

Development Path of Low-Altitude Logistics and Construction of Industry-Education Integration Community from the Perspective of New Quality Productive Forces

Xudong Li*

Guangdong Communication Polytechnic, Guangzhou, Guangdong, China

**Corresponding Author.*

Abstract: Low-altitude logistics is an important focus point for the formation and development of new quality productive forces and low-altitude economy. Firstly, the current research status of low-altitude logistics was reviewed, and the significant advantages of low-altitude logistics were analyzed. Then, from the perspective of new quality productive forces, the opportunities and main problems faced by the development of low-altitude logistics were analyzed, and the main paths for the development of low-altitude logistics were proposed. The trends and prospects of low-altitude logistics research were also analyzed. On this basis, the construction of the industry-education integration community from the perspective of new quality productive forces was explored. A series of measures for the construction of the industry-education integration community were proposed from multiple dimensions such as mechanism, platform, vision, and talent cultivation, in order to break through the bottlenecks of industry-education integration, promote the high-quality development of vocational education, and provide strong support for the sustainable development of the low-altitude logistics industry.

Keywords: Development Path; Industry-Education Integration Community; New Quality Productive Forces; Low-Altitude Logistics

1. Introduction

New quality productive forces plays a leading role in innovation, breaking away from traditional economic growth models and development paths of productivity, and possessing advanced productivity qualities

characterized by high technology, high efficiency, and high quality, in line with the new development concept [1]. Since its first public mention in September 2023, a series of important national discussions on how to develop new quality productive forces have provided scientific guidance for accelerating technological innovation and promoting high-quality economic development in the new era and new journey [2]. New quality productive forces has become a key policy keyword for promoting high-quality development in the future [3].

The core essence of new quality productive forces is to integrate technological innovation resources, lead the construction of a modern industrial system, and create strategic emerging industries such as low-altitude economy, biomanufacturing, and commercial aerospace, thereby opening up new fields and tracks for development and shaping new driving forces and advantages for development. Among them, as a representative of new quality productive forces, low-altitude economy has become a new driving force for development, and UAV low-altitude logistics is an important field of low-altitude economy and an important focus for promoting the development of new quality productive forces.

2. Main Progress in Low-Altitude Logistics Research

In today's society, the logistics industry has become one of the important forces driving economic development. Although traditional logistics methods have certain advantages in reliability and stability, they also have problems such as long transportation time, low distribution efficiency, and high overall costs. With the development of disciplines such as aerospace, information and communication, and automatic control, UAV logistics based on

new UAV systems and advanced control technology is developing rapidly. UAV logistics can shorten delivery time, improve delivery efficiency and quality in emergency rescue, contactless distribution, and other fields. With the deep integration of drones with new generation information technologies such as cloud computing and the Internet of Things, UAV low-logistics systems are constantly improving and presenting more and more application scenarios. In the medical field, UAV low-logistics can be used for the transportation of emergency medical supplies; In the military field, it can be used for military supply; In the express delivery industry, UAV low-logistics can provide contactless and secure delivery. With the rapid development of drone control and management technology, UAV low-logistics has broad prospects for development in the future. However, in terms of the maturity of the logistics system, research on UAV logistics is still in its early stages of development. [4]

In the field of operation and management of UAV low-logistics, Zhou [5], Xu and Li [6], Gu [7], Zhang et al. [8], Ghelichi et al. [9], Dukkanel et al [10], Park et al. [11], Leon et al. [12], Pan et al. [13], Lu et al. [14], Ruan et al. [15], Li et al. [16] have conducted research on the operation and management of UAV low-logistics. Relevant literature focuses on the application scenarios of drones in heavy-duty and long-distance branch transportation, drone distribution management, drone warehousing management, etc.

In the other field of planning and management of UAV low-logistics, Ren et al. [17], Dorling et al. [18], Zhang et al. [19], Han and Zhang [20], Xu et al. [21], Arafat and Moh [22], Gonzalez-r et al. [23], Zhang et al. [24], Yi et al. [25] have conducted research on UAV low-logistics planning, with the main literature focusing on path optimization and network design of logistics.

Overall, the technical research and application of high-capacity and long-distance regional UAV need to consider transportation capacity limitations and improve management systems; In addition to considering supply side delivery management, policy and environmental optimization, research on drone delivery management should also strengthen consumer analysis, including consumer perception and innovation, as well as evaluation of drone

delivery service quality and level; In terms of drone warehouse management, breakthroughs are needed in drone control technology, warehouse modeling and positioning technology; In terms of optimizing UAV low-logistics paths, it is necessary to fully consider the special impacts of drone path problems, such as obstacle avoidance, drone fleet control, battery life, etc. In terms of logistics network design, it is necessary to combine it with the characteristics of UAV low-logistics, coordinate other transportation modes, and build a multi-modal composite logistics network.

3. Opportunities and Main Issues for the Development of Low-Altitude Logistics from the Perspective of New Quality Productive Forces

3.1 Opportunities for the Development of Low-Altitude Logistics from the Perspective of New Quality Productive Forces

The opportunities in the field of low-altitude logistics mainly lie in improving distribution efficiency, reducing operating costs, expanding service scope, innovating business models, improving safety, and the opportunities for cross-border integration and development will bring innovative, efficient, safe, and convenient logistics services to the industry. [26]

One is policy support. Under the background of low-altitude economy, low-altitude logistics is facing a good opportunity for development and has received strong support from national policies. With the Civil Aviation Administration of China and other relevant departments promoting the reform of low-altitude airspace management and optimizing the flight service guarantee system, the low-altitude economy is gradually unleashing its enormous development potential. Low-altitude logistics provides new development space for the low-altitude economy. UAV low-logistics delivery is one of the highlights, which can play an important role in reducing airspace congestion, lowering logistics costs, and improving delivery efficiency.

Secondly, there is a huge market demand for low-altitude logistics. With the development of social economy and the improvement of modern logistics system, the demand for efficient and fast logistics services is

increasing day by day. The development of low-altitude logistics provides new opportunities and possibilities for the low-altitude economy.

The third is technological innovation. The development of low-altitude logistics in the field of aviation logistics is at a critical stage. With technological innovation, industrial restructuring, and changes in market demand, the industry will face more opportunities and challenges. But it can be foreseen that with the continuous development and maturity of technology, the application of drones in the logistics field will become more extensive and in-depth in the future, which will promote China's logistics to play an increasingly important role in the global logistics and supply chain field.

The fourth is the coordinated development of industries. The coordinated development of low-altitude logistics in the field of low-altitude economy will help promote innovative development of related industries, improve logistics efficiency, and reduce logistics costs. At the same time, it will also help promote the high-quality development of our country's economy.

3.2 Main Problems Faced by Low-Altitude Logistics Development from the Perspective of New Quality Productive Forces

Low-altitude flight has great potential for development in the field of aviation logistics, but it also faces a series of challenges. In the process of development, it is necessary to strengthen technological innovation, policy support, and talent cultivation, overcome challenges, and promote the success of low-altitude flight applications in the field of aviation logistics. One is the airspace management system, which needs to take into account various needs and challenges, and support the development of low-altitude economy and aviation logistics through continuous optimization and adjustment of airspace planning, flight plan approval, airspace supervision and coordination, regulatory policies, safety guarantee and emergency response, and other aspects. Secondly, flight safety is a core issue in the field of aviation logistics, involving multiple aspects such as safe separation between drones and manned aircraft, air traffic management, emergency response, etc. The third is industry

standards. The flight of drones in the low-altitude logistics field needs to comply with China's laws, regulations, and policies, such as the Interim Regulations on the Management of UAV Flights; With the continuous development of drone technology, relevant standards are also constantly being improved. The fourth is talent cultivation and technological research and development.

Talent cultivation and technological research and development complement each other. Technological progress can provide new directions and tools for talent cultivation, and sufficient high-quality talents are an important guarantee for technological research and development. The government, enterprises, educational institutions, and social organizations should work together to provide support for the talent cultivation and technology research and development of low-altitude flight in the field of aviation logistics, and promote the sustainable development of the industry. Talent cultivation and technological research and development are important factors driving the development of this field.

4. The Main Paths of Low-Altitude Logistics Development from the Perspective of New Quality Productive Forces

4.1 Improving the Planning and Design of Low-Altitude Airspace

Improving the planning and design of low-altitude airspace is a key link in promoting the healthy development of low-altitude economy. It can drive the development of low-altitude airspace planning and design in China, promote the rapid development of low-altitude economy, and inject new vitality into China's economic development.

At the national level, policy planning should be coordinated, and research on laws and regulations for low-altitude airspace management should be accelerated. National ministries and commissions should increase their guidance to local areas and promote airspace management reform. To implement more flexible airspace management policies in the Greater Bay Area as a pilot area for low-altitude flights, it is necessary to establish a sound regulatory mechanism and standard system. In the process of utilizing low-altitude airspace, it is necessary to clarify the

responsibilities and rights of the government, enterprises, pilots, and aircraft owners to ensure that the rights and interests of all parties are protected. Encourage and support the development and utilization of various low-altitude flight application scenarios, strengthen the infrastructure construction of low-altitude airspace, encourage enterprises to develop aircraft that meet low-altitude flight requirements, and improve the performance and safety of aircraft. Referring to international experience such as the International Civil Aviation Organization airspace classification system, strengthen cooperation and exchange, and enhance the internationalization level of low-altitude airspace management in China.

4.2 Strengthening Supervision and Management

To address security challenges and strengthen supervision and management. Develop detailed emergency plans and improve the ability to respond to air safety emergencies through deduction and on-site exercises. Regularly provide professional training for air safety personnel, encourage them to participate in industry exchange activities, share experiences, and enhance their overall quality. Air crew members and relevant departments work closely together to streamline and optimize work processes, ensuring standardized and efficient operations. In emergency situations, maintain close communication with the ground and work together to ensure passenger safety. By utilizing new technologies for real-time monitoring and analysis of security work, we aim to improve the level of intelligence in security management. Establish and improve relevant laws and regulations, clarify the responsibilities and authorities of air safety personnel, and provide strong support for air safety management. Provide psychological counseling and support to staff to enhance their ability to handle stress. Clarify the safety responsibilities of all parties, ensure that responsibilities are assigned to individuals, and form a good situation of joint management. Enhance the ability to address air safety challenges, elevate the level of air safety, and create a safer flying environment.

4.3 Building a Sound Coordination Mechanism for Low-Altitude Flights

Establish a multi-level coordination

organization responsible for formulating policies, planning, and coordinating low-altitude flight activities. Strengthen interdepartmental collaboration, share information resources, and ensure low-altitude flight safety. Improve regulatory systems and standardize low-altitude flight activities. Implement refined management, formulate targeted management measures, and ensure safe and orderly low-altitude flight. Utilizing modern information technology, artificial intelligence, etc., to achieve real-time monitoring, early warning, and disposal of low-altitude flight activities. Popularize knowledge of low-altitude flight safety and create a good social atmosphere. Develop emergency plans for low-altitude flight incidents, clarify emergency response procedures, and improve the ability to respond to emergencies. Optimize air traffic layout, plan air routes reasonably, and increase air traffic flow. It helps to establish a sound coordination mechanism for low-altitude flight, promote the development of the low-altitude economy industry, and ensure the safety of low-altitude flight.

4.4 Accelerating Talent Cultivation and Increase Investment in Technological Research and Development

Establish a comprehensive education system and improve the quality of talent cultivation. Strengthen school enterprise cooperation, promote the integration of industry, academia and research, and improve the professional skills and comprehensive quality of talents. Create a favorable innovation environment and stimulate the innovative potential of talents. Increase government investment in technology research and development, and encourage enterprises to increase their R&D expenditures. Establish a technology innovation fund to support the research and development of key technologies. Promote cooperation between enterprises and research institutes, share R&D resources, and improve R&D efficiency. Implement an innovation driven development strategy and encourage enterprises to pursue breakthroughs in core technologies. Improve the quality of talent cultivation and technological research and development in our country, promote economic and social development and technological progress.

4.5 Improving Industry Standards and Safety Awareness

Regularly evaluate and update industry standards to ensure they reflect the latest technological advancements and market demands. Strengthen the enforcement of standards and strictly supervise products and services that do not meet the standards. Encourage standardized communication and cooperation within the industry and among enterprises to enhance the overall standard level. Carry out extensive safety education and publicity activities to raise public awareness of industry safety issues. Strengthen the training of practitioners to ensure that they possess the necessary knowledge and skills for safety production. Establish a safety culture and incentive mechanism to encourage enterprises to proactively identify and address safety hazards. Strengthen safety supervision, ensure effective implementation of safety production regulations through law enforcement and supervision inspections, and enhance the national level of safety production.

5. Outlook on the Research Trend of Low-Altitude Logistics

Based on the analysis of literature research hotspots and cutting-edge trends, the future research on low-altitude logistics tends towards precise and efficient delivery of UAV logistics, collaboration between UAV logistics industry chain and supply chain, and other delivery methods.

One is the precise and efficient delivery of UAV low-logistics, which mainly includes the use of drones in food, medicine, special mail, and cargo express delivery, and targeted research using emerging theories and technologies. The research value focuses on expanding the usage scenarios of drones in the logistics field, promoting the intelligent development of UAV low-logistics while improving the convenience and safety of life. The second is the logistics industry chain and supply chain. The research content mainly includes: strengthening the research on the UAV low-logistics industry chain and supply chain, focusing on the management and control of large drone fleets; The research value focuses on achieving large-scale full coverage of drone delivery and strengthening collaboration with the economy and industry. The third is the collaboration between UAV

low-logistics and other delivery methods, which includes comprehensive consideration of the collaboration between drones and other delivery and transportation methods, taking into account the impacts on society, economy, and environment; The research value mainly lies in balancing the economic benefits and environmental impacts of logistics distribution, and promoting sustainable socio-economic development.

6. The Construction of an Industry-Education Integration Community from the Perspective of New Quality Productive Forces

6.1 The Necessity of Building an Industry-Education Integration Community

The industry-education integration community is a new organizational form of industry-education integration jointly established by industry leading enterprises, universities, and vocational schools, scientific research institutions, and upstream and downstream enterprises. It is a developmental, long-term, and strategic institutional design for the modernization of Chinese style vocational education. As one of the important entities in the construction of the industry-education integration community, vocational colleges should actively implement the main tasks of national vocational education, adhere to resonance with industry progress, industrial transformation, and regional development, actively explore new models of vocational education and industry-education integration development, and empower the high-quality development of the community [27].

New quality productive forces is a high-quality productive forces formed by driving technological innovation, supporting high-level innovative talents, using strategic emerging industries and future industries as carriers, and based on digitization, intelligence, and greening [28]. From the perspective of new quality productive forces, it is worth conducting in-depth research on how vocational colleges can overcome existing traditional contradictions, grasp the correct relationship between two-way empowerment with new quality productive forces, form key factors that are compatible with new quality productive forces, and improve the ability of the community to serve new quality productive

forces in the process of industry-education integration community construction.

6.2 Establishing a Sound Operational Mechanism to Ensure the Efficient Operation of the Community

From the perspective of new quality productive forces, vocational colleges need to firmly grasp the demand points and relationship lines of both parties in community cooperation, integrate resources, optimize structures, establish and improve community management and operation mechanisms, take efficient collaboration and overall coordination as the core elements of cooperation, innovate cooperation application scenarios, smooth cooperation information channels, match the interests and demands of all parties, eliminate explicit and implicit barriers between cooperation parties, promote the "multi chain" integration of education chain, industry chain, and innovation chain, and build a new demonstration model of "government administration school enterprise" industry-education integration.

6.3 Building a Science and Technology Innovation Platform to Strengthen the Sense of Community Responsibility

In the process of integrating industry and education, the diverse entities of industry and education must work together to achieve a common vision and goals, and obtain better development conditions. They must jointly assume the responsibility of maintaining and promoting the coordinated development of vocational education and industry. By establishing a science and technology innovation platform, vocational colleges can closely cooperate with government, industry, and enterprises to efficiently implement their main responsibilities, clarify and tighten the responsibility chain, improve performance, and form a work pattern of clear responsibilities and individual accountability.

6.4 Creating a Vision of Shared Benefits and Optimizing the Relationship of Community Interests

In the process of empowering the construction of industry-education integration, vocational colleges should take mutual benefit and win-win as the core orientation, engage in interest games based on the interests and demands of

different stakeholders, efficiently promote interest coordination and sharing, promote balanced distribution of common interests, and establish a common interest community with a connected destiny.

6.5 Strengthening the Joint Force of Education and Cultivating High-Quality Talents for the Community

Vocational colleges should fully implement the fundamental task of cultivating morality and talents, adhere to the integration of education, technology, and talent, strengthen interdisciplinary studies, implement the integration of science and education, enrich educational elements, continuously deepen the reform of innovative and top-notch technical talent training models, make multidimensional efforts to improve the quality of technical and skilled talent training, and cultivate urgently needed innovative talents for the industry-education integration community.

7. Conclusion

At present, there are both opportunities and challenges for the development of low-altitude logistics under the background of new quality productive forces, but the opportunities outweigh the difficulties. Developing low-altitude logistics can focus on exploring paths from multiple dimensions such as airspace planning, supervision and management, flight coordination, talent cultivation, and industry standards. In the future, the main research areas of low-altitude logistics will mainly include precise and efficient delivery of UAV logistics, UAV logistics industry chain and supply chain, and collaboration between UAV low-logistics and other delivery methods. The industry-education integration community is an important new organizational form and a strategic institutional design for the modernization of vocational education. As an important entity in the construction of the community, vocational colleges should actively explore and participate in the construction of the low-altitude logistics industry-education integration community, improve the operating mechanism, establish a scientific and technological innovation platform, optimize the interests of the community, cultivate high-quality talents in the community, organize the cultivation of a group of low-altitude logistics high-tech talents,

tackle a number of key core technologies, output a batch of high-quality achievements, and transform them into new quality productive forces, achieving mutual benefit and win-win results for universities, institutions, and enterprises, and releasing the multiplier effect of the integrated development of education, science, and technology talents.

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