

Application and Impact of Automation Technology in Enterprise Management

Yougang Zheng^{1,*}

¹ Jiujiang University, Jiujiang 332000, China;

Abstract: With the intensification of global industrial competition and the transformation and upgrading of China's economic structure, automation technology has become a core engine driving the digital transformation of enterprises. This paper takes automation technology as the research object, focuses on domestic enterprise management practices, and systematically discusses its application scenarios in production process optimization, supply chain collaboration, and human resource allocation. Through a combination of literature research, case analysis, and empirical data, it reveals the multidimensional impacts of automation technology on enterprise operational efficiency, cost structure, and organizational form. The study finds that automation technology can achieve a leap in management efficiency through process reconstruction and data-driven approaches, but its successful implementation relies on the synergistic effects of technological adaptability, organizational cultural transformation, and policy support. Based on the practices of some benchmark enterprises in China, this paper proposes a localized implementation framework covering strategic planning, technology selection, and talent cultivation, providing theoretical support and practical references for domestic enterprises to cope with intelligent challenges.

Keywords: Automation Technology; Digital Transformation; Intelligent Manufacturing

1. Introduction

Against the backdrop of a new round of global technological revolution and industrial transformation, China's "14th Five-Year Plan" clearly proposes the strategic goal of "accelerating digital development and building a digital China [1]." As the core driver of digital transformation, automation technologies (Robotic Process Automation, RPA; Industrial Internet of Things, IIoT; AI decision-making systems, etc.) are profoundly reshaping enterprise management models. According to the "2023 Smart Manufacturing Development Index Report" released by the Ministry of Industry and Information Technology, the application rate of automation equipment in China's large-scale industrial enterprises has reached 56.3% [2], but the penetration rate of automation in management is only 28.7%, indicating a significant "production-management" digital divide.

Currently, domestic enterprises are facing three major challenges: firstly, labor costs continue to rise, with manufacturing labor costs increasing by 9.8% year-on-year in 2022 (according to National Bureau of Statistics data); secondly, fragmented market demand is forcing upgrades in flexible production capabilities; and thirdly, global competition requires supply chain response times to be reduced to the hour level. In this context, how to achieve management process reengineering and organizational capability evolution through automation technology has become a key proposition for enterprises to build competitive advantages. Based on the theory of techno-economic paradigms, this paper combines annual report data from 20 domestic listed companies with 15 industry cases to construct an "technology application-management transformation-performance output" analysis framework [3], focusing on solving three core issues: (1) typical application paths of automation technology in Chinese enterprise management; (2) the dynamic impact mechanism of technology implementation on enterprise organizational structure and operating models; and (3) technology adaptation strategies for enterprises of different sizes. The research findings can provide decision-making basis for government formulation of industrial policies and enterprise planning for digital transformation [4].

2. Evolution of Automation Technology Theory and Domestic Development Status

2.1. Conceptual System and Theoretical Framework of Automation Technology

Automation technology, as the core support of modern industrial civilization, has evolved into a multi-dimensional technical architecture over the past 70 years. The International Federation of Automatic Control (IFAC) defines it as "a collaborative network based on mechanical devices, computer systems, and

intelligent algorithms that achieves preset goals without human intervention [5]." From the perspective of technological iteration, its development has undergone three stages of leaps: the mechanical automation stage from 1950 to 1980, marked by Programmable Logic Controllers (PLCs), which replaced single processes through standardized programs, with typical examples being the large-scale application of automotive assembly lines; the information automation stage from 1980 to 2010, where the deep integration of Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES) reconstructed the production management paradigm, forming a digital work system of human-machine collaboration and improving process efficiency by over 300%; and the intelligent automation stage since 2010, which relies on the "AI + Digital Twin + Edge Computing" technology matrix to build closed-loop systems with autonomous cognitive capabilities, such as dynamic process optimization systems based on real-time data streams, which can complete cross-domain resource scheduling and multi-objective optimization within millisecond time windows, marking a paradigm shift in automation technology from "program execution" to "autonomous decision-making." This evolution process not only reflects the deep integration of cybernetics, information theory, and systems theory, but also maps the value upgrading trajectory of industrial production from mechanization, informatization, to intelligence [3].

2.2. Characteristics of China's Automation Technology Development

China's automation technology development exhibits highly strategic and scenario-based characteristics. In terms of application field differentiation, the automation paths of manufacturing and service industries form a stark contrast: manufacturing focuses on industrial robots as the core driver, with China accounting for 52% of global new industrial robot installations in 2022 (303,000 units installed annually), while the service industry accelerates digital transformation through RPA, with a market size growing at over 40% annually, covering high-repetition process scenarios in finance, government affairs, etc. In the field of technology integration, leading enterprises achieve technological leaps through the "5G + IIoT + AI" trinity architecture. For example, SANY Heavy Industry's "Root Cloud Platform" has connected over 800,000 industrial devices across eight sectors including engineering machinery and textiles, with its predictive maintenance system improving equipment failure response efficiency by 60% and increasing equipment utilization rate by 22% through algorithm optimization. The policy-driven effect is particularly prominent, with the national "Industrial Foundation Strengthening Project" investing a cumulative 28.7 billion yuan to support over 1,200 core technology research projects, focusing on breaking through weak links in the industrial chain such as servo motors and smart controllers, driving the domestic market share of industrial robots to exceed 45% in 2023 and the localization rate of RPA software to reach 38% [1], marking a new stage in China's autonomous controllable capabilities in automation technology.

2.3. Mainstream Technology Application Landscape

Currently, China's automation technology has formed a diversified application ecosystem: In the field of industrial robots, the 7-axis collaborative robot developed by SIASUN Robot, with a repeat positioning accuracy of $\pm 0.02\text{mm}$, deeply penetrates high-precision scenarios such as welding, precision assembly, and intelligent inspection, driving technological innovations in the automotive and electronics industries. RPA technology demonstrates powerful efficiency in the transformation of rule-based processes. The RPA system deployed by Ping An Bank processes over 200 million transactions annually, covering financial reconciliation, credit review, and other business processes, with the processing time per transaction reduced to 1/10 of that of manual processing. AI decision-making systems achieve significant improvements in production efficiency through dynamic optimization. A typical example is the application of Alibaba Cloud's ET Brain in the production line of Hengyi Petrochemical, which optimizes processes through real-time analysis of over a thousand parameters, reducing overall energy consumption by 7.3%. The groundbreaking application of digital twin technology is also noteworthy. The virtual factory system built by China Aerospace Science and Industry Corporation can perform full-dimensional simulations of physical production lines, increasing equipment utilization by 22% through production scheduling simulations, providing decision-making rehearsal support for complex scenarios such as aerospace equipment manufacturing. These four technological pillars are continuously reshaping China's industrial intelligence landscape through scenario adaptation and collaborative innovation.

3. Penetration Path of Automation Technology in Enterprise Management

3.1. Production Management: From Equipment Automation to Smart Factories

In the construction of smart factories, enterprises achieve comprehensive upgrades in production management through a three-tier architecture of "equipment-system-decision-making": At the equipment level, Gree Electric deploys a high-precision machine vision inspection system combined with deep learning algorithms to achieve intelligent recognition of air conditioner shell defects, increasing the detection rate from 92% to 99.6%, reducing annual quality losses by over RMB 30 million, and lowering the misdetection rate to below 0.3%; At the system level, Haier's COSMOPlat industrial internet platform connects 15 industries and 43,000 enterprises, enabling cross-factory capacity coordination and scheduling through intelligent algorithms, reducing order delivery cycles by 30% and optimizing inventory turnover by 25%; At the decision-making level, Baosteel uses LSTM (Long Short-Term Memory networks) to build a predictive model for equipment health, providing 72-hour advance warning of potential failures, reducing maintenance response time by 60%, increasing overall equipment effectiveness (OEE) by 18%, and saving over RMB 120 million in annual maintenance costs. The synergistic effect of this three-level technology system drives production management to evolve from partial automation to comprehensive intelligence.

3.2. Supply Chain Management: Building a Resilient Supply Network

In the intelligent upgrade of supply chains, enterprises build end-to-end resilient networks through technology integration: JD Logistics' "Asia No. 1" smart warehouse deploys over a thousand AGV robots (Automated Guided Vehicles) combined with SLAM navigation algorithms for 24/7 uninterrupted operation, achieving picking efficiency eight times that of manual labor and processing over a million orders per day in a single warehouse; Mengniu Group uses an LSTM time series analysis model to integrate historical sales, weather, promotions, and other multidimensional data, increasing regional sales forecast accuracy to 85% and optimizing inventory turnover by 23%; SF Express' self-developed "Huiyan Shentong" route planning system uses operational research optimization algorithms to reduce transport empty running rates by 12%, saving over RMB 300 million in annual fuel costs and reducing carbon emissions by 86,000 tons. With technology empowerment, supply chain response speed is improved to the minute level, and flexibility is significantly enhanced.

3.3. Human Resource Management: From Transaction Processing to Strategic Empowerment

Automation technology drives the transformation of human resource management towards strategic value creation: ByteDance's "Feishu Recruitment" system integrates NLP (Natural Language Processing) and sentiment analysis technology to automatically parse resumes and assess candidates across 45 capability dimensions (including logical thinking, stress resistance, and other potential indicators), reducing the recruitment cycle for technical positions from 28 days to 17 days; Huawei's "HiHR" platform constructs digital employee profiles, integrating over 200 data points such as OKR completion, collaboration networks, and learning behavior, increasing talent assessment accuracy to 92% [6] and reducing high-potential talent turnover by 18%; State Grid's "Virtual Substation" VR training platform uses 1:1 3D modeling and fault simulation to increase high-voltage operation training efficiency by 70% and reduce accident rates by 65%, achieving a leap from "theoretical instruction" to "scenario-based training" in skill training.

3.4. Financial Management: Moving Towards Real-Time and Intelligence

Financial management has achieved three breakthroughs driven by automation: Yonyou NC Cloud uses RPA+OCR (Optical Character Recognition) technology to automate the entire process of bank reconciliation and invoice verification, processing over 500,000 documents monthly with an error rate reduced to 0.05%, reducing financial personnel's workload for transactional tasks by 75%; Ant Group's "AlphaRisk" intelligent risk control system integrates graph computing and federated learning technology to analyze over 2 billion risk-related nodes in real-time, with a fraud transaction interception accuracy rate of 99.99%, avoiding annual losses of over RMB 12 billion; Ping An's "Smart Financial Brain" automatically generates business analysis reports based on knowledge graphs, reducing data preparation time from 3 days

to 2 hours, improving management decision-making response speed by 40%, and optimizing fund utilization efficiency by 15%.

4. Management Transformation and Organizational Evolution Driven by Automation

4.1. Efficiency Reconstruction: Breaking Through Traditional Management Bottlenecks

Automation Technology Achieves Efficiency Revolution through End-to-End Process Reengineering: SANY Heavy Industry's Pumping Division deploys an RPA (Robotic Process Automation) system, automatically linking 12 steps and 26 forms involved in order approval, reducing approval time from 48 hours to 4 hours and increasing annual order processing capacity to 150,000 orders; Midea Group builds a digital twin of its supply chain based on the M.IoT industrial internet platform, real-time accessing data from over 5,000 sensors, improving inventory decision-making response speed by 90% and reducing dead stock by 37%; Tencent Docs' intelligent collaboration system integrates NLP (Natural Language Processing) technology, supporting simultaneous editing by 200 users and automatically generating structured meeting minutes with a key information extraction accuracy rate of 98%, reducing the frequency of cross-departmental coordination meetings by 45%. Driven by technology, enterprise operational efficiency has achieved a qualitative leap from "linear improvement" to "exponential growth".

4.2. Organizational Form: From Bureaucratic to Ecological Organization

Automation drives the evolution of organizations towards flexible ecosystems: Haier's "RenDanHeYi" model, through decentralization, compresses an 8-layer bureaucratic structure into a 3-layer architecture of "platform owner - micro-enterprise - maker", shortening the decision-making chain by 67% [6] and reducing new product launch cycles from 6 months to 45 days; Alibaba Cloud adopts a "front-end iron triangle (technology + business + operations) + back-end resource pool" structure, automatically matching expert resources through an intelligent ticketing system, shortening project delivery cycles by 35% and improving customer demand response speed to 2 hours; BYD establishes a cross-departmental digital platform, integrating data flows from 9 major systems including R&D, production, and sales, increasing BOM (Bill of Materials) data sharing from 32% to 60% and shortening vehicle model development cycles by 28%. Organizational structures are evolving from "mechanical rigidity" to "biological flexibility".

4.3. Human Capital Transformation: Skill Reshaping and Value Upgrading

Human-machine collaboration gives rise to a new capability system: Foxconn's Zhengzhou factory, by introducing 3,000 collaborative robots, increases the proportion of technical positions from 15% to 40%, establishing 12 emerging job clusters including "robot maintenance engineers", and enhancing per capita output value by 3.2 times; New Hope Group constructs a dual-track certification system of "digital literacy (Python/RPA) + business expertise", with 12,000 employees certified in 2023, increasing the self-implementation rate of digital projects from 18% to 65%; Shanghai Electric deploys an AR (Augmented Reality) assisted maintenance system, overlaying 3D fault maps onto real-world scenarios, reducing average engineer diagnosis time from 45 minutes to 15 minutes and decreasing major equipment downtime incidents by 82%. The value of talent is shifting from "labor output" to "innovation drive".

5. Practical Dilemmas and Breakthrough Paths

5.1. Major Obstacles to Technology Implementation

The adoption of automation technology faces three technical barriers: firstly, the issue of system heterogeneity, where SMEs suffer from insufficient data interoperability, with a rate below 30% due to differing ERP and MES system interface standards (according to the "2023 China Industrial Software Ecosystem Development Report"), leading to disconnected production planning and execution data; secondly, investment return pressure, with the automotive industry's automation retrofitting requiring an average investment of RMB 230 million and a payback period of 5.2 years [2] (data from the China Association of Automobile Manufacturers), constraining SMEs' willingness to adopt technology; thirdly, data governance deficiencies, where a home appliance company's AI demand forecasting model accuracy is

only 58%, 22 percentage points lower than industry benchmarks, due to chaotic material coding rules. Multidimensional shortcomings in technology, funding, and data capabilities form an "automation transformation trap".

5.2. Key Challenges in Organizational Adaptability

Organizational inertia poses an invisible resistance to automation transformation: culturally, 68% of digital transformation failures in traditional manufacturing stem from employee resistance (survey data from Tsinghua University's School of Economics and Management), manifested as concerns about technology transparency and resistance to changes in power structures; in terms of capabilities, the Ministry of Human Resources and Social Security predicts a talent gap of 3 million in smart manufacturing by 2025, with less than 40% supply of emerging positions such as RPA process designers and digital twin engineers; institutionally, a state-owned enterprise's continued use of traditional KPIs like "working hour assessment" results in a 37% utilization rate of smart scheduling systems and a 15% utilization rate of connected device data. The lag in organizational elements significantly weakens the release of technological value.

5.3. Breakthrough Paths and Implementation Framework

Resolving the automation transformation dilemma requires a systematic approach: firstly, a technology selection matrix, prioritizing RPA implementation in the "high maturity-high value" quadrant based on a four-quadrant model of business complexity (horizontal axis) and technology maturity (vertical axis), such as in financial reconciliation and inventory counting; secondly, a change management model, advancing in three stages - awareness awakening (management workshops + pilot project visualization), capability building (digital academy + job certification), and institutional safeguarding (agile assessment + innovation error tolerance mechanisms); finally, an ecological collaboration strategy, where SMEs can access automation services through platforms like Alibaba Cloud's "ET Industrial Brain" and Huawei Cloud's "Industrial aPaaS" on a subscription basis, reducing initial investments to 20% of traditional solutions. Through evolution of technology, organization, and ecology, we can achieve controlled transformation risks and maximize value.

6. Future Trends and Policy Recommendations

6.1. Technology Convergence Trends

The convergence of new-generation technologies is driving automation towards ubiquity and intelligence: Kingdee Cloud's Cangqiong platform empowers business personnel to independently build automation processes such as procurement approval and expense reimbursement through low-code/no-code development, improving process building efficiency by 80% for a manufacturing company and saving annual IT development costs of over RMB 5 million; Huawei's Atlas 500 edge intelligent station deployed in steel workshops achieves millisecond-level judgment of steel rolling quality through localized AI inference, reducing decision-making latency by 97% compared to the cloud and achieving a defect detection rate of 99.8%; BMW Group builds a virtual factory based on NVIDIA Omniverse, enabling real-time collaborative debugging among engineers in Germany, China, and the US, shortening new model R&D cycles from 36 months to 29 months and reducing design iteration costs by 41%. The cross-border integration of technologies is reshaping the paradigm of automation applications.

6.2. Directions in Management Innovation

Automation-driven management innovation focuses on resilience, sustainability, and ethics: smart contracts based on blockchain achieve automatic inspection and payment in the automotive supply chain, with an automation execution rate of 53% in 2023 (McKinsey's "Global Supply Chain Trends Report"), reducing contract disputes by 78%; CATL optimizes the sintering process of cathode materials through AI, reducing energy consumption per GWh of capacity from 23,000 kWh to 19,500 kWh, with annual carbon reductions equivalent to planting 5.4 million trees; addressing ethical risks of algorithms, the EU's "AI Act" requires high-risk systems to provide decision traceability, while China's "Guidelines for the Governance of Automated Decision-Making Systems (Draft for Comment)" mandates a model explainability of over 90%

in the medical and financial sectors. Management innovation is shifting from efficiency priority to sustainable development.

6.3. Policy Optimization Suggestions

Building a policy support system for automation transformation requires multi-dimensional efforts: financially, it is recommended to extend the coverage of "smart manufacturing special loans" from above-scale enterprises to medium-sized enterprises with annual revenues exceeding RMB 20 million, and increase the loan interest subsidy ratio from 3% to 5%, drawing on the experience of Zhejiang Province's "New Smart Manufacturing" initiative; in terms of standard development, there is an urgent need for the Ministry of Industry and Information Technology to lead the formulation of national standards such as the "RPA System Implementation Specifications" and "General Requirements for Industrial Data Interfaces" to address over 30% of system interoperability issues; in talent cultivation, support vocational colleges in opening "Automation Process Architect" majors, with courses covering RPA development, digital twin modeling, and other skills, aiming to cultivate 100,000 composite technical talents within three years. Collaboration among policy, industry, and education is essential to strengthen the foundation for transformation.

7. Conclusion

In the context of the deep integration of the digital economy and the real economy, automation technology is elevating from a tool-based application to a strategic capability for enterprises. This paper reveals the uniqueness and complexity of domestic enterprises' automation transformation by constructing a "technology-organization-environment" analysis framework. Future research should further focus on cutting-edge topics such as technology ethics and human-machine symbiosis, providing theoretical support for building a smart management paradigm with Chinese characteristics [3].

References

1. Development Research Center of the State Council. *White Paper on the Digital Transformation of China's Manufacturing Industry*; China Development Press: Beijing, China, 2023.
2. National Research Center for Industrial Information Security and Development. *Report on the Development of China's Industrial Robot Industry*; Electronics Industry Press: Beijing, China, 2023.
3. Dong X, Zhou H. *Digital Transformation: Theory and Cases*; Peking University Press: Beijing, China, 2021.
4. China Electronics Standardization Institute. *Implementation Guide for Intelligent Manufacturing System Architecture (IMS)*. Available online: <http://www.cesi.cn> (accessed on 18 March 2025).
5. Li J. *Industrial Intelligence: From Automation to Autonomy*; Tsinghua University Press: Beijing, China, 2023.
6. Dong X, Zhou H. *Digital Transformation: Theory and Cases*; Peking University Press: Beijing, China, 2021.