Policy Recommendations for High-Quality Development of Shandong's Artificial Intelligence Industry

Gang Li[1,*] and Mingxi Ji[2] and
Qianlong Liu[2] and Hengyu Zhang[2]

[1]Shandong Computer Science Center (National Supercomputer Center in Jinan), Jinan, 250000, China
[2]SHANDONG SCICOM Information and Economy Research Institute Co., Ltd., Jinan, 250000, China

*Liuwh@sdas.org

Abstract. The rapid iteration and disruptive evolution of artificial intelligence (AI) technologies are profoundly reshaping the industrial landscape, making the industrialization of AI a central focus of current strategic frameworks and competitive dynamics among stakeholders. Shandong Province has developed a relatively comprehensive AI infrastructure, with its core industry beginning to take shape and demonstrating an overall development pattern characterized by "dual growth poles driving progress, supported by multiple regions." However, compared to more advanced regions, the development of Shandong's AI industry still faces challenges, including insufficient core research and development (R&D) capabilities, a relatively underdeveloped industrial scale, and an ecosystem that requires further strengthening. In this context, this study systematically analyzes the key elements of AI industry development, aligns them with the actual conditions of Shandong's AI sector, and proposes targeted recommendations. These recommendations include accelerating breakthroughs in core technologies, enhancing the supply of foundational resources, optimizing the industrial ecosystem, promoting scaled industrial development tailored to local conditions, and refining the industrial support system. The findings provide a valuable reference for advancing the high-quality development of Shandong's AI industry.

Keywords: Artificial Intelligence Industry, High-Quality Development, Policy Recommendations.

1 Introduction

Artificial intelligence (AI) is a pivotal force in the new generation of technological revolution and industrial transformation[1]. Its robust technical capabilities in data processing, autonomous learning, and intelligent decision-making are accelerating industrial innovation and reshaping business models, making it a key battleground for global competition in technology and the economy[2][3]. As a critical driver for transitioning to

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high-quality economic development, the AI industry has become a core strategic focus of China's planning in recent years.

East China's Shandong Province is making significant progress in the AI sector, supported by a pioneering policy framework and a robust industrial ecosystem. This ecosystem features a comprehensive industrial structure, substantial economic scale, and advanced integration of industrialization and informatization. However, challenges such as limited industrial scale and the need to enhance competitiveness have gradually emerged within Shandong's AI sector. In response, this study provides an overview of the industrial development level of artificial intelligence in Shandong Province by synthesizing relevant data from reports published by the Ministry of Industry and Information Technology (MIIT), the Central Cyberspace Administration of China (CAC), and information from the Shandong Statistical Yearbook.

2 Current status of Shandong's AI industry

2.1 The Industry has Achieved Initial Scale

Shandong now hosts nearly 1,000 core AI enterprises, most of which are clustered in the Jinan–Qingdao AI Innovation Pilot Zone. This concentration has produced clear agglomeration effects and a well-defined dual-hub structure: Jinan and Qingdao act as the primary engines, with Zibo and Yantai serving as secondary nodes.

Jinan alone is home to more than 430 AI companies, including industry leaders such as Inspur, Huayi Micro-electronics, Synthesis Electronic Technology, and Dareway Software. Within the city, 62 enterprises are developing large language models (LLMs); seven of their models have obtained generative-AI service licences from the Cyberspace Administration of China (CAC), while 40 have completed registration for deep-synthesis algorithms.

Qingdao, the second hub, hosts over 30 LLM developers. Flagship models include the Hanhai Xingyun general-purpose LLM and the COSMOPlat Tianzhi industrial model. Beyond the two main cities, Zibo's Zhiyang Innovation Technology ranked among China's Top 50 LLM patent holders in 2023, and Yantai-based Gogetter Intelligence has launched the country's first chemical-industry large model.

2.2 The Foundational Resources are Relatively Complete

Computing power, storage capacity, network transport capability, and data are the foundational elements that support AI development[4]. Shandong Province boasts a well-established infrastructure across all these domains, providing robust support for the growth of its AI industry.

The scale of intelligent computing has expanded rapidly. As of January 2025, the province's total computing power reached 9.66 exaflops (E), with intelligent computing accounting for over 30%. Shandong has completed its computing network, which connects 16 municipal backbone nodes and more than 100 edge nodes, significantly

enhancing its ability to coordinate and supply diverse heterogeneous computing resources.

Storage capacity continues to expand significantly. The province now operates over 350,000 standard racks with a total storage capacity exceeding 45 exabytes (EB), providing robust support for extensive data storage and exchange. The quality of network transport has improved remarkably, with total data center network export bandwidth reaching 189,000 Gbps. With both Jinan and Qingdao serving as national internet backbone direct connection points, Shandong remains the only province with this "dual-hub" status, marking a substantial enhancement in its backbone network capacity. Data resources have become increasingly abundant. The launch of two direct connection points will significantly enhance the efficiency of cross-network access with other provinces. For instance, when Xi'an Mobile connects to the communication source of Jinan Unicom, it no longer needs to reroute southward to Shanghai. This change can reduce the transmission distance by approximately 1,100 kilometers. Additionally, the inter-provincial network latency has decreased from 39.03 ms to 29.84 ms, representing a reduction of 23%. The packet loss rate has also dropped from 0.086% to 0.024%, a decrease of 72%. This infrastructure not only facilitates the rapid local circulation of data, computing power, and algorithms but also enables Shandong enterprises to seamlessly integrate into the national and AI ecosystem with minimal latency, maximum reliability, and optimal cost efficiency.

2.3 Breakthroughs are Continuously Being Made in Key Areas

The province has strategically focused on key cutting-edge areas, implementing comprehensive initiatives in LLM and embodied intelligence.

In the LLM sector, Shandong has approved eight new large models for national generative AI service registration in 2024. Inspur's HaiRuo LLM has gained global recognition by winning the QASC Challenge with an impressive accuracy of 93.70%. It is the only product in China to secure all three registrations from the Cyberspace Administration of China (CAC) for foundational models, intelligent agents, and algorithms. Additionally, the Laoshan Laboratory has launched the "WenHai" model, establishing a domestically developed AI foundation for high-resolution forecasting of the global marine environment.

In the field of embodied intelligence, Shandong Province is home to six complete machine manufacturers and 162 key component suppliers. In 2024, the market size for humanoid robots in China was approximately 2.76 billion yuan, with Shandong's humanoid robot industry generating an output value of 410 million yuan. Shandong has established a comprehensive industrial chain that encompasses design, R&D, and manufacturing. Notable enterprises such as Guohua (Qingdao) Intelligent Equipment and Fengguang Precision have integrated innovative products—including harmonic reducers and planetary roller screws—into global supply chains. Yobotics's "Xingzhe Taishan" has achieved stable operation at a speed of 7.2 km/h, setting a leading benchmark within the domestic market.

3 Problems of Shandong's AI industry

In terms of limitations, this study analyzes the subject from both macro and micro perspectives. At the macro level, the paper examines the industrial scale of Shandong's AI industry. At the micro level, it specifically investigates the factors influencing this industrial scale, including foundational support capabilities and the competitiveness of the core industry.

3.1 The Industrial Scale Lags Far Behind

In 2024, Shandong's AI industry output exceeded 90 billion yuan, achieving an impressive average annual growth rate of 30% over the past two years. However, due to foundational and structural constraints, the province's core AI industry significantly lags behind that of more developed regions. For instance, Guangdong's output in 2024 exceeded 220 billion yuan, while Beijing's output increased from 268.6 billion yuan in 2023 to nearly 350 billion yuan in 2024, as illustrated in Figure 1. Consequently, Shandong's output represents only 41% of Guangdong's and 25.7% of Beijing's. Although Shandong has a slightly higher growth rate, the absolute increase in output remains insufficient to bridge this gap.

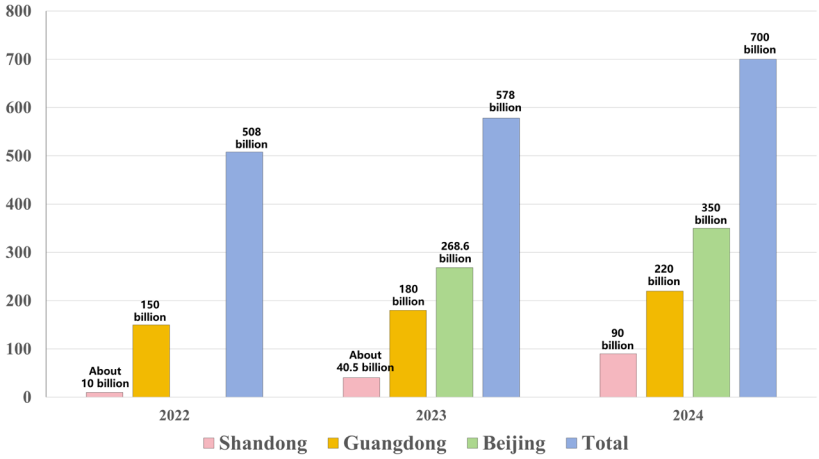

Fig. 1. AI Core Industry Scale (Unit: billion yuan).

3.2 Foundational Support Capacity Requires Enhancement

Shandong Province currently ranks seventh nationwide in the comprehensive computing power index, with its total and operational computing capacity both placing eighth. However, its under-construction computing infrastructure and computing efficiency do not rank within the top ten. In terms of storage capacity, the province's comprehensive storage sub-index stands at seventh place nationally. Notably, Shandong was excluded from China's strategic "East Data, West Computing" project, which designated eight national computing hubs and ten national data center clusters, placing the province at a

distinct disadvantage in the efficient coordination of computing resources. Furthermore, while China has established seven national-level data labeling bases that support 121 domestic AI large models, Shandong has yet to develop either a national data annotation base or professional service platforms. As a result, its data labeling capabilities remain relatively underdeveloped compared to leading regions.

3.3 Insufficient Industrial Competitiveness

The polarization trend in China's AI industry has become increasingly pronounced[5][6], with the top 50 national enterprises, such as Cambricon and SenseTime, predominantly clustered in Beijing, Shanghai, and Guangdong. In contrast, Shandong lacks nationally influential AI leaders comparable to Cambricon in chip technology or iFlytek in algorithms. This disparity is particularly evident in the large model sector. As of June 2025, only 11 of China's 439 CAC-registered large models (2.47%) originated from Shandong, which is significantly fewer than those from Beijing (132), Shanghai (82), and Guangdong (66). Similarly, Shandong accounted for just 69 (2.01%) of the 3,476 deep synthesis algorithm filings disclosed by the CAC through May 2025, trailing far behind Beijing's 946 and Guangdong's 729, as illustrated in Figure 2. These metrics collectively illustrate Shandong's peripheral position in China's core AI innovation ecosystem.

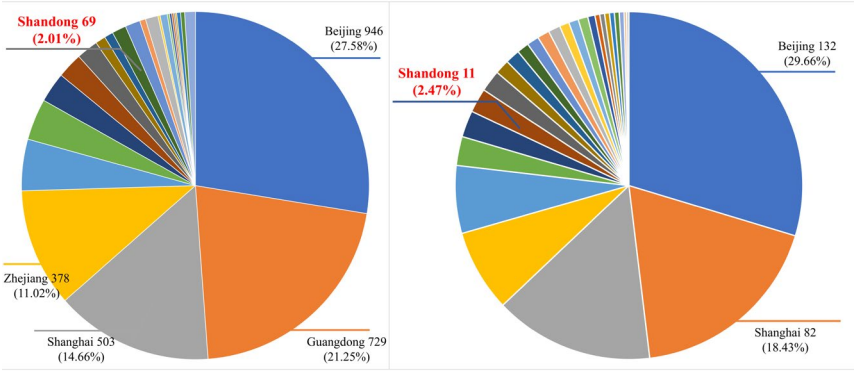

Fig. 2. Number of LLMs filings (left) and algorithm filings (right) of each province with CAC.

4 High-Quality Development Paths for the AI Industry

From the perspective of technological evolution, the three core elements of artificial intelligence—computing power, algorithms, and data—are transitioning from collaborative optimization to deep integration and innovation. Cutting-edge technologies, such as large-scale models and spatial intelligence, will synergistically advance AI systems from specialized applications to general-purpose capabilities. This progress will propel industrial applications beyond isolated solutions to ecosystem-wide adoption, making the development of an innovation-driven, deeply collaborative industrial ecosystem a key priority for future planning, as illustrated in Figure 3.

Furthermore, while unlocking technological benefits, the advancement of AI will also transform the combination of production factors. Shandong's key industries—including new energy, advanced materials, healthcare, and high-end chemicals—offer abundant opportunities for AI applications. Conversely, the deep integration of AI will mutually reshape the competitive advantages of these sectors. Leveraging this reciprocal empowerment mechanism and optimizing the allocation of production factors will be essential for advancing Shandong's AI industry.

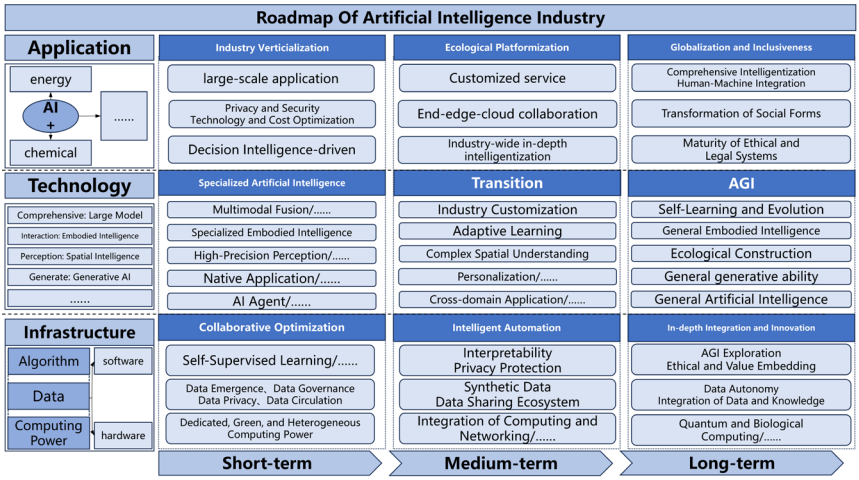

Fig. 3. Roadmap Of Artificial Intelligence Industry.

5 Conclusions

Based on the current state of research developments and the domain pathways discussed above, this paper draws the following conclusions.

Increase the R&D investment. At first, it is crucial to increase R&D investment in AI technologies. Major provincial projects should prioritize large models, brain-inspired intelligence, and embodied intelligence, utilizing a selection mechanism to identify the most effective research teams. Leading enterprises must collaborate with universities, research institutes, and industry partners to collectively address key technological challenges. Second, promote cutting-edge AI research by enhancing policy support and increasing funding for fundamental AI studies. Encourage academic institutions to investigate explainable and generalizable next-generation AI methodologies. Targeted research and development efforts should focus on both emerging domains and existing challenges, with particular emphasis on theoretical breakthroughs in AI-driven engineering sciences and other interdisciplinary fields[7][8].

Accelerating the Supply of Foundational AI Resources. By leveraging the national Internet backbone's direct connection points in Jinan and Qingdao, establish two low-latency data center core areas. Based on the advantageous industrial layout of each city, develop data center clusters and support cities with the necessary conditions to build regional computing power centers. Deploy several industry application nodes that focus

on key sectors such as manufacturing, and create edge computing nodes. In regions with high demand for computing power and robust industrial capabilities, explore the development of urban computing power networks to facilitate efficient alignment between urban computing resources and demand, thereby effectively reducing the cost of computing power usage. Optimize the business environment for AI industries, foster a culture of innovation, and incentivize long-term investment in R&D. Strengthen service-oriented government initiatives to create a conducive environment for retaining and developing technical talent[9][10].

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Disclosure of Interests

The authors have no competing interests.

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