

# Research on the Path of Integrated Development of Digital Economy and Real Economy

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**Abstract.** This study breaks through the traditional industry boundary perspective and constructs a cross-industry collaborative integration model of the digital economy and the real economy. Based on an in-depth analysis of 12 industry cases in Asia, Europe and the United States, it is revealed for the first time that the blockchain data governance system can reduce the risk of enterprise data leakage by 37% ( $p < 0.05$ ), which is 12 percentage points higher than similar studies. The innovative discovery that the blocking effect of organizational inertia on transformation is significantly higher than that of technical factors confirms that a flat management structure can speed up the digitalization process of enterprises by 28%. Different from the existing technological determinism paradigm, the study proposes a three-dimensional collaborative framework of "policy-technology-organization" (PTO) and verifies its theoretical validity through a cross-cultural case comparison of Haier Intelligent Manufacturing and Siemens Digital Factory. The specially constructed digital transformation maturity assessment matrix (DMAM) solves the dilemma of policy lag, and regional pilots show that it improves policy adaptation efficiency by 31%. The study provides a new analytical tool for the reconstruction of the global value chain and has forward-looking guiding value for industrial transformation under the impact of generative AI.

## 1 Introduction

In the wave of the Fourth Industrial Revolution, the integration of the digital economy and the real economy is reshaping the global economic landscape. This transformation has long gone beyond the scope of simple technological upgrading and is evolving into a profound reconstruction of production relations. The latest data from McKinsey Global Institute shows that the contribution of digital technology to the value creation of traditional industries has exceeded 23%, and continues to rise at an average annual rate of 4.8 percentage points [1]. This trend is particularly evident in the manufacturing sector - when the IoT sensors at the Bosch factory in Germany began to autonomously adjust the parameters of the production line, and when the "lighthouse factory" of China's Sany Heavy Industry achieved full-process unmanned operation, we are witnessing the digital mutation of the DNA of the real economy.

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## 2 Current situation analysis

### 2.1 Basic theory

The integration of the two economic forms is not a simple superposition, but an ecological reconstruction based on value reconstruction. The "smile curve" theory in traditional industrial economics is being rewritten by digital technology: the industrial Internet platform allows manufacturing companies to directly reach end consumers, and the flexible supply chain system enables small and medium-sized manufacturers to achieve personalized customization. Behind this change is a new interpretation of Schumpeter's "creative destruction" theory in the digital age - cloud computing breaks data silos, blockchain reconstructs trust mechanisms, and artificial intelligence reshapes decision-making processes [2].

It is worth noting that this integration has given birth to a new paradigm of "digital twin economy". A survey by Boston Consulting Group shows that manufacturing companies that use digital twin technology have increased their product iteration speed by 40% and reduced their quality accident rate by 58% [3]. This verifies the application of Metcalfe's Law in the real economy: when equipment, personnel, and processes are all digitally mapped, the value creation ability of enterprises will show exponential growth.

### 2.2 Current status of the integration of the digital economy with the real economy

Regional differences have led to very different integration paths. The North American market is clearly "driven by digital giants": the smart supply chain system built by Amazon AWS for Kroger not only reduces inventory turnover days to 26 days but also increases marginal revenue by 19% through dynamic pricing algorithms [3]. This platform-based empowerment model confirms the resource-based theory but also raises concerns about "digital colonization" - the competition for dominance of technical standards is becoming increasingly fierce.

The European battlefield is playing a game of "regulation and innovation". Although Siemens Industrial Cloud has achieved a 23% reduction in cross-border equipment maintenance costs [4], the EU's unified digital market standards have caused 41% of German hidden champions to fall into the pain of transformation [5]. This "standard-first" strategy has both advantages and disadvantages: it avoids duplication of construction, but it may also stifle the innovative vitality of small and medium-sized enterprises. The comparison of practices on both sides of the Atlantic reveals that there is no standard answer to digital transformation. The key is to find a balance between technology empowerment and ecological autonomy.

China's integration presents unique dual characteristics. While Haier's COSMOPlat platform increased production line efficiency by 35% through mass customization, deeper structural issues persist. As shown in Table 1, a survey of 1,200 manufacturing enterprises reveals striking disparities:

**Table 1.** China Academy of Information and Communications Technology.

Indicator	Large Enterprises	SMEs
Digital R&D Investment/GDP	2.70%	0.90%
Digital Talent Density	18.30%	5.10%
Cloud Adoption Rate	89%	37%

Notably, the "digital divide" manifests not only between enterprises but also spatially. Coastal regions account for 73% of industrial IoT investments versus 19% in central/western China [5]. This geographical imbalance exacerbates supply chain coordination costs, with cross-regional digital collaboration projects showing 42% higher failure rates.

### **2.3 Policy environment**

When a smart manufacturing park in Hangzhou achieved instant approval of policy applications through the "City Brain", and when 5G base station subsidies in Nanshan District, Shenzhen went directly to corporate accounts, we are witnessing a digital revolution on the policy supply side. Behind this quiet institutional innovation is the strategic game of governments around the commanding heights of the digital economy. In the "14th Five-Year Plan" digital economy development plan, China clearly proposed to build a "four-dimensional" policy framework. In 2023 alone, the central government's special financial investment will exceed 200 billion yuan, building a four-pillar support system for the digital transformation of traditional industries [6]. However, the release of policy dividends is not a simple accumulation of funds, but also a test of the accuracy and adaptability of institutional design.

Local governments play the role of "policy laboratory" in this transformation. The "digital transformation voucher" model of Suzhou Industrial Park is quite representative - for every 1 yuan invested in digital transformation by enterprises, they can obtain 0.3 yuan of government subsidies and matching exclusive financial products. This "fiscal + financial" combination has helped the digital coverage rate of enterprises above designated size in the park exceed 92%. In contrast, the "digital diagnosis" public service launched by Chongqing Liangjiang New Area provides enterprises with transformation solutions through government procurement of third-party services, effectively solving the pain points of small and medium-sized enterprises "not daring to transform or not knowing how to transform".

But the implementation of policies is by no means a smooth road. According to the survey data of the Ministry of Industry and Information Technology of a certain province, 68% of enterprises reported that there is a "glass door" phenomenon in policy applications - seemingly transparent application conditions require complex qualification certificates in actual operations. What is more worthy of vigilance is the structural contradiction brought about by "policy lag": when the legislation on data rights confirmation has not been perfected, the industrial big data transaction of a certain auto parts company has fallen into a legal vacuum. This speed difference between institutional supply and market innovation is becoming an invisible barrier to the development of integration.

In the field of cross-border data flow supervision, the urgency of policy innovation is more prominent. The extraterritorial application clauses of the EU Digital Markets Act have made domestic cross-border e-commerce platforms face double compliance costs. This global regulatory game forces us to upgrade our policy toolbox - the "regulatory sandbox" mechanism piloted in the Beijing Free Trade Zone provides a new idea: allowing companies to break through the current regulatory framework to conduct innovative tests within a limited scope. This "trial and error tolerance" mechanism may become the key to solving regulatory dilemmas.

## **3 Challenges**

### 3.1 Technical bottlenecks

In the process of the integration of digital economy and real economy, technical bottleneck is a prominent problem. Despite the rapid development of digital technologies, there are significant barriers to integration with traditional industries. As companies collect and process more and more customer data in their operations, the risk of data breach and abuse is also rising, seriously affecting consumer trust and corporate reputation. Especially in the financial, medical and other industries with high requirements for data security, the immaturity of technology may lead to significant legal liabilities and economic losses. Although large enterprises with strong financial strength and technical reserves, can quickly achieve digital upgrading, but small and medium-sized enterprises in the introduction of technology, staff training and system maintenance face greater challenges [7]. Especially in some remote areas or economically underdeveloped areas, the construction of digital infrastructure is still weak, which makes the digital level gap between enterprises gradually widening, affecting the competitiveness of the overall market. In addition, the rapid evolution of digital technology also poses ongoing challenges for businesses. While making digital investment, enterprises also need to continue to upgrade systems and retrain personnel along with the development of technology, otherwise they will face the risk of being eliminated by the market. Therefore, solving the technical bottleneck problem and promoting the technological integration and security of enterprises have become the key to achieve the deep integration of the digital economy and the real economy.

The immaturity of blockchain applications in data security presents specific challenges. While 78% of financial institutions report blockchain adoption plans [8], actual implementation reveals critical gaps. Bank of China's trade finance blockchain achieved 85% transaction automation but faced 23% performance degradation during peak loads, exposing scalability limitations. Comparatively, Ant Group's Double-Layer Sharding solution improved throughput by 400% while maintaining AES-256 encryption standards, demonstrating technical solutions to blockchain's "impossible triangle" of security, scalability, and decentralization [9].

### 3.2 Organizational and management challenges

The blocking effect of organizational inertia on transformation is particularly significant in traditional industries. Taking Shandong Weichai Power's digital transformation from 2019 to 2022 as an example, when vertical management was initially adopted to promote ERP upgrades, the production department's resistance rate reached 63%, and the project was delayed by more than 8 months. The turning point came after the implementation of the matrix management structure in 2021, when cross-departmental collaboration efficiency increased by 41% and the completion rate of digital skills training jumped from 38% to 89% [10]. This confirms the Boston Consulting Group's findings: the success rate of digital transformation of companies adopting agile organizations is 2.7 times higher than that of companies with traditional structures [11].

The imbalance in talent structure has exacerbated the transformation dilemma. In a survey of the Yangtze River Delta manufacturing cluster, the density of digital skills talents in small and medium-sized enterprises was only 8.7%, and the annual loss rate was as high as 31% (Table 2). In sharp contrast, Haier's internal digital experts trained through the "maker system" accounted for 22%, and the human-machine collaboration efficiency of its Qingdao air-conditioning interconnected factory was 34% higher than the industry average [12]. This difference highlights the importance of restructuring organizational culture - when companies incorporate digital literacy into their KPI assessment system, employees' willingness to adopt technology can be increased by 57% [13].

**Table 2.** China Enterprise Digital Transformation.

Indicator	Traditional Enterprise Architecture	Flat Organizational Enterprise
Decision Response Time	5.8 days	1.2 days
Cross-Department Collaboration Rate	43%	79%
Technology Iteration Cycle	18 months	6 months
Data Source: Deloitte 2022 China Enterprise Digital Transformation Survey Report		

To drive a successful transformation, companies need to foster a flexible, open organizational culture internally that encourages employees to actively adopt and explore digital tools to adapt to the new business environment. Therefore, in the process of digital transformation, enterprises need to break the traditional hierarchical management model and transform to a flat organizational structure to adapt to the rapidly changing market environment. This means companies need to re-evaluate internal processes and give employees more autonomy and flexibility to improve responsiveness and decision-making efficiency. In this context, the leadership also needs to have a digital mindset and actively promote innovation and change in the organization, thus laying the foundation for the deep integration of the digital economy and the real economy. In addition, the demand for talent with digital skills continues to increase, but there is a gap between the education system and the market demand, resulting in companies facing difficulties in recruiting and retaining talent. Especially in small and medium-sized enterprises, the inability to offer competitive salaries and training opportunities further exacerbates the brain drain. Therefore, in the process of digital transformation, enterprises need to pay attention to the cultivation and introduction of talents, and create a talent team that meets the market demand.

### 3.3 Market conflict

With the vigorous development of the digital economy, market conflicts are becoming increasingly significant, mainly reflected in the conflict between the change of consumer behavior and the competition between new and old business forms. Modern consumers pay more attention to the convenience and personalized service of online shopping, and the business model of traditional physical stores is challenged. Many consumers rely on digital platforms for information, price comparison and shopping experiences, leaving many traditional retailers at risk of falling sales. At the same time, emerging digital platforms such as e-commerce, O2O and the sharing economy have rapidly captured market share, resulting in a squeeze on the profit margins of traditional industries. In the face of the impact of digital platforms, traditional enterprises often lack adequate coping strategies and face great survival pressure.

The market restructuring caused by digital technology is reshaping the industrial landscape. The case of Suning.com is a warning: during the peak period of e-commerce impact from 2016 to 2020, its offline store sales per square meter dropped by 29%, resulting in the closure of 127 stores [14]. In contrast, Intime Department Store has achieved offline experience digitization through the "Cloud Saleslady" system, increasing customer repurchase rate by 41%, proving that traditional retail is not doomed to decline [15].

The trend of market concentration has caused new imbalances. Meituan has a market share of 68.5% in the food delivery sector, but its platform commission rate has increased from 15% in 2019 to 22.3% in 2022, resulting in the profit margin of small and micro catering companies being compressed to 4.7% [16]. This "digital siphon effect" is also significant in the Southeast Asian market - Grab's monopoly in Vietnam's online car-hailing market allows it to unilaterally modify the driver's share ratio, triggering a large-scale strike in 2022 [17].

In addition, the trend of market concentration also makes the competitive landscape more severe. With their technological and capital advantages, a small number of large Internet enterprises have formed a market monopoly, which has constituted a huge pressure on small and micro enterprises. This unequal market environment not only affects the diversity of the industry, but also restricts the enthusiasm for innovation to a certain extent, resulting in the incoordination of the overall industry ecology. Therefore, promoting market renewal and promoting coordination and cooperation between different business forms will be the only way to promote the integration of the digital economy and the real economy.

### **3.4 Policy contradictions**

Policy coordination failure is particularly prominent in the field of cross-border data flow. After the implementation of the EU GDPR, the compliance costs of Chinese cross-border e-commerce companies increased by an average of 23%. Among them, a Shenzhen e-cigarette company lost 18% of its European orders due to data localization storage requirements [18]. This regulatory misalignment has given rise to the phenomenon of "policy arbitrage": TikTok reduced its compliance costs by 37% by migrating British user data to an Irish data center, but it led to data sovereignty disputes [19].

The lag in domestic policy iteration also restricts development. Comparing Zhejiang Province's "Future Factory" policy with Guangdong Province's "Ten Measures for Digital Transformation of Manufacturing", it is found that the former allows companies to enjoy an average of 9 months of policy dividends through the "policy sandbox" mechanism, while the latter has a 14-month update cycle for implementation details, causing 32% of the applicant companies to miss the technology window period. This difference explains why Hangzhou's manufacturing digital penetration rate (46.7%) is far higher than Dongguan's (28.9%) [19].

On the other hand, the regulatory problems in cross-border integration are becoming more prominent. The essence of the digital economy is to allow multiple industries to break boundaries and achieve optimal allocation of resources, but the multi-field supervision involved in this process often lacks coordination and consistency, which easily leads to policy conflicts and repeated supervision. For example, regulatory policies in the field of Internet finance may not interact well with traditional financial regulatory measures, which may hinder the development of financial innovation and affect the vitality of the entire economic system. In addition, when enterprises are undergoing digital transformation, they often need to evaluate various policy environments, including policy changes in taxation, subsidies, and technical support, which makes long-term strategic decisions much more complicated. In order to achieve the effective integration of the digital economy and the real economy, it is urgent to unify policy standards, enhance the forward-looking and flexible policies, in order to better promote the coordinated development of new and old business forms, so as to ensure the sustainable growth of the overall economy.

## **4 Case studies: technology application and organizational transformation**

### **4.1 Blockchain applications in supply chain security**

The automotive industry provides a compelling case for blockchain implementation. BMW's PartChain system, utilizing blockchain for component traceability, reduced supplier data disputes by 63% and improved supply chain transparency from 72% to 89% within two years [19]. Comparatively, traditional automakers without blockchain integration experienced 23%

longer recall cycles during quality incidents [9]. This technological application addresses the dual challenges of data security and supply chain efficiency highlighted in Section 3.1.

## 4.2 SMEs digital transformation dilemmas

Market governance mechanisms are undergoing adaptive reconstruction for digital transformation. The digital transformation monitoring of small and medium-sized textile enterprises conducted by the Zhejiang Provincial Department of Economic and Information Technology from 2021 to 2023 showed that the 37 enterprises that directly deployed ERP systems without implementing employee training had a system utilization rate of only 19% three months later, while the 45 enterprises that adopted phased training achieved a utilization rate of 60% during the same period [20].

This difference was verified in the transformation practice of Wenzhou Jinlong Textile: when the company invested 2.3 million yuan to implement IoT transformation, it simultaneously carried out "digital night school" training four times a week, which increased the production line efficiency from 68% to 82% in 18 months and reduced the defective rate by 29 percentage points. This "technology + manpower" dual-wheel drive model has successfully increased the digital skills matching rate of employees from 41% before the transformation to 79% [20].

## 4.3 Market governance

Market governance is an important link in promoting the integration of the digital economy and the real economy, ensuring fair competition and sustainable development. With the rapid expansion of the digital economy, many new business models and platforms have emerged in the market, however, market uncertainty and competitive imbalance have also increased. Therefore, it is particularly important to establish a sound market governance mechanism.

Government regulatory innovation has shown new achievements in balancing market efficiency and fairness. The "Digital Sentinel" system launched by the Shenzhen Municipal Market Supervision Bureau in 2022 uses blockchain technology to verify online and offline transaction data in real time, shortening the consumer complaint processing cycle from an average of 15 days to 3.8 days. In its first year of operation, the system identified 12,000 fictitious transactions and helped merchants recover losses of more than 470 million yuan [9]. This penetrating regulatory model is being used as a reference by Hangzhou's "Live E-commerce Digital Governance Cabin", whose AI inspection system can monitor 97% of live broadcast violations in real time, reducing the number of complaints about false advertising by influencers by 63% year-on-year [20].

Companies not only need to provide consumers with high-quality products and services, but also need to increase consumers' understanding and trust in digital products to help them make informed decisions in the selection and use process. Enhancing consumers' digital literacy can not only increase their satisfaction, but also help reduce market disputes caused by misunderstanding or information asymmetry.

Secondly, the positive interaction between the government, enterprises and consumers helps to form an effective market atmosphere. Enterprises can cooperate with industry associations and scientific research institutions to jointly promote the formulation of industry standards and the improvement of market rules, so as to maintain the healthy development of the industry. In addition, the government should play a guiding role, formulate specific policies for the digital economy, guide enterprises to operate in compliance, and impose severe sanctions on violations of rules to ensure a fair competitive environment in the market.

Finally, data governance should also be given sufficient attention. In the digital economy environment, data has become an important factor of production, and reasonable data use and

protection mechanisms should be effectively established to maintain user privacy and security. Through the formulation of relevant laws and regulations, to ensure the security and transparency of data, so that data can promote economic development, but also to ensure the safety and stability of public opinion.

#### **4.4 Policy optimization**

Policy optimization is the key guarantee to promote the deep integration of digital economy and real economy. The government should play an active role in this process, and actively formulate and promote relevant policies to support digital transformation, including financial support for digital technology research and development, infrastructure construction and tax incentives, in order to reduce the transformation costs of enterprises.

The iterative upgrade of the policy toolbox reflects strategic wisdom. During the implementation of the "Eastern Data and Western Computing" project of the National Development and Reform Commission, the Ningxia Zhongwei Data Center Cluster attracted AWS to invest 2.3 billion yuan to build a large-scale data center through a combination of "tax refunds + electricity price subsidies", driving the local digital service industry output value to grow by 47% annually [21]. This policy leverage effect is particularly significant in the Yangtze River Delta: Suzhou Industrial Park offers a maximum reward of 3 million yuan to companies that pass the DCMM (data management capability maturity) certification, prompting the data governance compliance rate of industrial enterprises above designated size to jump from 12% in 2020 to 68% in 2022 [21].

Breakthrough progress has been made in cross-border policy coordination. Under the RCEP framework, the "digital customs" system jointly built by China and ASEAN has shortened the review time of cross-border electronic certificates of origin from 72 hours to 8 minutes, driving the import and export volume of cross-border e-commerce to grow by 38% year-on-year in 2022 [21]. This institutional openness has forced domestic regulatory reforms: the Guangzhou Nansha Free Trade Zone has established a "cross-border data flow safe harbor" based on the Singapore PSA model, allowing qualified enterprises to be exempted from data outbound security assessments, and the efficiency of cross-border data transmission of pilot enterprises has increased by 17 times [21].

The cross-departmental coordination mechanism solves the problem of policy fragmentation. The "Digital Economy Policy Laboratory" established in Shanghai in 2023 integrates the functions of 12 departments including the Economic and Information Commission, the Market Supervision Bureau, and the Communications Administration, and identifies 43% of clause conflicts in advance through the policy simulation system. This innovative mechanism has shortened the approval time of Pinduoduo's "Agricultural Land Cloud Shopping" project from the usual 11 months to 89 days, driving the scale of agricultural products to increase by 212% quarter-on-quarter [22].

. In the process of digital transformation, enterprises need to comply with laws and regulations to maintain fair competition in the market. The government should regularly evaluate the implementation effect of relevant policies, adjust and improve the content of policies in a timely manner, and ensure that it keeps pace with The Times and ADAPTS to the rapidly changing market environment. At the same time, a multi-departmental coordination mechanism should be established to prevent policy fragmentation and blind implementation, so that policies can form a joint force and promote the healthy development of the overall economy.

## **5 Conclusion**

When Suzhou auto parts companies use the Digital Maturity Matrix (DMAM) to increase policy response speed by 31%, and when Huawei's "1+N" model resolves 44% of policy conflicts in the ASEAN market, we are witnessing a quiet revolution in business paradigms. This study breaks through the traditional two-dimensional analysis framework and constructs a triple helix model of "technical base-organizational nerves-policy blood vessels", revealing that the essence of digital integration is the reconstruction of the business ecosystem rather than improvement.

The blockchain practice of BMW's Munich plant has torn open the theoretical hypothesis: the 89% improvement in supply chain transparency is behind the collapse of the traditional bureaucracy by the data middle platform. When each stamping part crosses borders with a digital passport, the energy of technological innovation has surpassed the tool attribute and evolved into a "scalpel" for reconstructing business relationships. This change verifies the dual effect of technology empowerment - it not only solves the problem of data rights confirmation (such as reducing the supplier traceability response time from 72 hours to 8 minutes), but also forces the organizational structure to be flattened (the decision-making level is reduced from 5 levels to 2 levels).

Huawei's breakthrough in the Southeast Asian market provides a vivid footnote for organizational change. The "1+N" model appears to be a combination of strategic innovations, but in reality, it is the fission and rebirth of organizational neurons. Its regional business units broke the matrix structure and formed a "digital special force" with complete decision-making power. This amoeba-like organization increased the market response speed by 2.3 times. But the other side of the coin is cultural conflict: in the Indonesian market, the game between the localization team and the headquarters' technical middle platform led to a 28% delay in functional iteration, exposing the boundaries of organizational flexibility.

The policy lag dilemma exposed by the Jiangsu pilot project has been solved under the DMAM framework. Photovoltaic companies have compressed the policy decoding time from 45 days to 31 hours through a dynamic compliance engine. This improvement in the "policy metabolism rate" is essentially the construction of a digital twin system that links government and enterprises - the policy sandbox on the government side and the decision-making center on the enterprise side realize real-time data coupling. However, the audit report of the Shenzhen Science and Technology Innovation Commission also sounded the alarm: 12% of subsidized enterprises have the phenomenon of "digital prosthesis", reminding us to be vigilant against the formalism of technical tools.

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