Research on the Mechanism, Path, and Countermeasures of Digitalization Empowering Economic Development

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Abstract—In the paper we explore the mechanism and path selection of digital empowerment for the economic development and growth of major industries in Shandong Province, and propose targeted countermeasures and suggestions, is of great theoretical significance and practical value for the in-depth implementation of "Digital Shandong" construction and the realization of high-quality economic and social development in Shandong.

Index Terms—digitalization, development mechanism, path selection, countermeasure research.

I. INTRODUCTION

The digital economy takes digital knowledge and information as key production factors, digital technology as the core driving force, modern information networks as important carriers, and achieves deep integration of digital technology and the real economy through information and communication technology and artificial intelligence, greatly improves economic efficiency and optimizes economic structure, continuously improves the level of digitalization, networking, and intelligence of the economy and society, then accelerates the reconstruction of a new economic form of economic development and governance model [1]. China attaches great importance to the development of the digital economy and elevates it to a national strategy. From the 14th Five Year Plan, to the 20th National Congress of the Communist Party of China, and to the 2023 National People's Congress, the top-level design and industry guidelines for developing the digital economy and building a digital China have been repeatedly mentioned and continuously clarified. According to the Digital China Development Report (2022), the scale of China's digital economy reached 50.2 trillion yuan in 2022, accounting for 41.53% of GDP. All provinces (autonomous regions, municipalities directly under the central government) in China prioritize the layout and development of the digital economy.

In 2023, the total digital economy of Shandong Province reached 4.3 trillion yuan, accounting for over 47% of GDP. The digital economy has taken up half of the province's economy. However, Shandong Province still faces problems such as incomplete digital infrastructure construction, weak industrial digital transformation, weak digital innovation capabilities, and insufficient digital professionals. Therefore, facing the great opportunity for the development of the digital economy, Shandong Province faces both opportunities and challenges. Analyzing the mechanism and path of digital empowerment for economic development, and proposing corresponding countermeasures and suggestions, is of great theoretical significance and practical value for the in-depth implementation of the "Digital Shandong" construction and the realization of high-quality economic and social development in Shandong.

II. MECHANISM AND PATH SELECTION

A. Leads the High-quality Development of Modern Agriculture

Shandong Province is an important agricultural product production base in China. The development of the digital economy has provided new technological means and tools for modern agricultural production, and technological innovation has given new development impetus to

modern agriculture. The cutting-edge digital production technology leads the high-quality development of modern agriculture [2]. In response to the development of digital agriculture in Shandong, firstly, we need to promote the construction of smart agriculture, achieve digital management of the entire agricultural production process, explore the pilot application of smart agriculture, carry out agricultural Internet of Things demonstration projects, build a collection, analysis, monitoring and warning system for the entire industry chain data resources, carry out the application of automated, unmanned, and information-based agricultural intelligent equipment, and improve the efficiency of modern agricultural production; Secondly, we need to promote the e-commerce process of agricultural product circulation, accelerate the popularization of new models and formats such as video live streaming, short videos, online group buying, and community group buying, promote the e-commerce sales of characteristic agricultural products, create rural characteristic industries and agricultural product network brands, and continuously promote the construction of county-level and rural logistics distribution systems; Thirdly, we need to build a high-quality agricultural product supply and marketing chain, control the entire process of commercial development of agricultural products through blockchain technology, establish an agricultural product industry chain that radiates the province and even the whole country, accelerate the circulation speed of agricultural products, reduce intermediate link costs, and increase farmers' income; Fourth, we should rely on digital technology to promote the digitalization of agricultural public services, constantly promote the development of service models such as "science and technology+services", "Internet+services", and "agriculture material+services", and expand employment channels with the help of the development of digital agriculture; The fifth is to promote agricultural and rural big data centers and e-commerce centers, and support the creation of a number of important agricultural product full industry chain demonstration application bases.

B. Drives the Transformation and Upgrading of the Manufacturing Industry

With the support and drive of the digital economy, we actively promote the transformation and upgrading of the manufacturing industry. With the development of the digital economy, the research and development of big data, cloud computing, and AI robot computing platforms are vigorously promoting the transformation and development of the industrial economy [3]. At the same time, the application of 5G technology provides a new means of quality control and monitoring for the overall control and project system operation of industrial enterprises. Some intelligent safety management systems are widely used, promoting scientific decision-making and major event warning and forecasting in industrial enterprises, and promoting the transformation and development of the manufacturing industry [4]. (1) For the digital transformation of the manufacturing industry, it is necessary to actively promote the implementation of the new generation of information technology, such as artificial intelligence, blockchain, edge computing, etc. By strengthening the deep integration of digital technologies, such as digital parks, digital simulation, MES, ERP, intelligent logistics, etc., with the manufacturing industry, it is necessary to constantly improve the digital level of manufacturing research and development and production, take customer demand as the starting point of research and development and production, constantly improve product quality and production efficiency, Realize intelligent manufacturing and low consumption manufacturing. (2) We will focus on implementing digital benchmarking actions in the manufacturing industry, creating a "digital leader" enterprise, and cultivating the "industrial brain" and "digital economy headquarters" of key industries. Actively carry out technological transformation and upgrading actions in the manufacturing industry, promote the development of the manufacturing industry towards digitization, networking, and intelligence, improve the core competitiveness of enterprises, and achieve industrial structure upgrading. (3) Recognize a group of digital workshops, intelligent factories, and high-tech enterprises with high standards, actively strive to become provincial intelligent

manufacturing benchmarks and national intelligent manufacturing pilot demonstration projects, and gradually cultivate "provincial-national" intelligent factories in a hierarchical manner.

C. Accelerates the Construction of Smart Culture and Tourism

Shandong has a profound cultural heritage and a developed cultural and tourism industry. Since the comprehensive and large-scale launch of 5G base station construction in 2019, Shandong has built over 190 thousand 5G base stations, and the core areas of various cities and counties (cities, districts) have achieved 5G coverage. 5G base station construction plays a key role in cultural and tourism development and the creation of cultural and tourism digital platforms. While promoting the construction of 5G base stations, we should closely combine 5G integrated applications, industrial innovation and development with a new industrialized city. Starting from the chain owners and leading enterprises of various industrial chains, we should vigorously develop the industrial Internet, promote 5G application promotion and industrial innovation, and accelerate the digital and intelligent transformation of various industries. Promote the deep integration of 5G technology in various fields such as culture, tourism, government affairs, transportation, finance, etc., actively build a 5G ecosystem with Shandong characteristics, and quickly form a group of well-known and widely promoted integrated application models. Key efforts will be made to promote the construction of intelligent monitoring facilities in scenic areas, establish a dynamic monitoring system for tourists, improve smart supervision of the tourism industry, promote smart tourism services, and enhance the immersive experience of tourists through artificial intelligence technologies such as virtual reality. Actively guide scenic spots to develop digital products, popularize intelligent services such as scenic spot electronic maps, QR code recognition, and online reservations. Comprehensively promote the intelligent construction of hotels, homestays, and small restaurants, explore new models of non-contact services, and actively promote and comprehensively promote tourism resources in Shandong through domestic high traffic video platforms.

D. Drives the Opening Up of the Service Industry

The development of the digital economy mainly drives the opening up of the service industry through three paths: digital industrialization, industrial digitization, and consumption upgrading. The digital economy forms economies of scale by promoting the expansion of regional digital industrialization, improving the efficiency of regional industrial resource allocation, thereby exerting productivity effects, and driving the development of the e-commerce market to improve the level of service industry openness. The digital economy utilizes industrial digitization to input data elements as emerging production factors, improving industrial efficiency. The digital development has significantly improved the service-oriented level of enterprises, and at the same time, the degree of digital development and regional service industry openness will have an interactive impact on the service-oriented level of enterprises. From the perspective of the digital transformation of the service industry itself, the digital transformation of the service industry can promote the comprehensive upgrading of digital infrastructure, improve the efficiency of resource allocation in the service industry, reduce transaction costs, and drive the expansion of the service industry's opening up, achieving a change from "quantity" to "quality". In response to the digital transformation of the service industry, the combination of big data and digital intelligent technology will enable service industry operators to more accurately obtain consumer needs, meet new development needs such as personalization, online and intelligent services, and further enhance the openness and consumption upgrading of the service industry [5].

III. COUNTERMEASURES AND SUGGESTIONS

A. Accelerate the Layout, Construction, and Improvement of Digital Infrastructure

The high-quality development of the digital economy cannot be achieved without the coordinated promotion of digital infrastructure, digital industrialization, industrial digitization, and digital innovation capabilities. Improving digital infrastructure is a prerequisite and foundation for ensuring the development of the digital economy.

First, we will actively promote the transformation and improvement of traditional digital infrastructure. For areas with weak digital infrastructure, we will transform and improve broadband networks, build gigabit networks, and achieve full coverage of the Internet in urban and rural areas of Shandong. We will continue to increase investment in digital infrastructure construction, and promote inclusive digital infrastructure construction. In addition, we will accelerate the construction of a new generation of digital economy development carriers, accelerate the layout and construction of broadband Internet of Things, create strong digital infrastructure for the real economy, and promote the integration and development of digital technology and industry industries. From the perspective of comprehensive and coordinated development in Shandong, we will consider the layout, construction, and improvement of new generation information infrastructure such as 5G base stations, blockchain, and artificial intelligence. [8] examined the development and refinement of possible mathematical models for the intellectual system of career guidance. Mathematical modeling of knowledge expression in the career guidance system, Combined method of eliminating uncertainties, Chris-Naylor method in the expert information system of career guidance, Shortliff and Buchanan model in the expert information system of career guidance and DempsterSchafer in the expert information system of career guidance method has been studied. The algorithms of the above methods have been developed. [9] discussed that according to the observations in this paper, an existing mathematical model of banking capital dynamics should be tweaked. First-order ordinary differential equations with a "predator-pray" structure make up the model, and the indicators are competitive. Numerical realisations of the model are required to account for three distinct sets of initial parameter values. It is demonstrated that a wide range of banking capital dynamics can be produced by altering the starting parameters.

B. Break the Regional Barriers and Promote the Regional Collaborative Development of Digital Economy

Firstly, fully leverage the radiation capabilities of regions with good digital economy development such as Jinan and Qingdao, accelerate the deep integration of big data, Internet of Things, blockchain, and other industries, create a good ecosystem for the integration of new technologies and industries, highlight the construction of innovation pilot zones and demonstration zones in key areas, and drive the development of the digital economy in the province. Secondly, fully utilize the advantageous industries of the digital economy in Shandong Peninsula, form a good pattern of regional digital economy interaction and development, promote the transfer of peninsula technology and industrial resources to the inland areas of Shandong, gradually narrow the gap between the levels of digital economy development, and achieve data and information sharing. Furthermore, in January 2024, the Jinan and Qingdao metropolitan areas were approved, and Shandong has ushered in good development opportunities in industrial structure upgrading, emerging digital economy related industries such as big data, high-end equipment, big health, and advanced materials, and is about to take off [6].

C. Integrate the Industrial Resources and Empower the Digital Transformation and Upgrading of Traditional Industries

Based on the development needs of the digital economy in Shandong Province, we encourage local traditional industries to transform and upgrade towards digitalization, and promote the widespread application of digital technology in various industries. Improve the application level of digital technologies such as big data and artificial intelligence, and reconstruct the production mode of traditional industries with industrial Internet. By introducing high-tech enterprises and entrepreneurs, cultivating local innovative enterprises to grow and strengthen, supporting major technological breakthroughs and achievement transformation, we will increase support for real economy enterprises, thereby empowering the digital transformation and upgrading of traditional industries. In terms of digital industrialization, with a focus on value-added data services and effective circulation of data element resources, further improve relevant supporting policies. Promote the integration of blockchain, big data, artificial intelligence and other technologies, and apply digital innovation models in fields such as culture, tourism, commerce, and

finance to create advantages in the digital economy industry. In terms of industrial digitization, we will integrate the digital industry resources of Shandong Province, promote the agglomeration development of the digital industry, improve the innovation ability of digital related industries, and strive to build Shandong into a leading digital industry cluster in Shandong Province. Shandong Province has abundant industrial resources such as agriculture, manufacturing, cultural tourism, and service industries. In the development of the digital economy, these advantageous industrial resources should be fully explored, and a digital economy industry with characteristics such as agriculture, industry, finance, cultural and creative industries, and tourism should be created to improve industrial added value and core competitiveness. In addition, establish provincial and municipal digital economy associations, coordinate industry university research cooperation research, and actively promote and implement digital industrialization application models.

D. Enhance the Innovation Environment of the Digital Economy and Improve the Security Guarantee System of the Digital Economy

Firstly, promote the construction of a digital government in Shandong Province. The construction of a digital government is an important guarantee for the development of the digital economy. Shandong Province needs to comprehensively carry out digital government construction as soon as possible, complete the integration and digital management of government information resources as soon as possible, and improve the efficiency and level of government services. Secondly, for regions with a low level of digital economy development, we can strengthen the governance environment and innovation environment by deepening the application of government affairs Internet, promoting the exchange and sharing of government affairs data, increasing the number of patent applications, increasing R&D funding, cultivating digital professionals, and improving the number of employees in software and information technology services. Furthermore, regions with higher levels of digital economy development can strengthen the innovation environment and improve the digital economy security system, thereby driving areas

with lower levels of development, promoting further optimization of the digital economy development environment in the province, and building a good innovation environment and security system for the coordinated and rapid development of the digital economy in Shandong Province.

E. Strengthen the Talent Introduction, Training, and Cultivation Efforts

Based on the actual situation in Shandong, we propose to (1) actively strengthen the construction of the scientific and technological talent team through various measures such as talent introduction, especially in the introduction of high-level and high-tech talents, tilt towards digital technology talents, introduce corresponding talent introduction and preferential policies, achieve talent aggregation, and provide strong intellectual support for the revitalization of Shandong. (2) Shandong should increase cooperation and support with universities within the province, and universities should also adhere to market demand orientation, abolish "backward" majors, actively apply for urgently needed majors such as big data and artificial intelligence, actively connect with social needs, and serve the development of the digital economy. Universities should also promote the reform of talent training programs, vigorously practice the educational model of integrating industry and education, school enterprise cooperation, and industry university research collaboration, and build a community with a shared future for universities and industry enterprises. (3) Vigorously develop vocational education, enhance the digital skills of existing employees in enterprises through digital vocational skills training and other methods, so that they can meet the requirements for digital economy positions. (4) Cultivate and introduce high-quality high-end enterprises and entrepreneurs, attract high-tech enterprises to settle down through the construction of digital economy characteristic industrial parks, guide enterprises to actively participate in external cooperation, and strengthen the vertical depth and horizontal breadth of digital economy cooperation. At the same time, we should strengthen the connection between the industrial chain, actively connect with business cooperation, improve the level of openness of the digital economy, and

vigorously cultivate new driving forces for the development of the digital economy. (5) Encourage local enterprises to research and innovate, focus on cultivating digital talents, and increase their deep cultivation in digital technology. The government should also increase its support for innovation and entrepreneurship, provide preferential policies and an entrepreneurial environment, promote the development of the digital economy industry and the growth of innovative and entrepreneurial enterprises, actively promote the listing of high-tech enterprises, expand financing channels, and expand industry influence. (6) Create a good talent environment that can be hired, retained, and done well. Consolidate the foundation of digital talent construction, introduce talent incentive measures, vigorously support high-level talents to apply for national and provincial talent projects, increase the cultivation, rewards, and transformation of scientific research achievements, and promote the rapid development of Shandong's digital economy.

F. Accelerate and Improve the Construction of Digital Industry Platforms

Deeply tap Shandong's advantageous industrial resources, explore and form a number of regional, enterprise and industry level industrial Internet platforms, and accelerate the development of competitive industrial platforms such as smart agricultural platforms, e-commerce platforms, logistics platforms, financial service platforms, bulk commodity trading platforms, digital medical platforms, as well as public service platforms such as smart education, smart social security, and smart parking. In addition, a comprehensive regional data center should be established to effectively apply and develop data, strengthen data circulation review, enhance data security functions, leverage the spillover effects of the digital economy, and effectively enhance the value of the digital economy [7].

IV. Conclusion

Entering the digital age, the digital economy has become an important direction for the development of countries and regions, as well as a new engine for economic growth. The digital economy in Shandong Province is also showing a rapid development trend, becoming an important support for economic development. This is not only a trend, but also a new track and key increment for achieving high-quality development. The digital economy in Shandong Province has good development prospects and broad development space. By doing a good job in top-level planning, formulating targeted guidance and support policies, adhering to targeted and precise implementation, accelerating the improvement of digital infrastructure construction, taking the path of industrial digitization and digital industrialization, accelerating the digital transformation and upgrading of manufacturing, promoting the integration of advanced manufacturing and modern service industries, supporting the development of high-tech enterprises, introducing and cultivating high-quality enterprises, and promoting the implementation of a batch of standardization Modular and precise digital application scenarios can better promote the continuous development of Shandong's digital economy industry, achieve digital, intelligent, and high-end economic growth, and make Shandong's economy healthier and more sustainable.

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