

Liability Allocation in Autonomous Vehicles: From Ethics to Law

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Abstract:

This paper addresses the complex issue of liability allocation in autonomous vehicle accidents, considering both legal and ethical perspectives. With the rapid development of autonomous driving technology, traditional legal frameworks struggle to cope with the new challenges posed by driverless vehicles. The ambiguity in liability arises from the involvement of multiple parties, including vehicle manufacturers, software developers, and car owners. Ethically, decisions made by autonomous vehicles in unavoidable accident scenarios raise difficult questions about moral responsibility, such as whether to prioritize passengers or pedestrians in emergency situations. The paper explores these ethical dilemmas, using the “Trolley Problem” as a reference, and argues for the development of an ethical framework for algorithmic decision-making. Additionally, the paper critiques the lag in legal adaptation and proposes reforms to establish clear liability frameworks. In conclusion, it emphasizes the need for a legal system that integrates technological progress with ethical considerations to ensure fairness and accountability in the era of autonomous vehicles.

Keywords: Autonomous Vehicles, Liability Allocation, Ethical Dilemmas

1 Introduction

With the rapid development of technology, the emergence of new technologies, including autonomous vehicles, has sparked considerable attention and discussion. Autonomous driving technology plays an important role in improving traffic safety and increasing travel efficiency, while also posing significant

challenges in the legal and ethical domains. Many of these challenges are related to issues of liability. As an emerging technology, the complexity of autonomous driving makes liability attribution somewhat ambiguous. Unlike traditional human-driven vehicles, autonomous vehicles involve multiple parties, including car manufacturers, software developers, car

owners, and pedestrians, making the causal relationships of accidents more complex. Therefore, defining legal liability has become a major challenge that needs to be addressed as autonomous driving technology develops.

At the same time, the ethical issues involved in autonomous vehicles are increasingly prominent. For example, when an autonomous vehicle faces an unavoidable accident, can its algorithmic decision-making meet societal moral standards? The choices made by the algorithm at critical moments may involve ethical dilemmas such as “sacrificing one to save many,” and these decisions not only concern human life but also impact public opinion, potentially lowering the public’s acceptance of autonomous driving technology. This makes the discussion on the ethical standards of autonomous vehicles more and more important within both academia and industry, as decision-makers need to find a balance between technological development and ethics.

From a legal perspective, how the current legal system adapts to the challenges posed by autonomous driving will directly influence the technology’s integration and application in society. However, most legislative bodies around the world have yet to enact relevant laws that match the current situation. This lag in lawmaking not only affects the clarity of accident liability but also involves broader issues such as data privacy and cybersecurity. The author believes that the issue of liability allocation in autonomous vehicles cannot be resolved without further development and improvement of the law. Therefore, this paper will analyze the shortcomings in the current legal system and explore possible institutional designs to promote the safe and compliant development of autonomous vehicles.

2. The Contradiction Between Technological Development and Legal Lag

The speed of development of autonomous driving technology far exceeds the rate at which the current legal framework can be adjusted, leading to insufficient legal grounds for determining liability in accidents. This gap not only makes the law ineffective in the face of new technologies but also increases public concern about the safety of autonomous vehicles. Currently, most legal systems still regard humans as the primary agent of driving behavior, relying on the “fault-based liability” principle to allocate traffic accident liability^[1]. However, in a driverless environment, this traditional legal framework^[2] is gradually becoming outdated and needs to be reexamined and adjusted.

According to Article 76 of the Road Traffic Safety Law, liability for traffic accidents is typically determined based

on the degree of fault of the driver or the vehicle user. This means that in the absence of specific regulations for autonomous vehicles, liability allocation may still primarily focus on the “vehicle user” (i.e., the car owner or driver), regardless of whether the vehicle is in autonomous driving mode. As the control of driving shifts from humans to algorithms and AI systems, technological advancements raise questions about existing legal provisions, and defining and allocating responsibility becomes a significant challenge. For instance, when an autonomous vehicle causes an accident due to an algorithm error, the responsible parties may include the car manufacturer, software developer, vehicle owner, and passengers. Should the law attribute accident liability to the algorithm developer or the car manufacturer who designed the algorithm? Some local regulations have started to explore the division of liability in autonomous driving. For example, the 2022 “Shenzhen Special Economic Zone Intelligent Connected Vehicle Management Regulations” introduced special rules for liability in autonomous driving mode, stating that when the vehicle is in full autonomous driving mode, the driver is not directly liable, and liability may be attributed to the car manufacturer or the autonomous driving system developer, subject to investigation results^[3]. How the law can effectively identify and allocate these responsibilities will be a challenge for future lawmakers. This issue involves not only the clear allocation of legal liability but also deep ethical and technological discussions.

Law is a product of human limited rationality, and legal rules themselves reflect and adapt to human limitations. Recognizing their own limitations, when designing rules, lawmakers consider what is feasible based on the “average person” standard, using an individual with average intellectual and physical capacity as the basis for rule feasibility^[4]. Clearly, existing laws have not sufficiently addressed the complex scenarios arising from autonomous driving technology, which may result in victims’ legitimate rights not being effectively protected. Therefore, future legal reforms should focus on how to establish a more comprehensive and adaptable liability attribution mechanism that ensures the reasonable protection of the rights and interests of all parties involved while advancing technological progress.

3. The Ethical Dilemma of Liability Allocation

As autonomous driving technology becomes more widespread, vehicles may face increasingly complex situations on the road, requiring them to make difficult decisions. In the context of autonomous driving, the “human” agent in

decision-making seems less directly involved, raising the question of whether humans should be held responsible for these decisions or if new forms of liability need to be introduced. Autonomous vehicles often face ethical choices in decision-making, especially in emergency situations, where balancing the interests of passengers and pedestrians becomes key. For example, when an autonomous vehicle must choose between protecting the passenger or the pedestrian, the issue of liability becomes especially complex, involving both legal definitions and ethical reflections.

The “Trolley Problem” is a classic example of this ethical dilemma. It is a well-known ethical thought experiment designed to explore moral decision-making in dilemmas. The problem assumes that a runaway trolley is heading towards five people, and if no action is taken, they will be killed. However, a bystander can pull a lever to divert the trolley onto another track, where one person is located. The bystander must decide whether to pull the lever, sacrificing one person to save five^[5]. The Trolley Problem reflects the conflict between utilitarianism and Kantian deontological ethics: utilitarians advocate for minimizing harm, thus opting to sacrifice one person, while deontologists argue that pulling the lever is morally unacceptable as it involves active harm. This ethical dilemma is exacerbated in the decision-making processes of autonomous vehicles. When an autonomous vehicle encounters an unavoidable accident scenario, its algorithm must decide how to allocate risk and harm.

For instance, if the vehicle suddenly loses control and must choose between hitting a pedestrian or injuring a passenger, the vehicle’s decision algorithm might face a situation similar to the Trolley Problem, needing to weigh whether to sacrifice a few to save many or avoid any direct harm. This choice involves not only the reasonableness of the technical decision but also prompts a public debate about the value of human life. Algorithm developers should aim to minimize total harm, but passenger safety must be prioritized, and the balance between the two is crucial. Furthermore, who has the authority to determine the moral standards for these algorithms? In my view, the design standards should be developed collaboratively by a range of stakeholders, including technical experts, legal professionals, ethicists, and the public, to ensure transparency and fairness in the algorithms.

The practical application of autonomous vehicles transforms the “Trolley Problem” from a philosophical thought experiment into a real-world challenge, prompting deep reflection on the role of AI in ethical decision-making. Autonomous driving systems must make decisions between protecting passengers, pedestrians, and other traffic participants in emergency situations. This complex de-

cision-making scenario requires significant adjustments to legal and social ethical systems. Achieving a balance between algorithmic decision-making and ethical principles is essential for ensuring fairness and responsibility. To avoid ethical imbalances resulting from technical decisions, society needs to build clear ethical and legal frameworks for autonomous driving technology through public discussion and legal refinement. Specifically, in the allocation of liability, the boundaries of responsibility between autonomous driving system developers, users, and the system itself must be carefully considered to ensure fairness and practicality in liability distribution.

In this context, “algorithmic justice” should become the core ethical guideline in autonomous vehicle system design. This includes incorporating transparency, fairness, and accountability mechanisms into algorithmic design to ensure that decisions align with human moral values. Ultimately, the ethical foundations, decision-making logic, and legal responsibilities of autonomous driving algorithms should be constructed within the framework of “algorithmic justice” to achieve a harmonious integration of technological progress and ethical safeguards^[6].

The complexity of ethical issues also arises from the fact that different cultures and social contexts may lead to varying understandings and acceptance of responsibility. For example, in some cultures, the absolute value of individual life may be prioritized over other considerations, while in others, collective interests may be viewed as more important. In Germany, due to the strong influence of Kantian deontological ethics, there is a stronger emphasis on individual responsibility and moral obligations towards society. The German legal system, under the civil law tradition, emphasizes legal codification and the logical system of laws. Individual rights protection is a core principle of German law, as stipulated in Article 1 of the Basic Law (“Grundgesetz”), which asserts that “human dignity is inviolable.” This forms the foundation for prioritizing individual rights, and Germany’s 2018 “Ethical Guidelines for Autonomous Vehicles”^[7] reflect this deontological focus, indicating that the law tends to protect individuals. As such, individual decisions and actions will be scrutinized in accident liability cases. In contrast, the United States’ legal development is influenced by utilitarian thought, tending to focus on maximizing overall social benefits to achieve fairness. The U.S. Constitution places high importance on freedom and equality, particularly the concept of “Equality of Opportunity,” which encourages individuals to compete fairly. Therefore, in liability determination, U.S. law may focus more on the impact of actions on overall societal benefits, especially in high-tech areas like autonomous driving, where innovation and economic benefits are prioritized. This requires lawmakers to

consider not only the technical reasonableness of technology but also the social diversity of ethical values, crafting a more inclusive legal framework.^{[8] [9]}

In developing relevant laws, legislators should widely solicit public input and explore ethical concepts across different cultural contexts to create a legal system that better addresses the challenges posed by autonomous driving technology. In conclusion, the challenge of liability allocation is not limited to technical or legal dimensions but extends to broader ethical and cultural considerations. Autonomous driving systems must be designed with ethical values in mind, while the law must adapt accordingly to ensure that fairness, justice, and accountability are integrated into this new technological era.

4 Conclusion

In summary, the allocation of liability in autonomous vehicle accidents remains a challenging legal issue with profound ethical implications. As technology evolves, it is critical for legal frameworks to adapt and ensure the protection of rights and responsibilities in these novel scenarios. A comprehensive, transparent, and balanced legal system must emerge to accommodate the complexities of autonomous driving. In addition, ethical considerations, including the incorporation of “algorithmic justice,” will play a key role in shaping how autonomous vehicles are regulated. Ultimately, only through the collective efforts of lawmakers, technologists, and ethicists can we ensure that autonomous vehicles contribute to a safer and more equitable society.

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