



Research on the High-Quality Development of Industrial Software in Shandong Province

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Abstract. Industrial software serves as the foundational infrastructure of the industrial system. Its advancement toward high-end, self-sufficiency capabilities has become a crucial pathway for driving high-quality industrial transformation and accelerating the emergence of new productive forces. However, China's industrial software sector faces increasing external monopolies and restrictions. In Shandong Province, the development of industrial software encounters both industry-wide challenges and region-specific issues, including limited industrial influence, weak support from foundational technologies, insufficient industrial collaboration, and an underdeveloped ecosystem. This study, aligned with the goals of building a strong digital province and a leading advanced manufacturing region, and taking into account the province's actual industrial conditions, focuses on the innovative development of industrial software. The following development pathways and recommendations are proposed: enhancing industrial development capacity; promoting whole-chain collaboration and integration; accelerating core technology research and development; and improving the software industry ecosystem.

Keywords: Industrial software, High-quality development, Shandong Province

1 Introduction

As the core underpinning of a modern industrial system, industrial software carries strategic significance across the entire industrial chain and the full lifecycle of production and manufacturing. It acts as a key engine for building a strong manufacturing sector and bolstering core industrial competitiveness.

From the perspective of development context and regional positioning, Shandong constitutes a vital strategic pillar for northern China's economic development and a major industrial base, shouldering the important mission of leading regional economic

growth. In terms of industrial foundation, Shandong ranked fourth nationwide in software business revenue in 2025.

Nevertheless, in light of the demands for industrial transformation and high-quality development, Shandong still faces prominent gaps in the independent controllability and high-end development of industrial software. To align with the industrial upgrading initiatives in the 15th Five-Year Plan and advance the key task of advancing new industrialization, accelerating innovative breakthroughs and high-quality development in the industrial software industry has become a core strategic focus for the province.

2 Current Status of the Industrial Software Industry in Shandong Province

The industrial sector in Shandong has grown steadily. As a major industrial province, Shandong boasts a solid industrial foundation, a comprehensive industrial system, a leading industrial economy nationwide, and the highest number of national-level manufacturing single champions in China^[1]. Within this context, industrial software in the province enjoys extensive coverage and deep penetration across application scenarios, with its industrial scale expanding consistently. On the demand side, the digital transformation of key sectors such as high-end chemicals, iron and steel, and advanced equipment manufacturing has generated substantial and rigid demand for industrial software and supporting core technologies, including edge computing and industrial large models. Driven by this strong domestic demand, world-class industrial internet platforms, represented by COSMOPlat and Inspur Yunzhou, have been developed, serving as key platforms for the large-scale deployment of various industrial software and intelligent technologies. On the supply side, the province has established 247 provincial-level software engineering technology centers, forming a market-oriented technological innovation system centered on enterprises and deeply integrating industry, academia, and research. Leveraging the full-chain layout of leading industrial enterprises, significant progress has been made in nurturing industrial software firms. Forty-seven large industrial enterprises, including Shandong Iron and Steel Group and Shandong Energy Group, have integrated digital resources and incubated local industrial software companies such as Shanxin Software, Sinopec Matrix Corporation, Shandong Victorysoft, and Yunding Technology.

Regional development characteristics have initially taken shape. From the supply side, the province hosts two renowned Chinese software cities—Jinan and Qingdao—ranked fourth and 24th nationally, respectively. Jinan focuses on empowerment through basic and industrial software, providing comprehensive industrial software solutions that cover the entire chain from R&D and design to production, manufacturing, and operation management. It has also established an AI + industrial software data cluster. In the core field of computer-aided design (CAD) software, Hoteam Software's CAD software enjoys a significant market advantage with a 1.7% market share, ranking seventh nationwide and third among domestic manufacturers. Amid continuous growth in its industrial scale, the company initiated its IPO process at the end of 2025. In the production control (MES) sector, Inspur Digital leads the equipment manufacturing

industry with a 10.2% market share, ranking first nationally. In the enterprise resource planning (ERP) field, notable companies such as Inspur General Software and Shanxin Software have emerged. Qingdao focuses on the Industrial Internet and its deep integration with distinctive advantageous industries. Led by Haier COSMOPlat—the world’s first platform in the field of mass customization—a multi-domain, multi-level industrial internet platform matrix has been established.

Breakthroughs in core technologies across multiple fields. In underlying technologies, leading cross-sector industrial internet giants like Haier COSMOPlat and Inspur Yunzhou have attained multiple top-tier breakthroughs in foundational architecture, industrial large models, core scenarios, and international standards. Qingdao Digital Intelligent Ship & Ocean Technology has introduced FastCAE, the nation’s first independently developed open-source CAE integration framework. In infrastructure, Shandong Cvicse Middleware’ foundational middleware products have achieved full-stack independent control across key information infrastructure sectors. In R&D and design, Hoteam Software’s CrownCAD platform features the country’s only independently developed “3D geometric modeling engine ” and “geometric constraint solver ” In additive manufacturing, Shandong Charm Ray has pioneered the formulation of China’s first international standard for “additive manufacturing product data protection,” led by a private enterprise. On the industrial application front, Sinopec Matrix Corporation’s launch of its logging-while-drilling measurement and control core technology has broken foreign monopolies, and its SINOLOG900 network imaging logging system has reached internationally advanced levels.

3 Problems in the Development of Shandong’s Industrial Software Industry

Insufficient Industrial Influence. Despite its large industrial scale, Shandong has yet to convert its volume into corresponding market influence and brand power. According to industry research, although competitive leading enterprises such as COSMOPlat, Hengyuan Intelligent Technology, Shanxin Software, and Mesnac have been developed, their capabilities in cross-industry integration, cross-regional expansion, and full-stack software-hardware integration remain insufficient. The province has not yet established comprehensive leading enterprises comparable to Baosight Software or ZWSOFT, which possess full-sector coverage, core technological dominance, and leadership within the industrial ecosystem. While core technology enterprises such as Hoteam possess technological advantages and have established an initial industrial ecosystem by attracting over 30 upstream and downstream firms, they still lag significantly in scale and model compared to platform-level ecosystems in the Yangtze River Delta and the Guangdong-Hong Kong-Macao Greater Bay Area. These regions integrate hundreds of digital service providers and supporting enterprises through industrial operating systems, industrial internet platforms, digital capability centers, and digital marketplaces.

Inadequate Industrial Collaboration. Industrial software relies on underlying technologies that involve a deep interdisciplinary integration of mathematics, physics, engineering, and computer science. This integration demands talent and capital beyond

the capacity of individual enterprises [2]. Despite a high external dependence on core technologies, intra-provincial collaboration remains project-based rather than focused on systematic research of foundational technologies or ecosystem development. Specifically, R&D and design software lack mature collaborative capabilities. Although the province's 11 provincial-level software parks host over 11000 enterprises, they have not fully mobilized or integrated resources for industrial software. Nationally, ecosystem aggregation models have emerged: the Greater Bay Area National Technology Innovation Center facilitates cross-enterprise, cross-software-hardware, cross-provincial, and cross-industry clustering for full-stack optimization; Shanghai's Minhang District has brought together 114 enterprises to build an industrial software ecosystem. While Qingdao Noah International Technology's Xishi Industrial Software Community serves as a local benchmark, overall collaboration remains in its early stages, driven primarily by policy guidance and voluntary participation, and is far from institutionalized or platform-based systems.

Unresolved Breakthroughs in Core Underlying Technologies. Core underlying technologies still require significant breakthroughs. Amid a lack of independent software R&D platforms, heavy reliance on European and American technology systems for key technologies, and limited capacity for deep software customization, core technologies such as geometric constraint solvers and process simulation have become critical bottlenecks hindering the high-quality development of the industrial software sector in Shandong Province and across China. In high-end manufacturing sectors such as aviation, petrochemicals, shipbuilding, and new energy vehicles, industrial software in the province has revealed prominent issues, including insufficient multi-physics coupling accuracy, frequent disruptions in the process data chain, outdated knowledge base updates, low software maturity, and weak supply chain resilience. From a development perspective, the province has gradually formed scale advantages by leveraging its comprehensive industrial system. As the digital and intelligent transformation of industry continues to deepen, the province's abundant industrial scenarios are driving increasing demand for industrial software. Currently, as shown in Figure 1, the province has certified 9 batches totaling 1659 provincial-level first-release high-end software products, fully unleashing the vitality of small, medium, and large enterprises. However, only a few companies, represented by Hoteam CAD and Inspur ERP, have reached the first tier of domestic industrial software providers. The transition from quantity to quality requires further advancement.

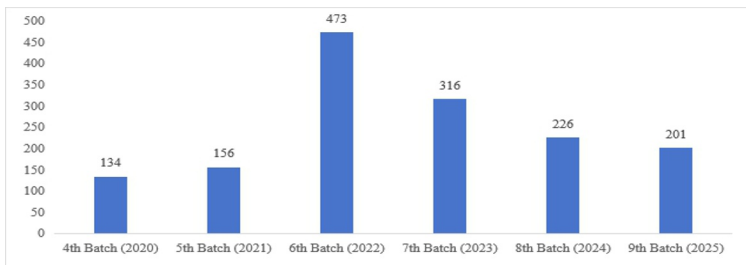


Fig. 1. Construction status of the first-release high-end software in Shandong Province

4 Recommendations

Elevate the industrial development grade. Cultivate leading industrial software companies with national and industry-level dominance to strengthen regional influence. Establish a tiered classification and certification system for industrial software, creating a closed loop that includes scenario validation, pilot-scale testing, third-party joint testing, and data feedback. Progress steadily along the "pilot–iteration–promotion" pathway, fostering a cohort of industrial software brands with distinctive regional identities. Leverage emerging models such as AI-native and "chain-based" promotion to lower adoption barriers, establish industry benchmarks, and enhance industry penetration and user engagement^[3]. Through targeted support and R&D promotion, assist enterprises in opening scenarios and providing testing opportunities to facilitate large-scale application demonstrations and activities, thereby fostering regular events and cultivating a regional brand of collaborative ecosystems while deepening and expanding localized applications. Building on the province's development foundation of "Ten Chains, One Hundred Clusters and Ten Thousand Enterprises" conduct precise supply-demand research and alignment based on the breadth and depth of industrial applications.

Promote full-chain collaboration and integration. At the systemic level, leverage the province's strengths in information resource development and information technology innovation to conduct joint technology research and collaborative system development. Establish industrial software collaboration platforms, standardize collaboration processes, and implement systematic communication mechanisms. Facilitate cooperation between industrial software enterprises and industry leaders, accelerate the strategic integration of leading companies in key sectors, promote the consolidation of industrial chains, and advance the development of full-stack, platform-based industrial software integration. At the service level, attract and cultivate digital service providers related to industrial software, while planning and building specialized service platforms and collaboration networks to enable the efficient flow of innovation resources and accelerate deep industrial integration. Encourage local universities, research institutions, and leading enterprises to jointly establish innovation consortia and industry-education training platforms for industrial software based on real industrial needs, fostering the sharing of valuable resources between academia and industry. Additionally, for areas within the province lacking industrial software, the government should compile demand information and encourage, guide, and fund targeted research and development efforts. Driven by large-scale demand, improve the evaluation system for state-owned enterprise procurement and government first-purchase tendering, promote the deep alignment of domestic industrial software with industrial chain resources, and build an industrial ecosystem characterized by co-construction across the entire chain and collaborative innovation^[4].

Accelerate core technology R&D. Targeting the province's key industries such as steel, chemicals, and equipment manufacturing, advance the validation and application of production control scenarios, drive key technological breakthroughs based on real-world demands^[5], and collaborate with leading entities such as Inspur, Cvicse Middleware, and Hoteam to build an industrial ecosystem that promotes the synergistic development and independent control of hardware and software. In cutting-edge technology

areas, establish special industrial software initiatives to guide enterprises toward breakthroughs in core fields such as 3D CAD/CAE core engines and operating systems for process industries. Seize the opportunity presented by AI technology empowerment, accelerate the development of high-quality industrial datasets, and promote the localized adaptation and deployment of advanced technologies such as industrial large models and AI agents. Implement a classified, phased core technology breakthrough strategy. In the short term, support market expansion and industry development with demand-driven, scenario-specific software R&D, thereby building forward-looking technology reserves and R&D paradigms that will support the long-term development and design of specialized and foundational software. This will create a virtuous cycle of "scenario-driven demand → technological breakthroughs → product iteration".

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Disclosure of Interests

The authors have no competing interests to declare that are relevant to the content of this article.

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