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Research on the Collaborative Mechanism of the Emergency Management Industry Chain from the Perspective of Low-Altitude Economy

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Abstract

In recent years, with the rapid development of the low-altitude economy, the management and utilization of low-altitude airspace have become a new growth point for the economy. However, under the background of low-altitude economy, there are still many challenges in the collaborative mechanism of the emergency management industry chain, such as asymmetry of rescue information, weak rescue perception, difficult communication coordination and low rescue decision-making efficiency of rescue equipment, conflicts of interest among relevant departments and imperfect collaborative mechanisms. This study aims to explore the collaborative mechanism of the emergency management industry chain from the perspective of low-altitude economy, analyze the existing problems and challenges in the current collaborative mechanism of the emergency management industry chain, and propose an optimization path for the collaborative mechanism based on the stakeholder theory and the collaborative governance theory.This study adopts the methods of literature analysis and case study, aiming to provide theoretical support and practical guidance for the emergency management of low-altitude economy and promote the healthy and orderly development of low-altitude economy.

Keywords: low-altitude economy, emergency management, stakeholder theory, collaborative governance theory

1. Introduction

1.1 Research Background

The low-altitude economy is an economic form dominated by the general aviation industry. In recent years, it has gradually become an important part of the national development strategy. In the 2024 National Two Sessions, the low-altitude economy was for the first time included in the government work report and was classified as a new type of productive force. The low-altitude economic industry has ushered in a broader space for development, which also means that it will play an increasingly important role in fields such as emergency management. In the emergency management industry chain, the application of low-altitude economy has demonstrated tremendous potential and advantages. For instance, low-altitude aircraft can be used for auxiliary rescue operations. With their compact and flexible features, aircraft can enter narrow and dangerous spaces to carry out search and rescue missions. Meanwhile, aircraft are used to survey the disaster-stricken area, providing a scientific basis for rescue operations. Thus, a scientific and accurate rescue plan can be formulated in the first place, effectively reducing casualties and property losses. However, in the process of integrating the low-altitude economic industrial chain, some urgent problems that need to be solved have also been exposed. For instance, there are problems such as asymmetry of rescue information, weak rescue perception, difficult communication coordination and low rescue decision-making efficiency of rescue equipment, conflicts of interest among relevant departments and imperfect coordination mechanisms. By strengthening information sharing, promoting technical standardization, and adaptively adjusting policies and regulations, the problems existing in the industrial chain collaboration mechanism can be effectively addressed, promoting the healthy development of the low-altitude economy and providing more efficient and safe guarantees for emergency management.

1.2 Research Significance

The application of low-altitude economy in emergency management is mainly reflected in the use of low-altitude aircraft such as unmanned aerial vehicles and flying cars for rescue and material delivery. These aircraft, due to their compact and flexible features, can quickly reach the disaster area to carry out search and rescue operations and deliver supplies, significantly enhancing the efficiency of emergency rescue. For instance, at the Shenzhen

Blood Center, a drone delivered 10 units of de-white suspended red blood cells to the hospital in just 6 minutes, providing a guarantee for the smooth progress of the surgery.

In addition, the application of low-altitude economy in emergency management is also reflected in its ability to collect and share data in real time, making up for the lack of connection among various systems in traditional emergency management platforms. The data collected by low-altitude aircraft can provide a scientific basis for rescue operations, enabling the formulation of scientific and accurate rescue plans in the first instance and effectively reducing casualties and property losses. The development of low-altitude economy not only brings new technical support to emergency management, but also injects new vitality into the quality improvement and development of emergency science and technology.

With the development of the low-altitude economy, it will inevitably bring about a large number of new risks and new safety issues, and at the same time, a large number of high-tech that can be used for emergency management will surely emerge.

1.3 Research Methods

This study employs two commonly used methods in academic research: the literature analysis method and the case study method. By adopting the literature analysis method, through the systematic collection, organization and analysis of existing literature materials, the research background, theoretical framework and development trend of the synergy of the low-altitude economy and the emergency management industrial chain are revealed.
At the same time, the shortcomings of the research and new research directions can be discovered. By using the case study method, actual cases such as earthquakes, fires and floods are selected for in-depth analysis to reveal the patterns and causes behind the cases.

2. Relevant Theoretical Basis

2.1 Stakeholder Theory

Stakeholder theory (stakeholder theory) It is a management theory that holds that the development of any enterprise or organization cannot be separated from the input or participation of stakeholders. With the development of theory, the concept of stakeholders has expanded from the initial "influence" to "participation" and then to "co-governance", reflecting the three stages of deepening the relationship between organizations and stakeholders. In the field of emergency management, the application of stakeholder theory is particularly important. Emergency management is the process of prevention, preparation, response and recovery for sudden events, such as natural disasters and public health incidents. The application of stakeholder theory in emergency management requires us to re-examine and adjust the relationship between organizations and stakeholders, emphasizing the importance of co-governance and multi-party cooperation. By identifying and responding to the expectations of multiple stakeholders, we can achieve harmonious coexistence between the organization and society, and enhance the efficiency and effectiveness of emergency management.

2.2 Collaborative Governance Theory

The theory of collaborative governance is a comprehensive governance model that emphasizes the cooperation and coordination among multiple subjects in the process of public management. This theory holds that different stakeholders such as the government, non-governmental organizations, enterprises and citizens should collaborate with each other and jointly participate in the management of public affairs to maximize public interests. In the field of emergency management, the theory of collaborative governance is particularly important as it involves rapid response to emergencies and efficient allocation of resources. The timely sharing of information can significantly enhance the accuracy of decision-making and the speed of response. By establishing an effective information sharing mechanism, all participating entities can obtain the latest event information in real time, thereby making more reasonable decisions and taking actions. In conclusion, the application of the theory of collaborative governance in emergency management not only enhances the efficiency and effectiveness of emergency response but also strengthens the overall disaster resistance capacity of society. Through the joint efforts and collaborative cooperation of all parties involved, people's lives and property can be better protected and the losses caused by disasters can be reduced.

3. Analysis of the Current Situation and Main Problems of the Low-altitude Emergency Management Industry Chain

3.1 Overview of the Low-Altitude Economic Emergency Management Industrial Chain

The low-altitude economic emergency management industrial chain is a complex and rigorous system, covering multiple links from the initial preparation of emergency response to the final rescue execution. The development

of unmanned aerial vehicle (UAV) technology has injected new vitality into the general aviation industry and promoted innovation in application scenarios such as UAV delivery, medical rescue, and agricultural and forestry plant protection. Meanwhile, the integration of emerging technologies such as 5G and Beidou Navigation with the low-altitude economic industry will enhance the efficiency and safety of low-altitude flights and promote the development of new business forms such as urban air transportation. In addition, the integration of industrial chains also involves regional integration, policy integration and talent integration. The government should establish and improve the coordination mechanism for airspace policies, clarify the rules and schedules for airspace usage, simplify the approval process, and provide policy guarantees for the development of the low-altitude economy.

3.2 Current Situation of the Industrial Chain Collaboration Mechanism

In the current emergency management industrial chain, the construction and operation of a collaborative mechanism are the key to ensuring the efficiency and effectiveness of emergency response. However, although the industrial chain collaboration mechanism has been explored and attempted both in theory and practice, there are still many problems in actual operation. First of all, information asymmetry is a major problem in industrial chain collaboration. The insufficiency of information sharing leads to information asymmetry, which not only hinders the construction of trust among all participants but also weakens the effectiveness of cooperation. Take traditional enterprises as an example. The outdated systems they adopt are difficult to integrate with modern information technology, forming information silos and affecting the coordination and response capabilities of the entire supply chain. Therefore, promoting technological standardization and system integration, and formulating unified low-altitude economic and technical standards have become the key to solving this problem. Judging from the current development trend, some large enterprises at home and abroad have begun to adopt this model, using mergers, acquisitions or the purchase of core assets to continuously extend their industries from top to bottom. By establishing a unified information platform, promoting technological standardization and system integration, and adaptively adjusting policies and regulations, these problems can be effectively addressed, and the efficiency and effectiveness of industrial chain collaboration can be enhanced.

3.3 The Problem of Asymmetry in Rescue Information

Information asymmetry refers to the disparity in information between rescue forces and disaster-affected parties due to unequal exchange or sharing of information during rescue operations. This disparity can stem from various factors, such as technical limitations, communication barriers, and poor organizational coordination.

First, technical constraints are a major cause of information asymmetry. Communication barriers also frequently contribute to this issue. For example, during the "7·20" catastrophic rainstorm event in Zhengzhou, Henan, government rescue signals failed to reach those in need in time, leading social rescue forces to rely on an online document for coordination. While this document helped collect and disseminate disaster-related information, its limitations—such as limited coverage, fragmented data, inconsistent scale, and issues like duplicate entries, false reports, and unverifiable information—highlighted the challenges of information asymmetry in emergency response.

In addition, poor organizational coordination is also an important factor leading to information asymmetry. In the cross-departmental collaboration of emergency logistics, not only the military but also local governments are involved. It is precisely because of the large number of departments involved that a complete rescue plan and command system cannot be formed in the first place. Therefore, it is bound to lead to an unclear and multi-headed command situation in emergency rescue work, which will reduce the overall efficiency of emergency logistics and result in corresponding cost increases. In conclusion, information asymmetry is a problem that cannot be ignored in emergency rescue operations. It is caused by the combined effect of multiple factors and has far-reaching and serious impacts. Therefore, establishing an effective information sharing mechanism, enhancing the timeliness and accuracy of information transmission, and strengthening organizational coordination are the keys to improving the efficiency and effectiveness of rescue operations.

3.4 Weak Perception Problem of Rescue Equipment

In the current aviation emergency rescue system, the limitation of the perception capability of rescue equipment is a problem that cannot be ignored. This deficiency in perception ability directly affects the efficiency and effectiveness of emergency management. This limitation of perception ability not only increases the difficulty of rescue operations but also raises the cost of rescue. More importantly, it may endanger the safety of rescue workers and their precious lives. In addition, the insufficiency of perception ability can also lead to poor information sharing in emergency management. In emergency situations, cross-departmental information sharing is the key to improving rescue efficiency. However, if the rescue equipment fails to provide accurate data support, information

sharing among various departments will become difficult, thereby affecting the uniformity of decision-making and the effective allocation of resources.

3.5 Difficulties in Communication Coordination

The main reasons for the difficulty in communication coordination can be attributed to poor information sharing, unclear division of responsibilities, and the lack of an effective overall coordination mechanism. For instance, in the field of low-altitude economy, although multiple low-altitude economy industrial parks have been formed in various regions, when making layouts in different fields, there is a lack of overall planning and coordination among the regions, resulting in inconsistent development and inefficient utilization of resources. The insufficiency of this coordination mechanism restricts the effective integration and utilization of low-altitude economic resources and affects the development efficiency of the low-altitude economy. In the current operation of emergency communication, due to the lack of effective communication and coordination, the timely arrival of emergency communication support materials, equipment and personnel has been affected. As a result, when the self-prepared materials of emergency on-site response personnel for communication support are insufficient, it is impossible to provide necessary equipment support and other logistical support. For instance, during the 2021 earthquake disaster in Yunnan, due to the deep focus of the earthquake, the transmission of earthquake information was somewhat restricted. There was a lag in information transmission in some affected areas, which led to a decrease in the speed of rescue response. Local governments find it difficult to promptly understand the true situation of the disaster, which may affect the emergency rescue of the affected people.

3.6 Problem of Low Efficiency in Rescue Decision-Making

In the emergency rescue command system, the low efficiency of decision-making is a widespread problem, which directly affects the timeliness and effectiveness of rescue operations. Firstly, the untimely collection and transmission of information is one of the main reasons for the low efficiency of decision-making. To solve this problem, it is necessary to establish a more efficient information collection and transmission mechanism to ensure the comprehensiveness and timeliness of the information. This includes the use of modern communication technologies, such as satellite communication and the Internet, to enhance the speed and accuracy of information transmission. Secondly, the imbalance in resource allocation is also an important issue. This might require the establishment of a central dispatch center to be responsible for the real-time allocation of rescue resources based on the disaster situation, ensuring the rational allocation and utilization of resources. In addition, the imperfection of the collaborative mechanism is also an important factor affecting the efficiency of rescue decision-making. In many cases, such as when Typhoon Haguppy hit Guangdong in 2020, the collaborative cooperation among various levels of departments and rescue forces was affected by poor information communication and an unclear command chain. To improve this situation, it is necessary to establish a more explicit and flexible collaborative cooperation mechanism to ensure that different departments can effectively share information and coordinate actions. This might require the formulation of more detailed norms for collaborative cooperation and command systems to ensure prompt and effective responses in emergency situations.

3.7 The Issue of an Imperfect Collaborative Mechanism

In the current management of low-altitude airspace, the insufficiency of the collaborative mechanism has become a key factor restricting the development of the low-altitude economy and the efficiency of air traffic management. Although it involves multiple departments, the information sharing and coordination mechanisms among these departments are not perfect, and there is a lack of an efficient collaboration platform to integrate the information and resources of all parties. In terms of improvement directions, the first step is to establish a cross-departmental collaboration platform to achieve real-time information sharing and exchange through technical means. For instance, a unified airspace management information system can be developed to enable all relevant departments to access and update flight plans, weather conditions and airspace usage in real time. In addition, it is necessary to formulate clear collaboration processes and emergency response plans to ensure that all departments can respond promptly and work in coordination in emergency situations. Establish cross-departmental collaboration platforms, enhance the coordinated development of the industrial chain, formulate unified management plans, and optimize emergency response mechanisms, etc. Through these measures, the efficiency and safety of low-altitude airspace management can be effectively enhanced, promoting the healthy development of the low-altitude economy.

4. Optimization Path of Collaborative Mechanism Based on Stakeholder Theory

4.1 Stakeholder Identification

In the low-altitude economic emergency management industrial chain, key stakeholders include government agencies, insurance companies, enterprises and the public. These entities play their own unique and important roles

in emergency management and together form an organic whole of the emergency management system. Government agencies are the core force in low-altitude economic emergency management, responsible for the management of hazard sources, public education, the preparation of emergency supplies, and the response to emergencies and post-disaster recovery.

Insurance companies are another important stakeholder, especially playing a significant role in disaster reduction, prevention, and post-disaster response and recovery. Insurance companies need to bear the risk of using policyholders' money to compensate disaster victims and the resulting losses after a disaster occurs. Therefore, they will pay more attention to whether disaster reduction policies and measures can better protect regional security. The application of insurance companies in the low-altitude economy, such as the insurance services provided by drones in the scenarios of "low-altitude + logistics" and "low-altitude + inspection", not only offers a strong guarantee for the safe and stable development of the low-altitude economy, but also demonstrates the potential of the insurance industry in emergency management.

Enterprises are important stakeholders in the emergency management of the low-altitude economy, especially playing an active role in disaster reduction and emergency preparedness. Especially for technology companies engaged in the production of emergency rescue equipment, through technological innovation, they can address the shortcomings of rescue equipment, such as weak rescue perception, difficult communication and coordination, and low efficiency in rescue decision-making. At the same time, they also take on the responsibility of quickly restoring public services after disasters. In European and American countries, enterprises have opened up new paths for participating in emergency management through the reform of marketization of public services, making them no longer merely private sectors but gradually transforming into the main body of disaster reduction and emergency preparedness. In China, enterprises have achieved participation in regional emergency management by taking part in the formulation of local emergency management policies, and they play different roles in the framework of multi-subject joint governance of regional risks.

The public are indispensable stakeholders in the emergency management of the low-altitude economy. Their active participation and support serve as an effective foundation for the legitimacy of government policies. By engaging in the formulation of local emergency management policies, the public have achieved involvement in regional emergency management and play diverse roles within the framework of multi-stakeholder collaborative governance of regional risks.

4.2 Stakeholder Participation Mechanism

In the process of building a full industrial chain ecosystem for the low-altitude economy, the extensive participation of stakeholders is the key to ensuring its long-term stable development. The low-altitude economy not only involves the research and development, production, flight operation and service support of unmanned aerial vehicles (UAVs), but also includes multiple links such as airspace management and technical platform construction. The collaborative cooperation among these links requires close collaboration among stakeholders. Therefore, designing an effective stakeholder participation and collaboration mechanism is of vital importance for the sustained growth of the low-altitude economy.

Firstly, the design of the stakeholder collaboration mechanism should start from the legal and institutional levels, clearly defining the rights and responsibilities of all parties. For instance, at the level of unmanned aerial vehicle (UAV) manufacturing, enterprises need to increase investment in technological research and development, enhance the safety, endurance and intelligence of aircraft, and address the shortcomings of current emergency rescue equipment. During this process, government departments should provide corresponding policy support and supervision to ensure that technological research and development and product production comply with national standards and industry norms. Secondly, at the operational level, aircraft operators need to establish an efficient and collaborative operation management system to ensure the timely completion of flight missions and the guarantee of flight safety. This requires close communication and collaboration between operators and government airspace management departments, technical support teams, etc., to form an efficient collaborative network. In addition, the management of airspace resources also requires an innovative management platform, an intelligent dispatching system based on big data and AI to optimize the allocation and utilization of airspace resources. This not only enhances the utilization efficiency of airspace resources but also reduces the risks of flight operations.

In the design of the stakeholder collaboration mechanism, the innovation of regional emergency management models should also be taken into consideration. Regional governments should not only play the role of "distributors", but also act as "moderators" and "hosts", providing a communication platform for stakeholders to express and seek their own interests, and granting them equal say. Through thorough discussions and bargaining

among all stakeholders, the rational allocation of emergency resources under the regional emergency management policy was ultimately determined.

5. Optimization Path of Collaborative Mechanism Based on Collaborative Governance Theory

5.1 Design of the Collaborative Governance Framework

The theory of collaborative governance emphasizes that subsystems generate an orderly state of the macro system through reasonable collaboration, which has been fully demonstrated in the practice of emergency volunteer services in China. The emergency volunteer service system, as a nonlinear open system consisting of multiple subsystems, constantly exchanges materials, resources and information with the outside world. The interaction states among its subsystems directly determine the overall efficiency of the entire system. Take the Wenchuan earthquake as an example. When the various self-organizing participants in the crisis response act on their own, lack institutionalized cooperation mechanisms, and the interaction among subsystems is in a disorderly state, the entire emergency volunteer service governance system will not operate smoothly and be inefficient. This indicates that to enhance the collaborative efficiency of emergency volunteer services, the key lies in establishing clear order parameters and evolving new structures and functions through competition and cooperation to govern the orderly operation of the macro system.

Therefore, identifying the order parameters of collaborative governance in emergency volunteer services is a crucial step towards achieving collaborative governance. The core of the order parameter lies in the establishment and fulfillment of a series of common rules. Under the domination of rules, numerous participating entities, through nonlinear coupling and collaboration, transform the originally disordered subsystems from chaos to order, achieving the evolutionary phase transformation process of the macroscopic system. Through this framework design based on the theory of collaborative governance, we can better understand and guide the collaborative governance practice of emergency volunteer services, enhance the efficiency and response speed of the entire system, and thereby respond more effectively to public crisis events, reducing casualties and property losses.

5.2 Construction of a Collaborative Governance Mechanism

The specific content and implementation steps of building a collaborative governance mechanism are an indispensable part of the development of the low-altitude economy. In the governance structure of the low-altitude economy, it is necessary to establish a collaborative governance structure that is horizontally compatible with multiple entities and vertically covers multiple levels of departments, in order to promote the high-quality development of low-altitude technology. The establishment of this framework involves the joint participation of various social entities such as regulatory authorities at all levels, relevant technology companies, characteristic industry associations, and the public.

First of all, as a meta-ruler, the government needs to provide a basic platform for multi-party consultative governance through policy design, regulatory control and interest coordination. This includes formulating and improving relevant laws and regulations to clarify the requirements for the management, use, supervision and other aspects of low-altitude aircraft.

Secondly, as the main body of innovation, technology enterprises should rely on technological research and development and application promotion to actively participate in the formulation of technical standards for risk prevention and control. This not only requires enterprises to constantly innovate in technology, but also their active participation and promotion of safety standards.

Furthermore, the public plays a supervisory role in the application of low-altitude economic scenarios, forming a governance closed loop of risk feedback. This requires the public to enhance their awareness and understanding of the low-altitude economy, actively participate in the safety management of the low-altitude economy, and promptly identify and correct illegal and non-compliant behaviors through reporting, complaints and other means.

Finally, it is also necessary to conduct regular emergency drills and training for relevant personnel to enhance their emergency response capabilities and handling efficiency. By simulating various possible security incidents, the practical ability of the emergency response plan is tested. Strengthen the publicity and education of low-altitude economic safety knowledge through various channels and forms to enhance the public's safety awareness and prevention capabilities.

6. Conclusions and Prospects

6.1 Research Conclusion

With the development of the low-altitude economy, new risks and safety issues have emerged, but this has also given rise to a series of high-tech innovations, providing new solutions for emergency management. The low-

altitude economy, relying on the low-altitude airspace and dominated by the general aviation industry, encompasses the low-altitude flight activities of both manned and unmanned aircraft. Its comprehensive economic form not only promotes the integrated development of related fields but also has become an important strategic direction under the national policy framework.

In the field of emergency management, application research on low-altitude economy shows that unmanned aerial vehicles and other aircraft have played a significant role in multiple aspects such as rescue, fire fighting, industrial safety, agricultural safety, and urban community safety. For instance, in emergency situations such as floods and earthquakes, drones can quickly enter the affected areas, conduct on-site investigations, provide scientific basis for rescue operations, and thus formulate scientific and accurate rescue plans, effectively reducing casualties and property losses.

In addition, the design of the low-altitude economic emergency management platform based on cloud computing has achieved data sharing among systems and on-demand allocation of resources, providing efficient and stable emergency management services. This platform, by leveraging abundant aircraft resources, can calculate the traffic flow on congested sections in real time, relieve traffic pressure by regulating traffic lights, and solve the problem of data transmission among various software. In application scenarios such as "low-altitude + logistics", "low-altitude + agriculture", and "low-altitude + inspection", the risks faced by low-altitude aircraft mainly include property damage risks and risks in specific scenarios, such as navigation failure, power failure, and mid-air impact caused by equipment failure, operational errors, and adverse weather conditions. Through technological innovation and policy support, the risks brought by the low-altitude economy can be effectively addressed, while providing more efficient and scientific solutions for emergency management. With the further development of the low-altitude economy, its application in the field of emergency management will become more extensive, which is of great significance for enhancing public safety, reducing disaster losses, and promoting social stability and development.

6.2 Research Prospects

The value of the integration of the low-altitude economic industrial chain is reflected in multiple aspects. Firstly, it will promote industrial upgrading and economic development, give rise to new industrial forms and business models, and inject new vitality into economic growth. It will promote scientific and technological innovation and talent cultivation, facilitate the research and application of emerging technologies such as unmanned aerial vehicles and urban air traffic, and enhance the country's scientific and technological strength. Ultimately, it will enhance the resilience and security level of the industrial chain, promote breakthroughs in key core technologies, reduce reliance on external technologies, and improve the independent control capacity of the industrial chain.

In the future, the development trend of the integration of the low-altitude economic industry chain will be more prominent. In terms of technology integration, the development of unmanned aerial vehicle (UAV) technology will inject new vitality into the general aviation industry, promote the development of application scenarios such as UAV delivery, medical rescue, and agricultural and forestry plant protection, and drive the innovation of general aviation service models. The value and future development trend of the integration of the low-altitude economic industrial chain will have a profound impact on industrial upgrading, economic development, social benefits, environmental benefits, technological innovation, talent cultivation and other aspects.

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