

Artificial Intelligence Technology in the Digital Transformation of State-Owned Enterprises: Opportunities, Challenges, and Implementation Path

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Date: 2023-02-21T00:00:00+00:00

Abstract

Artificial intelligence technology will play a critical role in the digital transformation of state-owned enterprises. The State-owned Assets Supervision and Administration Commission's (SASAC) 'Notice on Accelerating the Digital Transformation of State-owned Enterprises' explicitly states that enterprises should 'leverage new-generation information technologies such as artificial intelligence to explore and construct novel IT architecture models—including "data middle platform" and "business middle platform"—that align with enterprise business characteristics and development requirements, accelerate the establishment of group-level digital technology enabling platforms, and provide efficient data and integrated service support for business digital innovation.' Based on the operational characteristics of state-owned enterprises, this paper analyzes the opportunities and challenges of artificial intelligence technology in the digital transformation process, and proposes an implementation roadmap for digital transformation centered on the construction of an 'intelligent middle platform', thereby offering an action guide for the digital transformation of state-owned enterprises.

Full Text

Preamble

Artificial intelligence technology will play a pivotal role in the digital transformation of state-owned enterprises (SOEs). The State-owned Assets Supervision and Administration Commission's (SASAC) "Notice on Accelerating the Digital Transformation of State-owned Enterprises" explicitly states that enterprises should "leverage new-generation information technologies such as artificial intelligence to explore and construct new IT architecture models—including 'data

middle platforms' and 'business middle platforms'—that align with their business characteristics and development needs, thereby accelerating the formation of group-level digital technology enablement platforms that provide efficient data and integrated service support for business digital innovation.” Based on the operational characteristics of SOEs, this paper analyzes the opportunities and challenges of AI technology in the digital transformation process, proposes an implementation roadmap centered on building an “intelligent middle platform,” and provides an action guide for SOE digital transformation.

Keywords: state-owned enterprises, digital transformation, artificial intelligence, data middle platform

Classification Number: TP393

In 1956, McCarthy, Shannon, and Rochester first introduced the concept of Artificial Intelligence at the Dartmouth Conference, launching humanity's relentless exploration of methods to construct human-like intelligence. In recent years, propelled by unprecedented advances in computing power and big data governance capabilities, new-generation AI technologies—represented by deep learning—have achieved breakthrough progress in vision, language, and speech tasks, dramatically enhancing productivity and profoundly impacting social production and lifestyles. Consequently, major countries worldwide are focusing on developing AI technology. The Chinese government, with foresight, has elevated AI to a national strategic priority through a series of policy measures. In July 2015, the State Council issued the “Guiding Opinions on Actively Promoting ‘Internet Plus’ Action,” incorporating AI into key tasks for the first time. In July 2017, the State Council released the “New Generation Artificial Intelligence Development Plan,” elevating it to a national strategy. In March 2021, AI was written into the “14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Long-Range Objectives Through 2035.” By 2022, the Party Central Committee, the State Council, and various ministries had issued more than 10 AI-related policies, with AI being included in the Government Work Report for six consecutive years, and over 20 provinces and municipalities had successively introduced more than 60 AI-specific plans. Using AI technology as a means to promote social digital transformation is a critical choice for China's “14th Five-Year Plan” and new century journey—a strategic initiative to seize future development opportunities, optimize industrial structures, and gain advantages in complex international relations.

In advancing China's digital transformation, SOEs—as the pillars of our economy—naturally bear greater social expectations and responsibilities, and should and must play a “vanguard” role in mastering and applying AI technology. However, China's SOEs are currently concentrated in traditional foundational industries such as energy, transportation, and infrastructure, with relatively weak capabilities in digitalization and AI construction. Although private internet enterprises are active in applying new-generation IT technologies like AI, their application scenarios, scale, and fundamental objectives differ significantly from those of SOEs, making their experiences and models difficult to directly transfer. In

this context, SOEs whose primary business is IT technology should take the lead in making breakthroughs, leveraging their domain advantages to explore AI and digital transformation paths that align with China's national conditions and the operational temperament of SOEs, achieving "model output and point-to-area expansion" to drive the collective intelligence and digitalization of the state-owned economy. This paper studies and analyzes the opportunities and challenges of AI technology in the digital transformation process based on the actual conditions of SOEs, and proposes an implementation roadmap centered on building an "intelligent middle platform" to provide an action guide for SOE digital transformation.

2. Opportunities for AI Technology in SOE Digital Transformation

This section analyzes the favorable factors for AI technology in China's digital transformation from three perspectives: technological development, domestic foundation, and policy environment.

2.1 Technological Development

New-generation AI, represented by deep learning, is accelerating its evolution and deployment, entering a period of technological dividend realization. Currently, AI technology is developing rapidly, demonstrating near-human or even superhuman performance in intelligent tasks such as image recognition, machine translation, and speech recognition. The technological dividend is quickly translating into productivity, with successful implementations in numerous fields. For example, computer vision and speech recognition technologies have been initially applied in industrial quality inspection, production line inspection, and intelligent customer service. As shown in [Figure 2: see original paper].¹, visual industrial quality inspection technology can quickly and accurately detect minute defects in components (even a burr on a screw), greatly improving the efficiency and accuracy of defect detection. In production environments, visual AI methods can promptly identify operator violations. These technologies are highly compatible with the production and operation environments of SOEs and represent important footholds for AI in SOE digital transformation. Simultaneously, AI facilitates enterprise-wide decision optimization, significantly improving operational efficiency in scenarios such as recommendation systems and supply chains. While recommendation systems are primarily applied to retail consumption in the private economy, many internal functional tasks within enterprises can be framed as recommendation problems. For instance, the recruitment process can be constructed as "algorithms recommending suitable candidates from a resume pool to positions," leveraging recommendation algorithms' capabilities in interest discovery and long-tail mining to identify diverse talents more fairly and comprehensively. Furthermore, AI-enhanced innovation chains have propelled basic scientific research in materials, chemistry, and physics, as well as applied technology research in drug development and manu-

facturing process enhancement, into a data- and intelligence-driven development stage. AI technology is accelerating the efficiency of research and experimental processes such as literature data acquisition and experimental discovery.

2.2 Domestic Foundation

China possesses a solid foundation and significant potential in AI technology. The State Council's "New Generation Artificial Intelligence Development Plan" states: "The overall assessment is that China belongs to the global first echelon in the AI field." After years of continuous accumulation, China has made important progress in AI, ranking second worldwide in international scientific paper publications and invention patent authorizations, with breakthroughs in core key technologies in some areas. Visual recognition and speech recognition technologies are world-leading, while capabilities such as adaptive autonomous learning, intuitive perception, comprehensive reasoning, hybrid intelligence, and swarm intelligence are initially poised for leapfrog development. Chinese information processing, intelligent monitoring, biometric identification, industrial robots, service robots, and autonomous driving are gradually entering practical application, with AI innovation and entrepreneurship becoming increasingly active and a number of leading enterprises accelerating their growth, gaining widespread international attention and recognition. In terms of professional talent, China's education tradition emphasizing mathematical and scientific foundation training provides fertile soil for cultivating AI practitioners. These factors constitute China's unique advantages in AI development, which SOEs should fully leverage in their digital transformation to convert advantages into victories and accelerate industrial layout optimization.

2.3 Policy Environment

AI technology enjoys a superior policy environment in China. The Chinese government has systematically laid out AI development at the national strategic level, successively issuing policy documents such as the "Guiding Opinions on Actively Promoting 'Internet Plus' Action," the "New Generation Artificial Intelligence Development Plan," and the "New Generation AI Industry Innovation Key Task Tackling Work Plan" to strengthen the AI industry. In March 2021, AI was written into the "14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Long-Range Objectives Through 2035." As the backbone of China's economy, SOEs bear tremendous national expectations in developing AI technology. The SASAC's "Notice on Accelerating the Digital Transformation of State-owned Enterprises" explicitly states that enterprises should "leverage new-generation information technologies such as artificial intelligence to explore and construct new IT architecture models—including 'data middle platforms' and 'business middle platforms' — that align with their business characteristics and development needs, thereby accelerating the formation of group-level digital technology enablement platforms that provide efficient data and integrated service support for business digital

innovation.”

3. Challenges for AI Technology in SOE Digital Transformation

SOEs generally lack development strategies and implementation paths for AI deployment. Concentrated primarily in traditional industries such as energy, transportation, and infrastructure, most SOEs lack professional understanding of emerging IT technologies like AI and do not possess AI R&D and implementation capabilities. This results in most enterprises struggling to formulate clear AI development strategies from the outset, with planning for AI integration with their business remaining at a macro level, repeatedly proposing vague objectives such as “using AI technology to make decisions based on historical business data.” Most SOEs’ IT architectures center on ERP, CRM, and other systems, focusing only on optimizing individual local business processes without strategically planning how to drive digital transformation through AI technology from an enterprise-wide development perspective. Additionally, traditional information architectures centered on ERP contain numerous process breakpoints and information silos, creating a “chimney-style” IT architecture where data from R&D, design, production, quality control, logistics, marketing, and other functions are scattered across isolated systems, preventing effective data aggregation and integration across systems and failing to provide comprehensive, sufficient training data for data-driven technologies like AI.

AI technology faces a “dwarfing adaptation” problem in SOE digital transformation. Currently, AI technology is highly active in internet industry applications because business scenarios in this sector typically face end-users directly, accumulating massive amounts of user behavior logs and unstructured data (video, text, language, and speech) at the consumer end—precisely the types of data that new-generation AI technologies excel at processing. Unlike internet companies, SOEs often neglect the accumulation of consumer-end business data and lack unstructured data describing user behavior. Their IT systems, centered on closed systems like ERP and CRM, accumulate primarily structured data describing internal local processes, creating a mismatch with new-generation AI technologies in terms of both data type and volume. The common problem facing many digital transformation teams is that “various deep learning algorithms for vision, language, and speech cannot find application scenarios in the relational databases of traditional IT systems (such as ERP),” often forcing them to “de-intellectualize” intelligent solutions, temporarily shelving advanced AI technologies and attempting to adopt early-stage, shallow machine learning methods to “dwarfingly adapt” to business scenarios.

SOEs face talent shortages in AI. “Artificial intelligence is, in the final analysis, intelligence realized by humans” —people are the most important factor in AI implementation. As one of the most cutting-edge topics in academia and industry, AI imposes higher requirements on R&D personnel than other IT work. A typical AI R&D and application team should include an algorithm director, al-

gorithm engineers, data engineers (for cleaning and annotation), and other roles, with relatively stable team members showing no major turnover for at least two years. However, most SOEs' main businesses are unrelated to IT, resulting in a lack of stable, professional IT teams; or their IT teams are primarily outsourced, with engineers mastering only relatively basic development skills capable of only simple "CRUD" (Create, Read, Update, Delete) system development and maintenance, and high personnel turnover. The contradiction between the surging demand for AI talent across industries and insufficient AI talent reserves is also a major obstacle in enterprise digital transformation. China's AI industry faces an effective talent gap of approximately 300,000. Taking the Shanghai market as an example, only about 3% of enterprises possess basic AI R&D capabilities. The implementation of AI technology in enterprise digital transformation severely lacks cross-disciplinary talent who simultaneously possess AI technology expertise and industry knowledge to drive AI deployment in vertical industries.

4. Implementation Roadmap for AI Technology in SOE Digital Transformation—Centered on the Intelligent Middle Platform

Leveraging AI to drive digital transformation is an essential path for SOEs to enhance their internal capabilities and optimize industrial operations, a mission and responsibility entrusted to SOEs by the state to align with social development trends, and a long-term and arduous undertaking. This section first proposes solutions to the difficulties and challenges identified in Section 3, then presents a specific technical implementation roadmap centered on the "intelligent middle platform."

First, enterprises must establish a group-level digital transformation strategy that clearly positions AI technology at the core of the transformation process. Digital transformation should follow a top-down strategic goal formulation with 逐级分解细化 (hierarchical decomposition and refinement) in implementation. Transformation begins with mindset shifts, requiring unified thinking and the most open attitude toward embracing new-generation IT technologies like AI. In practice, various business sectors must shift from siloed operations to multi-domain collaboration, breaking down barriers in traditional "chimney-style" IT architectures. Through a "middle platform-style" architecture, they should aggregate and integrate structured data from internal ERP, CRM, and other systems, as well as multi-source heterogeneous data extending from external consumer-end user behaviors, presenting business participants with a "one-stop, end-to-end" data perspective to form big data governance, thereby laying a solid data foundation for data-driven technologies like AI. Enterprises must cultivate data-driven thinking, transforming business process digital reconstruction from traditional completely top-down flow and decision-making to data- and AI-driven (assisted) intelligent forms, while actively attempting to use AI to optimize production, operation, and functional processes within a risk-controlled scope.

In the early stages of digital transformation, AI technology should appropriately “dwarfingly adapt” to current SOE business models, while SOEs should learn from internet and other emerging industries to “elevate” their business and data governance models toward the intelligent stage. As previously discussed, AI in SOE digital transformation must address the “dwarfing adaptation” problem; however, excessive dwarfing would severely limit the potential of new technologies. Therefore, this paper proposes a more reasonable approach of two-way “mutual adaptation” between technology and enterprise business models. From the technology perspective, since current SOE IT systems involve primarily structured data describing internal management processes, data types and scale temporarily cannot support large-scale deep learning deployment. Therefore, enterprises can first attempt to adopt traditional shallow machine learning and data mining methods (such as clustering, classification, decision trees, frequent item mining, matrix factorization, recommendation, and business process discovery) to enhance internal operation intelligence levels. For advanced AI methods, enterprises can first leverage third-party services to introduce large-scale pre-trained models, such as language dialogue models and visual industrial defect detection models, applying them to functional departments (like call centers) and production lines. By quickly enjoying the dividends of advanced technology, they can enhance confidence in AI, accelerating the R&D, deployment, and popularization of intelligent applications. On the other hand, traditional IT systems represented by ERP and CRM primarily serve internal management, making them products of the information age. During the digital transformation era, SOEs in traditional industries should learn from internet companies, extending IT business scope from internal management to consumer-end customer behaviors, forming comprehensive collaboration and linkage across R&D, design, production, quality control, logistics, marketing, and other links with customers. This truly establishes a customer behavior-centered enterprise operation philosophy, capturing customer behaviors to accumulate large-scale structured and unstructured data, laying a solid data foundation for AI applications, and thereby enabling AI technology to perceive impending “butterfly effects” in the market from the consumer and client ends, winning advantageous positions for enterprises in responding to market changes.

“Importing” and “self-cultivating” should proceed simultaneously to achieve steady construction of SOE AI talent teams. Talent acquisition is the most direct way for enterprises to obtain domain expertise. However, as described in Section 3, China currently faces a large AI talent gap, and due to the high degree of AI specialization and strong talent attraction in emerging industries like internet and new energy vehicles, SOEs in traditional industries are at a competitive disadvantage in talent recruitment. Under these circumstances, enterprises must vigorously strengthen the cultivation of AI business capabilities in their existing workforce while recruiting external talent. Senior management needs a clear understanding of the current state and trends of AI technology development to formulate reasonable transformation strategies aligned with industry characteristics and digital transformation requirements. Middle managers need to

continuously understand cutting-edge AI knowledge, contemplating how to enhance their business through AI means to complete tactical implementation of transformation strategies. Frontline employees with IT R&D capabilities should deeply study AI R&D knowledge, accurately and professionally describing their requirements as clients when engaging with AI technology vendors, evaluating vendor technical solutions, and enhancing their business capabilities through full participation in AI project implementation to complete the intelligent upgrade of their professional skills. Other frontline employees need to proficiently use AI tools, providing continuous feedback and correction information for projects during usage.

The above factors—enterprise strategy, business model, and talent team construction—are primary considerations for SOEs in traditional industries when promoting AI technology applications. For SOEs whose main business is IT technology, they should also leverage their strong digital R&D capabilities to explore intelligent middle platform technical architectures that align with their business and have strong universality for SOEs, in accordance with the spirit of SASAC’s “Notice on Accelerating the Digital Transformation of State-owned Enterprises.” This will form a group-level digital technology enablement platform that provides efficient data and integrated service support for business digital innovation, offering transformation templates for SOEs in traditional industries. In specific implementation, this paper recommends an iterative R&D and steady advancement approach through two stages: “Intelligent Middle Platform 1.0” and “Intelligent Middle Platform 2.0.”

Intelligent Middle Platform 1.0: Digital transformation does not mean demolishing existing information systems but rather using cloud-enabled and big data technologies to integrate business systems such as ERP, CRM, MES, WMS, and TMS, breaking down data barriers both physically and logically. It aggregates originally dispersed data from various business ports into a unified data lake house, providing users with a unified operational perspective across multiple organizations and systems. The scope of IT data governance will extend from internal operations to external partners (such as supply chains) and consumer ends, initially forming an open and collaborative digital ecosystem. Based on this foundation, AI methods are initially applied to optimize some business processes and eliminate high human-energy-consumption points. The technical blueprint for this vision is Intelligent Middle Platform 1.0, with the overall architecture shown in [Figure 4: see original paper].¹ (marked as Digital 1.0). Specifically, internal business data and external industrial chain and consumer-end data are uniformly aggregated into a lake-warehouse-integrated data middle platform, where structured data enters MPP data warehouses directly, and semi-structured and unstructured data first enters the data lake and then enters the data warehouse after ETL processing. Based on the MPP data warehouse, Intelligent Middle Platform 1.0 provides high-performance online analytical processing (OLAP) for microservices-based business middle platforms. This analysis is based on perspectives spanning multiple business departments (because the lake warehouse integrates data from different business systems), providing hor-

izontally coherent business views for roles focusing on different businesses (as shown in the figure). Regarding AI applications, Intelligent Middle Platform 1.0 focuses primarily on “intelligent process automation” and “key parameter prediction,” introducing intelligent RPA robots to automate high-frequency, repetitive tasks such as financial reconciliation, delivery order verification, and human resources review, while using classical machine learning methods like ridge regression to predict key parameters in business processes such as quotation sheets, auxiliary material planning, and sales forecasting. Overall, the main tasks during the Intelligent Middle Platform 1.0 period are constructing the lake-warehouse-integrated data middle platform, microserving front-end businesses, and optimizing processes and key parameters using AI methods.

Intelligent Middle Platform 2.0: The main task of this stage is to standardize and systematically build AI capabilities, centralizing the scattered algorithm models from the 1.0 period into a unified environment to improve model reusability, while R&Ding and applying more advanced algorithm models to empower more business links. Overall, the 2.0 period covers three major construction aspects: data, computing power, and models, ultimately forming a platform-based “intelligent hub” (as shown in [Figure 4: see original paper].1). The intelligent hub meets AI’s data and computing power needs by establishing an “AI Collaborative R&D Platform” and an “Elastic Computing Power Platform,” providing the “fossil fuel” for generating “electricity” for AI technology. The AI Collaborative R&D Platform further cleans the multi-source heterogeneous data in the lake warehouse, provides online collaborative annotation functions for data requiring labeling, utilizes collective intelligence to truly transform the massive data accumulated in the lake warehouse into high-quality training data for AI algorithm models, and shares it across the group. For enterprises with strong AI R&D capabilities, the AI Collaborative R&D Platform should also establish an online collaborative model development environment, improving model R&D, release, and deployment efficiency by unifying the environment for AI development dependencies. The Elastic Computing Power Platform addresses AI computing power needs across the group through cloud-native approaches, enabling “units and projects to apply for as much computing power as needed and release it after use,” achieving efficient sharing of computing resources, eliminating the high costs of 各单位自行建立算力集群 (each unit building its own computing cluster), and reducing carbon emissions. Physically, the Elastic Computing Power Platform consists of deep learning server clusters (GPU) and big data server clusters (CPU), targeting deep learning tasks for vision and language and classical machine learning tasks, respectively. Supported by the AI Collaborative R&D Platform and Elastic Computing Power Platform, the Intelligent Middle Platform 2.0 stage applies more advanced AI technologies to form an AI Capability Center that empowers various business links. Specifically, the AI Capability Center comprises two major model libraries: general models and specialized models. The general model library includes pre-trained models for vision, natural language processing, speech recognition, recommendation systems, etc., such as classification, object detection, tracking, face recognition, behavior

recognition, OCR, and defect detection in vision methods, providing general AI capabilities. The specialized model library provides algorithm models for specific business scenarios, such as defect detection for computer components, worker behavior recognition for production line safety, OCR for entity relationship extraction in sales contracts, large-scale pedestrian and vehicle identity authentication and tracking for park security, and recommendation systems for recruitment scenarios. In summary, the Intelligent Middle Platform 2.0 construction period focuses on applying advanced AI technologies such as deep learning to extensively empower all aspects of enterprise operations. Based on the massive and diverse data accumulated in the data lake house during the 1.0 period, it fully draws on internet enterprises' AI R&D and application experience, elevating SOEs' intelligence level to an advanced standard. Through technological and conceptual advancement, enterprises gain societal respect and achieve a "bone-changing" degree of digital transformation.

5. Conclusion

Rome was not built in a day, and the digital transformation of SOEs cannot be accomplished overnight. Integrating existing IT systems, eliminating chimney-style information architectures, and learning from internet industries to implement lake-warehouse-integrated governance of enterprise internal and external ecological chain data are "debts" that SOEs must repay in digital transformation. Based on this foundation, systematically building enterprise AI capabilities with the "intelligent middle platform" architecture as the core is the threshold that must be crossed to comprehensively enhance internal and external capabilities, become an "enterprise respected by the industry," and achieve truly "bone-changing" high-quality digital transformation.

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Note: Figure translations are in progress. See original paper for figures.

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