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NEW OPPORTUNITIES FOR THE DEVELOPMENT OF LOW ALTITUDE ECONOMY IN SCO MEMBER STATES IN THE DIGITAL ECONOMY ERA

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At present, due to the advancement of cutting-edge digital technology, the global low-altitude economy is accelerating. However, there are also problems such as slow progress in infrastructure construction, weak key core technologies, lagging market system development, and urgent need to improve the management system. In this regard, we should further accelerate the construction of digital infrastructure, focus on key industries and fields, promote the industrialization and commercialization of the low-altitude economy, and reduce the cost of entrepreneurship; improve the regional coordinated development management system of the low-altitude economy within the SCO, promote regional standard mutual recognition, promote the efficient use of airspace resources, expand the application field of low-altitude industries, and further explore diversified and sustainable low-altitude economic value release paths.

Keywords: low-altitude economy; digital infrastructure construction; digital economy; new development trends.

НОВЫЕ ВОЗМОЖНОСТИ РАЗВИТИЯ «LOW ATTITUDE» ЭКОНОМИКИ В ГОСУДАРСТВАХ – ЧЛЕНАХ ШОС В ЭПОХУ ЦИФРОВОЙ ЭКОНОМИКИ

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В настоящее время в связи с развитием передовых цифровых технологий ускоряется развитие мировой экономики низких высот. Однако существуют и такие проблемы, как медленный прогресс в строительстве инфраструктуры, слабые ключевые основные технологии, отстающее развитие рыночной системы и острая необходимость в совершенствовании системы управления. В этой связи следует ускорить строительство цифровой инфраструктуры, сосредоточиться на ключевых отраслях и областях, содействовать индустриализации и коммерциализации экономики низких высот и снизить издержки предпринимательства; улучшить региональную скоординированную систему управления развитием экономики низких высот в рамках ШОС, содействовать взаимному признанию региональных стандартов и совместно строить экономический коридор низких высот; изучать диверсифицированные и устойчивые пути высвобождения экономической стоимости низких высот.

Ключевые слова: экономика низких высот; строительство цифровой инфраструктуры; цифровая экономика; новые тенденции развития.

In recent years, with the continuous progress and innovation of digital infrastructure, including 5G base stations, data centers, cloud computing platforms, industrial Internet of Things and other technologies, the integration and innovation between industries have been deepened, providing digital technology soil for the development of new industries, new models and new momentum. In the SCO, China created the concept of "low-altitude economy" to deal with its general aviation development problems. It is not only a reflection on the scientific allocation and management reform of low-altitude airspace resources, but also an exploration and innovation under the current new model of digital economic development. Today, the development of the global low-altitude economy is accelerating and has become a new field and new track for major economies to compete. Due to the core

characteristics of "heterogeneous, high-density, high-frequency and high-complexity", the development of digital infrastructure is an important part of its reliance, which shows that the low-altitude economy has a unique digital gene and is constantly improving the core competitiveness of the industry under the drive of the digital economy. In the current context of the global rush to layout the low-altitude economy, it is of great practical significance to sort out and analyze the international situation of the development of the low-altitude economy, the current situation and existing problems of the digital low-altitude economy of the SCO member states, and put forward corresponding policy recommendations, which is of great practical significance for promoting the orderly development of low-altitude economic cooperation in the region.

The core connotation and characteristics of low-altitude economy. Low-altitude economy refers to the economic form formed by various aviation activities and related industries carried out in low-altitude airspace with low-altitude aviation transport (usually below 1,000 meters, which can be extended to no more than 3,000 meters according to actual needs) and operating equipment technology as the main means, guided by national and market needs. It is essentially a strategic emerging industry with full-field digitalization centered on low-altitude activities. Low-altitude economy has the characteristics of spatial three-dimensionality, regional dependence, industrial integration, and radiation-driven nature. First of all, low-altitude economy is an economic form that relies on the development of three-dimensional space and has a strong spatial three-dimensionality. Low-altitude manufacturing, low-altitude support and comprehensive services mainly operate on the ground, providing products, services, infrastructure, publicity and other support and assistance for low-altitude flights, and the connection between air and ground is relatively close. Secondly, the development of low-altitude economy relies on highly concentrated regional industrial clusters and has a strong regional dependence. The management and services of low-altitude flights must rely on fully digitalized, intelligent, autonomous and self-evolving systems, and can even replace humans for management and services in some businesses.

International situation of low-altitude economic development. The global low-altitude economy has been driven by multiple factors since 2021, such as the prominent problem of ground traffic congestion, the gradual maturity of low-altitude aircraft manufacturing technology, and the gradual improvement of various laws and regulations. Application scenarios represented by air taxis and drone delivery continue to open up new space for the development of low-altitude economy, and promote the industry to accelerate into the stage of application popularization. At present, the global low-altitude economic industry is generally in the popularization stage, and various economies are focused on exploring and enriching low-altitude economic application scenarios. The gap between them is not large, among which the United States, Japan, the European Union and other countries and regions have certain leading advantages.

The United States seizes the opportunity of low-altitude economic development with the general aviation industry foundation of the market competition model. The aviation transportation industry has always been one of the important pillar industries of the US economy. At present, the United States is the world's largest general aviation consumer and general aircraft manufacturer, with a fairly complete infrastructure and a large number of general aviation aircraft, and its industrial development level is ahead of other economies. Relevant data show that the United States has more than 5,000 general aviation airports, which is 11.92 and 29.54 times that of China and Russia respectively; the number of registered aircraft remains stable at more than 200,000; the number of pilots exceeds 800,000, accounting for 0.24 % of the total population; and the contribution rate to the US GDP exceeds 0.5 %. Japan: Based on the "government planning + enterprise participation + technological innovation" model, actively promote the development of low-altitude economy. As an active explorer of low-altitude economy, Japan has continuously improved relevant policies in the low-altitude field and clarified industrial expansion plans and commercialization goals. The EU low-altitude economy is mainly laid out in four major areas: airport operations, air traffic services, air traffic management and aviation infrastructure. Among them, Germany focuses on industrial and logistics applications and occupies a leading position in the EU low-altitude economy early.

Development of low-altitude economy in SCO member states. China's huge demand for air transport has driven the rapid development of China's civil aviation industry, making it the world's second largest air transport country after the United States. From 2008 to 2020, China's low-altitude airspace reform was gradually piloted, and ultra-low-altitude consumer drone consumption began to rise. By 2021, China's low-altitude economy will enter a rapid cultivation stage, and the industry will develop rapidly. In 2023, the scale of China's low-altitude economy will reach 505.95 billion yuan, with a growth rate of 33.8 %; it is expected to exceed 1.5 trillion yuan in 2025 and may reach 3.5 trillion yuan in 2035. Russia leads in traditional general aircraft and aviation engine technology, but the application of low-altitude economy is mainly cross-border logistics pilot, which has not yet formed a scale. Due to international sanctions and geopolitical conflicts, its domestic low-altitude airspace management is fragmented, and the cross-regional flight approval process is relatively complicated. In the early stage, India's low-altitude economy was mainly piloted in the fields of agricultural plant protection, medical distribution, etc. In 2024, the scale of its low-altitude logistics market will be only 100–400 million, and the core components of low-altitude eVTOL (flight control systems) will rely on imports. Kazakhstan has rich airspace resources and many flight days throughout the year. It focuses on oil field inspections, low-altitude tourism and other scenarios, and cooperates with Xinjiang, China in the fields of agricultural and forestry plant protection, emergency rescue, etc. Other Central Asian and South Asian member states (Kyrgyzstan, Tajikistan, and Uzbekistan) have weak infrastructure (few general airports and low communication network coverage), and drones are mostly used for military or border patrols. The application of drones in civilian scenarios is limited to small-scale agricultural operations. As a newly joined member state, Belarus has not yet formed an advantageous field and is in the popularization stage.

Main problems faced by the development of digital low-altitude economy in SCO member states. Although some member states of the organization have made significant progress in the development of low-altitude economy, there are also problems such as slow progress in infrastructure construction, weak key core technologies, lagging market system development, and urgent need to improve the management system in the process of development, which restrict the high-quality development of low-altitude economy.

(I) Slow progress in low-altitude infrastructure construction

Low-altitude infrastructure is an important carrier of low-altitude economic activities, especially low-altitude flight activities. Due to the high complexity of the interaction between low-altitude and the ground, it requires complete infrastructure support such as general aviation airports, aircraft take-off and landing stations, airspace management information systems, and high-speed wireless networks. At present, the construction of low-altitude infrastructure in SCO member states is slow, and the construction of supporting infrastructure is lagging behind, which is not enough to support the large-scale demonstration application and commercial development of low-altitude economy in the organization region.

Insufficient supply of hardware infrastructure. In recent years, although digital development has been rapid and the distribution of digital facilities has been broadened, the number of general airports in member states has increased little, and ground service support facilities are not perfect.

Software infrastructure construction needs to be strengthened. The information system of urban air traffic control, airspace management auxiliary system, flight service station system, urban three-dimensional transportation network, etc. are scattered in different fields such as aviation and communications, and integration is difficult. In many areas, the time limit and procedures for service stations and general aviation plans are not unified, which increases the coordination workload between service stations or peer enterprises and affects the operation efficiency to a certain extent. At the same time, there is a lack of effective network information infrastructure to support low-altitude perception detection and communication.

(II) Key core technologies are still relatively weak

Technological innovation is the key to the development of low-altitude economy. At present, the technological innovation capabilities of the low-altitude economic development of member countries

are insufficient, especially the barriers to key core technologies are relatively more. The key core components such as main control chips, intelligent instruments and sensors required for the manufacture of drones have not yet been fully mastered, especially the key technology research and development capabilities of drone core batteries, communication systems, intelligent perception, positioning and navigation, obstacle avoidance, engines, noise reduction, etc. are relatively weak, which affects the improvement of product maturity. In the aircraft industry chain of low-altitude economy, whole machine design, system integration, manufacturing process and airworthiness certification are core links, but the technical level gap is large compared with developed economies, and there are certain barriers to achieving technological breakthroughs.

(III) The development of the low-altitude economic market system lags behind

At present, among the member states, only China has basically formed a complete industrial chain of low-altitude industry, but the overall development of the industrial chain is unbalanced, especially the guarantee and service links are relatively weak, and the scene application field is still under exploration. The development of the low-altitude economic market system in other member states is relatively lagging behind.

The development of the low-altitude economic service industry lags behind. The development of low-altitude maintenance and technical support, operation services, information services, safety assurance, air traffic control service assurance and other links in various member states lags behind. The drone insurance service system is not yet perfect, and the insurance coverage is not highly consistent with the commercial scene. Insurance companies have insufficient development of insurance products for low-altitude commercial applications such as logistics, manned, and urban management.

The popularity of scene applications is low. At present, the low-altitude economy is mainly used in agricultural plant protection, power inspection, tourism, entertainment shooting, short-distance delivery, medical first aid, fire emergency, disaster relief and other scenarios.

Regional cooperation and development suggestions. Facing the future economic development of the SCO, accelerating the development of the low-altitude economy requires further strengthening the coordinated development among the member states, increasing the support of relevant supporting policies among the member states, and further exploring diversified and sustainable low-altitude economic value release paths. China's low-altitude economic development is the most mature among the SCO member states. Russia and Kazakhstan have potential but need to break through policy bottlenecks. Other countries are still in the starting stage. In the future, it is necessary to promote the regional low-altitude economy from "single point breakthrough" to "full-area linkage" through technical collaboration, infrastructure co-construction and policy mutual recognition

Technology sharing and industrial chain collaboration

At present, the low-altitude economy is gradually becoming a new engine to promote economic innovation and development. It is necessary to take the enhancement of low-altitude scientific and technological innovation as the guide, accelerate the conquest of a number of key technologies in the low-altitude field, and develop a number of drones, fixed-wing aircraft, eVTOL and their core components with independent intellectual property rights. At the same time, promote the incubation and transformation of low-altitude economic industry achievements, focus on cultivating leading talents for industry development, and thus promote the basic realization of independent control of the low-altitude economic industry chain. Member country China can export drone and eVTOL technologies to other member states, jointly develop key components (such as high energy density batteries), and promote the incubation and transformation of low-altitude economic industry achievements. Establish the "SCO Low-altitude Economic Cooperation Fund" to support Central Asian countries in building general airports and low-altitude navigation networks.

Policy coordination and mutual recognition of standards

Regularly publish low-altitude economic cutting-edge technology application standards, build a low-altitude economic standard library, promote the industrialization of research and development design such as eVTOL and special flight platforms and aircraft reconstruction support, and promote

precise matching of supply and demand. Fully attract graduates of various aviation schools and retired air force pilots to work in the general aviation industry, integrate flight human resources, and establish an internal flight talent pool. Promote mutual recognition of airworthiness and flight license certification among member states, simplify cross-border flight approval procedures, and pilot "low-altitude free trade zones"

Scenario co-construction

Through technical complementary, industrial chain embedding, and policy coordination, SCO member states can form a multi-dimensional scenario matrix of "logistics - tourism - manufacturing -environmental protection". The key is to choose the intersection of member states' demands (such as Russia's extreme cold technology needs, Central Asia's agricultural upgrading needs, and Belarus's agricultural needs). You can also establish a SCO low-altitude tourism alliance to unify service standards and insurance systems. Based on the existing cooperation foundation between China and Belarus (such as the China-Belarus Industrial Park and joint scientific and technological research and development) and the technical and scenario characteristics of the low-altitude economy, China exports agricultural drones and AI analysis platforms for precise management of field crops. Relying on the China-Belarus Agricultural Science and Technology Demonstration Park, it promotes the integrated monitoring of "drones + satellite remote sensing", and Belarus provides farmland data (such as soil moisture and crop growth cycle). Jointly develop intelligent fertilization algorithms suitable for the plains of Eastern Europe to reduce the use of chemical fertilizers on the land.

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