

## Original Paper

# Research on Determining Liability for Traffic Accidents Involving Autonomous Vehicles

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### **Abstract**

*As the commercialization of autonomous driving technology accelerates, related industries are undergoing unprecedented rapid development. Simultaneously, a series of traffic accidents caused by X Automobile's autonomous driving system have exposed significant shortcomings in the existing traditional legal framework, particularly regarding the identification of liable parties. This issue not only challenges the current legal system but also impacts social governance and ethical concepts. Taking the 2016 fatal accident caused by X Automobile's autonomous driving system as a representative case, this paper operates at the intersection of technology, law, and society. Employing comparative analysis, empirical research, and socio-legal methodologies, systematically examines the complex theoretical challenges in determining liability for autonomous driving accidents—including product liability, manufacturer obligations, algorithmic transparency, users' reasonable reliance and duty of care, as well as insurance and compensation mechanisms. It explores potential pathways for institutional innovation to adapt to technological change at two levels: legal philosophy reform and institutional construction. This aims to provide theoretical reference for establishing a safe, fair, and forward-looking legal regulatory framework for autonomous driving.*

### **Keywords**

*autonomous vehicles, traffic accidents, liability, product liability*

## **1. Introduction**

### *1.1 Case Summary*

On January 20, 2016, a traffic accident occurred on the Beijing-Hong Kong-Macau Expressway in Handan, Hebei Province, where an X sedan rear-ended a road sweeper. Driver Gao Yaning died instantly as the vehicle failed to brake or take evasive action. Initially, traffic police determined driver

Gao Yaning bore primary responsibility.

The accident investigation revealed that the vehicle's Autopilot system was operating in cruise control mode under clear weather conditions prior to the collision. Dashcam footage showed the system failed to detect the preceding vehicle, leading to the subsequent crash. Meanwhile, the victim, who had activated cruise control, was observed with both hands off the steering wheel in a relaxed posture one minute before the accident, indicating no signs of manual intervention at the scene.

Based on this, the family of victim Gao Yanling argued that the X-brand vehicle's autonomous driving system contained recognition flaws that caused the accident. They sued Tesla China Sales Company in September of the same year, seeking 10,000 yuan in compensation. During the trial, dashcam footage, vehicle EDR data, and traffic police investigations confirmed the vehicle was in autonomous driving mode at the time of the accident and detected no manual operation. After a year, the brand's engineers were compelled to admit the system was controlling the vehicle at the time. Although the court did not publicly disclose the liability ratio, the automaker accepted partial liability for the accident based on the evidence, overturning the traffic police's initial determination of "full driver responsibility" under traditional traffic accident liability rules. This case became China's first judicial ruling assigning liability to an autonomous driving system in an accident, exposing gaps in current laws regarding liability attribution for traffic accidents involving autonomous vehicles under new technologies.

### *1.2 Key Issues in Dispute*

The focal points of contention in the Handan X Automobile autonomous driving fatal accident case center on two core contradictions: the difficulty in identifying the responsible party and conflicts in legal application.

From a technical perspective, the Autopilot system installed in the accident vehicle, as a Level 2 driver assistance technology, theoretically requires the driver to maintain constant monitoring and be ready to take control at any time. However, during the accident, the system failed to recognize the stationary sweeper ahead and did not initiate any braking measures, exposing the algorithm's deficiencies in identifying complex road conditions. Although the X automaker ultimately acknowledged the vehicle was in autonomous mode, it emphasized the system served only as an auxiliary tool, maintaining that the driver bore primary responsibility. Judicial practice requires establishing causation between technical defects and accident outcomes, yet the opaque nature of this technological black box complicates precise liability determination.

Regarding legal application, the current Road Traffic Safety Law establishes a liability framework centered on driver negligence. However, autonomous driving technology fundamentally alters traditional driving patterns. The victim, Mr. Gao, an experienced driver, relied on the system, leading to distracted driving. Whether this constitutes legal "negligence" or should be attributed to system design flaws remains a point of contention. Furthermore, X Automobile Company's marketing heavily emphasized "autonomous driving" capabilities despite the technology not yet achieving full autonomy, potentially constituting false advertising liability. However, consumers must prove that the discrepancy

between advertised features and actual functionality was misleading—a burden of proof that is extremely difficult to meet.

Thus, while autonomous vehicles undeniably offer significant convenience, the emergence of numerous autonomous vehicle accident cases in public life compels people to confront these challenges. The most pressing issue in autonomous vehicle accidents currently revolves around liability assignment: Who bears responsibility? And how? Traditional liability principles for conventional motor vehicle accidents no longer fully apply to the multi-party dynamics of new autonomous vehicles. Legal lag has already created a regulatory vacuum, with technological advancement once again challenging the legal framework.

## **2. Challenges in Determining Liability for Traffic Accidents Involving Autonomous Vehicles**

The challenge in determining liability for traffic accidents involving autonomous vehicles primarily stems from the structural conflict between the existing legal framework and technological advancements. The 2016 fatal accident in Handan involving an X-brand vehicle equipped with autonomous driving features serves as a typical case study. The core issues can be summarized in the following three aspects.

### *2.1 The Current “Driver-Vehicle” Dual Liability Framework in Existing Laws Faces the Risk of Deconstruction*

According to Article 76 of the Road Traffic Safety Law, liability determination in motor vehicle accidents centers on the “party at fault.” However, with the widespread adoption of autonomous driving technology, actual control of vehicles has gradually shifted from human drivers to onboard AI systems, posing a fundamental challenge to traditional liability frameworks. In this case, despite X Automobile Company ultimately confirming the vehicle was operating in Autopilot mode at the time of the accident, the judicial ruling still held driver Gao Yaning primarily liable for failing to take effective control of the vehicle in a timely manner. This phenomenon of “mismatched responsibility allocation” highlights the limitations of current laws when confronting highly automated driving: when AI systems fully control driving behavior in specific scenarios, drivers are still held liable for “failure to perform physical controls,” which fundamentally contradicts the basic legal principle that “responsibility must correspond to actual conduct.”

Simultaneously, existing laws and regulations lack clear, unified operational standards for the “human takeover obligation” required of Level 3 and higher autonomous driving systems. The timing for takeover, the reasonable reaction time required for intervention, and the specific boundaries of the duty of care remain undefined at the legislative level. This legal vacuum leads to judicial practice where judges often rely solely on traditional duty of care standards from conventional driving scenarios for adjudication. This approach not only struggles to align with technological realities but also exposes drivers to unforeseeable liability risks. Therefore, against the backdrop of rapid autonomous driving technology advancement, a systematic reconstruction of the relevant liability framework is urgently

needed. This must encourage technological innovation while ensuring liability allocation aligns with actual circumstances, thereby upholding the fairness and predictability of the law.

### *2.2 The Rules for Determining Product Liability Bearers Exhibit Multiple Ambiguities*

The “unreasonable hazard” standard under Article 46 of the Product Quality Law faces application challenges in the smart product sector. In this case, the X-brand automaker argued that its Autopilot system complied with design standards. However, accident investigations revealed target recognition algorithmic biases under specific lighting conditions. The dispute over whether this algorithmic flaw constitutes a “design defect” or a “warning defect” exposes the legal system’s insufficient recognition of technological complexity (Zheng, Z. F., 2022, pp. 48-58, pp. 156-157).

Simultaneously, the “producer liability” principle under Article 1202 of the Civil Code faces interpretive challenges. For instance, in Level 4 systems, should new entities like algorithm developers and sensor suppliers be included within the scope of liable parties? Academic debates persist between the “narrow interpretation” and the “broad interpretation”: the former advocates strictly limiting liability to end manufacturers with physical manufacturing activities, while the latter argues it should extend to entities involved in the development and iteration of autonomous driving systems. Specifically, according to SAE J3016 standards, defects in decision-making systems may directly cause accident risks in Level 4 and above autonomous driving scenarios (Deng, J. Z., & Cheng, Z. T., 2022, pp. 13-20). If liability is solely attributed to vehicle manufacturers in such cases, it not only violates the principle of aligning risk with control but may also trigger systemic imbalances in supply chain liability allocation.

### *2.3 Technical Obstacles in Accident Cause Investigation Mechanisms*

Traditional accident investigations rely on a dual-dimensional verification framework of “driver behavior-vehicle status.” However, autonomous driving accidents actually exhibit a complex causal structure involving “hardware failure-algorithm deviation-dynamic decision rules.” In this case, the accident cause could only be confirmed by analyzing encrypted logs from the vehicle’s central computing unit. Throughout the investigation and trial, Automaker X consistently refused to provide the complete algorithmic decision tree, citing “dynamic data evolution,” resulting in the absence of critical evidence.

Technical obstacles also stem from the “cognitive black box effect” inherent in autonomous systems. The neural network weight parameters generated by current AI decision models—based on deep reinforcement learning—are inherently uninterpretable, rendering traditional fault tree analysis methods entirely ineffective (Zhang, T. L., & Qian, R., 2022, pp. 85-101, p. 132). This technological black-box nature traps accident liability determination in a dual predicament of “data barriers” and “algorithmic opacity.” As U.S. NHTSA statistics reveal, 71% of autonomous driving incidents involve missing data integrity.

### 3. Recommendations for Determining Liability in Autonomous Vehicle Traffic Accidents

In response to the challenges in determining liability outlined above, and drawing on international experience, the following recommendations are proposed to align with China's national conditions:

#### 3.1 *Dynamic Liability Framework: Tiered Attribution Based on Human Intervention Levels*

The fault-based liability system established under Article 76 of the current Road Traffic Safety Law—centered on “driver control”—faces fundamental challenges in Level 3 and above autonomous driving scenarios. In this case, despite Tesla's acknowledgment that the vehicle was operating in Autopilot mode, the court still ruled that driver Gao Yaning bore primary responsibility for failing to effectively take control. This “mismatch in responsibility allocation” stems from traditional law's lack of clear standards for the “duty to take control.” The time gap between an L3 system's “request for takeover” and the “actual takeover” often becomes a key point of contention in determining accident liability.

To address this, we propose establishing a dynamic assessment model for “human intervention levels.” During Level 3 assisted driving, a dual standard of “operational control + operational benefit” should be adopted, incorporating the driver's “passive inaction” in failing to respond to takeover requests as an element of fault. Specific reference can be drawn from accident handling practices in Shanghai's testing zone, where failure to respond within 3 seconds after the system triggers a takeover request constitutes negligence. For L4-L5 full autonomous driving, manufacturers should bear strict liability for algorithmic decision systems and sensor accuracy (Yang, M. L., 2020, pp. 124-127). Judicial precedents also offer guidance: In a Hangzhou case, courts reviewed EDR data and algorithm logs to determine that system decision flaws directly caused a collision, holding the automaker fully liable. This dynamic assessment model for “human intervention levels” throughout the entire process can objectively determine the driver's proportion of liability in an accident. It does so by analyzing the dynamic changes in AI system data and algorithm logs to assess whether the driver intervened manually and to what extent during the incident. If no driver intervention contributed to the accident, liability should be attributed to the producers, developers, or other “creators” of the AI system.

#### 3.2 *Optimizing Product Liability Rules: Transcending Traditional Defect Determination Frameworks*

The “unreasonable hazard” defect standard established under Article 46 of the current Product Quality Law faces significant applicability challenges when addressing complex technological products like intelligent connected vehicles. Traditional standards focus on physical safety and manufacturing defects, struggling to effectively cover systemic risks stemming from intangible factors such as software algorithms and sensor fusion. This case exemplifies this dilemma: Automaker X defended itself by asserting that its Autopilot system met preset design standards. However, a thorough accident investigation revealed inherent biases in the system's image recognition algorithms under specific backlit or low-light road conditions, preventing accurate detection of stationary obstacles ahead. For this case and the inevitable increase in similar disputes in future judicial practice, a core contention lies in whether such algorithmic flaws—arising from deep neural network decision logic and manifesting in

specific edge cases—should be classified as “design defects” or as “warning defects” due to inadequate warnings. To address this challenge, it is necessary to systematically reconstruct the producer liability framework for the intelligent era. The core approach involves: First, expanding the scope of liable parties beyond the traditional single framework of vehicle manufacturers. Key developers of autonomous driving algorithms, core sensor suppliers, high-precision map service providers, and other new technological entities deeply involved in product functionality should be included within the scope of joint liability regulations based on their actual technical contributions. Second, establishing dynamic defect determination standards. Beyond the traditional “unreasonable hazard” standard, the “risk-benefit” balancing principle from U.S. product liability law can serve as a complementary framework, comprehensively weighing technical feasibility, alternative design costs, and societal safety benefits. Particularly when an autonomous driving system makes a dangerous decision in routine driving scenarios that violates the reasonable expectations of an ordinary driver (e.g., sudden braking without cause, lane deviation), it can be directly deemed defective even if it complies with industry technical standards. Finally, introduce a “burden of proof shift” mechanism, mandating that automakers provide complete, unaltered algorithmic decision logs and sensor data streams via the vehicle’s Event Data Recorder (EDR, commonly known as the “black box”) to reconstruct the system state at the moment of the incident. Should an automaker refuse to provide this data without justifiable cause or submit incomplete data, it should be presumed to bear adverse consequences regarding product defects or negligence.

### *3.3 Synergy between Technological Empowerment and Institutional Innovation: Building a Multi-Dimensional Traceability System*

In autonomous driving accidents similar to this case, the investigation and determination of accident causes heavily rely on analyzing encrypted operational logs generated by the central computing unit of the vehicle's artificial intelligence system. However, in current practice, automakers often erect formidable data barriers under commercial or technical justifications such as “algorithms constitute trade secrets” or “data undergoes continuous dynamic evolution,” refusing to provide complete, raw system decision-making data to investigative agencies or judicial authorities. This unilateral control over evidence directly creates fundamental challenges in accident attribution within judicial practice: external forces struggle to penetrate the technological black box to verify whether the system experienced perception errors, decision-making failures, or execution malfunctions at the moment of impact, thereby deadlocking liability determination.

To resolve this core evidentiary dilemma, institutional optimization must be advanced synergistically at two levels: ordinary civil entities and national regulation. At the civil entity level, the core lies in establishing clear data recording and retention obligations. It is recommended that legislation or mandatory standards require all vehicles equipped with Level 3 or higher autonomous driving capabilities to install enhanced event data recorders (EDRs, commonly known as “black boxes”) compliant with the ISO 26262 functional safety standard. This device must tamper-proofly record: -

Driving mode transition trajectories during critical periods before and after accidents - Final source of control commands (human or system) - Vehicle environmental perception data (e.g., raw camera/radar signals and fusion results) - System planning and decision sequences Simultaneously, to clearly delineate human-machine responsibility boundaries, physiological monitoring data of the driver (e.g., gaze direction, hands on the steering wheel) should be collected to objectively determine whether they fulfilled necessary takeover readiness obligations. This structured evidence forms a solid foundation for precisely allocating liability among vehicle manufacturers, system developers, and drivers, and even determining whether responsibility should extend to other parties like software suppliers or map service providers.

At the national regulatory and public governance level, higher-tier coordination mechanisms must be established. It is recommended that the Ministry of Industry and Information Technology, the Ministry of Transport, the Public Security Traffic Management Bureau, and standardization authorities lead the creation of a national unified reporting and sharing platform for autonomous driving accident data. All vehicle-mounted “black box” data anonymized from traffic accidents involving autonomous driving functions must be mandatorily uploaded to this platform. The platform should employ blockchain technology to ensure data immutability from the moment of upload and establish strict data access and usage permissions. Building upon this foundation, artificial intelligence algorithms can be applied to conduct in-depth analysis of massive accident datasets, establishing systematic defect risk identification and early warning models. This initiative will not only fundamentally dismantle data silos created by individual manufacturers—preventing “dynamic data changes” from being used as excuses for shifting responsibility—but also reveal common defects and high-risk scenarios across autonomous driving systems at a macro level. It will provide critical decision support for optimizing technical standards, refining regulatory policies, and enhancing public safety.

#### *3.4 Insurance Mechanism Innovation: Achieving Socialized Risk Sharing*

The current compulsory traffic insurance, centered on “driver fault,” struggles to meet the demands of autonomous driving technology. In the Handan case, victims’ families had to pursue compensation through litigation, while automakers evaded liability via “exemption clauses” in user agreements.

For such scenarios, it is recommended to establish a dual-track insurance system—combining the UK’s insurance relief framework for autonomous vehicles with China’s national context—comprising “technology liability insurance” and “traffic accident insurance.” Technology liability insurance would be mandatory for automakers based on automation levels, covering system defect risks. Simultaneously, expanding the coverage of traffic accident insurance to include both in-vehicle occupants and third-party damages. This innovative “dual-track parallel” claims mechanism allows victims to seek compensation directly from insurers. After advance payment, insurers acquire subrogation rights to pursue defect origins through specialized agencies (Cao, J. F., & Zhang, Y. H., 2018, pp. 66-73). This institutional design addresses the urgency of victim relief in judicial practice while leveraging market mechanisms to compel enterprises to enhance technological safety. Within the legal framework, it

preserves the remedial functions of traditional motor vehicle liability systems while utilizing insurance technology innovations to achieve scientific liability determination and socialized risk dispersion. This approach effectively safeguards consumer rights while fostering a tolerant legal environment for autonomous driving technology development, ultimately aiming to achieve a dynamic equilibrium between technological innovation and public safety.

#### 4. Conclusion

As the first judicial precedent in China to establish liability for autonomous driving systems in accidents, this case holds significance not only in its individual ruling but also in driving coordinated revisions to the Road Traffic Safety Law and the Product Quality Law. Future legislation must balance technological innovation and public safety within a framework of “mandatory technical compliance certification and liability insurance pools,” establishing a closed-loop system of “risk dispersion-rapid compensation-liability tracing.” Through the deep integration of technological rationality and legal values, it should strive to safeguard victims’ rights while providing institutional safeguards for safety governance in the era of intelligent transportation and creating a tolerant legal environment for autonomous driving technology development.

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