# Legal and Ethical Analysis Based on Three Autopilot Accidents

Tingting Li[1*]

[1] School of Public Administration, Nanfang College Guangzhou, Guangzhou, 510000, China

[*] L1963629503@outlook.com

## Abstract

This paper selects three typical cases, namely, the fatal accident of Tesla Model S in the United States in 2016, the fatal accident of Uber's self-driving vehicle in 2018, and the defective case of Tesla's 'phantom brakes' in Germany in 2023, and discusses the legal and ethical attribution of responsibility in three self-driving accidents based on the legal frameworks of China's Road Traffic Safety Law, the Civil Code, and Hong Kong's Tort Law and the Road (Traffic and Licensing Regulations in Hong Kong, the study systematically explores the attribution of legal and ethical responsibilities in autopilot accidents using case analysis and jurisdictional comparisons. The study finds that technical defects are the core cause of accidents, and the manufacturer should be the first responsible party to bear the responsibility for product defects; however, in the assisted driving mode, the user's failure to comply with the operational norms (e.g., ignoring system warnings, disengaging from the steering wheel monitoring) also needs to be shared with the responsibility. In a completely driverless scenario, the operator and the manufacturer share the systemic risk. Existing laws are lagging behind, making it difficult to clearly define the boundaries between technical defects and human negligence, and the ethical dimension faces challenges such as the choice of the value of life and the contradiction of technological autonomy. Based on this, this paper proposes that we need to refine the criteria of responsibility division by scenario-based thinking, promote special legislation on autonomous driving, strengthen the obligation of manufacturers to be transparent about technology, and build a global ethical framework that takes into account cultural differences, so as to balance technological innovation and public safety, and to promote the sustainable development of autonomous driving technology and social trust.

**Keywords** Autonomous Driving Technology; Law and Ethics; Accident Liability; Legal Framework; Ethics

## 1    Introduction

With the development of technology, the application of self-driving technology is moving from the laboratory to the market and has attracted widespread attention worldwide. According to statistics, the world's major automakers and technology companies have invested tens of billions of dollars in the research and development of self-driving technology, and it is expected that by the end of 2025, the size of the global self-driving car market will exceed tens of billions of dollars. However, along with the rapid development of the technology, self-driving accidents have occurred frequently, exposing many legal and ethical dilemmas in the application of the technology. Self-driving cars pose significant ethical and social challenges that require the adoption of relevant ethical applications [1]. In particular, there is an urgent need to establish a sound legal and ethical framework in the determination of accident liability, ethical considerations of algorithmic decision-making, and data security.

Currently, the academic research on autonomous driving accidents mainly focuses on the two aspects of technological improvement and legal regulation. At the technical level, the research focuses on the optimisation of perception system and the improvement of decision-making algorithms, etc. At the legal level, it mainly explores the issues of liability determination standard and compensation mechanism. However, there is a relative lack of systematic research that combines the legal framework with ethical considerations, especially in the comparative research between different jurisdictions. This is because the development of autonomous driving technology is not only a technical issue, but also involves legal and social challenges, and requires comprehensive consideration of various factors [10].

Therefore, this paper selects three representative cases of autonomous driving accidents, combines the legal frameworks of mainland China and Hong Kong, China, to deeply analyse the legal liability

determination of autonomous driving technology, and analyses the deep-rooted problems of accident liability from an ethical perspective. This study adopts a combination of case analysis and comparative research, aiming to provide theoretical support for improving the legal norms and ethical framework of autonomous driving technology.

## 2    Anatomy of Legal Dilemmas in Autopilot Accidents

### 2.1    Legal Attribution of Accident Liability

Governments are developing different responses to address the risks posed by self-driving cars, including safety, liability, privacy and cybersecurity [2]. For example, in mainland China, the application of self-driving technology has brought unprecedented challenges to the determination of liability for traffic accidents. According to the relevant provisions of the Road Traffic Safety Law of the People's Republic of China and the Civil Code of the People's Republic of China, the determination of liability usually needs to take into account a variety of factors, such as the technical system, the driver's behavior, and the external environment. In an autonomous driving accident, how to divide responsibility and define fault has become a complex legal issue. Often, the existing legal framework is still difficult to adapt to the needs of this emerging field, and there is an urgent need to further clarify and refine the relevant legal provisions, especially in the determination of the subject of liability.

In Hong Kong, China, although there are certain provisions in the relevant legal system, such as the Roads (Traffic and Concessions) Regulations and the Torts Act, there are still limitations in the applicability of these laws to autonomous driving technology. In particular, with the increasing complexity of the technology, how to deal with the issues of design defects of autonomous driving systems, monitoring responsibilities and the responsibilities of vehicle owners and users have become difficult in the application of the law. The legal system in Hong Kong emphasizes the comprehensive assessment of multi-faceted liabilities, in particular the reliability of the technical system, the monitoring responsibilities of the driver or safety officer, and the safety and security responsibilities of the manufacturer, which need to be further clarified in future law reforms.

### 2.2    Inadequacies in the Legal Framework

The rapid development of autonomous driving technology has far exceeded the coverage of the existing legal framework, resulting in the frequent lack of a clear legal basis for dealing with autonomous driving accidents. On the one hand, the existing legal framework has not yet provided sufficient guidance for the application of automatic driving technology, especially in the areas of product liability and technical defects determination, etc., and the current law cannot timely adapt to the needs of technological progress. On the other hand, the existing traffic legal system is mainly applicable to the traditional manual driving mode, and in the context of the increasing popularity of autonomous driving technology, the lagging nature of the existing laws has caused trouble in the legal settlement of accidents and the determination of responsibility.

And while driverless cars, as a technology, provide human beings with a new experience in terms of science and technology, there are ethical and value-based factors behind the social problems they cause, and the resolution of these problems requires the intervention of the law [16]. Therefore, it is necessary to revise the existing laws, especially to clarify how to divide responsibilities between self-driving system failures, driver behavior, and other related factors. Whereas the development of self-driving cars is at the forefront of the intersection of artificial intelligence and the law, the existing legal framework may have difficulty adapting to this technological advancement [9]. Specialized legislation related to autonomous driving is urgently needed in places such as mainland China and Hong Kong to ensure the safety and reliability of the technology and its social acceptance.

### 2.3    Torah Analysis of Specific Cases

From 2016 to 2021, traffic accidents related to automated driving technology have occurred one after another in several countries around the world, especially in China, the United States, and Germany, where different degrees of accidents have occurred during automated driving tests. These accidents reflect the inadequacy of autonomous driving systems in complex environments, where problems such as technical

failures, poor decision-making, and driver monitoring failures occur. The frequency of accidents not only reveals the limitations of autonomous driving technology in practice, but also the shortcomings of the existing legal framework in dealing with emerging technologies. Differences in the application of laws in different countries in dealing with these accidents further exacerbate the challenges in terms of attribution of liability, compensation mechanisms and public safety protection. Against this background, the specific case studies that follow will explore the legal application and ethical considerations in autonomous driving accidents in mainland China, the United States, and other countries.

Case 1: May 7, 2016, Tesla Model S fatal accident in Florida, USA

On May 7, 2016, a fatal Tesla Model S accident occurred in Florida. At the time of the accident, the vehicle was in "Autopilot" mode and the driver, although seated in the driver's seat, did not actively intervene. Tesla's Autopilot system failed to recognize a semi-trailer truck crossing the highway in front of the vehicle, resulting in a high-speed collision with the truck that killed the driver. Following the accident, Tesla and the authorities investigated the technical flaws in the system. Although the system demonstrated a high level of autopilot capability under certain conditions, in this accident, the system's perception and reaction capabilities were significantly insufficient and failed to avoid the accident.

As far as the relevant laws in mainland China are concerned, according to Article 76 of the Road Traffic Safety Law, if a traffic accident is caused by the driver's behavior, the determination of responsibility should be based on the principle of fault. In this case, although the vehicle was in auto-pilot mode, the driver still had monitoring responsibility. According to Article 123 of the Civil Code, if a product defect causes damage to another person, the victim can claim compensation from the producer or seller. In the case of the Tesla Model S accident, Tesla may be partially liable for product defects if the investigation shows that the system was defective in perception or decision-making.

In addition, the driver's over-reliance on the autopilot system and failure to take over control in a timely manner may have led to a failure to fulfill his or her obligation to drive safely, and thus the driver may also be partially responsible for the accident. Overall, the determination of accident liability needs to balance the defects of the technical system and the negligent behavior of the driver, and to clarify the boundary of responsibility between the two.

In terms of the relevant laws of Hong Kong, China, according to the principle of negligence liability in Hong Kong's Tort Law, if the driver fails to take over the vehicle in time, it may constitute negligent behavior, and he or she needs to bear the corresponding responsibility for the accident. Under the Roads (Traffic and Licenses) Regulations, vehicle manufacturers are responsible for ensuring the safety of their autopilot systems. If the investigation results show that Tesla's system has technical defects, Tesla may be partially liable for failing to fulfill its safety and security obligations. Therefore, Hong Kong law similarly needs to clarify the allocation of responsibility between the system developer and the driver, taking into account the roles of technical defects and human negligence. Therefore, in order to effectively assign liability for autopilot accidents, the O'Connell's razor principle and the effective and practical principle of liability should be followed when dealing with related accidents again [15].

Case 2: Uber self-driving vehicle fatal accident in Tempe, Arizona, USA, March 18, 2018

On March 18, 2018, Uber's self-driving test vehicle was involved in a fatal accident in Tempe, Arizona, USA. The vehicle was in self-driving mode but failed to recognize a pedestrian crossing the road in time, resulting in the pedestrian's death. The accident exposed the shortcomings of self-driving systems in handling complex environments, especially when it comes to recognizing irregular obstacles such as pedestrians. At the time of the accident, there was a safety officer sitting in the driver's seat of the vehicle, ready to take over control if necessary, but due to a delayed reaction, the accident could not be avoided in time.

According to Article 76 of the Road Traffic Safety Law of mainland China, if the pedestrian is not at fault, the motor vehicle party shall bear the responsibility for the accident. In the accident, the pedestrian was not at fault, so Uber, as the motorized vehicle party, should bear full responsibility for the compensation. At the same time, according to Article 123 of the Civil Code, if the self-driving system has technical defects, Uber, as the producer of the system, needs to bear the corresponding product liability. The accident revealed the defects of the self-driving system in a complex traffic environment, and Uber may be liable for its technical defects due to poor product design.

In addition, the failure of Uber's safety officer to take over the vehicle in time may also be considered negligent behavior. According to the principle of fault liability in the Civil Code, Uber may be liable for the safety officer's negligence. Ultimately, the apportionment of liability for the accident will need to take into account the technical problems of the self-driving system and the monitoring responsibility of the safety officer.

In Hong Kong, according to the principle of fault liability under the Tort Law, if the safety officer fails to take over the vehicle in a timely manner, he/she may have to bear part of the responsibility for the accident. Meanwhile, the Roads (Traffic and Licensing) Regulations stipulate that vehicle manufacturers have a duty to ensure that the self-driving systems they produce are safe and reliable. If there is a technical defect in Uber's self-driving system that prevents it from recognizing pedestrians or reacting correctly, Uber will be liable for the safety of the system.

Case 3: Tesla Model 3 Autopilot "Ghost Brake" Defect in Germany, 2023

In 2023, the District Court of Traunstein, Germany, ruled that the Tesla Model 3's Autopilot system had a design defect and was "not suitable for normal use". The case arose after the owner, Christoph Lindner, repeatedly experienced the vehicle braking without warning when entering and exiting tunnels, changing road conditions, or approaching large vehicles (i.e., "phantom braking"), which resulted in an extremely unsafe driving experience. For example, the Autopilot system suddenly decelerated to 96km/h for no apparent reason when the vehicle was traveling at 140km/h on a highway, without detecting any obstacles or traffic signals. Similar situations occurred frequently during the 700-kilometer expert test and even forced the suspension of the test due to safety risks. The court found that such technical defects significantly increased the risk of traffic accidents and violated the reasonable expectations of consumers regarding the functional reliability of high-priced models, and ultimately ruled that Tesla should fix the vehicle defects. The case then proceeded to appeal before the Higher Court of Munich, where the owner claimed that the repair alone could not solve the problem and demanded that the purchase contract be terminated or the vehicle be replaced with a non-defective one.

According to Article 76 of the Road Traffic Safety Law of the People's Republic of China, liability for traffic accidents must be apportioned on the basis of the principle of fault, and if the accident is caused by a technical defect in the vehicle, the manufacturer is liable. Article 123 of the Civil Code further specifies that if a defective product causes damage to another person, the infringed person has the right to request compensation from the producer or seller. In this case, if the Tesla Autopilot system is proved to have algorithmic misjudgment or sensor defects (e.g., the "phantom brakes" are caused by environmental misrecognition), Tesla, as a manufacturer, is liable for product liability. In addition, although the Road Traffic Safety Law emphasizes the driver's duty to control the vehicle, if the system's autonomous decision-making directly triggers dangerous behavior (e.g., braking without warning), the driver's duty to monitor and control the vehicle may be mitigated due to technological uncontrollability. However, if the driver is overly reliant on the system and fails to intervene in a timely manner, the proportion of responsibility still needs to be determined in the context of the specific situation. This case reflects the need to further clarify the criteria for defining "technical defects" and the mechanism for balancing the responsibilities of the producer and the obligations of the user when dealing with defects in automated driving technology in mainland China.

According to the principle of negligence under Hong Kong's Tort Law, manufacturers are obliged to ensure that their products meet reasonable safety standards. If the Tesla Autopilot system is proved to have a design defect (e.g. "ghost braking" behavior) and the defect directly leads to driving risks, Tesla may be held liable for breaching its safety obligations under the Roads (Traffic and Licensing) Regulations. At the same time, Hong Kong's Sale of Goods Ordinance requires goods to be of "merchantable quality", i.e. of a quality that meets the reasonable expectations of consumers in terms of functionality and safety. In this case, the court found that the Autopilot system was "not fit for normal use", indicating that it did not meet the standard of reliability expected of a high-priced vehicle, and the consumer could seek rescission of the contract or make a claim on this basis. In addition, although the Hong Kong Personal Data (Privacy) Ordinance does not directly address technical defects, it does require companies to make transparent disclosure of product performance. If Tesla fails to adequately inform the limitations of the Autopilot system (e.g. the risk of miscalculation in specific scenarios) in its sales, it may constitute misleading publicity and be subject to civil or administrative liability. This case suggests that Hong Kong law needs to refine the meaning of "merchantable quality" in the field of autonomous driving and strengthen the obligation of manufacturers to inform the public of technical risks.

## 3    Anatomy of Ethical Dilemmas in Autonomous Driving Accidents

The rapid development of autonomous driving technology has dramatically changed the transportation system, bringing efficiency gains and safety improvements, but it is also accompanied by a series of complex ethical dilemmas. Self-driving cars have far-reaching implications at the moral and social levels, including issues such as attribution of responsibility, dignity and justice [4]. These issues are mainly

reflected in the aspects of technological autonomy and human control, the choice of life value, and privacy protection and data security, reflecting the profound contradiction between technological progress and social moral norms.

### 3.1    Technological Autonomy and Human Right to Control

One of the core advantages of autonomous driving technology is its high degree of autonomy, which can significantly improve driving efficiency and safety. However, with the increasing degree of technological autonomy, algorithmic decision-making in self-driving vehicles involves ethical and technical issues, including potential biases and safety risks [3], and self-driving technology raises significant challenges at the moral and ethical levels, especially its contradiction with human control constitutes a major ethical dilemma.On May 7, 2016, the Florida, USA Tesla Model S fatal accident in Florida, USA on May 7, 2016, profoundly revealed this dilemma. The vehicle was in "Autopilot" mode, and the system failed to recognize a semi-trailer truck crossing the highway in front of it, causing the vehicle to hit the truck at high speed and killing the driver. The accident investigation revealed that the system failed to detect the contrast between the white body of the truck and the sky, and therefore failed to apply the brakes. At the same time, the driver did not perform any maneuvers on the vehicle for seven seconds prior to the accident, demonstrating his over-trust in the system. This accident not only exposed the limitations of self-driving technology, but also reflected deeper problems in human-computer interaction.

Further evidence of this dilemma is the fatal Uber self-driving vehicle accident that occurred on March 18, 2018 in Tempe, Arizona, USA. In the world's first fatal crash involving a self-driving vehicle, the vehicle failed to recognize a pedestrian crossing the street while traveling at approximately 40 mph in fully autonomous driving mode. Despite being equipped with a safety officer, the vehicle similarly failed to take over in time to avoid an accident. The incident further highlights the deep tension between technological autonomy and human control in self-driving technology. A key issue is the limitations of the system's ability to make decisions in complex environments, especially at night or in poorly lit conditions; on the other hand, the safety officer's over-reliance on the system has led to a failure to adequately fulfill his monitoring responsibilities.

These two accidents have triggered a wide-ranging discussion on the attribution of responsibility for autonomous driving technologies. The technical limitations of the system and the over-reliance of the user create an irreconcilable contradiction. As technological autonomy increases, the human driver's ability to respond to emergencies may gradually deteriorate, rendering him or her unable to effectively take over the vehicle at critical moments. This imbalance between technological dependence and human intervention capabilities constitutes a central problem in the development of autonomous driving technology that needs to be addressed. Although it is significant that the German ethical guidelines for autonomous driving lead the world in laying the ethical foundation; however, there are serious flaws in its provisions on ethical dilemmas, which may ultimately shift the subject of responsibility for accidents from the autonomous driving system to the human driver [16]. At the same time, this also highlights that how to enhance technological autonomy while maintaining a moderate human intervention capability in the design of autonomous driving systems is an important issue that needs to be explored in depth.

### 3.2    Choice of the Value of Life

The choice of the value of life is one of the challenging issues in the ethical dilemma of autonomous driving technology. The system is faced with scenarios in which it has to make a difficult choice between protecting passengers inside the vehicle and external pedestrians in an emergency situation. For example, the German Ministry of Transportation issued an ethical guideline on self-driving cars in 2017, which aims to provide a framework for ethical decision-making in self-driving systems. The guideline explicitly states that self-driving systems must not make distinctions in the value of life in emergency situations based on factors such as age, gender, or race. This provision aims to avoid systems discriminating against specific groups in their decision-making and to ensure that the value of life is equally respected for all people. However, this guidance has also generated extensive discussion. For example, if a system must choose between protecting passengers in the vehicle and protecting pedestrians, what should be the trade-off? The popularity of self-driving cars raises significant ethical issues, including how to make decisions in life-and-death situations [8]. In addition, people in different cultures prioritize the value of life significantly differently, and this guideline may face challenges in its global application.

According to the MIT "Moral Machines" survey, there are significant differences in the ethical decision-making of people in different countries and cultures with respect to autonomous driving systems. The survey collected public perceptions of life-value choices by simulating decision-making scenarios of self-driving vehicles in emergency situations. The findings show that there are significant differences in people's ethical decision-making about self-driving systems across countries and cultures. And the different preferences of people in different cultural contexts for the ethics of autonomous driving decisions revealed by this experiment pose a challenge for the development of a globally harmonized ethical framework for autonomous driving [13]. For example, some societies tend to favor the protection of the majority, while others are more concerned with the protection of vulnerable groups. This finding reveals that ethical considerations are crucial in the development and deployment of self-driving cars to ensure that they are in line with societal values [6][7]. Ethical issues play a central role in the design and decision-making process of self-driving cars, as these systems need to make ethical choices in times of crisis [11]. The algorithmic design of autonomous driving systems is usually based on universal ethical principles, but these principles may not be accepted in different cultural contexts. Therefore there is a need to set mandatory ethical standards in self-driving cars according to different situations to ensure ethical decision making in critical situations [5].

### 3.3    Ethical Dilemma of Liability Determination

With the rapid development of self-driving technology, the problem of attributing responsibility for self-driving vehicles in traffic accidents is becoming more and more complex. In the case of automatic driving systems and human drivers participating together, how to define the responsibility of both has become a core problem to be solved at the legal and ethical levels. Especially when it comes to the malfunctioning of autonomous driving systems or failure to take timely emergency measures, the determination of responsibility is not only a technical issue, but also an ethical and moral challenge.

The inability of autonomous driving systems to perfectly recognize complex traffic environments or make instantaneous decisions in some cases has led to a profound contradiction between technological autonomy and the responsibility of driver monitoring. In the context of increasing technological autonomy, the driver's responsibility to monitor the vehicle has been neglected in many accidents. The existing legal framework, while providing for driver responsibility, lacks targeted clarity on the handling of autonomous driving technologies. For example, in the fatal Tesla Autopilot accident in 2016, despite the system's theoretically high level of automation, its failure to recognize the obstacle ahead in time led to the accident. At this point, the question arises as to how the law defines liability: is it solely attributable to the system's design flaws, or should it take into account the driver's failure to fulfill his or her duty to supervise? This question involves not only the improvement of the technology itself, but also how to ethically draw clear boundaries for different responsible parties.

In addition, the ethical dilemma of autonomous driving technology is also reflected in the contradiction between "over-reliance" and "proper supervision". Drivers often rely too much on the decision-making ability of the system when using autonomous driving systems, resulting in failure to take over the control in time when the system malfunctions or critical situations occur. Ethically, should this "over-reliance" be an important factor in determining liability? If the driver fails to fulfill his basic monitoring responsibilities at critical moments, does it mean that he should be partially responsible for the accident? This question has been raised in a number of autonomous driving accidents, especially when the system and human decision-making are not properly coordinated, and the attribution of responsibility becomes ambiguous.

From a legal perspective, there are limitations in the applicability of the existing legal system to autonomous driving technology. In mainland China, for example, although the Road Traffic Safety Law and the Civil Code stipulate the basic principles for determining liability in traffic accidents, in the context of automated driving technology, these legal provisions are not able to effectively address the legal liability issues arising from technical failures or system imperfections in actual operation. In particular, the existing legal framework still does not provide a clear answer as to how to define the responsibilities of the manufacturer, vehicle owner and driver in an accident. Meanwhile, the relevant legal system in Hong Kong faces similar challenges. While the Torts Act and the Roads (Traffic and Licensing) Regulations provide a framework for determining liability in traffic accidents, the existing laws fail to adequately take into account the rapid advancement of technology and the new ethical liability issues that arise as a result in the face of the complexity of autonomous driving systems.

Ethically, the dilemma of liability determination is not only a matter of legal application, but also involves how to balance the rights and obligations of different subjects. For example, can the boundary

between the product safety responsibility to be borne by the manufacturer and the supervisory responsibility to be fulfilled by the driver find a reasonable distribution in each accident case? At the same time, how to assess the relative responsibility between the design defects of an automated driving system and the negligent behavior of a driver after an accident also requires more careful ethical thinking. The legal frameworks of different jurisdictions may differ in their answers to this question, but all need to find a balance at the intersection of technology and ethics. As autonomous driving technology becomes more widespread and the public's expectation of liability determination grows, the law and ethics should be updated in tandem to ensure that the development of technology and the implementation of social responsibility can be harmonized with each other.

Overall, the ethical dilemma of responsibility determination triggered by autonomous driving technology is not only a challenge to the existing legal framework, but also a profound reflection on the relationship between technology and human behavior. In the dual dimensions of law and ethics, how to reasonably divide responsibility and avoid the imbalance between technological dependence and human regulatory responsibility is the key to promoting the healthy development of autonomous driving technology. The solution to this problem requires joint efforts from the improvement of laws, the formulation of ethical principles, and the improvement of technology, in order to ensure that autonomous driving technology can realize sustainable progress and application under the leadership of the legal framework and social ethical norms.

# 4    Conclusion

The rapid development of autonomous driving technology is profoundly reshaping the liability pattern of the transportation system, and the determination of accident liability must be based on the balance between the differences in technology application scenarios and legal ethics. Under the current practice framework, the manufacturer of the self-driving vehicle should be regarded as the first responsible subject of the accident, because as the core subject of technology development and system design, it has the unshirkable obligation to guarantee the reliability of the algorithm, the accuracy of the sensor and the safety of the system. Whether it is the "phantom braking" caused by the environmental miscalculation of Tesla's Autopilot system or the fatal accident caused by the failure of Uber's test car to recognize pedestrians, technological defects have always been at the core of the root causes of accidents. When an autonomous driving system has design flaws or fails to meet reasonable safety standards, the manufacturer is primarily liable under the principle of product liability. However, the division of responsibility is not absolute, especially in the field of private cars that are not yet fully driverless, the interaction between user behavior and system prompts is also critical. If the driver fails to comply with the operating regulations (e.g., takes his hands off the steering wheel, ignores the system warnings) when turning on the autonomous driving function, his negligent behavior may form the basis for the allocation of liability. At this point, the law needs to establish a dynamic balance between the manufacturer's technical defects and the user's supervisory failures, and should not over-emphasize the user's responsibility to weaken the company's investment in technical safety, nor should it exempt the user from the basic duty of care due to technological dependence.

It is worth noting that the attribution of responsibility for commercialized vehicles such as completely driverless cabs is significantly different. In such scenarios, where control of the vehicle is fully ceded to the system and passengers or third-party users cannot intervene in driving decisions, the scope of responsibility of manufacturers and operators should be further expanded. On the one hand, operators need to ensure the continuous and reliable operation of vehicles in complex environments, and assume full responsibility for system failures or algorithmic miscalculations; on the other hand, manufacturers need to provide transparent support for technology iteration, to avoid systemic risks due to data training bias or insufficient scenario coverage. In contrast, private car users retain ultimate control, and their liability should be determined in conjunction with technical limitations and operational compliance. For example, if the system explicitly requires the driver to maintain attention and the user causes an accident due to over-reliance on the technology, the proportion of responsibility should be tilted in favor of the user. The future improvement of the legal framework needs to be based on scenario-based thinking, and for the different modes of completely driverless and assisted driving, the obligation boundaries of manufacturers, operators, users and regulators should be refined, so as to build a sustainable liability ecosystem between technological innovation and public safety. Only through the double guarantee of legal clarity and ethical inclusiveness can autonomous driving technology truly realize the symbiosis of social trust and technological development.

# 5    Prospect

As an important driving force for future transportation development, autonomous driving technology is reshaping the way we travel at an unprecedented speed. Its rise seems to bring us one step closer to the "perfect transportation system", but the calmness and rationality of technology cannot completely replace human emotions and moral judgment. How to prioritize the life of each self-driving car in the face of emergencies and how to balance personal privacy and public safety are issues of personal interest to every individual. We hope that technology can be an undifferentiated and impartial decision-maker, but in reality, the algorithms and data behind the technology often do not fully reflect the complex social ethics and cultural diversity. Because of this, the application of autonomous driving technology requires not only the iteration and updating of technology, but also the continuous improvement of the ethical framework, in order to truly allow the technology to serve human beings, rather than replacing human judgment and responsibility.

Reflecting on the ethical dilemmas of autonomous driving technology, we should not only focus on how to solve these problems through technical means, but also think about how to coexist and harmonize technological advances with social moral norms. The development of technology should not be divorced from human moral values, and the improvement of laws and policies, as well as the public's understanding of and participation in the technology, are the keys to ensuring that this technology can be widely accepted and benefit society. At the same time, technology innovators and policymakers need to always remember that technology exists for human beings, and only on the basis of respecting individual rights and safeguarding the public interest can technology truly promote social progress. Therefore, the development of automatic driving technology is not a road that can be traveled by technological breakthroughs alone, and it requires us to think cautiously in every progress: does the convenience of technology come at the expense of certain human values? How to find a balance between the coldness of technology and the warmth of humanity? These questions are not only reflections in the field of autonomous driving, but also a profound revelation of all cutting-edge technological development. In the era of rapid advancement of technology, we need to maintain the care of human values and social responsibility, only in this way, technology can truly move forward with mankind and bring a brighter future.

# Conflicts of Interest

The authors declare no conflicts of interest.

# References

1.  Holstein, T., Dodig-Crnkovic, G., & Pelliccione, P. (2018). Ethical and social aspects of self-driving cars. AI & Society, 33(4), 569–578.
2.  Taeihagh, A., & Lim, H. S. M. (2018). Governing autonomous vehicles: Emerging responses for safety, liability, privacy, cybersecurity, and industry risks. Transport Reviews, 38(1), 103–128.
3.  Lim H S M, Taeihagh A. Algorithmic decision-making in AVs: Understanding ethical and technical concerns for smart cities[J]. Transportation Research Part A: Policy and Practice, 2019, 130: 1-11.
4.  Dubljević, V., Wangmo, T., & Jox, R. J. (2021). Moral and social ramifications of autonomous vehicles. Frontiers in Psychology, 12, 642.
5.  Gogoll, J., & Müller, J. F. (2017). Autonomous cars: In favor of a mandatory ethics setting. Science and Engineering Ethics, 23(3), 681–700.
6.  Lin, P. (2016). Why ethics matters for autonomous cars. In M. Maurer, J. C. Gerdes, B. Lenz, & H. Winner (Eds.), Autonomes Fahren (pp. 69–85). Springer Vieweg+Teubner Verlag.
7.  Goodall, N. J. (2014). Machine ethics and automated vehicles. In Road Vehicle Automation (pp. 93–102). Springe.
8.  Lin, P. (2013). The ethics of autonomous cars. The Atlantic. Retrieved from https://www.theatlantic.com.
9.  McLachlan, S., & Dube, K. (2022). The self-driving car: Crossroads at the bleeding edge of artificial intelligence and law.
10. Maurer, M., Gerdes, J. C., Lenz, B., & Winner, H. (2016). Autonomous driving: Technical, legal and social aspects. Springer.
11. Lin, P. (2015). Why ethics matters for autonomous cars. In Robot Ethics 2.0: From Autonomous Cars to Artificial Intelligence (pp. 69–85). Oxford University Press.

12. Goodall, N. J. (2016). Away from trolley problems and toward risk management. Applied Artificial Intelligence, 30(8), 810–821.
13. Awad, E., Dsouza, S., Kim, R., et al. (2018). The moral machine experiment. Nature, 563(7729), 59–64.
14. Li, F., Jiang, F., et al. (2021). Research on the ethical, legal and social implications of autonomous vehicles. Global Science and Technology Economic Perspective, 36(7), 53–60.
15. Li, F., Pei, Y., Xu, F., Gao, F., & Jia, X. (2020). Reflections on the five ethical issues and principles of autonomous vehicles. Global Science and Technology Economic Outlook, 35(10), 36–45.
16. Ang, L., & Geng, X. (2021). Ethical dilemmas and legal regulations of driverless cars. Legal Theory & Practice, (4), 371–378.

## Biographies

1. **Tingting Li** is currently an undergraduate student majoring in Public Administration at the School of Public Administration, Nanfang College Guangzhou. Her research interests include autonomous vehicle ethics, public policy, and technology governance.

# 基於三起自動駕駛事故的律法與倫理剖析

李婷婷

摘要：本文選取2016年美國特斯拉Model S致命事故、2018年優步自駕汽車致命事故、2023年德國特斯拉「幻影刹車」缺陷事故三個典型案例，以中國《道路交通安全法》、《民法典》、香港《侵權法》和《香港道路（交通與許可條例）》等法律框架為基礎，探討了三起自駕事故責任的法律與倫理歸屬，運用案例分析和司法管轄權比較，系統探討了自動駕駛事故責任的法律與倫理歸屬和產品缺陷承擔責任的第一責任方。研究認為，在輔助駕駛模式下，用戶未能遵守操作規範（例如，忽視系統警告、脫離方向盤監控）也需要承擔責任。在完全無人駕駛的情況下，運營商和製造商共同承擔系統風險。現行法律滯後，難以明確界定技術缺陷與人為疏忽之間的界限，倫理維度面臨生命價值選擇和技術自主性矛盾等挑戰。基於此，本文認為需要完善基於情景思維的責任劃分標準，促進關於自動駕駛的專門立法，加強製造商對技術透明的義務，建立一個考慮到文化差異的全球倫理框架，以平衡技術創新和公共安全，促進自動駕駛技術的可持續發展和社會信任。

關鍵詞：自動駕駛技術；法律與倫理；事故責任；法律框架；道德準則