ISSN 2616-5902 Vol. 7, Issue 11: 97-102, DOI: 10.25236/AJBM.2025.071114

Optimization of Cargo Safety Liability and Insurance Legal Model under Intelligent Warehousing Environment

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Abstract: *With the increasingly prominent position of intelligent warehousing in the modern logistics system, issues related to its cargo safety responsibility and insurance legal model have gradually attracted attention. This paper focuses on the optimization of cargo safety liability and insurance legal model under the intelligent warehousing environment. By analyzing the basic theory of intelligent warehousing, this paper deeply discusses the loopholes in the current legal norms of cargo safety liability, the practical difficulties of insurance legal model and the challenges brought by technological development. In this paper, theoretical analysis and other methods are used to put forward the optimization path: to improve the legal system of cargo safety responsibility in intelligent warehousing, including defining the subject of responsibility, dividing the proportion of responsibility and establishing a traceability mechanism; Innovating insurance legal model, including launching customized products, scientifically determining rates and improving reinsurance mechanism; A coordinated development mechanism should be built to strengthen industry communication and cooperation. These optimization measures will effectively solve the problems existing in the current model, promote the coordinated development of the intelligent warehousing industry and the insurance industry, and provide a solid legal guarantee for the healthy development of the intelligent warehousing industry.*

Keywords: *Intelligent Storage; Cargo Safety Responsibility; Insurance Legal Model; Optimized Path*

1. Introduction

In today's digital wave, intelligent warehousing, as the key component of modern logistics system, is changing the pattern of goods storage and management at an unprecedented speed. With automation equipment, information technology and intelligent management system, intelligent warehousing greatly improves the efficiency and accuracy of warehousing operation and brings remarkable economic benefits to enterprises [1]. However, like any emerging field, in the process of rapid development, intelligent warehousing has also exposed a series of problems related to cargo safety liability and insurance legal model, which need to be deeply studied and properly solved [2]. From the actual situation, the definition of cargo safety responsibility in intelligent storage environment has become more and more complicated [3]. Under the traditional warehousing mode, the subject and scope of responsibility are relatively clear, but in intelligent warehousing, many new factors such as automation equipment failure, system software loopholes and network security threats are constantly emerging, which makes the determination of cargo safety responsibility full of variables [4].

The legal mode of intelligent warehousing cargo insurance is also facing severe challenges. With the continuous innovation of intelligent warehousing technology, the risk characteristics of insurance subject matter have undergone profound changes [5]. Traditional insurance clauses and underwriting methods are difficult to adapt to the diversity and complexity of goods risks in intelligent warehousing environment [6]. Some unique risks of intelligent warehousing, such as the loss of goods caused by data leakage, are often lack of targeted protection in existing insurance products [7]. When evaluating the risk of intelligent warehousing goods, insurance institutions are unable to accurately determine the insurance rate due to the lack of sufficient data and experience, thus affecting the healthy development of the insurance market. It is of great practical significance to optimize the legal mode of cargo safety liability and insurance under the intelligent warehousing environment. First of all, a clear cargo safety responsibility system can standardize the behavior of all participants in intelligent warehousing, and

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urge them to take more effective safety measures to reduce the risk of cargo loss and maintain market order. Secondly, the optimized insurance legal model can provide a more comprehensive and reliable risk transfer mechanism for cargo owners, enhance their ability to cope with smart warehousing risks and protect their legitimate rights and interests. Furthermore, a reasonable legal model will help to promote the coordinated development of the intelligent warehousing industry and the insurance industry, and promote the stability and prosperity of the entire logistics industry chain.

Under this background, it is undoubtedly of great theoretical value and practical significance to study the optimization path of cargo safety liability and insurance legal model in intelligent warehousing environment. By analyzing the problems existing in the current legal model, combining the development trend and actual demand of intelligent warehousing technology, we can explore practical optimization strategies, which can fill the theoretical gaps in related fields and provide new perspectives and ideas for legal research. This can provide a solid legal guarantee for the healthy development of the intelligent warehousing industry, and promote the modern logistics industry in China to a higher level.

2. Cargo safety liability and insurance theory in intelligent warehousing environment

Intelligent storage is a modern storage mode that integrates automation technology, information technology and intelligent management. Its core elements are automation equipment, Internet of Things (IoT) sensors and advanced management systems. It has the characteristics of high efficiency, low error rate, strong real-time performance and high automation. However, this technology-driven change is also deeply reshaping the connotation of cargo safety management [8].

Under the background of intelligent warehousing, the concept of cargo safety responsibility has been endowed with richer dimensions. The responsible subjects are diversified, not only confined to the traditional warehousing operators, but also extended to equipment suppliers, software developers, system integrators, and may even include network service providers. The scope of liability has also been expanded, including not only the physical damage of the goods themselves, but also the delay and wrong delivery of the goods indirectly caused by data security incidents.

At the same time, insurance plays a key role in risk transfer and economic compensation in the security system of intelligent warehousing goods [9]. Its basic principle is still based on the law of large numbers, and many policyholders with similar risks pay premiums to form insurance funds. This mechanism is of great help to stabilize the operation of enterprises and spread the risk of huge losses. The rise of intelligent warehousing puts forward new requirements for traditional insurance theory. The risk source has changed from a single man-made or natural factor to a compound risk of "technology-people-environment". Whether the unknown risks brought by new technologies belong to insurable risks needs to be re-evaluated by actuarial theory. The information that the insured needs to disclose is no longer limited to the value of goods and storage conditions, but also includes the technical scheme, network security level, system maintenance records, etc.

3. Problems of legal models for warehouse goods safety liability and insurance

(1) The loopholes in the legal norms of the safety responsibility of intelligent warehousing goods

The current law is not clear enough about the definition of the subject responsible for the safety of intelligent warehousing goods. Intelligent warehousing involves many subjects, such as warehousing operators, equipment manufacturers, software developers and so on. When the goods have safety problems, it is difficult to clarify the attribution of responsibility according to the existing laws. The proportion of responsibility is not clear, and all parties often pass the buck, which makes it difficult to protect the rights and interests of cargo owners.

(2) The practical dilemma of the legal mode of intelligent warehousing cargo insurance

The insufficient pertinence of insurance clauses is a prominent problem. Traditional warehousing insurance clauses are difficult to adapt to the special risks of intelligent warehousing. The network security risks faced by intelligent warehousing, such as the paralysis of the warehousing management system caused by hacker attacks, and thus the loss of goods, are rarely involved in the existing insurance clauses. There is no scientific basis for determining the insurance premium rate. The risk of intelligent warehousing is diverse and complex, and the existing data is insufficient, so it is difficult for insurance institutions to accurately assess the risk, which leads to the insurance premium rate being

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either too high, increasing the cost of enterprises, or too low, which makes insurance institutions face the risk of loss.

(3) The development of intelligent warehousing technology challenges the current legal model

The rapid development of intelligent warehousing technology, such as the wide application of Internet of Things, big data and artificial intelligence, makes the risk of cargo safety more complicated and changeable. Taking the Internet of Things technology as an example, although a large number of devices are connected to the Internet to improve management efficiency, it also increases the scope of network attacks and the risk of data leakage greatly increases. The current legal model is difficult to quickly adapt to the risk changes brought by these new technologies, and the lag of the law is prominent. See Table 1 for a summary of the current legal modes of intelligent warehousing goods safety liability and insurance. There are many problems in the current legal model of goods safety liability and insurance in intelligent warehousing, which seriously hinder the steady progress of intelligent warehousing industry and urgently need to be optimized and improved.

Table 1 Summary of Issues in Legal Models for Intelligent Warehousing

Issue Category	Specific Manifestations	Causes	Consequences	Typical Scenario Examples
Legal Norms for Safety Liability	The definition of liable parties is vague, and the proportion of liability assumption is unclear.	Intelligent warehousing involves multiple parties, and legal provisions are general.	It is difficult for cargo owners to safeguard their rights, and disputes are prone to arise among parties.	Automated sorting equipment malfunctions, causing damage to goods. The equipment manufacturer and the warehousing operator shift responsibilities to each other.
Insurance Legal Model	Insurance clauses lack targetedness, and premium rate determination lacks a basis.	The risks in intelligent warehousing are complex, traditional insurance is difficult to adapt, and there is insufficient data accumulation.	The scope of insurance coverage is limited, and there is an imbalance between enterprise costs and the risks of insurance institutions.	A hacker attacks the warehousing management system, causing cargo losses, but this is not covered by existing insurance clauses.
Challenges from Technological Development	Laws lag behind the risk changes brought about by intelligent warehousing technology.	The legislative process is complex, and technology updates rapidly.	It is impossible to promptly respond to the complex risks brought by new technologies.	The Internet of Things (IoT) technology increases the number of connected devices, raising the risk of data leakage, but there is no corresponding legal regulation.

4. Intelligent warehousing cargo safety responsibility and the optimization path of insurance legal model

(1) Improve the legal system of intelligent warehousing goods safety responsibility

The legislature should formulate laws and regulations specifically for the safety responsibility of intelligent warehousing goods, and clearly define the responsibilities of each subject. At the same time, a scientific mechanism for dividing liability proportions should be established, and the responsibility shares of all parties should be comprehensively determined by considering factors such as degree of fault and risk control capability. The legislature should also establish a traceability mechanism for the safety responsibility of intelligent warehousing goods, and use blockchain and other technologies to record the whole process information of goods warehousing, so as to ensure that the responsible subject can be traced quickly and accurately when problems arise.

(2) Innovating the legal mode of intelligent warehousing cargo insurance

The insurance industry should introduce customized intelligent warehousing goods insurance products, and set up special insurance coverage for special risks such as network security risks and data leakage risks. It is necessary to encourage insurance institutions to cooperate with technology companies, use big data analysis, artificial intelligence and other technologies to accurately assess the risks of intelligent warehousing and scientifically determine insurance rates. The insurance industry should also improve the reinsurance mechanism, disperse the risks of insurance institutions and enhance their underwriting ability.

(3) Building a coordinated development mechanism

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It is very important to strengthen the communication and cooperation between the intelligent warehousing industry and the insurance industry and establish an information sharing platform. Warehousing enterprises timely provide information such as warehousing technology updates and risk changes to insurance institutions, and insurance institutions provide risk management suggestions for warehousing enterprises. Government departments formulate incentive policies to guide the two sides to collaborate in innovation and promote the coordinated development of intelligent warehousing cargo safety liability and insurance legal model. See Table 2 for the optimization path and expected effect of the legal model of intelligent warehousing cargo safety responsibility and insurance. Through these optimization paths, it is expected to build a scientific and reasonable legal model of cargo safety liability and insurance that meets the needs of intelligent warehousing development, and promote the sustainable prosperity of intelligent warehousing industry.

Table 2 Optimization Paths and Effects of Legal Models for Intelligent Warehousing

Optimization Direction	Specific Paths	Expected Effects	Implementation Difficulties	Countermeasures
Improve the Legal System for Safety Liability	Formulate specialized regulatory details	Clear responsibility definition, fewer disputes, and better protection of cargo owners' rights.	Formulating regulations requires balancing the interests of multiple parties, which is difficult.	Conduct extensive research, solicit industry opinions through multiple rounds, and carry out expert demonstrations.
	Clarify liable parties and proportions		There is interest game among parties, and it is easy to have disagreements in responsibility division.	Introduce third-party professional evaluation institutions to scientifically divide responsibilities based on risk contribution, degree of fault, etc.
	Establish a traceability mechanism		Large technological investment and complex data management.	Adopt mature blockchain technology and establish data encryption and backup systems.
Innovate the Insurance Legal Model	Launch customized products	Comprehensive insurance coverage, reasonable premium rates, and more stable industry development.	It is difficult to assess emerging risks, and product design is challenging.	Collaborate with technology companies and industry experts to conduct risk modeling and analysis.
	Scientifically determine premium rates		Insufficient data accumulation makes it difficult to control accuracy.	Build an industry data sharing platform and use big data analysis technology.
	Improve the reinsurance mechanism		The participation level in the reinsurance market is not high.	Strengthen policy guidance and promote the advantages of reinsurance.
Establish a Collaborative Development Mechanism	Strengthen industry communication and collaboration	Promote collaborative innovation and joint development between the intelligent warehousing and insurance industries.	There are significant differences in industry concepts, and communication and coordination take a long time.	Regularly organize industry exchange meetings and establish joint working groups.
	Establish an information sharing platform		Information security management requirements are high.	Set up strict permission management and adopt encrypted transmission and storage technologies.
	Formulate incentive policies		Policy implementation requires coordination among multiple departments.	Establish a cross-departmental coordination mechanism and clarify job responsibilities.

5. Challenges and countermeasures of optimizing path implementation

The optimization path proposed in this paper has certain theoretical value and practical guiding significance, but from conception to actual implementation, it will encounter a series of complex problems. Facing up to these challenges and dealing with them effectively is the key to ensure the successful implementation of the optimization scheme.

Intelligent warehousing involves many fields such as logistics, automation and information technology, and insurance belongs to the financial industry. There are obvious differences between the two industries in knowledge system, business process and risk preference. In order to establish an effective communication and cooperation mechanism and information sharing platform, it is necessary to overcome the huge "communication" obstacle and interest game. In view of this situation, the government should also play a guiding role. Technical seminars, risk salons and other activities can be

ISSN 2616-5902 Vol. 7, Issue 11: 97-102, DOI: 10.25236/AJBM.2025.071114

held regularly to enhance mutual understanding. Standardized data interface specifications and information security protocols can also be formulated to realize limited and controllable sharing of key risk data on the basis of safeguarding core business secrets.

Blockchain, artificial intelligence and other technologies have broad application prospects in traceability mechanism and risk assessment, but these technologies themselves are in the stage of rapid development and iteration. When the legislature formulates special rules and regulations, if it is too specific, it may soon become outdated due to the development of technology; If it is too principled, it lacks practical operability. The regulatory authorities can set up a regulatory sandbox in specific areas or for specific projects, allowing enterprises to test new liability identification mechanisms and insurance products in a relatively relaxed regulatory environment. For example, the responsibility traceability system based on blockchain should be piloted, and a new type of insurance covering the risk of AI decision-making should be launched.

Whether it is scientifically determining the insurance premium rate or accurately dividing the proportion of liability, it is highly dependent on massive, true and high-quality historical data. However, at present, the intelligent warehousing industry is still in the development stage, and the accumulation of key data such as equipment failure rate, network attack frequency, and the amount of cargo damage caused by system collapse is seriously insufficient. Insurance institutions lack sufficient historical claims data to build actuarial models, and it is difficult for third-party evaluation institutions to obtain objective basis. Based on this factor, it is urgent to establish a national or industry-level "intelligent warehousing risk database". Government departments should encourage and support industry associations to take the lead in promoting major warehousing enterprises and insurance companies to report relevant risk events and loss data anonymously. By integrating various resources, an authoritative and comprehensive risk information base is formed.

With the maturity of cutting-edge technologies such as digital twinning and metauniverse, the intelligent storage environment will become more complex and immersive. In the future, the legal mode of cargo safety liability and insurance is expected to break through the passive limitation of "compensation afterwards". The virtual warehouse built by digital twin technology can simulate all processes before the actual physical operation. Based on this, insurance institutions can even give premium rewards for "zero accident" operation according to this model, thus encouraging enterprises to continuously improve their safety level. However, this has also triggered a series of brand-new ethical and legal problems, such as algorithmic bias and out-of-control of autonomous systems. Therefore, the optimization of the future legal model should not only focus on the technical and economic aspects, but also be forward-looking, including ethical review and man-machine collaborative governance framework.

6. Conclusions

This paper focuses on the core topic of cargo safety liability and insurance legal model optimization under the intelligent warehousing environment, and after many in-depth explorations, draws a series of conclusions with practical guiding value. In the process of research, the basic theory of cargo safety liability and insurance in intelligent warehousing environment is clarified. With its automation and intelligence, intelligent warehousing is significantly different from traditional warehousing, which makes the definition of the subject and scope of cargo safety responsibility more complicated, and the principle of insurance protection in it is based on risk transfer mechanism. However, there are many problems in the current legal model. In terms of legal norms of cargo safety liability, the definition of liability subject is vague and the proportion of liability is unclear, which leads to frequent disputes and it is difficult to protect the rights and interests of cargo owners. In the insurance legal mode, the lack of pertinence of clauses and the lack of scientific basis for determining rates restrict the effective support of the insurance industry for intelligent warehousing, and the rapid development of intelligent warehousing technology highlights the lag of the current legal mode.

Based on the above problems, this paper puts forward a feasible optimization path. In the aspect of improving the legal system of intelligent warehousing goods safety responsibility, it is expected to fundamentally solve the problem of unclear responsibility identification by formulating special laws and regulations, accurately dividing the responsibility ratio of each subject and establishing a responsibility traceability mechanism. Innovating the legal mode of intelligent warehousing cargo insurance, introducing customized insurance products, scientifically determining the premium rate and improving the reinsurance mechanism can comprehensively enhance the insurance's ability to protect

ISSN 2616-5902 Vol. 7, Issue 11: 97-102, DOI: 10.25236/AJBM.2025.071114

the special risks of intelligent warehousing. Building a collaborative development mechanism, strengthening communication and cooperation between intelligent warehousing and insurance industry, establishing an information sharing platform and relying on policy guidance will promote the collaborative innovation and common development of the two industries. These optimization paths are interrelated and complementary, and jointly build a legal model framework that meets the development needs of intelligent warehousing. If it can be effectively implemented, it will create a healthy and orderly development environment for the intelligent warehousing industry, enhance the risk response ability of all parties in the industry, promote the intelligent warehousing industry to play a greater role in the modern logistics system, and achieve a win-win situation for economic and social benefits.

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