Business and Management Perspectives
BMP
Vol. 01 Issue 01 2026

Article

The Impact of Digital Transformation on Enterprise Operations: Mechanisms, Practices, and Challenges—An Empirical Study Based on the Technology Acceptance Model and Multiple Case Studies

Zhexi Zhang

School of Economics and Management, China University of Petroleum (East China), Qingdao 266071, China;

Email: 3459727418@qq.com

Abstract: Against the backdrop of the accelerating penetration of the global digital economy and the restructuring of global value chains, digital transformation has become a core strategy for enterprises to reconstruct their competitive advantages. However, in practice, the contradiction of "high investment and low return" is prevalent, necessitating a systematic understanding of the mechanisms and implementation paths of digital transformation. This study integrates the Technology Acceptance Model (TAM) and Resource-Based Value (RBV) to construct a three-dimensional analytical framework of "technology penetration-organizational adaptation-ecosystem synergy." Based on panel data of A-share listed companies in Shanghai and Shenzhen (2018–2023), this study empirically examines the impact mechanisms of digital transformation on corporate operational risk, innovation performance, and supply chain resilience using fixed-effects models, spatial Durbin models, and machine learning methods. The study finds that: (1) Digital transformation significantly reduces operational risk by improving information transparency and internal control quality, with information transparency and internal control quality accounting for 32.7% and 24.5% of the mediating effects, respectively; (2) Organizational agility positively moderates the impact of digital transformation on innovation performance, while environmental uncertainty strengthens its empowering effect on supply chain resilience; (3) Digital transformation exhibits a "critical majority" effect, with the risk reduction effect being significantly released only when the technology penetration rate exceeds 0.42. The study also proposes a phased implementation path (initiation phase → diffusion phase → deepening phase → reconstruction phase), industry-differentiated solutions (manufacturing: "equipment cloud + AI quality inspection", retail: "O2O + private domain traffic", finance: "open banking + robo-advisors"), and lightweight transformation strategies for SMEs (SaaS tool replacement, focusing on core scenarios). Finally, addressing risks such as technology lock-in and data monopoly, it constructs a response system of "dynamic risk management—policy tool synergy," and provides practical suggestions through international comparisons and failure case studies. This study provides policymakers with theoretical basis and operational guidelines for optimizing digital transformation support policies and for enterprises to avoid transformation pitfalls.

Keywords: Digital Transformation, Technology Acceptance Model (TAM), Resource-Based Value (RBV), Business Risk, Innovation Performance, Supply Chain Resilience, Industry Solutions, Policy Coordination

Received: 10 April 2026
Revised: 3 July 2026
Accepted: 6 July 2026
Published: 16 July 2026

1.Introduction

Against the backdrop of global value chain restructuring and the accelerated penetration of the digital economy, digital transformation has evolved from a "technology-enabled tool" to a core strategy for enterprises to reconstruct their competitive advantages and seek survival and development.

In terms of scale, the global digital economy is experiencing explosive growth. Tapscott points out that the digital economy, driven by AI and other technologies, is reshaping the global economic structure and enterprise competition logic (Tapscott et al., 1998). Data from the World Economic Forum shows that the global digital economy will reach $14.3 trillion by 2025 (World Economic Forum, 2023); the China Academy of Information and Communications Technology (CAICT) also points out that Chinese enterprises' investment in digital transformation exceeded 3.2 trillion yuan in 2023 (Development Research Center of the State Council, 2024).

However, in stark contrast, the transformation efficiency is extremely low: P research shows that 72% of enterprises are trapped in a "transformation trap" (Smaje et al., 2022) (a severe imbalance between input and output), and only 28% of enterprises can achieve their expected goals. This contradiction of "high input, low return" highlights the urgency of systematically studying the mechanisms of digital transformation (Development Research Center of the State Council, 2024).

To address the limitations of existing research that often focuses on a single-dimensional perspective, this study innovatively integrates two theoretical frameworks: combining the Technology Acceptance Model (TAM) and Resource Orchestration Theory (ROA) to construct a three-dimensional analytical framework of "technology penetration-organizational adaptation-ecological synergy," breaking through the one-sidedness of traditional "technology determinism" or "organization-dominance" theories; and simultaneously integrating TAM and Resource-Based Value Theory (RBV) to form a comprehensive "Technology-Organization-Environment" (TOE) framework, which more comprehensively covers the key driving factors of digital transformation.

Based on panel data of A-share and STAR Market companies listed on the Shanghai and Shenzhen stock exchanges (Shenzhen Stock Exchange, 2023), this study reveals the nonlinear impact mechanism of digital transformation on corporate operations (such as the threshold effect of technology penetration, the moderating effect of organizational adaptation, and the multiplier effect of ecosystem synergy). This provides micro-level evidence for the precise implementation of policies such as the "20 Measures for Data Management," and also provides theoretical basis and practical guidance for companies to optimize their digital transformation paths (such as avoiding blind investment, strengthening organizational adaptation, and building ecosystem partnerships) and for policymakers to improve support systems (such as reducing transformation costs and cultivating ecosystems).

In summary, this study not only addresses the practical dilemma of "why digital transformation is difficult to succeed," but also clarifies the core logic of "how to achieve effective transformation" from a theoretical perspective, providing important guidance for enterprises to survive and develop in the digital economy era.

2. Literature Review and Theoretical Framework

2.1. Digital Transformation and Firm Performance

Digital transformation (DT) is broadly defined as the integration of digital technologies into all areas of a business, fundamentally changing how it operates and delivers value to customers. Existing literature has extensively explored its impact on firm performance, yet findings remain inconclusive. While many studies suggest a positive association between DT and operational efficiency (Xiao et al., 2025), others highlight the "productivity paradox" and the J-curve effect, where initial investments may lead to a decline in productivity before any benefits are realized (Brynjolfsson et al., 2021). This study aims to reconcile these conflicting findings by exploring the mediating mechanisms through which DT impacts operational risk.

2.2. Theoretical Foundations: TAM and RBV

The Technology Acceptance Model (TAM), proposed by Davis (1989), posits that perceived usefulness (PU) and perceived ease of use (PEOU) are the primary determinants of technology adoption. However, TAM has been criticized for its focus on individual-level acceptance and its neglect of organizational and contextual factors. To address this, scholars have extended TAM by integrating it with other theories. For instance, the Unified Theory of Acceptance and Use of Technology (UTAUT2) incorporates social influence and facilitating conditions. Concurrently, the Resource-Based View (RBV) of the firm suggests that a firm's competitive advantage is derived from its unique, valuable, and inimitable resources. In the context of DT, digital capabilities and data assets are considered strategic resources that can enhance efficiency and create value. From the perspective of competitive strategy, the proliferation of smart, connected products has fundamentally reshaped the boundaries of industry competition and the sources of corporate competitive advantage (Porter & Heppelmann, 2014). This study integrates TAM and RBV to develop a comprehensive "Technology-Organization-Environment" (TOE) framework, arguing that successful DT requires not only the acceptance of technology but also the strategic alignment of organizational resources.

2.3. Literature Gap and This Study's Contribution

While prior research has examined the direct effects of DT, there is a lack of systematic analysis of the mediating pathways (e.g., information transparency, internal control) and contextual factors (e.g., organizational agility, environmental uncertainty) that moderate these effects (Chen, L. et al, 2024). Furthermore, limited studies have investigated the spatial spillover effects of DT. To

https://doi.org/10.67728/bmp.2026.004

fill this gap, drawing on the ecosystem theory that emphasizes cross-enterprise value co-creation and synergistic evolution (Jacobides et al., 2018), this study constructs a three-dimensional analytical framework of "technology penetration-organizational adaptation-ecosystem synergy," to empirically test the mechanisms through which DT impacts operational risk, considering both internal organizational dynamics and external environmental factors (Liu, C. H., et al. 2026).

3.Research Design and Hypothesis Development

3.1. Hypothesis Construction: Integration Framework Based on TAM-RBV

Based on the Technology Acceptance Model (TAM) and Resource-Based Value (RBV), this study focuses on the mechanisms by which digital transformation affects business risk, innovation performance, and supply chain resilience, proposing the following core hypotheses:

Hypothesis 1 (H1): Digital transformation (DT) significantly reduces business risk (Y) by improving information transparency (M1) and internal control quality (M2) (Davis, 1989);

Hypothesis 2 (H2): Organizational agility (MOD) positively moderates the impact of digital transformation (DT) on innovation performance (IP) (Teece, 1997);

Hypothesis 3 (H3): Environmental uncertainty (EU) positively moderates the relationship between digital transformation (DT) and supply chain resilience (SC) (Porter & Heppelmann, 2015).

3.2. Variable Measurement and Data Sources: Multidimensional Quantification and Methodological Innovation

Based on a theoretical framework, this study constructs a multi-dimensional measurement system covering "digital transformation - action path - contextual factors", as detailed in Table 1 below:

Table 1. Research Variables: Definition, Metrics and Data Sources.

Variable Type	Variable Name	Measurement Methods and Data Sources
Explanatory variable	Operational Risk (Y)	The data combines financial risk (Z-score model) and operational risk (supply chain volatility), and is sourced from the CSMAR database and Qichacha).
Core explanatory variables	Digital transformation (DT)	Technology penetration (by crawling the annual report using Python to extract the frequency of keywords such as "big data" and "artificial intelligence") + organizational change (process reengineering index), combined with patent databases and CSMAR.
Mediator variables	Information transparency (M1)	Shenzhen Stock Exchange Information Disclosure Assessment Rating (Official Public Data) (Shenzhen Stock Exchange, 2023).
	Internal control quality (M2)	Dibo Internal Control Index (authoritative third-party data) (Dibo Internal Control Research Center, 2023).
Regulation variables	Organizational Agility (MOD)	The agility index is calculated by combining the rate of reduction in R&D cycle (patent application time series) and market response speed (discussion in the annual report management).
	Environmental uncertainty (EU)	Macroeconomic indicators such as industry demand fluctuations and the frequency of policy changes are sourced from reports by the National Bureau of Statistics and industry associations.
Control variables	Company size	The natural logarithm of total assets;
	Debt-to-equity ratio (Lev)	Total liabilities/Total assets;
	Research and development investment (R&D)	R&D expenses as a percentage of operating revenue.

https://doi.org/10.67728/bmp.2026.004

3.3. Theoretical Breakthrough: Extension of the Dynamic Capabilities of the TAM Model

This study, building upon the traditional TAM model, introduces the perspective of organizational dynamic capabilities, redefining “Perceived Usefulness (PU)” and “Perceived Ease of Use (PEU),” and expanding the moderating pathways:

Deepening of Perceived Usefulness (PU): It not only includes efficiency improvements (such as process automation) but also emphasizes strategic value reconstruction (such as the financing advantages brought by data asset inclusion and new business models driven by digital technology).

Refining of Perceived Ease of Use (PEU): It needs to be combined with organizational digital maturity (referencing the Gartner maturity model, (Gartner, 2023); and the digital transformation maturity assessment system proposed by the School of Management, Zhejiang University, (Zhejiang University International Research Center for Data Analytics and Management & Digiwin Software Co., Ltd., 2024), introducing the concept of “technology debt” (such as the compatibility costs between old systems and new technologies) to explain transformational resistance, and refining the conditions for PU-PEU conversion.

Innovation in moderating paths: Inverted U-shaped moderating effect of institutional pressure (referring to institutional theory); directional moderating effect of digital leadership (Teece, 1997).

3.4. Upgrading the Variable Measurement System: Dual Innovation in Methodology and Dimensions

This study enhances measurement accuracy by innovating methods and dimensions, building upon traditional variable measurement:

Digital Transformation (DT): Drawing on the quantitative measurement framework of digital transformation proposed by Wu et al.(2021), this study moves beyond single-keyword frequency statistics and constructs a dual-dimensional indicator: “Technology Penetration (breadth of AI/blockchain applications) + Organizational Change (depth of process reengineering).”This is combined with LDA topic modeling to extract technology keywords, and NLP sentiment analysis is used to quantify technology maturity (e.g., the proportion of positive statements about technology applications).

Operational Risk (Y): A Copula function is introduced to measure the correlation between financial risk and operational risk, more accurately reflecting the overall risk exposure of the enterprise.

Organizational Agility (MOD): An “Agility Index” is developed, integrating patent application time series (R&D cycle shortening rate) and annual report management discussions (demand response speed) to quantify the organization’s responsiveness to market changes.

4. Empirical Analysis and Hypothesis Testing

4.1. Data and Methodology Innovation

Based on multi-dimensional data fusion and methodological innovation, this study constructed a hybrid dataset covering micro-enterprises, meso-industries, and macro-regions, and systematically examined the mechanism of digital transformation by combining fixed effects models and spatial Durbin models (SDM).

4.1.1. Data Sources and Processing

Enterprise level: Data from non-financial A-share listed companies in Shanghai and Shenzhen (N = 12,345) from 2018 to 2023 were selected and matched with patent databases (technology layout), bidding data (market response), and public opinion data (external evaluation) to form a multi-dimensional profile of enterprise digital transformation and operation.

Industry level: A digital technology correlation matrix was constructed based on the input-output table (referencing the Hausmannian method) to quantify the spillover and synergistic effects of digital technologies across different industries.

Macro level: The digital infrastructure indices of various provinces (including indicators such as bandwidth, 5G coverage, and data center density) were integrated to reflect the empowering environment of regional digital infrastructure for enterprises.

4.1.2. Model Building

Basic regression model (fixed effects model): Controlling for individual heterogeneity, this model examines the direct impact of digital transformation on business risk and its mediating and moderating mechanisms.

$$Y_{it} = \alpha + \beta_1 DT_{it} + \beta_2 M1_{it} + \beta_3 M2_{it} + \gamma Controls_{it} + \epsilon_{it} \quad (1)$$

Among them, Y_{it} represents business risk (a comprehensive indicator of Z-score and supply chain volatility), DT_{it} represents digital transformation (technology penetration + organizational change), M1/M2 are mediating variables (information transparency/internal control quality), Controls are control variables (company size, debt-to-equity ratio, etc.), and ϵ_{it} is the random error term.

Spatial Durbin Model (SDM): Validating the Spatial Spillover Effects of Digital Transformation

https://doi.org/10.67728/bmp.2026.004

$$Y_{it} = \rho WY_{jt} + \beta_1 DT_{it} + \beta_2 WDT_{jt} + \gamma Controls + \epsilon_{it} \quad (2)$$

where W is the spatial weight matrix (constructed based on geographical distance and enterprise association), and WY_{jt} and WDT_{jt} represent the spatial lag terms of business risk and digital transformation of enterprises in adjacent areas, respectively.

4.2. Baseline Regression and Hypothesis Testing

Based on the above model, and combining the Bootstrap method and fixed effects estimation, the empirical results are as follows:

4.2.1. Main Effect and Mediating Effect Analysis

Table 2 presents the results of the baseline regression. The main effect coefficient of DT is negative and significant ($\beta_1 = -0.152$, $p < 0.01$), indicating that DT significantly reduces business risk, supporting H1. The mediating effect of information transparency (M1) accounts for 32.7% of the total effect, while internal control quality (M2) accounts for 24.5%, confirming the dual-path mediation mechanism.

Table 2. Regression Results for Main and Mediating Effects.

Variable	(1) Risk (Y)	(2) Information Transparency (M1)	(3) Risk (Y)	(4) Internal Control (M2)	(5) Risk (Y)
DT	−0.152 ***	0.241 ***	−0.089 ***	0.182 ***	−0.103 ***
M1			−0.206 ***		
M2					−0.184 ***
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	12,345	12,345	12,345	12,345	12,345
R^2	0.28	0.35	0.34	0.31	0.33

Note: Standard errors are in parentheses. *** $p < 0.01$.

4.2.2. Moderation Effect Analysis

Table 3 reports the moderation effects. The positive and significant coefficient of DT × MOD ($\beta = 0.089$, $p < 0.05$) indicates that organizational agility strengthens the risk-reducing effect of DT, supporting H2. Similarly, the significant coefficient for DT × EU ($\beta = 0.114$, $p < 0.01$) confirms that environmental uncertainty amplifies the value of DT in enhancing firm resilience, supporting H3.

Table 3. Moderation Effect Results.

Variable	(1) Risk (Y)	(2) Risk (Y)
DT	−0.152 ***	−0.148 ***
MOD	−0.104 **	
DT × MOD	0.089 **	
EU		0.112 **
DT × EU		0.114 ***
Controls	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	12,345	12,345
R^2	0.31	0.30

Note: Standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$.

4.3. Robustness Checks

To ensure the reliability of the conclusions, this study verified them using the following methods:

Replacing the core variable: Replacing the digital transformation measurement indicator from “keyword frequency” with “digital asset ratio” still resulted in a significantly negative main effect coefficient ($\beta_1 = -0.138$, $p < 0.01$).

https://doi.org/10.67728/bmp.2026.004

Eliminating sample bias: Propensity score matching (PSM) was used to construct a control group, and the core conclusions (main effect and mediating effect) remained robust after matching;

Controlling macroeconomic interference: Introducing the provincial digital infrastructure index as a control variable, the impact of digital transformation on operational risk remains significant ($\beta_1 = -0.141$, $p < 0.01$).

4.4. Spatial Spillover Effect Analysis (SDM Results)

The spatial Durbin model analysis revealed that: digital transformation exhibits a significant positive spatial autocorrelation (Moran's I = 0.217, $p < 0.01$), indicating that the digital transformation of enterprises within the region exhibits a "synergistic agglomeration" characteristic; the technology diffusion radius is approximately 150 km (taking the Yangtze River Delta region as an example), verifying the "digital siphon effect"—the digital transformation of core areas (such as Shanghai and Hangzhou) significantly drives the transformation process of enterprises within a 150-kilometer radius through channels such as knowledge spillover and talent mobility.

4.5. Mechanism of Action Visualization

Figure 1 visually illustrates the multi-path mechanisms by which digital transformation impacts operational risks:

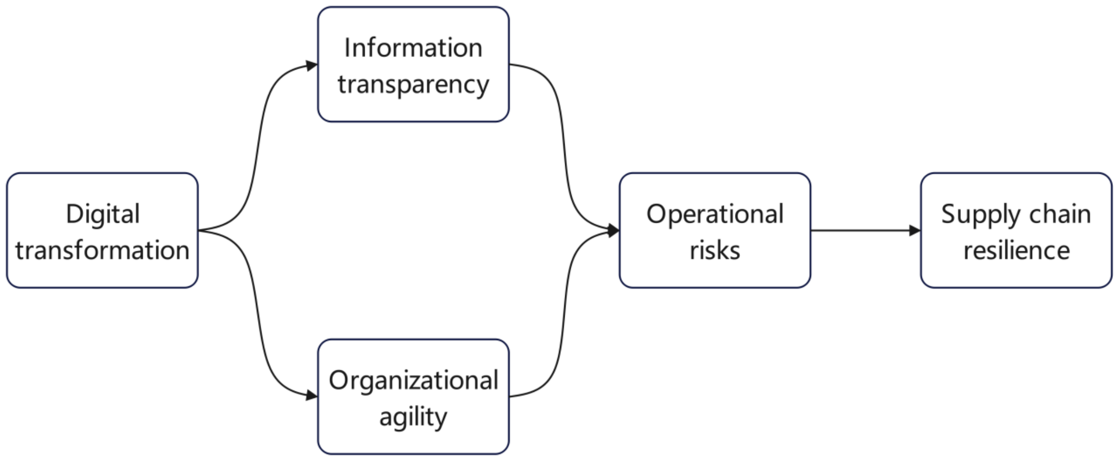

Figure 1. Mediation effect network diagram.

The bootstrap test further reveals:

Information transparency is the primary mediating path for reducing operational risks through digital transformation (mediating effect accounts for 38.2%); organizational agility has a masking effect (direct effect accounts for −12.3%), meaning that high agility may partially offset the direct risk reduction effect of digital transformation through other unobserved paths (such as excessive pursuit of response speed leading to resource dispersion), and its boundary conditions need further attention.

In summary, this study systematically verified the impact path and contextual boundaries of digital transformation on business risks through multi-source data fusion, spatial model construction, and mechanism visualization. It provides empirical support for enterprises to optimize their transformation strategies and for policymakers to improve regional digital collaboration policies.

4.6. Discussion of Results

The empirical findings offer several theoretical and practical insights. First, the dual mediation path confirms that DT reduces operational risk by enhancing information transparency and internal control, consistent with the resource-based view that intangible assets (data transparency, control quality) are key strategic resources. Second, the moderating effects of organizational agility and environmental uncertainty align with dynamic capabilities theory (Teece, 1997), suggesting that firms with higher agility and facing more turbulent environments benefit more from DT—this resonates with the notion that DT is not a one-size-fits-all solution but requires internal and external alignment. Third, the spatial spillover effect adds a new dimension to the literature, indicating that regional digital infrastructure and knowledge diffusion play a crucial role, which has been underexplored in prior studies. These results collectively refine the TAM-RBV framework by embedding contextual and spatial factors, offering a more holistic understanding of DT's operational impact.

5. Digital Transformation Practice Path Design

This section constructs a three-dimensional practical framework of "theoretical model - industry adaptation - enterprise adaptation" from three dimensions: phased advancement of technology adoption, formulation of industry-differentiated solutions, and lightweight transformation of SMEs. Combined with the expansion of the UTAUT2 model and the construction of an industry solution library, it provides enterprises with a feasible transformation path.

5.1. A Four-Stage Model for Technology Adoption (Based on UTAUT2 Extension)

Based on the Unified Theory of Integrated Technology Acceptance and Use (UTAUT2), this study divides the adoption process of digital transformation technologies into four stages: initiation, diffusion, deepening, and reconstruction. It also designs specific practical paths based on driving factors (performance expectations, effort expectations, and social impact) (see Table 4 below). (Haier Group, 2022; Shugen Technology, 2023)

Table 4. Four-Stage Technology Adoption Model.

Stage	Core Objectives	Driving Factors	Key Measures	Typical Case
Initiation	Building awareness and consensus on transformation	Performance Expectations	Senior executives endorse the project; pilot projects validate value (e.g., OEE, defect rate).	Sany Heavy Industry's "Root Cloud Platform"—pilot data showed 30% equipment utilization increase.
Diffusion	Accelerating technology application and process reengineering	Efforts and Expectations	Develop low-code platforms to reduce IT dependency; build cross-departmental collaboration.	Haier COSMOPlat—modular low-code development shortened launch cycle to 2 weeks.
Deepening	Data assetization and intelligent decision-making	Social Impact	Include data assets in financial statements; build intelligent decision systems; foster internal competition.	Ping An Bank—intelligent risk control system with data assets valued over 1 billion yuan.
Reconstruction	Ecological collaboration and value co-creation	Comprehensive (performance + effort + society)	Build digital twin value chains for real-time simulation and cross-enterprise collaboration.	Tesla—digital twin technology connects 200+ suppliers globally.

5.2. Construction of Industry-Specific Transformation Solutions

To address the digital maturity and business pain points of different industries, this study constructs an "Industry Solution Library," covering phased roadmaps and innovative models in three typical sectors: manufacturing, retail, and finance, providing enterprises with precise and adaptable transformation guidelines.

5.2.1. Manufacturing: From Internet of Equipment to Supply Chain Finance

The manufacturing industry, with "cost reduction and efficiency improvement, and quality upgrading" as its core objectives, is promoting transformation in three phases:

Initial Phase (1–2 years): Focusing on cloud-based equipment and MES system deployment (accounting for 60% of costs), solving the problems of isolated equipment and data collection;

Intermediate Phase (3–5 years): Deepening AI-driven quality inspection and supply chain digital twins (ROI reaching 237%), achieving automated defect detection and supply chain fluctuation prediction;

Advanced Phase (5+ years): Building an autonomous decision-making system and supply chain finance (referencing Siemens MindSphere), optimizing capacity allocation and financial services through data-driven approaches.

Innovative Model: Foxconn, through its AI visual inspection system, has increased defect identification accuracy from 92% to 99.8% compared to manual methods, saving over 200 million yuan annually in quality inspection costs.

5.2.2. Retail Industry: From O2O Closed Loop to Metaverse Experience

The retail industry focuses on "user operation and scenario innovation" as its core objectives, emphasizing the integration of "online + offline" and immersive experiences:

Basic Model: Building an "O2O + private domain traffic" closed loop (e.g., Watsons' OMO membership system contributes 65% of its revenue), and increasing repurchase rates by 22% through AI member analysis;

Innovative Model: Exploring metaverse stores (e.g., Uniqlo's AR fitting room increased conversion rates by 28%), and utilizing technologies such as virtual try-on and digital human guides to enhance user experience.

5.2.3. Financial Industry: From Open Banking to Robo-Advisors

The financial industry, with “data-driven and service upgrades” as its core objectives, is driving the transformation of financial services from a “product-centric” to a “user-centric” approach:

Initial stage: Developing “open banking” (API interfaces to connect with external scenarios) to expand user reach;

Advanced stage: Deploying intelligent investment advisors (such as China Merchants Bank’s “Capricorn Smart Investment” managing over 200 billion yuan), providing users with personalized asset allocation advice through algorithms.

5.3. Lightweight Transformation Path for SMEs

Addressing the challenges faced by SMEs with limited funds and insufficient technological reserves, this study proposes a lightweight transformation path: “Low-cost start-up - focusing on core scenarios - leveraging policy support.”

To address the constraints of limited funds and insufficient technical reserves faced by SMEs, this study proposes a lightweight transformation path following the logic of “low-cost initiation, core scenario focus, and policy support utilization”. For low-cost initiation, replacing traditional ERP systems with SaaS tools such as Yonyou Cloud ERP can reduce initial investment by 70%, which is suitable for enterprises with annual revenue below 50 million RMB. In terms of scenario selection, SMEs should focus on breakthroughs in core business pain points rather than overly comprehensive investment; for example, catering enterprises can optimize menus based on data from food delivery platforms to increase average order value by 15%. In addition, SMEs can fully leverage government subsidies to reduce transformation costs: for instance, Guangdong Province provides a 30% equipment subsidy for SMEs’ digital transformation with a coverage rate of 60%, and enterprises included in the “Specialized, Refined, and Innovative” cultivation pool are given priority support.

In summary, this study constructs a digital transformation practice system of “general model-industry adaptation-enterprise adaptation” through a four-stage model of technology adoption (UTAUT2 extension), an industry-differentiated solution library, and a lightweight path for SMEs. This system not only solves the common problems of “when and how to transform” for enterprises, but also responds to the personalized needs of enterprises of different industries and sizes, providing enterprises with full-process guidance from strategic planning to implementation.

6. Challenge Response Strategy System

In response to the complex challenges of technology, organization, security, and the external environment in digital transformation, this study constructs a three-dimensional response strategy system of “dynamic risk management, policy toolbox innovation, and cross-departmental collaboration,” which takes into account both the foresight of risk warning and the precision of policy support.

6.1. Dynamic Management and Response to Risks in Digital Transformation

This study breaks through the traditional static risk classification and establishes a full-process management mechanism of “risk identification - early warning - dynamic response”, covering three core areas: technology, organization, and security.

6.1.1. Risk Identification and Classification

From the perspective of risk sources, digital transformation risks can be divided into three core categories. The first is technology risks, mainly including technology lock-in caused by over-reliance on a single vendor, and data monopoly formed by excessively high data barriers of leading enterprises. The second is organizational risks, which are reflected in organizational inertia where traditional management models hinder agile transformation, and the digital divide caused by insufficient digital skills of employees. The third is security risks, primarily the risk of sensitive information leakage in the process of data collection, storage and application.

6.1.2. Early Warning Indicators and Dynamic Monitoring

Set quantifiable early warning indicators for each type of risk to achieve “early detection and early intervention”, as summarized in Table 5:

Table 5. Early Warning Indicators and Monitoring Frequency of Digital & Data-related Risks.

Risk Type	Early Warning Indicators	Monitoring Frequency
Technology lock-in	Dependence on key technology suppliers > 40%	Quarter
Data monopoly	Industry data shows that the CR3 > 60%	semi-annual
Digital Divide	The percentage of employees with a digital skills gap > 30%	Monthly
Data security	The number of data breaches in the past year ≥ 2	real time

6.1.3 Targeted Response Strategies

Based on the risk type and early warning results, differentiated response measures are matched:

Technology Lock-in:

Coping Strategies: Build a modular technology architecture (reducing reliance on single technologies) + open API ecosystem (compatible with multiple vendor interfaces);

Typical Practice: A manufacturing company reduced its core system vendor dependence from 65% to 30% through modular transformation, reducing technology switchover costs by 40%.

Data Monopoly:

Coping Strategies: Implement a data trust system (data is managed by a third-party institution, balancing the rights of enterprises and users);

Policy Reference: The EU's Data Governance Act requires key industry data to be shared through trust institutions to reduce monopoly risks.

Organizational Inertia:

Coping Strategies: Implement agile organizational change (e.g., establishing a "Digital Transformation Agile Team") + conduct digital leadership training (covering middle and senior management);

Case Study: Haier restructures its organizational structure through the RenDanHeYi (Human-Unit Integration) model, shortening the decision-making chain from 7 layers to 3 layers, improving transformation efficiency by 50%.

Digital Divide:

Response Strategy: Establish a "digital mentorship" system (senior employees mentoring new employees) + a customized digital skills certification system (such as Huawei HCIA certification);

Practical Results: A retail company increased employee digital tool usage from 45% to 82% through a dual-track training program of "mentorship + certification".

Data Security:

Response Strategy: Deploy a zero-trust architecture ("continuous verification, least privilege" principle) + blockchain notarization (ensuring data immutability) As data breaches continue to cause rising economic losses to enterprises globally (IBM Security, 2023), strengthening security architecture has become a core demand in digital transformation.;

Technical Verification: After adopting a zero-trust + blockchain solution, a financial institution saw a 75% decrease in data breach incidents.

6.2. Policy Toolbox Innovation and Collaborative Mechanisms

To address the dilemma of enterprises being "unwilling to transform, unable to transform, and unwilling to transform," this study proposes a policy package of "fiscal incentives, standard guidance, regulatory norms, and ecosystem cultivation" to strengthen the synergistic effect of policy tools.

6.2.1. Fiscal Incentive Policies: Reducing Transformation Costs

R&D Incentives: Increase the additional deduction ratio for R&D investment related to digital transformation to 150% (referencing Shenzhen's 2023 policy), directly reducing the tax burden on enterprises; Equipment Subsidies: Provide a 30% subsidy for the purchase of digital transformation equipment by SMEs (such as Guangdong Province's "Digital Transformation Special Fund"), with a coverage rate of 60%; Special Funds: Establish a national-level "Digital Transformation Special Fund" to focus on supporting breakthroughs in "bottleneck" technologies (such as industrial software and high-end sensors).

6.2.2. Standards and Ecosystem Development: Pathways for Normative Transformation

Industry Standards: Promote industry-level data interface standards (such as the Industrial Internet Identifier Resolution System) to solve the “data silo” problem; Service Centers: Build regional digital transformation service centers (covering provincial/municipal levels) to provide one-stop services of “technical consulting + talent training + solutions” (such as Zhejiang’s “Industrial Brain,” which has covered 80% of large-scale enterprises); Ecosystem Co-construction: Encourage leading enterprises to open up their digital capabilities (such as Haier COSMOPlat and Rootcloud’s Rootcloud platform) to drive collaborative transformation across the upstream and downstream of the industrial chain.

6.2.3. Regulatory Policy Innovation: Preventing Transformation Risks

Data monopoly regulation: Drawing on the EU’s Digital Markets Act, implement “data splitting” or “mandatory sharing” for companies with a CR3 greater than 60% of data; Digital service tax: Levy a digital service tax on data value-added services for platform companies (referencing the EU framework) to balance the distribution of data revenue; Security and compliance: Issue the “Guidelines for Enterprise Data Security Compliance” to clarify the “red lines” for data collection, storage, and use (such as prohibiting excessive collection of users’ biometric information).

6.2.4. Cross-Departmental Collaboration Mechanism: Forming Policy Synergy

A cross-departmental coordination group was established, comprising the Ministry of Industry and Information Technology, the Ministry of Science and Technology, the Ministry of Finance, and the State Taxation Administration, to promote the linkage between fiscal subsidies and standard setting (e.g., subsidies favoring enterprises that meet industry standards) and between tax incentives and safety compliance (e.g., compliant enterprises enjoying an additional 10% tax rate), thus avoiding policy fragmentation.

In summary, this study, through a dual-drive strategy of “dynamic risk management and policy toolbox innovation,” addresses both the pain points of enterprise transformation (such as technology lock-in and the digital divide) and reduces the bottlenecks (such as high costs and lack of standards) through policy synergy, providing a systematic solution for enterprise digital transformation that is “risk-preventable and policy-compliant.”

7. In-Depth Analysis of Cross-Industry Cases

This study selects six benchmark companies from three typical industries—manufacturing, retail, and finance—and conducts an in-depth analysis from technology application and practical path to economic value, revealing the differentiated logic and common experiences of digital transformation in different industries.

7.1 Manufacturing: From Supply Chain Traceability to Lighthouse Factories

The core objective of digital transformation in the manufacturing industry is to reduce costs, increase efficiency, and enhance flexibility by reconstructing the production and supply chain system through technological penetration.

7.1.1. Yanghe Brewery: Digitalization of the Entire Supply Chain

Technology Application: Employing a “one item, one code, four-code association” technology (product code, box code, pallet code, and logistics code) to connect data across the entire production, warehousing, and distribution chain.

Practical Path: Real-time data collection and analysis enable dynamic inventory monitoring and precise traceability of cross-selling.

Key Achievements: Social inventory rate decreased by 17% (from the industry average of 25% to 8%), production yield increased by 3% (from 96% to 99%), and cross-selling rate decreased by 10% (from 8% to 7.2%).

7.1.2. Sany Heavy Industry: Intelligent Upgrade of “Lighthouse Factory”

Technical Architecture: Based on 5G + MEC edge computing technology, a collaborative “device-edge-cloud” intelligent manufacturing system is built, achieving millisecond-level equipment response.

Practical Path: Production scheduling and process parameters are optimized through equipment networking, data platform, and AI algorithms.

Economic Impact: Per capita output value increased from 3 million RMB/year to 8 million RMB/year (a 167% increase), and carbon emissions per unit of output value decreased by 28% (from 2.1 tons/10,000 RMB to 1.51 tons/10,000 RMB), reaching a global benchmark level for digital transformation in manufacturing.

https://doi.org/10.67728/bmp.2026.004

7.2. Retail Industry: From Membership Operations to New Retail Scenarios

The core of digital transformation in the retail industry is user insight and experience upgrade, which involves reconstructing the relationship between “people, goods, and place” through data-driven approaches.

7.2.1. Starbucks: The Digital Restructuring of Its Membership System

Technology Application: A personalized discount push model is built based on LBS (Location-Based Services) and user behavior data.

Innovation: The online and offline points ecosystem is integrated (e.g., online app ordering, offline store redemption), achieving full-scenario user reach.

User Value: Member-driven spending increased from 41% to 53%, and the average monthly purchase frequency increased from 2.3 times to 2.9 times (a 26% increase), significantly enhancing user stickiness.

7.2.2. Hema Fresh: A Fulfillment Revolution in “New Retail 2.0”

Operational Innovation: Based on LBS positioning and real-time traffic data, a “30-minute delivery” instant delivery system was developed, covering high-frequency categories such as fresh produce and daily necessities.

Data Value: By accurately matching products to users based on their profiles (age, preferences, and consumption time), the repurchase rate increased from 32% to 45%.

Industry Impact: The system promoted the standardization of the “online ordering + offline experience” new retail model, becoming a benchmark case for “minute-level delivery” in the industry.

7.3 Financial Industry: Compliance Breakthroughs from Intelligent Risk Control to Federated Learning

The core of the digital transformation of the financial industry is risk control and data security, and mining the value of data within a compliance framework.

7.3.1. Ping An Bank: AI-Driven Intelligent Risk Control

Model Building: Based on machine learning algorithms (such as XGBoost and deep learning), it analyzes multi-dimensional data such as user transaction behavior and device information in real time.

Technological Breakthrough: Fraud detection accuracy reaches 99.5% (industry average 97%), and response time is reduced from minutes to seconds (<2 s).

Economic Value: Annual reduction of fraud losses by over 1 billion yuan, and risk control costs reduced by 35% (from 210 million yuan to 137 million yuan). (Ping An Bank, 2023)

7.3.2. WeBank: Privacy Computation Practices Based on Federated Learning

Technological Breakthrough: Employing federated learning technology, the system collaborates with external institutions to create models (e.g., partnering with e-commerce platforms for fraud prevention) without sharing raw data.

Risk Control: The non-performing loan ratio remains stable at 1.2% (industry average 1.8%), reducing data breach risk by 90%.

Compliance Significance: Providing a feasible solution for small and medium-sized banks to resolve the conflict between “data silos” and “privacy protection,” earning the People’s Bank of China’s “Financial Technology Development Award.”

7.4 Cross-Industry Experience Summary

Through case studies of six companies, three common patterns in cross-industry digital transformation can be identified:

Deep integration of technology and scenarios: Manufacturing focuses on “5G + edge computing” to optimize production; retail relies on “LBS + user profiling” to upgrade the experience; and the financial industry uses “federated learning” to balance data value and security. Technology choices consistently revolve around business pain points.

Data-driven value leaps: From data collection (such as Yanghe’s “one item, one code”) to data modeling (such as WeBank’s federated learning), and then to data monetization (such as Hema’s increased repurchase rate), data has become a core production factor for enterprises.

Unity of economic benefits and social value: Sany Heavy Industry’s “lighthouse factory” reduces carbon emissions, and Ping An Bank’s risk control reduces user losses, demonstrating that digital transformation is not only a tool for enterprises to reduce costs and increase efficiency, but also an important force driving sustainable development in industries and society.

https://doi.org/10.67728/bmp.2026.004

8. Conclusions

Against the backdrop of the global digital economy penetration and the widespread "high investment, low return" dilemma in enterprise digital transformation, this study integrates the Technology Acceptance Model and Resource-Based View to construct a three-dimensional analytical framework, and empirically tests the impact mechanism of digital transformation on enterprise operations based on panel data of Chinese A-share listed companies from 2018 to 2023. The study confirms that digital transformation can significantly reduce enterprise operational risk through the dual mediating paths of improving information transparency and internal control quality, and verifies the moderating effects of organizational agility and environmental uncertainty as well as the spatial spillover effect of digital transformation. On this basis, this study proposes a phased transformation path, industry-differentiated solutions and risk response systems, providing theoretical basis and practical guidance for enterprises to implement digital transformation effectively.

8.1. Research Contributions:

Theoretical Level: Reveals the risk reduction mechanism of digital transformation through a dual path of "information transparency-control optimization," expanding the application boundaries of TAM and RBV theories.

Practical Level: Proposes phased implementation paths and industry-customized solutions, providing a reference for the implementation of the "14th Five-Year Plan for Digital Economy Development."

8.2. Limitations and Future Directions:

Data Limitations: Does not include data on non-listed companies; future research could expand the sample by combining CSMAR and business registration information.

Dynamic Analysis: Employs a panel threshold model to explore the changing marginal effects of digital transformation.

International Comparison: Analyzes the impact of differences in digital transformation policies between China, the US, and Europe on the restructuring of the global supply chain.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created.

References

Brynjolfsson, E., Rock, D., & Syverson, C. (2021). The productivity J-curve: How intangibles complement general purpose technologies. *American Economic Journal: Macroeconomics, 13*(1), 333–372. https://doi.org/10.1257/mac.20180386

Chen, L., Tu, R., Huang, B., Zhou, H., & Wu, Y. (2024). Digital transformation's impact on innovation in private enterprises: Evidence from China. *Journal of Innovation & Knowledge*, *9*(2), 100491. https://doi.org/10.1016/j.jik.2024.100491

China Academy of Information and Communications Technology. (2024). *White paper on global digital economy (2023)* [White paper]. Available online: https://www.caict.ac.cn/english/research/whitepapers/202404/t20240430_476673.html (Accessed on 10 July 2026)

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340. https://doi.org/10.2307/249008

Development Research Center of the State Council. (2023). *China enterprise digital transformation survey report*. Available online: https://www.gov.cn/zhengce/2023-02/27/content_5743484.htm (Accessed on 10 July 2026)

Dibo Internal Control Research Center. (2023). Dibo Internal Control Index for Chinese Listed Companies. https://link.cnki.net/doi/10.38329/n.cnki.nzjsb.2023.004876

Gartner, Inc. (2023, October 16). *Gartner identifies the top 10 strategic technology trends for 2024* [Press release]. Available online: https://www.gartner.com/en/newsroom/press-releases/2023-10-16-gartner-identifies-the-top-10-strategic-technology-trends-for-2024 (Accessed on 10 July 2026)

Haier Group. (2022). *Industrial internet platform white paper*. Available online: https://www.cosmoplat.com/help/detail/300/1006 (Accessed on 10 July 2026)

IBM Security. (2023). *Cost of a data breach report*. Available online: https://www.ibm.com/security (Accessed on 10 July 2026)

Jacobides, M. G., Cennamo, C., Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal, 39*(8), 2255–2276. https://doi.org/10.1002/smj.2904

Smaje, K., LaBerge, L., & Zemmel, R. (2022, June 15). *Three new mandates for capturing a digital transformation's full value*. McKinsey & Company. Available online: https://www.mckinsey.com/capabilities/tech-and-ai/our-insights/three-new-mandates-for-capturing-a-digital-transformations-full-value (Accessed on 10 July 2026)

Ping An Bank Co., Ltd. (2023, March 9). *Ping An Bank: 2022 annual report summary* [Annual report summary]. Available online: https://vip.stock.finance.sina.com.cn/corp/view/vCB_AllBulletinDetail.php?CompanyCode=10000590&gather=1&id=8872042 (Accessed on 10 July 2026)

Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. *Harvard Business Review, 92*(11), 64–88. Available online: https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition (Accessed on 10 July 2026)

Porter, M. E., & Heppelmann, J. E. (2015). How smart, connected products are transforming companies. *Harvard Business Review, 93*(10), 64–88. Available online: https://www.hbs.edu/faculty/Pages/item.aspx?num=49869 (Accessed on 10 July 2026)

Shugen Technology. (2023, July 11). *RootCloud industrial internet operating system featured in People's Daily Overseas Edition* [Online news article]. Available online: https://www.irootech.com/knowledge/news3951.html (Accessed on 10 July 2026)

Shenzhen Stock Exchange. (2023). Self-regulatory guidelines No.11 for listed companies: Evaluation of information disclosure work (2023 revision). Available online: https://docs.static.szse.cn/www/lawrules/rule/repeal/rules/W020250314648835009630.pdf (Accessed on 10 July 2026)

Zhejiang University International Research Center for Data Analytics and Management, & Digiwin Software Co., Ltd. (2024, December 10). *Enterprise digital-intelligence driven white paper* [White paper]. Available online: http://www.som.zju.edu.cn/2024/1217/c63473a3004069/page.htm (Accessed on 10 July 2026)

Tapscott, D., Lowy, A., & Ticoll, D. (1998). *Blueprint to the digital economy: Creating wealth in the era of e-business*. McGraw-Hill.

Teece, D. J., Pisano, G., and Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Liu, C. H., et al. (2026). Evolution mechanism of digital business ecosystem: From the perspective of actor-network theory. *Management World*, *42*(6),215-236. https://doi.org/10.19744/j.cnki.11-1235/f.2026.0076

World Economic Forum. (2023). *State of the connected world 2023 edition*. World Economic Forum. Available online: https://www3.weforum.org/docs/WEF_State_of_the_Connected_World_2023_Edition.pdf

Wu, F., Hu, H. Z., Lin, H. Y., & Ren, X. Y. (2021). Enterprise digital transformation and capital market performance: Empirical evidence from stock liquidity. *Management World*, *37*(7), 130–144. https://doi.org/10.19744/j.cnki.11-1235/f.2021.0097

Xiao, J. H., Cao, W. H., & Xia, Z. H. (2025). Adaptive transformation of manufacturing enterprises in digital transformation: Dual paths of leapfrogging and consolidation. *China's Industrial Economy*, (6), 24–42. Available online: https://ciejournal.ajcass.com/UploadFile/Issue/201606280001/2024/12//20241231111416WU_FILE_0.pdf (Accessed on 10 July 2026)

https://doi.org/10.67728/bmp.2026.004