI-driven systems.

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While autonomous driving technologies have significantly reduced accident rates caused by human errors, their inevitable involvement in traffic accidents persists. From the “human-machine responsibility entanglement” in Advanced Driver Assistance Systems to the “full transfer of control authority” in Automated Driving Systems, technological evolution is progressively destabilizing the foundational logic of traditional tort liability systems. To address this challenge, a liability governance framework must be established that integrates tort liability allocation, protection of victims' rights and interests, and innovation incentives for manufacturers.

2. Defining autonomous vehicles

The classification of autonomous vehicles primarily adheres to two hierarchical frameworks at international and domestic levels.

At the international level, the SAE J3016 Taxonomy and Definitions for Driving Automation Systems established by SAE International categorizes driving automation into six levels (L0-L5). This standard explicitly distinguishes between Driver Support Systems (L0-L2) and Automated Driving Systems (L3+).For L0-L2 systems, such as adaptive cruise control and lane-keeping assist, human drivers retain full operational control authority and bear ultimate responsibility for dynamic driving tasks. In contrast, L3+ systems enable conditional transfer of vehicle control to the automated system within specified operational design domains, requiring human intervention only upon system failure or operational design domains boundary violations.

At the domestic level, Chinese Taxonomy of Driving Automation for Vehicles (GB/T 40429-2021) classifies driving automation into six distinct levels: Level 0 (Emergency Assistance), Level 1 (Partial Driving Assistance), Level 2 (Combined Driving Assistance), Level 3 (Conditionally Automated Driving), Level 4 (Highly Automated Driving), and Level 5 (Fully Automated Driving). Levels 0-2 are categorized as Advanced Driver Assistance Systems, where human drivers remain the primary control agents responsible for continuous monitoring and emergency interventions. In contrast, Levels 3-5 designate autonomous driving systems as the operational control entities, with human drivers transitioning to roles requiring intervention only under system failure or operational design domains boundary violations.

Both frameworks converge to reveal the intrinsic trajectory of autonomous driving technology evolution: as automation levels ascend, human drivers' supervisory duties undergo stepwise attenuation, ultimately disengaging from the liability chain and transitioning from contingency supervisors to liability-exempt passengers.

3. Legislative framework for autonomous vehicles in China

Globally, nations are vigorously cultivating favorable legal and policy frameworks to propel their autonomous vehicle industries, while actively asserting dominance in shaping industry standards and regulatory discourse for autonomous vehicle systems, striving to secure leadership positions in the ongoing AI-driven technological revolution[2]. As a key participant in this global competition, China has established a dual-track legislative framework for intelligent connected vehicles that synergizes central policy guidance with local pilot exploration, characterized by nationally coordinated strategic roadmaps and region-specific regulatory innovations.

Since the 2017 Medium- and Long-Term Development Plan for the Automotive Industry proposed constructing a legal framework for intelligent connected vehicles, central authorities have continuously advanced institutional innovation. The 2020 Intelligent Vehicle Innovation Development Strategy established a roadmap for synchronizing technical standards with legal oversight, mandating establishment of a China-standard system covering six dimensions including technological innovation and cybersecurity by 2025. The New Energy Vehicle Industry Development

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Plan (2021–2035) prioritizes accelerating the enhancement of policy frameworks for intelligent and connected vehicles. These frameworks encompass road traffic regulations, accident liability rules, and data governance systems, with a dedicated focus on establishing an accident attribution mechanism specifically designed for autonomous driving. The 2021 Interim Regulations on Road Testing and Demonstration Applications of Intelligent and Connected Vehicles (Trial) further refines practical pathways by standardizing access conditions, implementation procedures, and safety management protocols for autonomous vehicle road testing. These regulations explicitly define legal requirements such as qualifications of testing entities, vehicle technical standards, and liability allocation principles for accidents involving autonomous systems.

These top-level policy frameworks provide clear legislative guidance for local governments, fostering a collaborative mechanism where central authorities delineate overarching regulatory frameworks while local jurisdictions operationalize institutional details.

In this context, cities such as Beijing, Shanghai, and Shenzhen have enacted legislation to regulate and promote the innovation-driven development of autonomous vehicles. These jurisdictions are conducting pilot programs to address emerging technical challenges while simultaneously constructing regulatory frameworks to support technological advancement. For example, Article 31 of the Regulation of the Beijing Municipality on Autonomous Vehicles stipulates: "During the operation of autonomous vehicles on public roads, any violations of traffic laws or accidents shall be investigated by traffic authorities under national regulations. Drivers, safety officers, or platform monitors must implement immediate safety measures and report to authorities. For minor property damage cases with undisputed facts, parties may resolve disputes through mutual agreements." Meanwhile, Article 53 of the Shenzhen Special Economic Zone Regulations on Intelligent Connected Vehicles Management establishes a tiered liability system: "For human-supervised intelligent connected vehicles involved in accidents where liability lies with the vehicle, the driver shall bear full compensation responsibility; for fully driverless intelligent connected vehicles, the owner or operator assumes liability." Article 54 further clarifies that "if accidents are caused by product defects, the driver, owner, or operator may seek recourse against manufacturers after fulfilling compensation obligations." In Shanghai, the Pudong New Area Rules on Driverless ICV Innovation mandate that innovation entities upload at least 90 seconds of pre-accident data (including 10Hz vehicle dynamics and multi-angle video recordings) within 2 hours post-incident, while Article 49(2) of the Shanghai Measures for ICV Testing and Application allows victims to claim compensation directly from manufacturers for defects.

As Chinese autonomous vehicle industry transitions from testing to pilot demonstration and commercial operations, the country should elevate fragmented local legislation into higher-tier national statutes by revising the Road Traffic Safety Law and related regulations[3].

4. Challenges of autonomous driving technology to traditional tort liability systems

4.1. Traditional Chinese tort liability system

The current liability system for motor vehicle traffic accidents remains predominantly structured on a fault-based foundation[4]. For accidents between motor vehicles, the fault liability principle applies strictly, requiring proof of negligence by the responsible party. For accidents involving motor vehicles and non-motorized road users or pedestrians, the liability framework adopts a fault-based liability principle as the primary rule, supplemented by the motor vehicle's no-fault liability limited to a maximum of 10% compensation.

In summary, the core logic of the current legal framework remains anchored in the presumption of complete human operational control over vehicles, with fault constituting the central pillar for liability determination.

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4.2. Advanced driving assistance systems challenge traditional tort liability

For vehicles equipped with Advanced Driver Assistance Systems, current legal frameworks remain applicable. These systems provide limited assistance functions such as lane-keeping assist and adaptive cruise control, with human drivers retaining full operational control. In such cases, imposing liability on drivers under the fault liability principle is justified. This applies specifically when accidents stem from operational errors, such as delayed responses to system warnings or improper intervention during automated operations.

However, accidents may inevitably stem from system malfunctions such as sensor misjudgments, algorithmic decision errors, or human-machine interaction anomalies including control transfer conflicts and erroneous takeover timing assessments. In traffic accidents caused by these technological defects, strictly applying the traditional fault liability framework to hold drivers fully liable despite their absence of subjective negligence undermines the substantive fairness essential to damage compensation.

It must be emphasized that current disputes regarding liability for Advanced Driver Assistance Systems remain fundamentally confined to adaptive adjustments within existing legal frameworks. These disputes do not challenge the foundational principle of liability attribution under traditional tort law, which presumes human drivers retain full operational control over vehicles.

4.3. Autonomous vehicles face regulatory gaps

The complete transfer of vehicular control authority to autonomous driving systems presents a comprehensive challenge to the traditional tort liability framework. Autonomous driving systems have become the dominant controllers in autonomous vehicles, with drivers assuming a fully subordinate role[5]. When autonomous systems supplant human drivers as the primary decision-making entities, the foundational presumption of existing liability regimes—that human operators maintain full control over vehicles—is fundamentally destabilized. This paradigm shift invalidates the causal presumption mechanisms integral to fault liability doctrines, thereby exposing the traditional tort liability system to three systemic crises.

First, liability subjects in autonomous vehicle accidents lack clarity. Under current legal frameworks, Automated Driving Systems cannot bear tort liability owing to their lack of legal subject status, whereas vehicle users retain nominal ownership status yet are deprived of substantive control over driving operations. This dissociation between nominal and substantive control obscures accountability. Users, having no direct operational involvement, fail to meet traditional fault liability criteria, whereas Automated Driving Systems that directly cause accidents fall outside liability frameworks.

Second, the fault liability principle imposes excessive evidentiary burdens on victims. Traditional rules require victims to prove negligence by the vehicle operator. However, critical evidence such as driving data and algorithmic logs in traffic accidents caused by autonomous vehicles are exclusively controlled by manufacturers through technical encryption. Proving causation related to deep learning algorithm logic, sensor fusion failures, or ethical decision biases exceeds ordinary claimants' technical comprehension. This combination of data monopolies and technological black boxes creates insurmountable evidentiary barriers for victims, ultimately leading to the failure of legal remedies.

Third, the product liability regime faces an applicability paradox. Producers may be held liable under Article 41 of the Product Quality Law of the People's Republic of China. However, developers increasingly rely on the state-of-the-art defense within the same provision, which exempts liability if defects were " undiscoverable based on scientific and technical knowledge at the time of product circulation." This allows them to attribute accidents to unforeseeable defects arising from algorithmic

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self-evolution. On the other hand, current defect identification standards, rooted in physical flaws such as manufacturing errors or design failures, are ill-equipped to address emerging software-driven defects, including algorithmic decision errors, ethical judgment deviations, and autonomous system logic failures.Current defect identification standards are rooted in physical flaws, such as manufacturing errors or design failures. However, these standards fail to address emerging software-driven defects. Such defects encompass algorithmic decision errors, ethical judgment deviations, and autonomous system logic failures, which represent core challenges in modern product liability regimes.

Autonomous driving technology has fundamentally disrupted the traditional causal chain linking human conduct to harm, resulting in normative conflicts across multiple liability regimes such as fault liability, product liability, and risk liability. As vehicular control undergoes a qualitative shift from human drivers to Automated Driving Systems, victims face systemic barriers to obtaining legal remedies, thereby falling into a regulatory void.

5. Comprehensive framework for autonomous vehicle tort liability

The tort liability framework for autonomous vehicles must adopt a tripartite structure comprising vehicle owners, users, and manufacturers, reflecting their distinct control capabilities over the technology. Owners, as primary holders of operational authority, bear foundational responsibility for vehicle oversight. Users, acting as direct beneficiaries of autonomous operations, assume liability for operational risks. Manufacturers, functioning as technical controllers, are accountable for systemic defects. These three parties hold differentiated responsibilities for risk causation and prevention, proportionate to their respective roles and technical influence.

5.1. Assisted driving vehicles

Under Advanced Driver Assistance Systems, drivers retain the obligation to continuously monitor vehicle operations. This duty requires real-time awareness of the driving environment and system status, immediate resumption of manual control upon system-generated takeover requests, and proactive intervention in foreseeable risk scenarios. Fault liability principles remain applicable for accident determinations. Drivers who fail to meet reasonable care obligations, defined as the standard expected of a prudent operator under equivalent technological conditions, shall bear legal responsibility for resulting accidents.

In special circumstances where a driver has fulfilled the necessary duty of care yet failed to avoid an accident, technical factors must undergo rigorous legal evaluation. When an accident involves technical failures such as failure to issue takeover warnings, reaction times below safety thresholds, or hazard detection failures, the legal presumption of product defects in the driving assistance system shall be invoked. Article 46 of the Law of the People's Republic of China on Product Quality imposes strict liability on producers under such circumstances. Producers are thereby obligated to assume tort liability under Article 1202 of the Civil Code of the People's Republic of China.

The determination of concurrent supervisory negligence by drivers—such as persistent inattention to dynamic driving scenarios—triggers the application of Article 1173 of the Civil Code of the People's Republic of China. This statutory provision governing comparative negligence mandates proportional liability apportionment based on contributory fault.

Furthermore, where autonomous system anomalies override valid driver control commands and result in harm, the system shall be deemed to present unreasonable risks by default. Producers may nevertheless seek liability reduction by demonstrating that the driver's commands violated traffic regulations, exceeded reasonable cognitive expectations, and directly caused the damages through verifiable causal linkages.

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5.2. Autonomous vehicles

In the application scenarios of autonomous driving technology, liability determination shall establish a three-tiered management framework involving the actual user, vehicle owner, and manufacturer, based on the technical characteristics of the system.

5.2.1. Actual user

The duty of care imposed on actual users may be appropriately reduced when vehicles operate in autonomous driving mode. However, liability for negligence arises under two specific conditions. First, if the user activates autonomous systems in environments explicitly designated by manufacturers as unsuitable for autonomous operation, including scenarios such as extreme weather conditions or unmapped roads. Second, liability applies when the user fails to resume manual control within a reasonable timeframe after receiving system-issued takeover prompts.

5.2.2. Vehicle owner

Vehicle owners bear heightened legal obligations. When ownership and usage are separated, owners are presumptively jointly liable for damages. However, liability exemption may apply upon demonstrating fulfillment of reasonable examination obligations, including verifying the user's driving qualifications and fully disclosing vehicle performance specifications and operational protocols. Additionally, owners must ensure compliance with national safety and technical standards, conduct periodic professional maintenance inspections, and assume strict liability for unauthorized modifications.

5.2.3. Manufacturer

The delineation of producer liability must focus on technological defects, where accidents caused by flaws in autonomous driving system decision-making algorithms or perception system failures impose statutory liability on producers. A critical illustration is the 2018 Uber autonomous test vehicle fatality case: despite the perception system detecting the pedestrian six seconds before collision, Uber had set an excessively high activation threshold for emergency braking programs to avoid passenger discomfort from false alarms, prioritizing continued identification over immediate collision avoidance and thereby causing the accident. This precedent establishes core principles for product liability in the autonomous era, mandating producers to ensure technical compliance with safety standards and conduct ethical reviews of algorithms. Producers may nevertheless seek liability mitigation by proving direct causation through unauthorized code alterations, sensor tampering by users, or cybersecurity breaches where adequate protective measures were implemented.

To ensure the objectivity of accident investigations, legislation must establish mandatory data disclosure obligations for producers, requiring complete submission of raw records from vehicle data storage systems. As stipulated in the Regulations of Shanghai Pudong New Area on Promoting the Innovative Application of Driverless Intelligent Connected Vehicles, enterprises involved in accidents with driverless vehicles must upload at least 90 seconds of pre-collision video data to designated platforms within two hours post-incident. This presumption of liability mechanism shifts evidentiary burdens from victims to producers, addressing victims' inherent disadvantages in technical evidence collection through reversed burden of proof while enabling technical traceability via compulsory data disclosure. Such rules refine product safety standards by clarifying manufacturers' technical verification duties including compliance with functional safety and cybersecurity protocols, while establishing institutional constraints that foster sustainable industry

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development through standardized Research and Development obligations and ethical algorithm design aligned with public safety priorities.

6. Conclusion

This study focuses on the challenges posed by autonomous driving technology to traditional tort liability systems, exploring dimensions such as technical classification standards, domestic legislative frameworks, and the restructuring of liability subjects. It establishes a tripartite liability framework centered on actual users, vehicle owners, and manufacturers: actual users assume fault-based liability for unauthorized system activation or failure to regain control during emergencies, vehicle owners bear obligations to verify user qualifications and ensure maintenance compliance, while manufacturers are strictly liable for algorithmic defects. By clarifying the dynamic alignment between technological control transfers and liability allocation, this framework lays the groundwork for legislative refinement of accident liability rules and the implementation of mandatory data disclosure mechanisms. These advancements address evidentiary challenges arising from technical opacity, thereby facilitating the modernization of intelligent transportation governance systems through enhanced transparency and accountability.

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