Analysis of the Main Models and Paths for High-Quality Development of China's Low-Altitude Economy

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Abstract. After the rise of the concept of low-altitude economy, a series of plans, policies, and reform measures have been introduced from the central to local levels to promote breakthrough development of low-altitude economy. Based on the current domestic and international development situation, China has made various beneficial explorations in the development of low-altitude economy and achieved certain results. However, there are also some development problems and difficulties in key elements such as institutional mechanisms, airspace management, industrial ecology, technological capabilities, and infrastructure. Efforts should be made in the following aspects to promote high-quality development of China's low-altitude economy in the future: strengthening top-level design and improving the comprehensive organizational management system; Transforming development models and promoting integrated development of airspace management; Improve the industrial ecology and promote the strengthening and extension of the industrial chain; Intensify research and development to empower high-quality development; Moderately advance the layout and enhance the intelligence level of infrastructure.

Keywords: low-altitude economy; high-quality development; Airspace management; Industrial economy

1 Introduction

In February 2021, the Central Committee of the Communist Party of China and the State Council issued the "Outline of the National Comprehensive Three dimensional Transportation Network Plan", which for the first time incorporated the concept of "low-altitude economy" into national level planning. In December 2023, the Central Economic Work Conference explicitly listed low-altitude economy as a strategic emerging industry. With the recent release and implementation of a series of national policy measures, the reform of airspace management in Guangdong, Hainan, Sichuan,

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Hunan, Jiangxi, Anhui and other places has been deeply promoted, which is a prerequisite for the vigorous development of low-altitude economy.

As an emerging economic form, low-altitude economy has gradually become a representative of high-quality development and new productivity. In recent years, more and more scholars have paid attention to and studied low-altitude economy. Based on the basic principles and methods of terminology, Qin Rui[1] defined the concept of low-altitude economy and analyzed its main components in terms of its characteristics and mechanisms of action. Guo Chenyang, Ao Wanzhong, et al.[2] analyzed the intrinsic relationship between low-altitude economy and general aviation, drones, and UAM. Wang Jue and Li Zicheng[3] studied and analyzed the driving mechanism of low-altitude economy on new quality productivity based on the moderating effect of financial development and enterprise agglomeration. Li Xiaoyu[4] studied the current development status of drone countermeasures technology and its important role in low-altitude airspace management.

In terms of low-altitude economic methods and technologies, Yu Xiaojie et al.[5] proposed a low-altitude target trajectory threat recognition method based on hidden Markov models, Hao Kuangong et al.[6] constructed a drone risk assessment model and flight route planning model based on trajectory descent, Shen Chun et al.[7] studied the all-weather radar fine detection technology for low-altitude complex wind fields, and Zeng Jing[8] studied the key technologies of low-altitude communication systems, perception systems, and airspace management systems, exploring the development path of urban low-altitude economy.

In terms of low-altitude economic industry collaboration, Fan Yijiang and Li Weibo[9] explored different application scenarios such as freight logistics, manned travel, cultural and tourism activities, production operations, and public services. For logistics application scenarios, Zhang Honghai, Zhang Liandong et al.[10] fully considered factors such as operational risks, noise levels, and transportation costs to construct a set of urban low-altitude logistics drone trajectory planning methods. ZHANG H et al.[11] studied the role of drones in rapid delivery and improving logistics efficiency. Regarding agricultural application scenarios, Guo Weiguang[12] explored the role of low-altitude remote sensing technology in agricultural plant protection, monitoring, and data collection. Regarding government application scenarios, Tang Xugang[13], Li Gangyong et al.[14], Nwilag BD et al.[15], Guo Aibin et al.[16] have studied the important role of drones in environmental monitoring, geographic mapping, and fire rescue.

In terms of the development model of low-altitude economy, Wang Ting and Gao Bo[17] analyzed the development path and measures of low-altitude economy in Jiangxi Province, and explored the "Jiangxi model" for high-quality development of low-altitude economy. Huang Qiaolong[18] explored the establishment of an industrial model for high-quality development of Fujian's low-altitude economy industry from six aspects: developing airspace, formulating policies, optimizing services, cultivating industries, building brands, and expanding markets. Lao Chengqiang and Song Xiaodong[19] conducted an analysis from five aspects: institutional systematization, innovation systematization, digital systematization, market systematization, and service sys-

tematization, to study the ways and methods of constructing the low-altitude economic industry ecosystem in the Guangdong Hong Kong Macao Greater Bay Area.

At present, research on low-altitude economy involves various aspects, from conceptual connotations and driving mechanisms, to supporting technologies and system platforms, to application scenarios and development models. The research fields and methods are relatively diverse, but most of them are fixed-point research, lacking macro strategy research on the overall industry level of low-altitude economy, and lacking systematic sorting and summary of typical problems and development measures. This article will summarize and generalize the development models of low-altitude economy in major regions of China based on existing research results. In response to the pain points and difficulties in the current development of low-altitude economy, countermeasures and suggestions for low-altitude economy development will be proposed from the perspective of industrial development, providing support for relevant departments, local governments, etc. to formulate and promote the implementation of low-altitude economy strategic planning and policy measures.

2 The Connotation Concept of Low-altitude Economy

2.1 Definition

Low-altitude economy is a concept proposed in China to address the development of general aviation, which is related to general aviation but cannot be simply understood as a "general aviation economy" or a "new general aviation economy". The relationship between low-altitude economy, general aviation, and unmanned aerial vehicles is complex and has a certain degree of overlap, as shown in Figure 1. However, considering factors such as application scope and flight volume, the relationship between the three can be simply summarized as follows: general aviation is the main industry of low-altitude economy, unmanned aerial vehicles are the leading industry of general aviation, and also the leading industry of low-altitude economy.

Compared to general aviation and drones, the most essential feature of low-altitude economy is that it must rely on low-altitude airspace. Regarding "low-altitude", there are generally two interpretations. One is based on the "Opinions on Deepening the Reform of Low-altitude Airspace Management in China" issued by the State Council and the Central Military Commission in 2010, which considers "true altitude below 1000 meters" as "low-altitude"; Another approach is based on the Guiding Opinions on Promoting the Development of General Aviation Industry issued by the General Office of the State Council in 2016, which considers "true altitude below 3000 meters" as "low-altitude". From the long-term perspective of industrial development, "low-altitude" should not be an absolute concept, but a relative concept with demand orientation, policy orientation, and varying with time and place [2]. That is, as long as the personnel driving or riding the aircraft can maintain normal psychological and physiological activities without pressurization, oxygen supply, etc., the range of altitude above ground should belong to the low-altitude range. It will change with the promotion of low-altitude airspace management reform, continuous progress of low-altitude technology, and even the continuous changes of various factors such as re-

gional climate characteristics in different regions. The most commonly used definition of low-altitude economy is the concept proposed by the National Development and Reform Commission and the National Low-altitude Economy Integration and Innovation Research Center, which refers to a comprehensive economic form that is driven by various low-altitude flight activities of manned and unmanned aerial vehicles, radiating and driving the integrated development of related fields [20]. Various arguments and viewpoints in society are basically based on this definition.

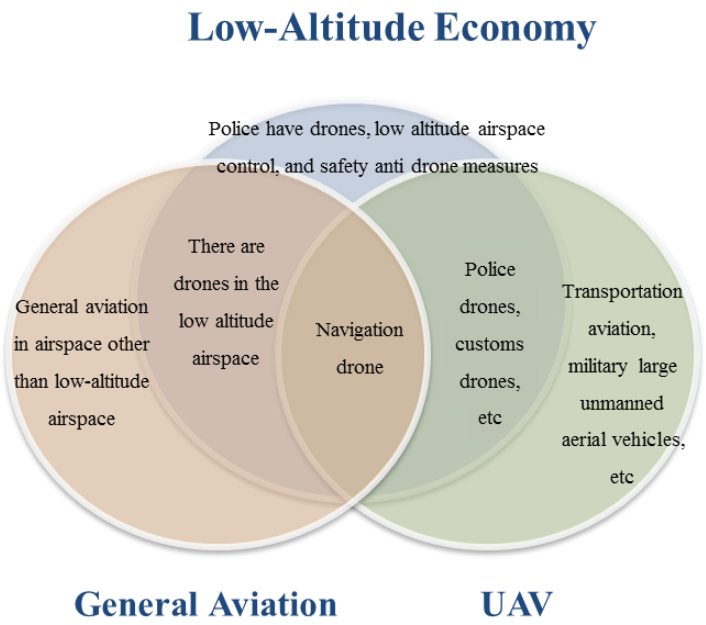

Fig. 1. The Relationship between Low-altitude Economy, General Aviation, and Drones.

2.2 Industry Characteristics

Low-altitude economy is a comprehensive new economic form that covers low-altitude manufacturing, low-altitude flight, low-altitude support, and comprehensive services, as shown in Figure 2. Low-altitude manufacturing provides products and services such as aircraft, components, and onboard equipment; Low-altitude flight covers various activities such as production operations, public services, and aviation consumption, and is the core of the low-altitude economy, playing a leading and driving role in the development of the entire low-altitude economy; Low-altitude support includes infrastructure construction and operation, low-altitude airspace management, drone flight countermeasures, etc., providing basic support for low-altitude flight and airspace safety; Comprehensive services cover aviation exhibitions, advertising consulting, science education, cultural media, and other content, supporting and assisting the development of low-altitude economy.

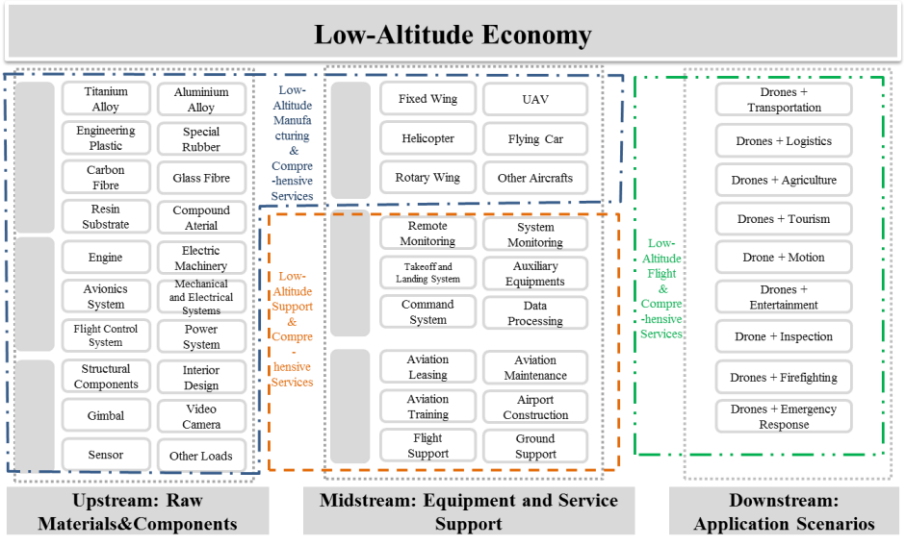

Fig. 2. Analysis of Low-altitude Economic Industry Chain.

The low-altitude economy has a long industrial chain, radiating basic industrial categories as well as strategic emerging industries such as high-end manufacturing, new generation information technology, new materials, and new energy. It has strong growth and driving force, spanning multiple fields such as civil, police, and military, connecting the primary, secondary, and tertiary industries, integrating typical features such as new technology research and development, new demand creation, new consumption guidance, new supply cultivation, and new ecological construction[9]. It plays a crucial role in promoting economic development, strengthening social security, and serving national defense.

3 Current Development Status at Home and Abroad

3.1 Global Development of Low-altitude Economy

The development of low-altitude economy is the result of reflection on the scientific allocation and management reform of low-altitude airspace resources[21]. Studying it as a new economic phenomenon or field was pioneered by China[22]. Although there is no relevant concept abroad, the development of related industries is a reality.

(1) United States.

The low-altitude economy management system in the United States is relatively complete, with advanced technological facilities and high market participation. The leading position of general aviation has laid a first mover advantage for the development of the low-altitude economy.

In terms of top-level design, in 2021, the United States passed the Advanced Air Traffic Coordination and Leadership Act to strengthen the construction of the Ad-

vanced Air Traffic (AAM) ecosystem. In May 2023, the Federal Aviation Administration (FAA) of the United States released the "Urban Air Traffic Operations Concept 2.0" white paper, updating the airspace and program change blueprint, and releasing the Urban Air Traffic (UAM) operations concept as a subset of Advanced Air Traffic (AAM) to adapt to the operation of future air taxis and other advanced air traffic. In July 2023, the Federal Aviation Administration (FAA) of the United States released the "Advanced Air Traffic Plan", proposing the "Innovate 28" plan, which presents a top-level plan for deploying advanced air traffic services for cities in the United States by 2028.

In terms of airspace management, the United States divides airspace into five categories: Category A is high-altitude controlled airspace, Category B is busy terminal controlled airspace, Category C is general terminal controlled airspace, Category D is airport controlled airspace, and Category E is general controlled airspace. Among them, E-class airspace is the main activity area for general aviation and drones, with relatively relaxed management policies. According to the regulations of "the true height of the lowest waiting altitude layer of traditional civil aviation fixed wing aircraft from the ground shall not be less than 600m" and "using 300m as a height layer", NASA has further divided the E-class airspace. The relatively open high-level airspace (true height above 600m) is the operating space for fixed wing drones, the low-level airspace (true height 120-600m) relatively close to buildings is the operating space for multi rotor drones that can decelerate and hover freely, and the airspace below 120m is the operating space for consumer grade drones.

In terms of industrial development, the United States has a complete industrial grade drone industry chain, an open and clear management system, specialized regulatory agencies, and policies and regulations such as the Federal Aviation Act, Federal Aviation Regulations, Drone System Integration Pilot Program, and Remote Identification Rules. Specific regulations and requirements have been made in low-altitude airspace configuration, operation rules, safety management, flight approval, remote identification, and other aspects to ensure safe and orderly drone flight. Compared to drones, the United States has performed more outstandingly in the field of general aviation, with the most complete infrastructure, high technological maturity, and large market size, leading the world. According to public data, as of the end of 2023, there are approximately 224000 aircraft in the United States, 19000 airports, and 3750 logistics service stations (FBOs). The annual flight time for general aviation is about 25 million hours, with 70% being manned transport flights, mainly for personal consumption and corporate business flights. General aviation plays an important role in the transportation system in the United States.

(2) Europe.

The development of general aviation in Europe mainly focuses on business jets, light jets, leisure gliding, and other aspects, as well as aviation operations, aviation training, aviation sports or flight performances.

In terms of top-level design and industrial development, Western Europe, as one of the three main manufacturing markets for industrial grade drones, gathers more than half of the world's "invisible champion" enterprises, with obvious manufacturing advantages. Among them, Germany attaches great importance to the research and de-

velopment of drone technology, investing heavily in low-altitude economy, developing precise navigation and flight technology, simplifying drone registration and flight related procedures, and continuously improving market vitality; The UK attaches great importance to the application of industrial scenarios. In March 2024, the UK Department for Transport released the "Future Flight Action Plan" to promote the accelerated normalization of drone and new electric aircraft operations. It is expected to achieve routine flights of eVTOL air taxis, crime fighting drones, and emergency service drones by 2028.

In terms of airspace management, Europe divides airspace into three categories: Category A is high-altitude controlled airspace, Category B is terminal controlled airspace, and Category C is low-altitude airspace. The Joint Implementation Body of European Sky Integrated Air Traffic Management (SESAR) has further classified Class C low-altitude airspace into X, Y, and Z categories, with X airspace mainly referring to ultra-low-altitude airspace with lower air/ground risks (true height below 150m), aimed at drone entertainment scenarios; Y airspace is mainly set up in areas with high operational risks such as densely populated ground areas (true height below 150m), targeting industrial level operational scenarios with low operational density such as emergency rescue and security inspections; Z airspace is suitable for setting up in areas with special risks such as airports (with a true height of less than 300m), targeting high-density commercial scenarios. European countries established relatively strict flight rules and approval procedures in the early stages, and gradually transitioned to implementing common low-altitude airspace management policies and regulations under the Electronic Flight Plan (ECAC) framework, promoting the integrated development and safe and efficient utilization of European airspace.

3.2 The Current Status of Low-altitude Economic Development in China

China's low-altitude economy is still in the initial exploration stage, and currently it is mainly promoted and developed through a model of national top-level design, local leadership guidance, and market driven implementation.

In terms of national policies, in 2010, the State Council and the Central Military Commission issued the "Opinions on Deepening the Reform of Low-altitude Airspace Management in China", officially opening the curtain of airspace reform. After three rounds of large-scale reform pilot projects, the management of low-altitude airspace has gradually achieved "non controlled, ready to use". The national government is responsible for unified planning and policy-making, and local governments are responsible for specific management and implementation of the low-altitude airspace management model, which has also taken shape. In 2021, a series of national plans including the National Comprehensive Three dimensional Transportation Network Planning Outline, the 14th Five Year Plan for Civil Aviation Development, and the Strategic Plan for Expanding Domestic Demand (2022-2035) were successively released, indicating the general direction of low-altitude economic development.

In terms of local policies, various regions have introduced supportive policies and are taking the lead in testing multiple areas. Shenzhen has issued the "Regulations on the Promotion of Low-altitude Economy Industry in Shenzhen Special Economic

Zone", taking the lead in introducing special regulations for low-altitude economy, providing strong policy and economic support in promoting airspace opening and route operation. Hefei has formulated the "Hefei Low-altitude Economic Development Action Plan (2023-2025)", which proposes the goal of basically building the Luogang Low-altitude Fusion Flight Test Area by 2024 and the "Low-altitude City" with international influence by 2025. Chongqing mentioned the need to accelerate the development of low-altitude economy, support the participation of various parties such as drones, military, civilian, state-owned enterprises, and private enterprises, and jointly promote the development of low-altitude economy industry. Nanjing has released the "Implementation Plan for High Quality Development of the Unmanned Aerial Vehicle Industry in the Core Area of Nanjing Civil Aviation Pilot Zone (2023-2025)", proposing that by 2025, the output value of related industries will exceed 1.5 billion yuan, and 50 innovative scenarios and 50 urban unmanned aerial vehicle routes will be developed. Shanghai has released the "Action Plan for Shanghai to Create a New High in Future Industries and Develop and Strengthen Future Industrial Clusters", which mentions breaking through technologies such as tilt rotor, composite wing, and intelligent flight, developing manned electric vertical takeoff and landing aircraft, and exploring new modes of air transportation. According to incomplete statistics, in 2024, a total of 26 provinces in China, including Sichuan, Hainan, Hunan, Jiangxi, and Anhui, will include low-altitude economy, general aviation, and other related content in their government work reports.

In terms of industry entities, the general aviation and drone industries have achieved rapid development in recent years, as shown in Tables 1 and 2. As of the end of 2023, there are 690 registered general aviation enterprises in China, operating 2900 aircraft with an average of 114000 flight hours per month. There are 449 general airports, and the construction of a three-level flight service guarantee system has also achieved initial results; In terms of drones, there are 19000 operating companies, 1.267 million registered drones, and approximately 23.11 million flight hours throughout the year[23]. The sales of unmanned aerial vehicles account for about 70% of the global market share, and beneficial explorations have been made in product, technology, standards, management, and service "going global".

Table 1. Statistics on the Development of China's General Aviation Market (2019-2023).

	2019	**2020**	**2021**	**2022**	**2023**	**Growth rate over the past 5 years**
Number of aviation enterprises (households)	478	523	599	661	690	56.64%
Fleet size (aircraft)	2707	2892	3018	3186	3303	27.70%
General airport (s)	246	339	370	399	449	97.52%
Flight hours (10000 hours)	106.5	98.4	117.8	121.9	137.1	30.08%

Data source: Statistical Bulletin on the Development of the Civil Aviation Industry from 2019 to 2023 (released by the Civil Aviation Administration of China)

Table 2. Statistics on the Development of China's UAV Market (2019-2023).

	2019	2020	2021	2022	2023	Growth rate over the past 5 years
Owner Registered Users (10000)	37.1	55.8	78.1	70	92.9	150.40%
Valid driver's license (10000 copies)	6.7218	8.8994	12.08	15.28	19.44	189.21%
Registered aircraft (10000)	39.2	51.7	83.2	95.8	126.7	223.21%
Flight hours (10000 hours)	125	183	143.6	2067	2311	1748.80%

Data source: Statistical Bulletin on the Development of the Civil Aviation Industry from 2019 to 2023 (released by the Civil Aviation Administration of China)

In terms of application scenarios, the development momentum of flight scenarios such as agricultural crop protection, emergency rescue, aerial photography performances, exploration and testing, and logistics distribution is good. Especially in logistics distribution, emergency medical supplies such as blood, fresh shrimp fry, matsutake mushrooms, cherries and other high-value, low weight, and time demanding materials are suitable for priority exploration and development. Shenzhen, Nanjing, Zigong, Shiyan and other places are exploring the establishment of low-altitude blood transportation routes. Zhuhai has successfully completed the transportation of fresh shrimp fry across sea and province using drones, and has also opened multiple regular freight and passenger routes. Qingdao has opened its first low-altitude logistics route carrying 1.3 tons of cherries to Beijing Miyun Airport. By the end of 2024, Qingdao Cihang Airport will also open 5 low-altitude logistics routes to various parts of the country, achieving normal operation.

4 Case Study on the Development of Low-altitude Economy in China

After a period of cultivation and development, China's low-altitude economy has initially formed three distinctive development models, which can be simply summarized as follows.

The typical representative of the comprehensive development type is Guangdong. Guangdong has outstanding comprehensive competitiveness in various aspects such as economy, talent, technology, and industry. It has a complete low-altitude economy industry chain system covering research and development, manufacturing, testing and certification, flight operation, and service guarantee. It has cultivated a large number of leading enterprises in the low-altitude industry, such as Yihang Intelligence, Xiaopeng Huitian, Guangzhou Automobile Group, DJI, and Fengyi Technology. The general aviation and unmanned aerial vehicle industries have a high degree of aggregation, and industrial parks are widely distributed. Guangzhou, Shenzhen, and Zhuhai are linked and developed in three core areas, making it a pioneer in China's low-altitude economy. According to data from the Shenzhen Drone Industry Association,

in 2023, there will be 1730 drone industry chain enterprises in just one city, Shenzhen, with an annual output value of about 96 billion yuan. The number of cargo drone flights is 600000, ranking first in the country in terms of flight scale. The global market share of consumer grade drones is about 70%, and the global market share of industrial grade drones is about 50%, leading the development of the low-altitude industry in China.

Reform driven, typical representatives are Hunan and Hainan,. Taking the pilot reform of low-altitude airspace as an opportunity to unleash the momentum of reform, Hunan has issued the first local aviation regulations in the country, and built the first A-class flight service station in the country that can serve the whole province - Changsha Flight Service Station. The monitoring coverage rate of low-altitude airspace below 3000 meters has reached 95%, and 33 registered commercial aviation companies, including backbone enterprises such as Shanhe Intelligence, Aviation Industry Landing Gear, and Boyun New Materials, have relied on Hunan to build the national (Changsha) Beidou professional characteristic demonstration park and other industrial certificates, closely focusing on key directions such as aviation equipment, Beidou industry, commercial aerospace, and general aviation, actively promoting industrial linkage and cross development, and constructing a military civilian efficient collaborative operation and management mechanism and a technical system guarantee system for overall coordination. Hainan has established a provincial government civil aviation work office and issued documents such as the "Recent Action Plan for the Development of General Aviation in Hainan Province (2022-2023)" and "Several Support Measures for Promoting the Development of General Aviation in Hainan Province". It has designated the largest provincial-level unmanned aerial vehicle (UAV) classification and control airspace and suitable flight airspace in the country, relying on its geographical advantages and the policy and institutional advantages of free trade ports, actively promoting the extension of general aviation trade, financial services, manufacturing and maintenance, and other fields, building a "low-altitude+" growth landscape, and opening up new channels for tourism and transportation integration.

Industry driven, typical representatives are Anhui, Sichuan, and Jiangxi. Anhui's manufacturing industry has distinct characteristics and strong technological innovation momentum. It has the world's first urban air traffic super hub airport and the country's first demonstration zone supporting integrated flight. It has issued documents such as "Several Policies to Support the Development of General Aviation Industry" and continuously increased its efforts in "double recruitment and double introduction". Currently, it has more than 300 enterprises such as General Aviation Holdings Group, China Electronics Technology Diamond Aircraft, Yihang Intelligent, Yingliu Aviation, etc., including more than 150 large-scale enterprises. Hefei and Wuhu vigorously promote the cluster development of low-altitude economy as a leading industry, and build a low-altitude economy development model that integrates manufacturing, application, management, service and other industries, strengthening the hard power of low-altitude research and development. Sichuan has important domestic aviation/unmanned aerial vehicle product verification and test flights bases such as Chengdu Huaizhou Airport and Pengzhou Base. Relying on the basic ad-

vantages of the aerospace and military industry, it has cultivated a group of industry chain leaders such as AVIC unmanned aerial vehicles, Zongheng Co., Ltd., Tengdun Technology, Aoshi Technology, etc., driving the coordinated development of many upstream payload manufacturing enterprises such as Haofu Technology and Hangwei Zhixin, as well as downstream supporting service enterprises such as Civil Aviation Institute 2, Xieen Technology, and Times Star. It also has future unicorn enterprises such as Wofei Changkong in eVTOL; In terms of industrial drone industry, Chengdu has maintained an average annual growth rate of over 20% in recent years. The scale of large (military) drones ranks first in the country, and the industrial drone industry ranks among the top three in the country. The enterprise foundation is good, and the development prospects of industrial drone and other industrial clusters are bright. Jiangxi is a traditional aviation province with a strong manufacturing foundation. It has parks such as Nanchang Aviation City, Yaohu Aviation Industrial Park, Ganzhou Low-altitude Economic Industrial Park, and Nankang District Drone Industrial Park. It has been approved as the first pilot for drone logistics and distribution in China, and has been granted the first operating license for drone aviation pilot points. It actively promotes the application scenarios of drone express delivery to villages and drone transportation of navel oranges down mountains to serve rural revitalization.

5 Analysis of Key Elements for Collaborative Development of Low-altitude Economy in China

China's low-altitude economy is still in the initial stage of accumulating experience through reform pilot projects. There is still a lot of room for improvement in key elements such as institutional mechanisms, airspace management, key core technologies, flight support systems, and infrastructure. The system is not sound, the industrial chain is short, the technical support capacity is insufficient, and the development of application scenarios is not sufficient

In terms of institutional mechanisms, the regulatory and standard system lags behind, and it is difficult to implement top-level design. Low altitude economy, as an emerging economic sector, lacks clear technical standards and flight rules to guide low altitude flight, comprehensive regulatory laws and regulations, and a complete system of policies, systems, regulations, statistical indicators related to operation, service, and management has not yet been formed. The planning is too 'high-end', surpassing the regional economic and technological strength and demand digestion ability. Fragmentation, homogenization, wide scope, long cycle, multi head management, unclear responsibilities, high costs, and inability to effectively mobilize social resources are common problems.

In terms of airspace management, the effectiveness of the reform is not obvious, and the collaborative management mechanism is not sound. At present, the management of low altitude airspace still follows the relevant ideas and methods of traditional navigation management. Although several provinces have carried out pilot reforms of low altitude airspace, the scope of opening is limited, and the proportion of reporting airspace available for low altitude flight is small and relatively scattered. The vast

majority of flight activities need to be approved according to the regulatory process, which is cumbersome and lacks market-oriented service entities. In addition, the unclear rights and responsibilities for the use and construction of low altitude airspace, as well as the lack of coordination and coordination between military, civilian, and industrial policies in airspace, have resulted in the inability to implement some policies and plans.

In terms of the main industry, the market development is slow, and the advantages of industrial integration are not fully realized. As the main industry of low altitude economy, general aviation lacks sufficient technical support capabilities and application scenario development. The market growth represented by traditional flight operations such as agriculture, forestry, animal husbandry, and fishing is slow, mainly relying on financial subsidies, with limited internal driving force. The industry itself has not formed a stable business model and market rules. Moreover, the current low altitude economy involves lower levels of production and service activities, fewer links, and insufficient demand for specialized markets. The role of "chain owner enterprises" in driving the entire industrial chain is not obvious, and the characteristics of the low altitude economy's long industrial chain, wide radiation, strong growth and driving force have not been manifested.

In terms of core technology, independent research and development capabilities need to be improved, and the form of security control is complex. Low altitude aircraft face serious bottlenecks in core components such as flight control, sensors, and power systems. The entire aircraft and aircraft engines heavily rely on imports, and there are few leading enterprises. There are no suitable solutions to the technical problems that need to be solved for commercial and normalized operation, such as perception and autonomous navigation control, reliable communication, endurance and power system efficiency, safety and emergency response. The safety control technology is not mature, and various systems are complex, with inconsistent standards, difficult system integration, and poor information sharing.

In terms of infrastructure, the overall layout capability and level of intelligence are insufficient. Infrastructure is a key carrier for low altitude flight activities, and the intelligence and stability of existing facilities and equipment are difficult to meet the requirements of low altitude economic development, requiring renovation and upgrading or intelligent replacement. The newly built facility network, air network, air route network, and service network have incomplete coverage, inconsistent standards, and lack of system design. Currently, most of them are built by enterprises, and there are prominent contradictions such as difficulties in resource sharing, repeated construction, and heavy financial burden.

6 Development Suggestions

The "Development of China's Low-altitude economy (2022-2023)" released by the National Low-altitude economy Integration and Innovation Research Center predicts that the comprehensive contribution of the low-altitude economy to China's national economy will reach 3 to 5 trillion yuan by the end of the 14th Five Year Plan period;

In February 2024, Han Jun, Deputy Director of the Civil Aviation Administration of China, revealed at a press conference of the State Council Information Office that the scale of China's low-altitude economy has exceeded 500 billion yuan by 2023 and is expected to reach 2 trillion yuan by 2030. Due to inconsistent measurement standards, the estimated output values of different channels may vary, but undoubtedly they all indicate the great potential for the development of low-altitude economy. Improving institutional mechanisms and clearing development obstacles are prerequisites for promoting high-quality development of the low-altitude economy.

(1) Strengthen top-level design and improve the comprehensive organizational management system

One is to innovate the system and mechanism for the integrated development of industries. According to the actual situation in various regions, adjust the organizational structure appropriately, clarify the responsible departments for the development of low-altitude economy, coordinate the relationship between low-altitude economy development and security, government and market, autonomy and openness, clarify development priorities, strengthen the coordination of key elements such as policies and regulations, airspace opening, technological innovation, and scene application, avoid problems such as rushing forward, overcapacity, and low-level redundant construction, and maintain the low-altitude economy industry ecology.

The second is to establish a policy, regulation, and standard guarantee system. Establish a sound system of low-altitude policies, regulations, and standards, improve management measures, build a dynamic monitoring and statistical system for low-altitude economic development, enhance the scientificity and accuracy of policy guidance, promote the upgrading of regulatory capabilities and systematic service levels, and accelerate the transition of industry management to standardization, normalization, and normalization.

(2) Transform the development model and promote the integrated development of airspace management

One is to transform development concepts and models. Adhere to the principles of "centralized management, military civilian integration, separation of management and administration, and safety and efficiency", and promote the development of airspace management from the current form of dividing the cake to flexible, dynamic, and integrated use of airspace rights and interests. Relying on 5G network, LEO satellite network, ground Internet and other infrastructure, as well as new technologies such as big data and artificial intelligence, we will continue to strengthen the networking, digitization and intelligence of low-altitude airspace management and control, support cities with mature conditions to take the lead, and strengthen the exploration in flight procedure approval, air traffic control, meteorology, communication, surveillance and other aspects of flight service guarantee system construction.

The second is to strengthen the mechanism for coordinated management between the military, civilians, and civilians. Strengthen the tripartite coordination between military, civilian, and civilian sectors, improve information exchange and resource sharing mechanisms, clarify the responsibilities and boundaries of each institution, promote local governments to take on more main responsibilities in the coordination and management of low-altitude airspace resources, reduce and decompose the cur-

rent situation of concentrated safety responsibilities, and promote the construction and development of military civilian integration, air ground integration, industry to industry integration, industry to local integration, and the integration of manned and unmanned aerial vehicles.

(3) Improve industrial planning and promote the strengthening and extension of the industrial chain

One is to develop application scenarios to stimulate market demand. Accelerate the construction of low-altitude application scenarios, especially in government fields such as urban fire protection, urban security, water inspection, and land surveying, promote the development of low-altitude logistics, low-altitude tourism, short distance transportation, and other industries, strengthen the participation of low-altitude services in emergency rescue, medical material transportation, and other fields, and create new demands to promote consumption upgrading and industrial innovation.

The second is to develop low-altitude industries according to local conditions. Strengthen support for low-altitude enterprises, formulate local policies that are more conducive to improving production efficiency, service levels, and management capabilities, leverage strengths and avoid weaknesses, and promote differentiated and distinctive development. For example, areas with abundant tourism resources can develop low-altitude tourism, areas with developed agriculture can develop drone smart agriculture, densely populated large cities can develop low-altitude transportation and logistics, and areas with manufacturing clusters can deeply explore the entire life cycle of aircraft manufacturing, maintenance, modification, and dismantling, promoting the deep integration of low-altitude industry contracts into local economic and social development.

(4) Intensify research and development to empower high-quality development

One is to accelerate the cultivation of leading enterprises. Intensify exploration of the construction and cultivation of leading enterprises in low-altitude technology, focus on key areas such as unmanned aerial vehicles, electric vertical takeoff and landing aircraft, and general aviation aircraft, actively layout, improve the cultivation system and support policies, guide enterprises to carry out industry foresight and key core technology research and development based on demand, strengthen cooperation between enterprises, scientific research institutions, and universities, and promote the emergence of low-altitude technology leading enterprises.

The second is to strengthen the research and development of key core technologies. Benchmarking the international leading level, accelerating the research and development of key technologies such as complete machines and key components, strengthening equipment safety technology research, and enhancing international exchanges and cooperation. Improve the systematic and task-based national innovation model, support leading enterprises to lead the formation of major innovation consortia, coordinate upstream and downstream innovation resources and technological innovation achievements in the industry, and explore the path of independent development and breakthroughs.

(5) Moderately advanced layout to enhance the intelligence level of infrastructure

One is to increase investment in low-altitude infrastructure construction. Focus on building the "four networks" for low-altitude flight, promote the construction of

ground support facilities such as parking garages, energy stations, meteorological stations, fixed operation bases, and aviation material support platforms, guide the completion of general airports and takeoff and landing sites to improve low-altitude support capabilities, improve the network construction of communication, navigation, surveillance and other related supporting facilities, accelerate the construction of industry standard systems, adhere to the equal emphasis on improving quality and expanding quantity, and build a new and sustainable infrastructure system.

The second is to enhance the level of intelligence and digitization. Accelerate the application of new technologies and equipment, such as Beidou short message, 5G network, low orbit satellite network, ground Internet, unmanned aerial vehicle operation identification, in the low-altitude field, support the exploration of low-altitude intelligent networking technologies and standards for the interconnection of space and space facilities and information exchange, promote the intelligent and digital construction of "soft infrastructure" dominated by air traffic management platform and "hard infrastructure" dominated by "airport, takeoff and landing point, communication/guidance/surveillance" equipment, build an integrated digital low-altitude base based on 3D geographic information, city information model (CIM), low-altitude flight airspace and other data, establish and improve low-altitude data management systems and standards, promote the interconnection of data and information on different platforms, and promote the construction of intelligent and efficient new low-altitude service guarantee system.

7 Conclusion

Low-altitude economy is a strategic emerging industry, a typical representative of new quality productive forces, and an important direction for cultivating and developing new driving forces. It has the characteristics of innovation leadership, green low-carbon, and integration of data and reality. In the future, its development should deeply grasp and follow its development laws and stage characteristics. We should pay attention to the problems and challenges in the development process, link up and down, strengthen the chain and supplement the chain, adapt to local conditions, take the path of characteristic and diversified development, enhance the level of scale, networking, and intelligence, and promote the stable and far-reaching development of low-altitude economy.

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