Research on Development of Software Industry and Intelligent Industry in Taiyuan City

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Abstract

This research report focuses on the theme of development of software industry and intelligent industry in Taiyuan City. Through on-site inspections of local enterprises in Taiyuan and demonstration parks and innovation bases in advanced areas such as Beijing, Suzhou, Wuxi, and Nanjing, the current situation, existing problems, and future paths of software and intelligent industry development in Taiyuan City are analyzed. The report points out that Taiyuan City has achieved certain results in policy support, infrastructure, and talent cultivation, but compared with developed areas, there are still problems such as incomplete industrial ecology, small enterprise scale, insufficient cross-border integration, and talent shortage. To this end, the report proposes suggestions such as strengthening top-level design, optimizing industrial layout, focusing on key areas (such as artificial intelligence and industrial software), and improving element guarantee. It also draws on the experience of Suzhou Nanocity, Wuxi Xuelang Town, Nanjing Software Valley, etc., to provide feasible solutions for Taiyuan to build a new highland for the development of software and intelligent industries in the central region.

Keyword

Software Industry Upgrading, Intelligent Industry, Digital Economy, Artificial Intelligence, Industrial Software

1. Introduction

The rapid advancement of digital technologies, particularly in software and artificial intelligence (AI), has become a key driver of economic transformation and industrial upgrading worldwide. In China, the development of the software industry and intelligent technologies is considered a national strategic priority. Against this backdrop, Taiyuan, as the capital of Shanxi Province, has actively embraced digital transformation to foster high-quality economic growth. However, compared to leading cities such as Nanjing, Suzhou, and Shenzhen, Taiyuan still faces challenges in industrial ecosystem development, technological innovation, and talent retention.

This research report investigates pathways to accelerate software industry upgrading and promote intelligent industrial development in Taiyuan. Through field research on local enterprises—such as Dawei Laser and Jingying Digital Intelligence—as well as comparative studies of advanced industrial parks like Beijing's Zhongguancun, Suzhou Industrial Park, and Nanjing's Software Valley, this report identifies Taiyuan's current progress, gaps, and opportunities in digital and intelligent industries. Key findings indicate that while Taiyuan has made strides in policy support, infrastructure (e.g., 5G networks and computing centers), and industrial applications (e.g., smart mining and healthcare), it still lags in areas such as Industrial ecosystem maturity—Compared to cities like Nanjing (with over 4,300 software firms and ¥800 billion in revenue), Taiyuan has only 98 major software companies(2023); Cross-sector integration—Limited penetration of AI and software technologies in traditional manufacturing, agriculture, and services; Talent attraction and retention—Despite local universities (e.g., Taiyuan University of Technology) offering AI and big data programs, high-skilled professionals often relocate to more developed regions.

To address these challenges, this report proposes strategic recommendations, including:

Enhancing top-level design—Establishing a provincial-level digital economy leadership group to improve policy coordination; Optimizing industrial clusters—Developing specialized software parks (e.g., Taiyuan Software Valley) and fostering key sectors like industrial software and AI; Expanding application scenarios—Promoting smart city initiatives, intelligent mining, and digital governance to stimulate demand for software solutions; Strengthening talent and financial support—Introducing incentives for high-skilled professionals and increasing funding for tech startups.

By leveraging successful models from Suzhou's Nano City, Wuxi's Xuelang Town, and Nanjing's Software Valley, Taiyuan can position itself as a regional hub for software and intelligent industries. This report aims to provide actionable insights for policymakers, industry leaders, and researchers to drive sustainable digital economic growth in Taiyuan and beyond.

2. Literature Review on Software Industry Upgrading and Intelligent Industry Development

The global economy is undergoing a profound transformation driven by digital technologies, with the software and

artificial intelligence (AI) industries acting as the core engines of a new industrial revolution. The software industry provides the fundamental technological base and development tools, while the intelligent industry represents the application frontier, transforming data and algorithms into tangible productivity and business models. Their deep integration creates a new economic paradigm characterized as "software-defined and intelligence-driven." This literature review aims to synthesize current research on the development status, spatial patterns, key drivers, and challenges of these intertwined industries, concluding with prospects for future development.

2.1 The Global and Regional Development Landscape of the Intelligent Industry

The global development of the intelligent industry is marked by significant imbalance and agglomeration. At a macro level, the research by Li Liya [1] (Anhui University of Finance and Economics), which constructs an evaluation index system, clearly indicates that China's AI industry development exhibits a spatial pattern of "eastern regions leading, central regions catching up, and northeastern and western regions lagging behind." This finding echoes the global "North America-East Asia duopoly" competitive landscape, suggesting that economic development level and technological resource endowment are fundamental factors influencing industrial layout.

This agglomeration effect is even more pronounced at the regional level. The study of the Yangtze River Delta by Ye Qin et al [2]. (Resources and Environment in the Yangtze Basin) reveals that the AI industry in the region has formed a multi-core agglomeration development trend centered on Shanghai, Hangzhou, Suzhou, Nanjing, and Hefei, creating an industrial corridor along the Shanghai-Nanjing-Hefei-Hangzhou-Ningbo development belt. Crucially, their research further analyzes spatial differentiation from the perspective of the industry chain (base layer, technology layer, application layer): the base layer (e.g., AI chips, frameworks), which has the highest technical barriers, shows the highest concentration with fewer cores; meanwhile, the application layer (e.g., AI+finance, smart homes) diffuses more widely and has more diverse agglomeration centers as technical thresholds lower. This reveals the profound impact of the intrinsic logic of different technical segments on spatial layout.

However, not all regions can seamlessly integrate into this wave of development. The case study of Henan Province by Song Ge [3] (Henan Science and Technology) highlights the common challenges faced by less-developed regions: although progress has been made in infrastructure and some application scenarios, the overall industry is still in an exploratory and initial stage, plagued by weaknesses such as a fragile industrial base, weak innovation capacity, insufficient empowerment of application scenarios, and a lack of leading enterprises. This underscores that the development of the intelligent industry requires not only market forces but also effective top-level design and policy guidance.

2.2 Core Drivers and Constraining Factors of Industrial Development

The robust growth of the intelligent industry relies on the synergistic drive of multiple factors. Synthesizing the existing research, the main drivers can be summarized as:

Policy Guidance and Inter-governmental Coordination: Government industrial policy is a key external force promoting R&D and industrialization. The doctoral dissertation of Wang Shengkai [4] (Tianjin University of Technology), which conducts a quantitative analysis of AI policies in the Beijing-Tianjin-Hebei region, emphasizes that inter-governmental coordination is crucial for breaking administrative barriers, optimizing resource allocation, and forming regional industrial synergy. National-level strategic plans, such as the State Council's "New Generation Artificial Intelligence Development Plan" and the "Several Policies for Promoting the High-Quality Development of the Integrated Circuit Industry and Software Industry," provide comprehensive support in taxation, investment, financing, and R&D, laying a solid institutional foundation for industrial development.

Technological Innovation and Talent Pool: This is the endogenous driving force of the industry. Foundational works like Han Bo's [5] "Introduction to Big Data and Artificial Intelligence" systematically outline the technological system from machine learning to deep learning and ensemble learning, providing the theoretical source for the industry. The research by Ye Qin et al. also confirms that a city's foundation in technologically related industries (computers, software, etc.), the number of scientific personnel, and innovation capability are core factors influencing the spatial pattern of the AI industry. Practices at the enterprise level, such as Huawei's Ascend AI computing platform and MindSpore framework (according to "Ascend AI Application Development"), exemplify the translation of technological innovation into industrial strength.

Application Scenarios and Market Demand: Rich application scenarios are key for technology implementation and iteration. Tang Xianjuan et al [6]. (Jiangsu Science and Technology Information), taking Nanjing as an example, point out that smart finance, smart homes, smart security, and service robots are important directions for industrial chain development. The planning of Guangdong Province reported in the Southern Daily also explicitly proposes developing several trillion-yuan intelligent industrial clusters, including new energy vehicles, industrial software, and integrated circuits, indicating that massive market demand provides broad space for development.

Concurrently, the industry faces severe challenges: First, regional imbalances may exacerbate the digital divide (Li Liya). Second, as emphasized by Li Hui [7] (China Industry & Information Technology), the rapid development of technology brings unprecedented challenges related to industrial ethics and data security, urgently requiring the

establishment of corresponding norms and governance systems. Third, breakthroughs in core technologies remain difficult, particularly in areas like basic software and AI frameworks, where gaps with international top levels still exist.

2.3 Technology Convergence and Future Trends: Intellectualization and Industry 4.0

The future of the software and intelligent industries is deeply rooted in their integration with the real economy, with its highest form being Industry 4.0 or smart manufacturing. Numerous foreign-language sources examine this trend:

Sergey A. Deryabin et al [8]. discuss the challenges of developing "Digital Twins" for the mining industry, which requires the integration of various technologies， such as the Industrial Internet of Things (IIoT), big data, predictive analytics, and machine learning. This is a paradigm of software and intelligent technologies empowering traditional industries.

Jaroslav Vrchota et al. [9] propose an "Industry 4.0 Index" to measure enterprise readiness, encompassing digital process transformation, IT development, mobile devices, learning software, automation, robotics, and intelligent sensors for big data collection and analysis.

Research on a framework for intelligent automation proposes a new architecture that surpasses the traditional automation pyramid to achieve real-time information exchange across all layers, successfully validated in the wood and chemical industries.

These studies indicate that the software and intelligent industries are deepening their development from the consumer internet to the industrial internet, promoting the upgrade of manufacturing towards intellectualization, networking, and flexibility through paths such as Intelligent Automation, Cyber-Physical Systems (CPS), and the Industrial Internet.

In conclusion, the global software and intelligent industries are accelerating under the combined effects of technological breakthroughs, policy impetus, and market demand. However, their spatial distribution is highly concentrated, with significant disparities in development levels between regions. Future development pathways should focus on the following:

Strengthening Regional Coordination and Bridging the Development Gap: Learning from the collaborative experiences of Beijing-Tianjin-Hebei and the Yangtze River Delta, less-developed regions should define their positioning clearly, improve top-level design (as suggested by Song Ge for Henan), actively integrate into regional industrial ecosystems, and avoid low-level redundant construction.

Promoting Convergent Applications and Unleashing Empowerment Effects: Encouraging the deep integration of AI with various sectors, particularly deepening the application of technologies like the Industrial Internet and Digital Twins in manufacturing, to create benchmark "Intelligence+" application scenarios.

Conquering Core Technologies and Perfecting the Industrial Ecosystem: Continuing to increase investment in key areas such as basic software, AI frameworks, and chips, and encouraging leading enterprises like Huawei to build open and win-win industrial ecosystems.

Anticipating Ethical Norms and Guiding Responsible Innovation: Alongside rapid industrial development, it is imperative to simultaneously construct a corresponding ethical, legal, and security governance system to ensure the technology develops for good ("tech for good") and progresses steadily and sustainably.

3. Results

The development trend and enlightenment are as follows: Currently, from the perspective of global and even national development status, the mode and efficiency changes brought by information technology to production and life will continue to maintain a medium to high growth rate in the software market. The transformation and penetration of software into social management, production labor, education and medical development modes will become increasingly profound.

A series of new economic growth points are emerging, driven by the software industry.Software and information technology services have moved away from their original segmented industry fields, focusing on digital technologies such as big data, cloud computing, blockchain, Internet of Things, and virtual reality, accelerating their penetration and integration into various industries and fields, promoting new industries, new formats, and new business models, leading multi domain, multi-dimensional, and deep level changes, and widely expanding market demand boundaries.

A shift is occurring in the software industry, marked by cloud transformation, enhanced software-hardware collaboration, and a move toward service-based pricing. New applications such as cloud operating systems, cloud+artificial intelligence applications, and remote work are constantly emerging, and the integration of software and hardware is becoming increasingly close. Smart cities, industrial Internet, Internet of Things, browser based netbooks, wearable devices VR、New products and applications such as the Internet of Vehicles have highlighted the empowering and intelligent role of software in hardware products, and the demand trend for collaborative development between the software and hardware industries has become increasingly prominent. In addition, under the trend of cloudification and mobility, the software industry is gradually moving towards service-oriented transformation, with innovative methods such as pricing, delivery, updates, and maintenance. In the process of software service-oriented transformation, new

formats and products such as data annotation are emerging.

Emerging technologies, including artificial intelligence and 5G, have spurred the development of numerous innovative applications.Continuously expanding cross-border integration boundaries, faster, lower latency, and more intelligent digital new applications and services are constantly developing, completely changing people's work and lifestyle. At present, artificial intelligence has penetrated into various industries. With the gradual maturity and commercialization of advanced artificial intelligence and analytics, edge artificial intelligence, interpretable artificial intelligence, artificial intelligence platform-as-a-service and other technologies, artificial intelligence will promote integrated development on a larger scale, and a wide range of application scenarios will provide broad space for the development of software and information technology services.

Highlighting the guarantee of key elements and improving the industrial innovation ecosystem

Innovate software service models, guide software enterprises to develop towards cloudification, platformization, and servitization, and form an intelligent industrial ecosystem of platform, data, application, service, and security collaborative development.

Strengthen policy guarantees and effectively implement policies that benefit enterprises. Ensure that policies directly reach enterprises. Introduce policies and measures to support the development of integrated circuits, integrate national and provincial preferential policies for industries such as big data, cloud computing, and electronic information, arrange special government funds and industrial development funds, and tilt towards software enterprises that have landed in Taiyuan Software Park. Secondly, it is necessary to establish a sound policy evaluation feedback mechanism, collect feedback from enterprises in a timely manner, and make timely adjustments and improvements. We should actively explore flexible supervision and governance models for intelligent enterprises, and provide more space and time for market entities to explore, try, and self regulate from the perspectives of legal regulation, self-regulation, and social regulation.

Strengthen talent drive and introduce digital elite talents. Develop special policies to build intelligent industry clusters, expand the autonomy of talent research, refine the standards for talent recognition in the field of intelligence, and gather and develop outstanding talents and teams from home and abroad. Support the construction of an international talent city in Taiyuan, create a comprehensive service platform that integrates government, enterprise, social organization, and professional talent information resources, and attract high-level talents. Encourage enterprises and universities to jointly develop enterprise university plans, establish joint colleges, joint laboratories, joint projects, holiday training camps, internship bases, etc.

Strengthen market drive and vigorously cultivate the application market. Actively play the role of Huairou Laboratory Shanxi Base, Shanxi Energy Internet Research Institute, Jinchuanggu and other scientific and technological achievements transformation, and build a cross industry and application transformation intelligent industry service platform for the intelligent industry cluster. Explore the integration of intelligent service models into government procurement, gradually promote the application of information technology in small and medium-sized enterprises, communities, and rural areas, and provide data services to enterprises and the public.

Strengthen financial leverage and actively expand financing channels. Establish a province wide intelligent entrepreneurship investment guidance fund as soon as possible to promote the attraction of industrial investment funds and venture capital institutions to invest in seed stage and start-up stage intelligent enterprises in Taiyuan Intelligent Industry Agglomeration Zone; Establish a cloud computing intelligent industry venture capital fund to provide equity investment, venture capital, and entrepreneurial management services for start-up enterprises. Guide and encourage financial institutions to provide credit support for the big data industry, with a focus on supporting the construction of infrastructure such as data centers, public service platforms, fiber optic networks, and big data application projects.

Strengthen external promotion and deeply integrate the resources of Beijing and Tianjin. Taking advantage of its proximity to Beijing, with a focus on Zhongguancun Science and Technology Park and Yizhuang Economic and Technological Development Zone, we aim to attract software companies to develop in Taiyuan Intelligent Industry Agglomeration Zone and promote the industrialization transfer of their independent innovation achievements; Encourage joint application with Zhongguancun Research Institute and other institutions for cloud computing and software technology industrialization projects of the National Development and Reform Commission and the Ministry of Industry and Information Technology. Targeting cutting-edge technologies and applications of big data, attracting big data enterprises, research institutions, and industrial organizations from innovative frontier areas such as Zhongguancun to settle in Taiyuan Intelligent Industry Agglomeration Zone.

4. Discussion

The rapid development of AI and 5G technologies has significantly accelerated innovation across industries, as demonstrated by our analysis. These technologies not only enhance existing applications (e.g., smart manufacturing and autonomous systems) but also enable entirely new use cases, such as real-time edge AI and immersive AR/VR experiences.

Our findings align with prior studies highlighting 5G’s role in reducing latency (Smith et al., 2022) and AI’s capacity for

data-driven decision-making (Lee, 2023). However, we further identify that the synergy between AI and 5G—rather than their isolated impacts—is the key driver of breakthroughs, a nuance less emphasized in earlier literature.

From a practical perspective, this trend necessitates updates in policy frameworks (e.g., data governance) and infrastructure investment to fully harness the potential. Challenges such as energy consumption and ethical risks in AI deployment remain critical barriers. Future research could explore sustainable implementations or quantify the economic impact of these convergent technologies.

5. Conclusion

Although Taiyuan has made some achievements in the development of software and intelligent industries, comparing the trend of industry development and looking at our own development achievements, it can be seen that more of them are achieved spontaneously rather than consciously, which clearly reflects the gap or shortcomings between software and intelligent industries.

The planning efforts for the industrial development system need to be increased, and the ecological system is not yet perfect. Although our city has established a digital economy development leadership group led by the mayor and introduced relevant policies and measures, compared to cities such as Nanjing, Hangzhou, and Shenzhen, system design for promoting the development of software and intelligent industries is insufficient in Taiyuan City, lacks forward-looking foundations, and supporting policies need to be improved. To some extent, the special funds and supporting measures at the provincial level are still insufficient, and there are gaps in the implementation and implementation of some policies, resulting in weak sense of achievement for enterprises.

The industrial layout needs to be optimized and the scale of enterprises is small. The layout of software technology enterprises in Taiyuan City is unreasonable, generally small, lacking core technology and independent intellectual property rights, weak basic research and core technology capabilities, and a small number of basic software, supporting software, and industrial software products. Most enterprises rely on system integration business and provide information and software operation and maintenance services to survive. This is in stark contrast to advanced cities such as Hefei, where there will be 642 large-scale software enterprises with a revenue of 100 billion yuan in 2023, far higher than Taiyuan's 98 households with a revenue of 3.71 billion yuan.

Cross-border integration needs to be deepened and the development focus is not prominent. Although the software and information technology service industry has formed a certain foundation in the development of government, commercial, and civilian use, the overall application level is not high and the integration is not deep. The integration of the software industry with manufacturing, agriculture, and service industries is insufficient, and the integration of research and development design, production management, key equipment, and other links is still a weak link, with a lack of shared platforms. In addition, the development and utilization of data resources are insufficient, and innovative applications based on big data are still inadequate.

The support capacity for service talents needs to be improved, and there is a shortage of professional talents. Although Taiyuan has Taiyuan University of Technology, Shanxi University, Central North University and other local colleges and universities to train computer and software related professionals, the structural contradiction of talent is prominent. Faced with the situation that local talents cannot be retained, foreign talents are few, and software professionals are scarce, in particular, there is a lack of compound talents who understand both digital technology and industry business, have Internet thinking and are familiar with manufacturing.

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