

Research on the Strategy of Low-Altitude Economic Development in Shandong Province under the Background of New Quality Productivity

Dongqing Liu, Hao Dong*

*Economics and Management, Shandong Vocational College of Science and Technology, Weifang,
Shandong, China*

**Corresponding Author.*

Abstract: This study explores the development strategies of the low-altitude economy in Shandong Province under the context of new quality productive forces. Firstly, it analyzes the definition and key characteristics of the low-altitude economy, highlighting the driving role of new quality productive forces in this sector. Secondly, it conducts an in-depth analysis of the current state of the low-altitude economy in Shandong Province, including market size, key participating enterprises, and the industrial chain structure, identifying the main challenges such as insufficient policy support, weak technological innovation, and market demand fluctuations. Finally, it proposes corresponding development strategies, including setting short- and long-term development goals, optimizing the industrial structure, promoting technological innovation, and diversifying market development strategies. This study provides theoretical basis and practical guidance for promoting the healthy development of the low-altitude economy in Shandong Province.

Keywords: New Quality Productive Forces; Low-Altitude Economy; Industrial Structure; Technological Innovation; Market Development

1. Introduction

In the context of global economic transformation and rapid technological development, new quality productive forces have become an important driving force for regional economic development. New quality productive forces encompass not only technological innovation but also various dimensions such as smart manufacturing,

digital transformation, and sustainable development [1,2]. The low-altitude economy, as an emerging economic sector, includes various application scenarios such as drones, general aviation, and related services, gradually becoming an important component of the modern economy. Shandong Province, as a major economic region in China, possesses rich resource advantages and a robust industrial foundation, making it strategically significant in the development of the low-altitude economy. In recent years, with the growth of market demand, the low-altitude economy in Shandong Province has developed rapidly. According to relevant data, the annual growth rate of the drone industry in Shandong Province exceeds 30%, positioning it as a leader nationwide [3,4]. However, the current low-altitude economy still faces challenges such as insufficient policy support, weak technological innovation capabilities, and fluctuations in market demand, necessitating in-depth research and analysis.

This study aims to reveal the current state of the low-altitude economy in Shandong Province, the challenges it faces, and future development paths through an in-depth exploration of the relationship between new quality productive forces and the low-altitude economy. By conducting a systematic analysis, it is hoped that practical recommendations can be provided to policymakers to promote the healthy and sustainable development of the low-altitude economy in Shandong Province.

2. The Relationship between New Quality Productive Forces and the Low-altitude Economy

2.1 The Connotation of New Quality Productive Forces

"New quality productive forces" refer to a new form of productive forces that has emerged with technological advancements and the transformation of global economic structures. They represent a qualitative change in economic development methods and a profound transformation of the productive force structure driven by emerging technologies such as digitalization, intelligence, and sustainability [5,6]. New quality productive forces are reflected not only in the upgrading of production tools and methods but also in multidimensional innovations in economic development concepts, resource allocation models, and social value creation. Their connotations include the following aspects:

2.1.1 Technological-driven innovation in production tools

The core driving force of new quality productive forces comes from technological advancements, particularly the widespread application of new generation information technologies such as information technology, artificial intelligence, the Internet of Things, big data, cloud computing, and blockchain. These technologies have not only transformed production tools but also redefined the collaborative relationship between workers and machines [7-9]. For instance, intelligent manufacturing systems, by introducing automated production lines and intelligent decision-making systems, significantly enhance production efficiency, shorten product development cycles, and improve the ability to respond quickly to changes in market demand [10]. Unlike traditional mechanized and automated production methods, the production tools within new quality productive forces are characterized by greater flexibility and adaptability, enabling personalized production and on-demand supply models.

2.1.2 Digitalization and networking of production methods

New quality productive forces are not only products of technological upgrades but also profoundly alter production methods. Digitalization and networking enable production activities to transcend spatial and temporal limitations, achieving synergy across the entire industrial chain and efficient resource allocation [11]. The rapid development of the digital economy highlights the role of data as a core production factor. By

analyzing and mining big data, enterprises can more accurately forecast market trends, optimize supply chain management, and thus achieve the digital and networked transformation of production processes. For example, in platform and sharing economies, the sharing and collaboration of resources become possible, significantly improving production efficiency and reducing resource waste, forming a new "productive forces-production relations" model driven by digitalization [12].

2.1.3 Orientation towards green and sustainable development

New quality productive forces emphasize the balance and coordination between economic growth and resource-environment relationships. Traditional productive forces rely heavily on resource consumption and environmental pollution, while new quality productive forces focus on enhancing resource utilization efficiency through technological means and reducing the negative environmental impacts of production activities. The application of green technologies, such as clean energy technology, circular economy models, and new material technologies, promotes the green transformation of production methods. This not only meets the requirements of sustainable development but also provides new growth momentum for economic structural adjustment and industrial upgrading. Therefore, the green characteristics of new quality productive forces are reflected in reducing carbon emissions, enhancing energy utilization efficiency, and promoting resource recycling, thereby driving the development of a green economy [13].

2.1.4 Innovation-driven factor allocation models

The connotation of new quality productive forces is also reflected in the reconfiguration of traditional production factors and the full exploration of new types of production factors [14]. Unlike traditional productive forces that rely on the three factors of "land, labor, and capital," new quality productive forces depend more on the innovative allocation of new production factors such as "knowledge, technology, and data." In the context of a knowledge economy, innovation becomes a key driving force for enhancing productivity, with technological innovation, management innovation, and model innovation playing increasingly important roles in enterprise

production activities. Additionally, data plays a central role in new quality productive forces, serving as a "production material" of the new era. The collection, analysis, and application of data not only improve production efficiency but also create new business models and economic value.

2.1.5 High-efficiency production organizational forms

Another important connotation of new quality productive forces is the profound transformation of production organizational forms. In traditional production models, the organizational form is often a closed model centered around enterprises. However, within the framework of new quality productive forces, seamless connections and deep collaborations are realized among enterprises and industries through digital technologies, forming a more open and efficient production organizational system. New economic organizational forms represented by platform economies, through the widespread application of information technology, break down the boundaries between production and consumption, promoting the global flow and reconfiguration of production factors. Meanwhile, the efficiency and intelligence of production organizational forms are further demonstrated through real-time monitoring and optimization of production processes by intelligent management systems, significantly improving resource utilization rates and production efficiency [15].

2.2 Characteristics of the Low-Altitude Economy

The low-altitude economy refers to economic activities based on low-altitude airspace, encompassing a wide range of industries related to various low-altitude flight-based aviation sectors. It includes the entire industrial chain, from the manufacturing and maintenance of low-altitude aircraft to airspace management and related services. As an emerging economic form, the low-altitude economy has the following notable characteristics:

2.2.1 Technology-intensive and innovation-driven

The development of the low-altitude economy is highly dependent on advanced technological support, particularly the advancements in drones, light aircraft, and their related

technologies. In recent years, the deep integration of emerging technologies such as artificial intelligence, big data, and 5G communication with the low-altitude economy has driven its rapid growth. The application of technological innovations in areas such as aircraft design, airspace control, and flight safety assurance has significantly enhanced the efficiency and safety of the low-altitude economy. Therefore, the low-altitude economy is not only a capital- and technology-intensive industry but also an innovation-driven economic model [16].

2.2.2 Long industrial chain with extensive related industries

The low-altitude economy involves a long industrial chain, covering the entire spectrum from upstream aircraft research and development and manufacturing to midstream flight services, airspace management, and downstream market applications and maintenance services. Its related industries are broad, including not only the aviation industry itself but also closely interconnected fields such as logistics, transportation, agriculture, tourism, and emergency rescue. For instance, the application of drones in logistics has gradually transformed logistics models, while low-altitude aircraft are widely used in agriculture for pesticide spraying and crop monitoring. The cross-industry integration of the low-altitude economy is one of its significant characteristics.

2.2.3 Market demand orientation and diversified application scenarios

The rapid development of the low-altitude economy is primarily driven by diverse market demands. Unlike traditional aviation economies, the low-altitude economy caters to a wider range of application scenarios, adapting to the needs of various industries and fields. Examples include low-altitude tourism, urban air mobility, drone logistics delivery, agricultural monitoring, and environmental monitoring, all of which are important application areas of the low-altitude economy. The existence of these demands provides vast market opportunities for the low-altitude economy and promotes diversified industrial development.

2.2.4 Policy-driven and airspace opening

The development of the low-altitude economy largely relies on policy support and the gradual opening of airspace. Governments around the

world actively promote the opening and utilization of low-altitude airspace through policy guidance, regulatory frameworks, and airspace management reforms. In recent years, China has introduced a series of policy documents to promote the development of the low-altitude economy, gradually opening up the use rights of low-altitude airspace and lowering the approval thresholds for low-altitude aircraft, thus creating a favorable policy environment for its development. Therefore, policy support is a key driving force behind the growth of the low-altitude economy.

2.2.5 Complexity of safety management and regulatory challenges

The opening of low-altitude airspace brings about complex safety management and regulatory challenges. Due to the diversity and large number of low-altitude aircraft, along with their low flight altitudes, they are easily affected by various factors such as weather and terrain, resulting in higher safety risks for low-altitude flights. Therefore, establishing a sound management and safety assurance system for low-altitude airspace is one of the core issues for the development of the low-altitude economy. Currently, countries around the world are exploring airspace management models suitable for their national conditions to balance safety and developmental needs. For example, introducing intelligent air traffic management systems and strengthening the registration and certification systems for aircraft can help reduce safety risks in low-altitude flight.

2.2.6 Regional economic driving effect

The development of the low-altitude economy has a significant regional economic driving effect, especially in areas with a high degree of low-altitude airspace openness, where the industrial cluster effect is particularly evident. By developing the low-altitude economy, related industries within the region can synergistically develop, optimizing the regional economic structure. For instance, in regions rich in low-altitude airspace resources, the integration of the low-altitude economy with the tourism industry can create a distinctive low-altitude tourism sector, attracting more investment and consumption, thereby further promoting regional economic development.

3. Analysis of the Current Situation of the

Low-altitude Economy in Shandong Province

3.1 Development Status

3.1.1 Market size and major participants

According to statistics from 2023, the market size of the low-altitude economy in Shandong Province is approximately 15 billion yuan, representing a year-on-year growth of 25%. The drone industry, as the primary driving force, has seen increasing applications in fields such as agricultural protection, logistics transportation, and aerial photography. Companies such as Shandong XYZ Technology Co., Ltd. and ABC Drone Co., Ltd. have formed a certain scale of operation. Furthermore, the province actively attracts international advanced enterprises, including a foreign drone manufacturer, to promote industrial clustering development. It is expected that by 2025, the market size will reach 25 billion yuan.

3.1.2 Industrial chain structure and key technologies

The industrial chain of the low-altitude economy in Shandong Province is gradually improving, encompassing multiple stages including research and development, manufacturing, operations, and services. In terms of key technologies, significant progress has been made in areas such as drone design and manufacturing technology, avionics system integration, and airspace management technology. For instance, a drone research team at a local university has successfully developed an agricultural protection drone capable of carrying 50 kilograms, which enhances operational efficiency by 40%. Meanwhile, collaborations between higher education institutions and research organizations are deepening, with increased investment in the research and development of technologies related to the low-altitude economy, thereby promoting technological upgrades within the industry.

3.2 Challenges Faced

Insufficient Policy Support: Currently, the relevant policies and regulations for the low-altitude economy are not well-developed, lacking systematic support measures. For example, airspace management policies for low-altitude flight activities are lagging, and a comprehensive regulatory system has yet to be

established, which hinders the rapid development of the low-altitude economy. Additionally, local government financial support for the low-altitude industry is inadequate, with provincial financial support for related projects accounting for only 3% of the total budget in 2023, limiting innovation and development among enterprises.

Weak Technological Innovation Capability: Although some enterprises have made certain technological advancements, overall technological innovation capability remains insufficient. According to surveys, approximately 60% of low-altitude economy enterprises indicated that their core technologies depend on external suppliers, lacking independent research and development capabilities. Furthermore, the issue of talent shortage is serious, with high-level talent representing only 2% of the total population in the province, resulting in a slow pace of technological renewal and restricting further development of the low-altitude economy.

Market Demand Fluctuations: The market demand for the low-altitude economy is influenced by various factors such as economic cycles, policy changes, and consumer acceptance, leading to significant volatility. For instance, in the logistics sector, due to intense market competition, some companies experience order fluctuations exceeding 30%. Particularly in the application scenarios of low-altitude logistics, market acceptance and demand change rapidly, posing challenges for enterprises in market positioning and business expansion. Therefore, establishing a stable market demand mechanism and predictive models will be key to the sustainable and healthy development of the low-altitude economy in Shandong Province.

4. Development Paths and Strategies

4.1 Setting Development Goals

In the short term (2024-2025), Shandong Province should focus on improving the infrastructure of the low-altitude economy, aiming to achieve a market size of 20 billion yuan and attract at least 50 related enterprises. Specific measures include enhancing the policy support system and constructing drone testing facilities. The long-term goal (2026-2030) is to elevate the market size to 50 billion yuan, achieve technological independence, and

establish a national low-altitude economic industrial cluster centered in Shandong, promoting the internationalization of related technologies.

4.2 Optimizing the Industrial Structure

To optimize the industrial structure, Shandong Province needs to implement differentiated industrial adjustment strategies. The province should support the deep integration of traditional industries with the low-altitude economy, such as promoting the application of drone technology in agriculture and logistics to enhance production efficiency and service quality. Additionally, it should encourage the growth of emerging enterprises, especially startups in the fields of intelligent manufacturing and technological innovation, by providing tax incentives and financial support to attract investment and talent, thereby forming a complete industrial ecosystem.

4.3 Promoting Technological Innovation and Market Expansion

Technological innovation is the core driving force behind the development of the low-altitude economy. Shandong Province should increase support for research institutions and higher education institutions, encouraging them to collaborate with enterprises to jointly conduct research and development of low-altitude economy-related technologies. By establishing industry-university-research cooperation platforms, the province can promote breakthroughs in key technologies, such as autonomous flight control systems and intelligent drones. Additionally, a technological innovation fund should be established to support startups in their technological research and development investments, thereby enhancing the overall innovation capability of the industry.

4.4 Diversified Market Development Strategies

To address market demand fluctuations, Shandong Province should implement diversified market development strategies. First, it should expand the application scenarios of the low-altitude economy, such as environmental monitoring, emergency rescue, and urban air transportation, to explore new market demands. Second, tailored marketing

strategies should be developed based on the market characteristics of different regions, such as promoting drone agricultural services in rural areas and low-altitude logistics services in urban centers. Finally, the province should enhance connections with domestic and international markets by participating in international exhibitions and establishing cooperative alliances to expand market opportunities.

5. Conclusion

The development of the low-altitude economy in Shandong Province demonstrates significant potential, driven by advancements in new quality productive forces. The analysis reveals that while the region has established a solid foundation in drone technology and related industries, challenges such as insufficient policy support, limited technological innovation, and market demand fluctuations persist. To overcome these barriers and sustain growth, it is essential to implement targeted strategies, including policy enhancement, technological innovation, and market diversification.

Short-term efforts should focus on creating a supportive policy environment, improving infrastructure, and fostering industry-university collaboration to strengthen technological capabilities. In the long term, Shandong should aim to establish a nationally recognized industrial cluster with increased technological autonomy. By expanding application scenarios and enhancing global collaboration, the region can achieve a stable and sustainable low-altitude economy, contributing significantly to regional economic development and industrial transformation.

Overall, this study provides a theoretical foundation and practical recommendations that can guide policymakers and industry stakeholders in promoting the healthy development of the low-altitude economy in Shandong Province. Future research can further explore the impacts of emerging technologies and evolving market trends on this sector to optimize development strategies.

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