

Research on the Development Dilemmas and Optimization Paths of Autonomous Vehicle Insurance in China

Boran Wu*

Hebei University of Economics and Business, Shijiazhuang, Hebei, China

*2948226475@qq.com

Abstract

Since the launch of unmanned taxis represented by "Apollo Go", a series of driving safety accidents have drawn people's attention to the protection aspects of unmanned vehicle insurance. The technical complexity and special risks of Autonomous Vehicle pose challenges to the traditional automobile insurance system. This paper analyzes the special risks faced by Autonomous Vehicle, discusses the current protection status of relevant insurance in China, and expounds the implementation dilemmas of unmanned vehicle insurance in the country. In response to these dilemmas, drawing on the experience of typical foreign models, it puts forward optimized development suggestions from the aspects of insurance product innovation, improvement of legal supervision, insurance enterprises' strengthening of scientific and technological construction, and multi-stakeholder collaborative governance, so as to boost the development and progress of the unmanned vehicle-related industries in China.

Keywords

Autonomous Vehicle; Automobile Insurance; Development Dilemmas; Risks.

1. Introduction

Autonomous Vehicle is an intelligent means of transportation that realizes autonomous driving based on computer systems, sensors, artificial intelligence and other technologies. According to the level of automation, Autonomous Vehicle are divided into six levels from L0 to L5. L4 (high automation) and L5 (full automation), which can achieve full unmanned driving, are the main levels discussed in this paper[1]. In July 2024, the L4 unmanned ride-hailing service represented by "Apollo Go" launched operational tests in many cities such as Beijing, Wuhan and Chongqing, marking the gradual application of this technology in practice. However, the safety issues of Autonomous Vehicle have also aroused social concern. For example, "Apollo Go" had a minor collision with a pedestrian in Wuhan, and in particular, the Xiaomi SU7 had a serious traffic accident in March 2025 even when it was in the L2-level intelligent assisted driving state, which has exacerbated the public's doubts about the reliability of this technology. Against this background, whether traditional motor vehicle insurance can adapt to Autonomous Vehicle and effectively protect the rights and interests of car owners and pedestrians has become an urgent issue to be discussed. Therefore, this paper will discuss the risks of Autonomous Vehicle and the current situation of relevant insurance in China, analyze the dilemmas in developing related insurance products, draw on foreign models and experience, and put forward schemes for formulating insurance products and development suggestions.

2. Risks and Insurance Status Quo of Autonomous Vehicle

2.1. Risk Identification of Autonomous Vehicle

2.1.1. Equipment Failure Risks

Such risks are mainly caused by system malfunctions or algorithm errors, such as hardware system failures of radars, camera devices, braking equipment and other components, as well as positioning errors, abnormal driving trajectories and misjudgments caused by software failures of autonomous driving algorithms. Once the above problems occur, the vehicle is likely to be out of control, which will cause incalculable personal injuries and property damage, becoming a major hidden danger to road traffic. This is also the primary risk concerned and discussed by all sectors of society at present.

2.1.2. Cybersecurity Risks

Unmanned driving systems that rely on data and networks will inevitably face cybersecurity issues, such as damage to important data and systems caused by cyber attacks, resulting in economic losses from business interruption and system repair. In addition, traffic safety accidents caused by malicious attacks will also deal a huge blow to the reputation of unmanned vehicle-related enterprises. Moreover, the leakage of vehicle data and personal data privacy of on-board personnel is also an unignorable problem.

2.1.3. External Environmental Risks

Risks caused by the external environment cannot be ignored either. Extreme weather such as strong winds, heavy rains, ice and snow, and smog will seriously affect the perception system of Autonomous Vehicle. In extreme weather, the driving behavior of other vehicles and road conditions are inconsistent with normal situations, and it remains to be seen whether Autonomous Vehicle can adapt to such sudden environmental changes. Pedestrians and other vehicles on the road are also part of the external environment. Jaywalking by pedestrians and illegal driving by other vehicles also test the adaptability and response capacity of Autonomous Vehicle.

2.1.4. Human Risks

Most Autonomous Vehicle are equipped with safety officers, whose purpose is to take over the vehicle and avoid accidents in case of emergencies. However, the actual situation may not be as optimistic as expected. Traffic accidents often happen in an instant, and when safety officers receive error reports from the vehicle system and attempt to take over the vehicle, it is highly probable that they can do nothing to prevent the accident. Safety officers may also make operational errors when taking over the vehicle due to carelessness or dereliction of duty, leading to more serious traffic accidents.

2.2. Current Status of Relevant Insurance in China

At present, in the personal application field, China has no special unmanned vehicle insurance products sold or provided to individuals. Most of the "intelligent driving insurance" available on the market are jointly launched by automobile enterprises and insurance companies, but they are not filed with regulatory authorities. Instead, they are additional value-added options provided by automobile enterprises after the purchase of the primary insurance, with protection mostly covering the assisted driving functions below L3 level. In the event of relevant insurance accidents, the compensation is not paid by insurance companies but underwritten by automobile enterprises.

In the commercial operation field, most operating unmanned taxis are covered by a combination of insurance products required by mandatory policies through cooperation between automobile manufacturers and insurance enterprises, including Compulsory Traffic Accident Liability Insurance for Motor Vehicles, Carrier Liability Insurance and commercial

third-party liability insurance. The vast majority of these insurances are underwritten and settled in accordance with the traditional automobile insurance model. At present, insurance enterprises have begun the development and exploration of exclusive insurance for Autonomous Vehicle. In August 2024, Ping An Insurance and other institutions jointly developed and launched an exclusive protection plan for low-speed Autonomous Vehicle. Although it is not fully applicable to unmanned taxis driving on roads, it has identified the development direction. In October of the same year, Ping An Property & Casualty Insurance issued the first intelligent driving insurance policy for unmanned manned vehicles and launched a pilot program in Deqing, Zhejiang Province, setting a precedent for unmanned vehicle insurance in China.

3. Implementation Dilemmas of Unmanned Vehicle Insurance in China

3.1. Multiple Involved Subjects and Vague Liability Division

The liability division of traditional automobile insurance regards the driver's behavior as the core cause of accidents. Even if the vehicle itself malfunctions, it is likely to be attributed to the car owner's failure to detect risks in a timely manner or maintain the vehicle properly. Therefore, the clause design of traditional automobile insurance revolves around the driver as the core subject. However, the liability of unmanned vehicle insurance shifts to multiple subjects, including but not limited to vehicle manufacturers, software or algorithm developers, car owners and unmanned taxi operation platforms. Liability accidents may involve multiple technical links, such as algorithm errors, sensor failures, and vulnerabilities in the unmanned driving system, further increasing the complexity of the liability chain. Once a safety accident occurs, each subject may be held liable and required to compensate for property and personal losses. Insurance companies also face technical difficulties in the accident liability investigation process, and it is challenging to determine whether the cause of the accident falls within the scope of insurance liability.

3.2. Lack of Technical and Data Support for Insurance Companies

A large amount of driving data is the basic premise for the launch of unmanned vehicle insurance, but it is not easy for insurance enterprises to obtain such data. Automobile enterprises generally keep their own product data strictly confidential and even monopolize core driving data to prevent the leakage of core technologies or exposure of technical defects, which may damage the corporate image. For example, XPeng Motors refused to provide original data to insurance companies on the grounds of trade secrets and only provided indirect data. Incomplete data may lead to deviations in the calculated insurance premiums. In terms of data collection and analysis, insurance enterprises face numerous differences in data collection standards and storage formats among different automobile enterprises. Tesla abroad and Li Auto, NIO and XPeng Motors in China all adopt different data structures, requiring insurance companies to develop a variety of analysis tools at a high cost. Moreover, once the unmanned driving algorithm is updated iteratively, insurance enterprises have to re-price the insurance synchronously, which also poses challenges to the flexibility and forward-looking of insurance clauses.

3.3. Unpredictable New Risks

Unmanned driving technology has brought new risk challenges to the insurance industry. In addition to the risks faced by traditional vehicles, it also involves risks in multiple dimensions such as technology, privacy and liability division. For example, Autonomous Vehicle have new risks such as driving system malfunctions, algorithm defects and cybersecurity issues. In the event of an accident, insurance companies need to conduct professional technical testing on the vehicle or entrust professional institutions to identify the cause of the failure, which greatly

increases the cost of liability determination. The cumbersome and complex claim settlement process also affects the sustainable operation of unmanned vehicle insurance. At present, Autonomous Vehicle are only piloted on a small scale and not promoted on a large scale, so many risks are unpredictable. Inevitably, there are protection gaps or controversial contents in insurance clauses, which affect the public's acceptance of such insurance.

3.4. Lack of Unified Standards and Relevant Laws and Regulations

China lacks special laws, regulations and guiding policy documents for Autonomous Vehicle, and there are no clear normative standards for insurance related to Autonomous Vehicle. For example, the Action Plan for Strengthening Supervision, Preventing Risks, Promoting Reform and Driving the High-Quality Development of the Property and Casualty Insurance Industry issued in December 2024 requires strengthening research on new insurance fields such as intelligent driving and promoting their market-oriented pricing and product innovation. This document only puts forward support for the research and development of this field, but does not provide specific plans and planning tasks, leaving the development and research to the insurance, automobile and other industries on their own. There is a shortage of national exclusive insurance products, with only local insurance underwriting pilots as the main form. At present, there are no special laws and regulations for Autonomous Vehicle, and the Road Traffic Safety Law is still in use, resulting in legal lag.

4. Reference to Foreign Unmanned Vehicle Insurance Models

4.1. The United Kingdom

Through the Automated and Electric Vehicles Act enacted in 2018 and its subsequent amendments, the United Kingdom has established a dual insurance framework[2]. This framework clearly distinguishes between intelligent driving and unmanned driving, and adopts different insurance models accordingly. Among them, L3 and below are classified as intelligent assisted driving vehicles, with insurance liability consistent with traditional automobile insurance, and the vehicle driver bearing the primary liability. L4 and L5 are Autonomous Vehicle, and the legal liability for driving accidents caused by such vehicles is transferred from the driver to the relevant enterprises. To alleviate the difficulty for victims to claim compensation involving multiple enterprise subjects in driving accidents, the United Kingdom has adopted a single insurance contract model. A single insurance policy must cover the rights and interests of the vehicle and on-board personnel. In the event of an accident, the victim only needs to file a claim with the underwriting insurance company. However, the issue of whether the insurance company can exercise subrogation rights remains ambiguous.

4.2. Canada

Canada has established a single insurance framework covering all levels from L1 to L5. The insurance policy covers all accident liabilities caused by driver's negligence and autonomous driving technical failures. Regardless of whether an accident is caused by human factors or technical problems, the victim can claim compensation from the insurance company, thus aligning the underwriting and claim settlement of autonomous driving vehicles with traditional automobile insurance and simplifying the claim settlement process. Subsequently, insurance companies are allowed and encouraged to conduct investigations and collect evidence, and recover costs from automobile enterprises or technical suppliers through subrogation. However, investigations and evidence collection require various vehicle data as support, and Canada's strict data privacy legislation has greatly increased the cost of investigations and evidence collection for insurance companies. Solving the data acquisition problem may require mutually beneficial cooperation between insurance companies and various subjects, or overall planning and support from the government.

4.3. The United States

The United States adopts an insurance model centered on product liability insurance, where the liability subjects of L4 and L5 Autonomous Vehicle are completely transferred to manufacturers, software providers and other parties. State governments stipulate that vehicle manufacturers must purchase high-value liability insurance for Autonomous Vehicle under testing to ensure that there is sufficient compensation to cover any possible accidents. The high and uncertain compensation requirements force automobile enterprises to improve the safety performance of their products. The National Highway Traffic Safety Administration (NHTSA) of the United States requires Autonomous Vehicles above L3 to be equipped with at least 12 perception cameras and redundant hardware to achieve a 10-second safe stopping time. Faced with potential huge compensation and insurance costs, leading automobile enterprises such as Tesla have launched their own insurance products to control risks, provide protection for users at a lower cost and consolidate their market position.

4.4. Japan

The insurance framework centered on the "operator's liability" is prevalent in Japan. The operator refers to the subject that has control over the vehicle or can benefit from it, usually the owner and operator of the vehicle, transforming the traditional driving behavior into the broad operation of the vehicle itself. In practice, the owner or operator of an unmanned vehicle purchases insurance for the vehicle and bears liability for no-fault compensation in the event of an accident. The insurance company makes advance compensation to the victim. This model is consistent with the claim settlement method of traditional automobile insurance, avoiding the post-accident dilemma of liability investigation and ensuring that the victim can receive compensation and relief in the most timely manner. In addition, Japanese law allows insurance companies that have made compensation to exercise subrogation rights afterwards, which is conducive to forcing technology providers to continuously improve the safety and reliability of unmanned driving technology. However, the operator does not bear all liabilities. In the event of vehicle out-of-control accidents caused by extreme weather or malicious attacks on the system by third parties, the insurance compensation liability can be exempted or mitigated. The lack of protection in this regard has also promoted the innovative design of insurance to cope with the more complex vehicle driving environment in the future.

5. Suggestions for the Optimized Development of Unmanned Vehicle Insurance in China

5.1. Promote the Innovation and Optimization of Insurance Products

5.1.1. Introduce Cybersecurity Insurance

Introduce cybersecurity liability insurance into Autonomous Vehicle, covering losses and compensation from traffic accidents caused by cyber attacks, data leakage, losses from software system damage, and indirect losses from business interruption caused by cybersecurity accidents. In terms of underwriting, adopt an integrated "insurance + service" model, which is not limited to economic compensation but emphasizes the equal emphasis on prevention and governance. Insurance companies cooperate directly with the R&D departments of driving systems or technical service providers, conduct strict risk assessments on the protection mechanisms and cybersecurity facilities of driving systems before underwriting, and put forward targeted optimization suggestions. Preferential premium rates are given to enterprises with high safety ratings, which helps to encourage the construction of cybersecurity for Autonomous Vehicle. After insurance purchase, insurance companies conduct dynamic monitoring and provide safety services to help enterprises improve their cybersecurity systems.

In the event of a cybersecurity accident, insurance companies actively make compensation to reduce the losses suffered by enterprises.

5.1.2. Expand the Insuring Subjects and Insurance Objects

The applicant of traditional automobile insurance is generally the vehicle owner. Compared with traditional vehicles, the liability attribution of Autonomous Vehicle is completely different, which leads to the complex and vague definition of insurance liability subjects. In terms of insurance purchase, a multi-subject co-insurance model can be adopted, in which automobile manufacturers, software system providers, owners and other subjects jointly purchase insurance and perform their respective obligations separately. For example, the owner shall maintain the vehicle regularly, the automobile manufacturer shall ensure that the vehicle quality meets national safety standards, and the system software provider shall maintain the normal operation of the driving system. This can disperse the economic pressure of insurance purchase for each subject, clarify the scope of liability, make claim settlement well-founded, and to a certain extent, boost the enthusiasm for production and R&D. In terms of insurance objects, there is no strictly defined driver in an unmanned vehicle, and the role of on-board personnel has transformed into risk bearers, who face the risks brought by the unmanned driving system just like pedestrians on the road. Therefore, to protect the legitimate rights and interests of on-board personnel, they should be included in the scope of insurance liability objects. In the event of a traffic accident causing personal injuries or deaths, the victim and their family members shall be allowed to directly request advance compensation from the insurance company, so that the victim can receive timely relief, and the specific liability determination can be conducted afterwards.

5.1.3. Introduce the UBI Automobile Insurance Model

Unmanned driving technology is in its infancy, and vehicles are in the pilot testing stage. Insurers lack sufficient data to establish a pricing model. Out of prudence, most unmanned vehicle insurance products may have relatively high premiums, making large-scale promotion difficult. In this case, we can learn from the UBI (Usage-Based Insurance) model, which is a quantifiable insurance based on the combination of driving behavior and vehicle usage-related data. Insurance companies can install sensor devices such as OBD on underwritten vehicles to monitor data such as the driving behavior logic, danger early warning, driving speed, road conditions of Autonomous Vehicle, as well as the collision angle and direction at the time of the accident. Based on the data received by OBD devices, a customized premium is formulated for each vehicle and adjusted dynamically on a monthly or quarterly basis. This can also alleviate the problem of automobile enterprises monopolizing driving data to a certain extent and help insurance companies establish their own databases. In the future, when unmanned driving technology matures, insurance companies can carry out large-scale underwriting and obtain expected profits through the accurate actuarial calculation of risks by the UBI model.

5.2. Improve the Legal Supervision System and Clarify the Liability Boundaries

5.2.1. Establish Unified Normative Standards and Clarify the Liabilities of All Subjects

Product defect is the premise for determining product liability. China has not formulated detailed provisions for such vehicles, leading to difficulties in judging product defects in accidents and affecting the identification of product liability subjects. Therefore, it is imperative to formulate national and industrial standards for Autonomous Vehicle. Detailed provisions should be made for important components according to the technical characteristics of Autonomous Vehicle, especially for driving systems, including real-time data processing and feedback, software update and maintenance, functional safety, information security, decision-making early warning and auxiliary control functions. This ensures that accident investigations can confirm product defects in accordance with the law and protect the legitimate rights and

interests of victims. At the same time, it is also necessary to improve and perfect the norms for the sharing and use of automobile data, clarify the right to privacy, use and ownership of various types of data, so that compliant and desensitized data can be used by insurance companies to help them build actuarial models[3].

5.2.2. Improve the Supervision System

From the perspective of the current development of unmanned driving, a mandatory market safety access mechanism should first be established, requiring enterprises to submit functional safety (ISO) and Safety of the Intended Functionality (SOTIF) certification reports on a regular basis to strictly control the quality of Autonomous Vehicle[4]. At the same time, a relevant technical department should be set up to conduct regular technical testing on Autonomous Vehicle to avoid large-scale traffic safety accidents caused by system algorithms and minimize the harm of risks. The improvement of the regulatory framework can provide a more transparent and risk-controllable market environment for insurance companies, help reduce potential losses caused by unknown risks, and also provide a broader space for insurance companies to develop and innovate related products.

5.2.3. Reserve Partial Subrogation Rights for Insurers

Autonomous Vehicle are still in the pilot stage, with inaccurate actuarial models and ineffective risk control. Considering the principle of fairness, if insurers only pay compensation unilaterally, it will be difficult for them to make profits and even lead to losses, making sustainable operation impossible. However, reserving subrogation rights for insurers does not mean that the accident liability is completely borne by vehicle-related manufacturers or owners, otherwise insurance will lose its significance of risk compensation. In actual operation, after an accident occurs under the autonomous driving system, the insurer shall first make compensation to the accident victim, and then evaluate whether to exercise subrogation rights against the relevant manufacturers. For example, subrogation should be exercised in the following situations: obvious major defects in the unmanned driving operating system; serious dereliction of duty by the operator who has the ability to prevent danger but fails to take over the vehicle in a timely manner or turns a blind eye; artificial modification or tampering of the vehicle and even the operating system; and failure to maintain the vehicle on time. For accident cases with vague or doubtful liabilities, insurers exercise subrogation rights at a certain proportion, which is equivalent to sharing accident liabilities with manufacturers. In short, in the early stage of the development of Autonomous Vehicle, safety driving accidents may occur frequently, so insurers should be entitled to partial subrogation rights to avoid excessive losses affecting sustainable operation. Whether to gradually cancel the subrogation rights of insurance companies after the relevant technology is developed and improved can be discussed in the future.

5.3. Strengthen Industrial Capacity Building and Multi-stakeholder Collaborative Governance

5.3.1. Insurance Companies Strengthen Their Own Scientific and Technological Construction

The development and sustainable operation of unmanned vehicle insurance by insurance companies require the design and transformation of automobile liability insurance products on the basis of a full understanding of Autonomous Vehicle, which places relatively high requirements on the technology and management of insurance enterprises[5]. At the same time, it is necessary to deeply apply scientific and technological means to determine the cause of accidents. While cultivating their own talent teams, insurance companies should also strengthen cooperation with science and technology enterprises to conduct in-depth research on relevant issues. In addition, insurance companies can cooperate to build a special big data

platform to record data such as the cause of claims, loss amount and claim frequency of Autonomous Vehicle, and set different premium rates and a certain floating range. In the event of an accident, the cause of the accident can also be investigated through the automobile insurance big data platform to prove the causal relationship of losses and determine the compensation amount, realizing rapid claim settlement and providing a good development environment for unmanned vehicle insurance.

5.3.2. Implement Multi-stakeholder Collaborative Governance

Unmanned vehicle insurance involves multiple subjects such as automobile manufacturers, data subjects, technical service providers, insurance companies and regulatory authorities. Its complexity and diversity require a collaborative governance process. As a link connecting multiple subjects, insurance companies promote collaborative governance through contract and service mechanisms. After an insurance accident occurs, insurance companies not only bear the responsibility of economic compensation, but also coordinate third-party technical institutions to participate in accident investigation and remediation, and cooperate with regulatory authorities in compliance inspections to ensure the efficient handling of incidents. To achieve this goal, the endorsement and guidance of government agencies are needed to overall plan and coordinate the liability boundaries and interest relations of all subjects.

6. Summary

In summary, the technical characteristics of autonomous vehicles bring multiple risks such as equipment malfunctions and cybersecurity issues, posing significant challenges to the traditional motor insurance system. At present, relevant insurance in China is still dominated by traditional insurance combinations, with exclusive products still in the pilot stage. It also faces developmental dilemmas including ambiguous liability division, lack of technical data, unpredictable risks, and the absence of regulatory standards. Insurance models in the UK, the US, Japan and other countries provide diverse reference ideas for China. Combined with the actual situation of China's industry, efforts need to be made in multiple dimensions including product innovation, regulatory improvement, capacity building and collaborative governance. Only by innovating insurance product forms, clarifying the liability boundaries of various subjects, strengthening the technological capabilities of insurance companies, and promoting multi-stakeholder collaborative governance can we solve the industry's development problems, build an insurance system adapted to the development of autonomous vehicles, and lay a solid risk guarantee foundation for the large-scale and standardized development of China's autonomous vehicle industry.

References

- [1] Jiang W T, Lin S H, Huang H T. Discussion on the Development of Unmanned Vehicle Insurance[J]. China Insurance, 2022(11):41-44.
- [2] Yao S L. Development of Intelligent Connected Vehicle Insurance in the UK and Its Experience Reference[J]. China Insurance, 2024(05):53-55.
- [3] Ming X, Du F, Wu F,etal. Research on the Legislative Supervision and Insurance Practice of Autonomous Vehicle Insurance (Part 2)[J]. Shanghai Insurance, 2024(07):19-23.
- [4] Xie J J, Wang D, Kang X. International Experience of Unmanned Vehicle Insurance Development and Its Enlightenment to China[J]. Insurance Theory and Practice, 2025(06):101-109.
- [5] Teng L L. Research on the Structural Mismatch and System Reconstruction Countermeasures of Intelligent Driving Insurance[J]. Technology Innovation and Productivity, 2025,46(08):127-129+133.