

Quantifying the Impact of Digital Transformation on Enterprise Development: Evidence from Chinese Listed Companies

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Abstract

Digital transformation has become crucial for Chinese enterprises to optimize operating models, expand market share, and improve management efficiency. However, enterprises face significant challenges including slow technology updates, talent shortages, and incomplete data integration. Through data analysis of A-share listed companies, this paper examines digital transformation's contributions to comprehensive enterprise development, exploring core implementation problems and their causes. Based on China's macroeconomic environment and policy requirements, the research identifies specific implementation paths for optimizing digital transformation. Findings show that formulating sound corporate strategies, strengthening technology infrastructure, and recruiting data integration talent are key paths for Chinese enterprises to enhance management and operational efficiency through digital transformation.

Keywords: Digital Transformation, Enterprise Management Efficiency, Data Integration

Introduction

With the progress of the times and the rapid development of network technology, the global economic development is moving towards an unprecedented digital age. Digital transformation is not only the result of scientific and technological progress and economic development, but also a necessary strategic measure for enterprises to face the current market competition and promote their own development. At the enterprise level, digital transformation means efficiently integrating traditional enterprise management models with the latest digital

technologies, optimizing resource combinations, improving enterprise comprehensive management and operational efficiency, and promoting the intelligence and efficiency of business processing processes, thereby enhancing the market competitiveness of enterprises.

However, taking light industrial enterprises as an example, some enterprises are faced with the following problems in the process of fully implementing digital transformation: cumbersome management processes, unclear division of responsibilities, low data integration efficiency, lack of scientific and technological talents, high quality "information barriers", difficulty in obtaining quality information, incomplete quality management (such as incomplete supply chain, and incomplete information), inaccurate management information, and slow discovery, identification and elimination of quality problems, which seriously restrict the improvement of enterprise product quality management level^{Error! Reference source not found.}. Such problems will greatly affect the efficiency and depth of enterprises in implementing digital transformation. Therefore, how to overcome the development bottlenecks brought about by such problems in the digital transformation of enterprises has become an important issue that enterprises need to solve urgently. This article explores the specific contributions of digital transformation to enterprise management efficiency and comprehensive development. Combining data analysis and case studies, it analyzes the bottlenecks and causes faced by enterprises in implementing digital transformation and proposes targeted implementation paths.

Despite digital transformation's recognized importance for enterprise competitiveness, organizations face significant implementation challenges including slow technology adoption, insufficient specialized talent, incomplete data integration, cumbersome management processes, and inefficient information flow. Light industrial enterprises particularly struggle with quality management issues from fragmented systems and delayed problem identification. While existing literature establishes positive relationships between digital transformation and performance, critical gaps remain in understanding specific quantitative contributions across multiple dimensions—financial performance, innovation capability, scale strength, and digital empowerment—and in identifying evidence-based implementation pathways addressing organizational bottlenecks. The relative importance of organizational factors like financial resources, geographic location, and strategic approaches requires empirical clarification for managerial and policy decision-making.

This research contributes theoretically by empirically quantifying digital transformation's impact through a multi-dimensional index approach. Integrating the Digital Transformation Index (DTI) and Enterprise Comprehensive Development Index (CDI) within an OLS regression framework advances measurement methodologies and extends existing theoretical frameworks by demonstrating transformation effect magnitudes across organizational contexts. Practically, the quantified relationship ($\beta = 0.5345$, $p < 0.01$) provides concrete evidence justifying digital investments. The identification of registered capital as significant (coefficient = 0.1989, $p < 0.01$) informs financial planning, while geographic neutrality findings suggest less-developed regions can achieve comparable benefits. The three implementation pathways identified provide actionable road maps for organizations at different digital maturity stages and support policymakers in developing targeted support mechanisms.

Research Objectives

2.1 To quantify digital transformation's contribution to comprehensive enterprise development across multiple dimensions.

2.2 To identify and analyze implementation barriers including technology constraints, talent shortages, and organizational impediments.

2.3 To develop evidence-based implementation pathways for optimizing transformation processes.

2.4 To assess moderating effects of enterprise size and geographic location

2.5 To provide comparative insights across different enterprise contexts

2.6 To bridge theory and practice by connecting empirical findings with theoretical frameworks and translating insights into managerial and policy guidance

Literature Review

Digital transformation is the process where enterprises use technologies like big data, blockchain, and AI to reshape business models, optimize operations, improve efficiency, enhance user experience, and create value. Academically, this occurs at four levels: First, technical—adopting IT systems (ERP, CRM, intelligent production) to optimize processes and boost efficiency; second, business process—using digital tools to improve supply chain, design, sales, and customer service; third, organizational—restructuring the organization and digitizing decision-making to enhance overall effectiveness; fourth, strategic—leveraging technology to create new business models and ecosystems that drive operational transformation. Digital transformation goes beyond merely adopting technology; it uses digital tools to drive comprehensive enterprise innovation and upgrading.

The phenomenon of Enterprise Digital Transformation (EDT) has garnered substantial scholarly and practitioner interest in recent years. According to Ou and Tian (2025), EDT research requires systematic examination through organizational and social theory frameworks to identify critical advancement opportunities in this domain. Their work emphasizes the importance of understanding transformation drivers, implementation practices, and performance outcomes, while highlighting gaps that warrant further investigation. This comprehensive approach to EDT research establishes a foundation for understanding how digital initiatives contribute to holistic organizational development.

The evolutionary trajectory of digital transformation research reveals distinct developmental stages that inform current implementation approaches. Wang et al. (2025a) employed main path analysis to examine three decades of DT scholarship, analyzing 1,790 academic articles to identify the field's intellectual progression. Their findings demonstrate three distinct phases—engagement, enablement, and enhancement—each representing conceptual shifts in how organizations approach digital change. Furthermore, they identified five critical research frontiers: reimagining digital innovation capabilities, pathways for value generation through DT, integration of digital initiatives with business operations, definitional boundaries of the DT field, and leadership in digital contexts. These insights provide organizations with frameworks for anticipating technological evolution and strategically aligning transformation initiatives with comprehensive development objectives.

Sector-specific analyses reveal how digital transformation drives core business performance and sustainable development. Yu et al. (2024) investigated energy sector digitalization as a strategic mechanism for achieving sustainability goals, analyzing A-share listed companies from 2010 to 2021. Their research demonstrates that digitalization substantially enhances core business performance while exhibiting temporal variations. Notably, they found that digital initiatives improve innovation inputs and outputs, thereby strengthening operational efficiency through breakthrough innovations. However, their identification of a nonlinear threshold effect suggests that transformation benefits plateau beyond certain digitalization levels. This finding underscores the importance of calibrated digital investment strategies that support comprehensive enterprise development without diminishing returns.

The relationship between digital transformation and high-quality enterprise development has been systematically validated through meta-analytic research. Liang and Tian (2024) synthesized 40 empirical studies published between 2010 and 2022, employing the Resource-Based View framework to examine impact mechanisms. Their analysis confirmed that digital transformation significantly enhances enterprise development quality through three primary channels: innovation-related factors, operational performance metrics, and capital market outcomes. Importantly, these effects remained statistically significant across various organizational contexts and heterogeneity levels, reinforcing digital transformation's central role in fostering comprehensive organizational advancement and providing evidence-based guidance for strategic decision-making.

The strategic configurations of digital transformation initiatives significantly influence innovation outcomes in established organizations. Soto et al. (2023) utilized fuzzy-set Qualitative Comparative Analysis across 17 case studies to identify successful and unsuccessful digital service innovation patterns. Their research revealed that C-level executive involvement constitutes a necessary condition for successful innovation, while strategic partnership approaches vary based on competitive positioning and disruption threats. Organizations facing imminent digital disruption benefit from collaborative strategies, whereas those with competitive advantages may pursue independent development approaches. These findings illuminate the strategic pathways through which digital transformation contributes to comprehensive enterprise development through service innovation.

For micro, small, and medium-sized enterprises (MSMEs), digital transformation pathways exhibit distinctive patterns shaped by organizational characteristics and contextual factors. Marolt et al. (2024) employed a mixed-methods approach combining interviews with 66 MSME survey responses to identify transformation inhibitors and accelerators. Their research uncovered three distinct transformation trajectories—necessary, experimental, and committed—each reflecting unique combinations of facilitating and constraining factors. This differentiation suggests that comprehensive enterprise development through digitalization requires tailored approaches accounting for organizational size, resource availability, and strategic orientation, rather than uniform implementation strategies.

Sustainable digital transformation represents a critical dimension of comprehensive enterprise development for MSMEs. Martínez-Peláez (2023) conducted a systematic review of 59 publications from 2019 to 2023, identifying organizational capabilities and stakeholder roles essential for sustainable transformation initiatives. The research emphasizes that owners and senior managers must cultivate organizational cultures supporting sustainability-focused

decisions as a foundational step. Additionally, stakeholder engagement emerges as crucial for driving innovation and competitiveness, while big data technologies offer transformative potential for analytical capabilities and decision-making processes. This holistic perspective integrates sustainability considerations into digital transformation's contribution to comprehensive development.

The Technology-Organization-Environment (TOE) framework provides an analytical structure for understanding digital transformation adoption determinants in SMEs. Hoang (2024) examined DT adoption factors among SMEs in Danang, Vietnam, revealing that technological capabilities (cybersecurity and IT integration), environmental elements (client relationships and partnerships), and organizational factors (management support and governance) significantly influence adoption decisions. Notably, technological factors mediate relationships between organizational and environmental variables, suggesting that technical infrastructure development serves as a critical pathway through which other factors influence transformation success. This integrative perspective demonstrates the multifaceted nature of digital transformation's contribution to comprehensive enterprise development.

Digital transformation's role in fostering comprehensive capabilities and growth demonstrates unique dynamics. Kobusingye et al. (2025) investigated 634 SMEs through the lens of dynamic capabilities theory, examining how digital initiatives enhance innovation, market expansion, and organizational growth amid technological turbulence. Their findings confirmed that digital transformation positively influences all three capability dimensions, with innovation and market expansion partially mediating the transformation-growth relationship. However, technological volatility weakens these indirect effects, suggesting that resource-constrained environments present distinct challenges requiring strategic alignment of digital initiatives with capability development and policy support mechanisms.

The comprehensive impact of digital transformation on SMEs and venture companies encompasses multiple dimensions of organizational performance and regional innovation dynamics. Lee (2024) examined digital transformation effects across various organizational contexts, distinguishing between the digital economy's broad scope and the digital industry's technological focus. Through case study analysis of digital innovation clusters, the research demonstrated that patent registrations and R&D investments positively influence financial performance, while innovation certifications may exhibit delayed positive effects following initial negative impacts. These findings suggest that digital transformation's contribution to comprehensive enterprise development manifests through multiple mechanisms, including intellectual property development, research investment, and participation in innovation ecosystems, with temporal variations in outcome realization.

Collectively, this body of literature demonstrates that digital transformation contributes to comprehensive enterprise development through multiple, interconnected pathways including innovation enhancement, operational efficiency improvement, market expansion, sustainability integration, and strategic capability development. The research further reveals that transformation success depends on contextual factors including organizational size, industry sector, geographical location, resource availability, and strategic configuration, necessitating tailored implementation approaches rather than standardized solutions.

This research integrates three complementary theoretical perspectives to examine digital transformation's impact on comprehensive enterprise development. The Resource-Based View

(Barney, 1991) posits that competitive advantage stems from valuable, rare, inimitable, and non-substitutable resources. In digital transformation, RBV explains how enterprises leverage digital capabilities as strategic resources, though strategic deployment—not resource availability alone—determines transformation success. The TOE framework (Tornatzky & Fleischer, 1990) examines technology adoption through technological, organizational, and environmental contexts. This study employs TOE to analyze how organizational factors (registered capital, management capabilities) and environmental factors (geographic location) influence digital transformation adoption and enterprise development. Dynamic Capabilities Theory (Teece, Pisano, & Shuen, 1997) emphasizes organizations' ability to integrate, build, and reconfigure competencies amid rapid change. Digital transformation represents a dynamic capability enabling enterprises to sense opportunities, seize them through strategic investments, and transform processes, contributing to innovation capability, operational efficiency, and market competitiveness. These perspectives converge to form an integrated framework predicting that digital transformation significantly enhances comprehensive enterprise development, with effects moderated by organizational resources and contextual factors.

Methodology

This paper refers to the data acquisition and screening methods of Geng Xuejiao, Wang Huiyan, Duan Qiongjie, (Geng, 2025; Wang & Duan, 2025), selects the data of some A-share listed companies in 2024 as the research sample, and performs the following processing on the data of listed companies in 2024: screens out ST (special treatment, special treatment) data, screens out financial securities companies data, screens out corporate data with missing observation variables, and finally extracts a total of 100 observation sample values. The data required for this research are all from the CSMAR.

1. Explained Variable (Dependent Variable Y): The explained variable in this study is the Enterprise Comprehensive Development Index (CDI). A quantitative index analysis is conducted based on four indicator dimensions: financial performance, innovation capability, scale strength, and digital empowerment. The CDI is derived through a weighted summation method.

2. Core Explanatory Variable (Independent Variable X): In this study, the core explanatory variable is the Digital Transformation Index (DTI), a key indicator measuring a company's overall investment and application in the digital field. This article conducts a quantitative index analysis based on the three indicator dimensions of technology application breadth, digital investment, and transformation effect support. The DTI is derived through a standardized weighted summation method.

3. Control Variable Z (To Prevent Confounding Factors): In this study, the company's registered asset size and the company's location are selected as control variables Z to eliminate the influence of these factors on the explained variable, thereby ensuring more accurate measurement results.

The variable quantification method is shown in Table 1. This study combines the core explanatory variables (independent variable X) and the control variable Z to construct the following OLS basic regression model:

$$Y_i = \alpha + \beta X_i + \gamma Z_i + \epsilon_i \quad (I)$$

(Where: α is the constant term, i.e., the baseline value of the enterprise development level when all independent variables are 0; Y_i is the enterprise comprehensive development index; X_i is the digital transformation index; Z_i is the control variable; β is the contribution/core coefficient of digital transformation to the enterprise's comprehensive development; γ is the coefficient vector of the control variables, reflecting the impact of other factors; ϵ is the residual, i.e., the difference between each enterprise's actual Y and the regression predicted value.)

Table 1 Variable quantification methods.

Variable type	Variable name	Variable quantification method
The core explanatory variable	The Digital Transformation Index	Collects indicators such as enterprise information system applications, big data/cloud computing/IOT usage, and the proportion of online sales/digital marketing. Each indicator is standardized (Z-score or Min-Max), then weighted using entropy or principal component analysis to create a composite digital transformation index.
The explained variable	The Enterprise Comprehensive Development Index	Collects multi-dimensional enterprise indicators: financial performance (revenue growth rate, profit margin), innovation capability (ratio of R&D personnel/R&D expenditure/R&D investment), scale and strength (registered assets), and digital empowerment. Each indicator is standardized (Z-score or Min-Max), then weighted summed using entropy or principal component analysis to create a composite index.
Control variable	Enterprise size	Registered assets, directly collected and then standardized (Z-score or Min-Max)
	Industry category	Enterprise registration information, coded as a dummy variable (e.g., Manufacturing = 1, Other = 2)
	Region	Eastern China, coded as a dummy variable (e.g., Eastern China = 1, Other = 2)

Data source: All variable data are from the CSMAR, government portals, and corporate websites.

The data required for this research were standardized using the Min-Max standardization model:

$$X' = \frac{X - X_{\text{Min}}}{X_{\text{Max}} - X_{\text{Min}}} \quad (II)$$

After standardization, the data were weighted using the equal-weight method. The specific allocation rules are as follows: The core explanatory variable (DTI) consists of three components: 1. Breadth of Technology Application (weighted 60 points), including digital technology application (weighted 100 points); 2. Digital Investment (weighted 25 points), including the proportion of R&D personnel (30 points), the proportion of R&D investment

(weighted 40 points), and the proportion of R&D investment amount (weighted 30 points); 3. Transformation Effect Support (weighted 15 points), including net profit growth rate (weighted 60 points) and operating income growth rate (weighted 40 points). The explained variable (CDI) includes four parts: the first is the financial performance part (weighted 35 points), including the net profit growth rate (weighted 50 points) and the operating income growth rate (weighted 50 points); the second is the R&D innovation part (weighted 30 points), including the proportion of R&D personnel (30 points), the proportion of R&D investment (weighted 40 points), and the proportion of R&D investment amount (weighted 30 points); the third is the scale strength part (weighted 15 points), including the registered capital (weighted 100 points); and the fourth is the digital empowerment part (weighted 20 points), including the application of digital technology (weighted 100 points).

Results and Discussion

Table 2 and Tables 3-7 show the results of the visual regression analysis of the impact of enterprise digital transformation on the comprehensive development of enterprises. Among them, (1) is the result of the regression analysis of the project without considering the control variables and only considering the core explanatory variables. The research results show that the role of enterprise digital transformation on the comprehensive development of enterprises shows a positive impact at the significance level of 1%. The t-value under the relevant parameter estimation is as high as 13.49, indicating that digital transformation has a positive and significant effect on promoting the comprehensive development of enterprises. At the same time, after incorporating the two control variables of enterprise registered assets and the region where the enterprise is located into model formula (2), the effect of enterprise digital transformation on the comprehensive development of enterprises still shows a positive impact at the 1% significance level, indicating that the promoting effect of digital transformation is stable.

Table 2 Regression analysis.

Variable	Coefficient	t-stat	P-Value	Significance
(1) Simple Reg (DTI)	/	/	/	/
Intercept	0.2066	21.31	0.00	***
DTI	0.5688	13.49	0.00	***
(2) Multivariate Reg (DTI.Region.REGCAP-DN)	/	/	/	/
Intercept	0.2051	14.46	0.00	***
DTI	0.5345	15.58	0.00	***
Region	-0.0089	-1.0980	0.2749	

REGCAP-DN	0.1989	7.3389	0.00	***
Model-Level Info	/	/	/	/
Simple Reg R²	0.6499	/	/	/
Multivariate Reg R²	0.7783	/	/	/
Multivariate Reg F-stat	112.400	/	0.00	***
N	100	/	/	/

*p < 0.1, **p < 0.05, ***p < 0.01; "Significance F" is the F - stat's p - value

Table 3 Scatter visualization study on the impact of digital transformation on the comprehensive development of enterprises.

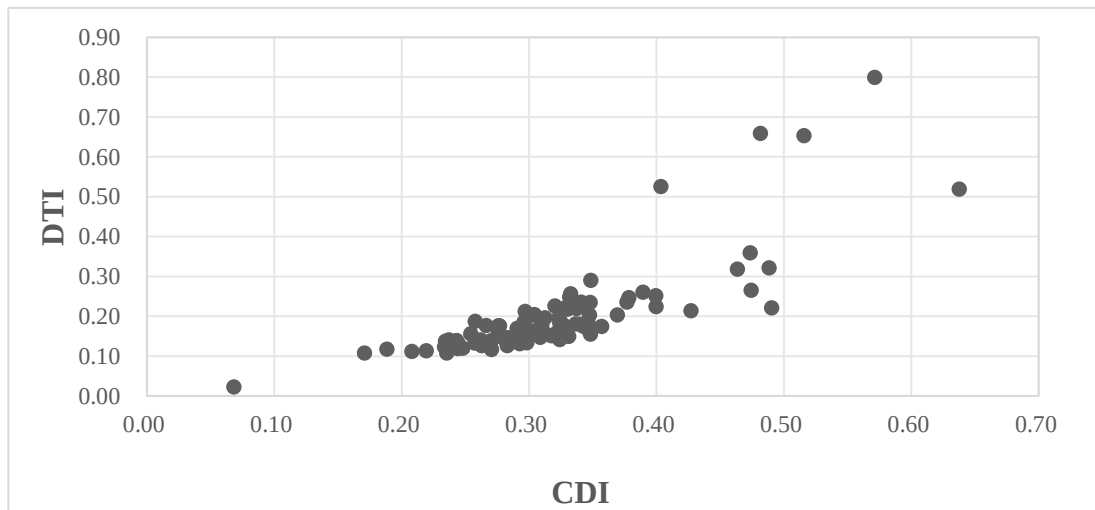


Table 4 Scatter visualization study on the impact of digital transformation on the comprehensive development of enterprises (High Assets).

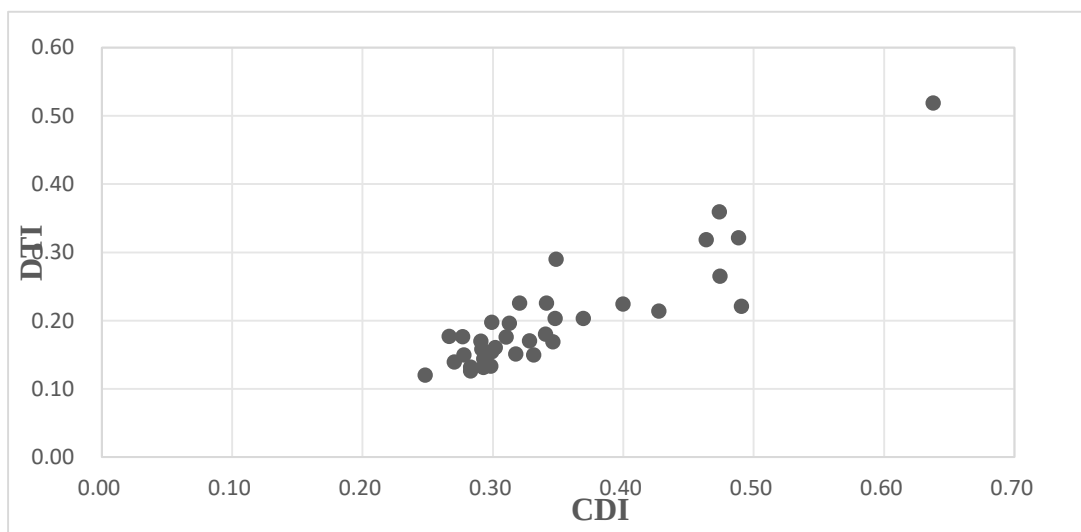


Table 5 Scatter visualization study on the impact of digital transformation on the comprehensive development of enterprises (Low Assets).

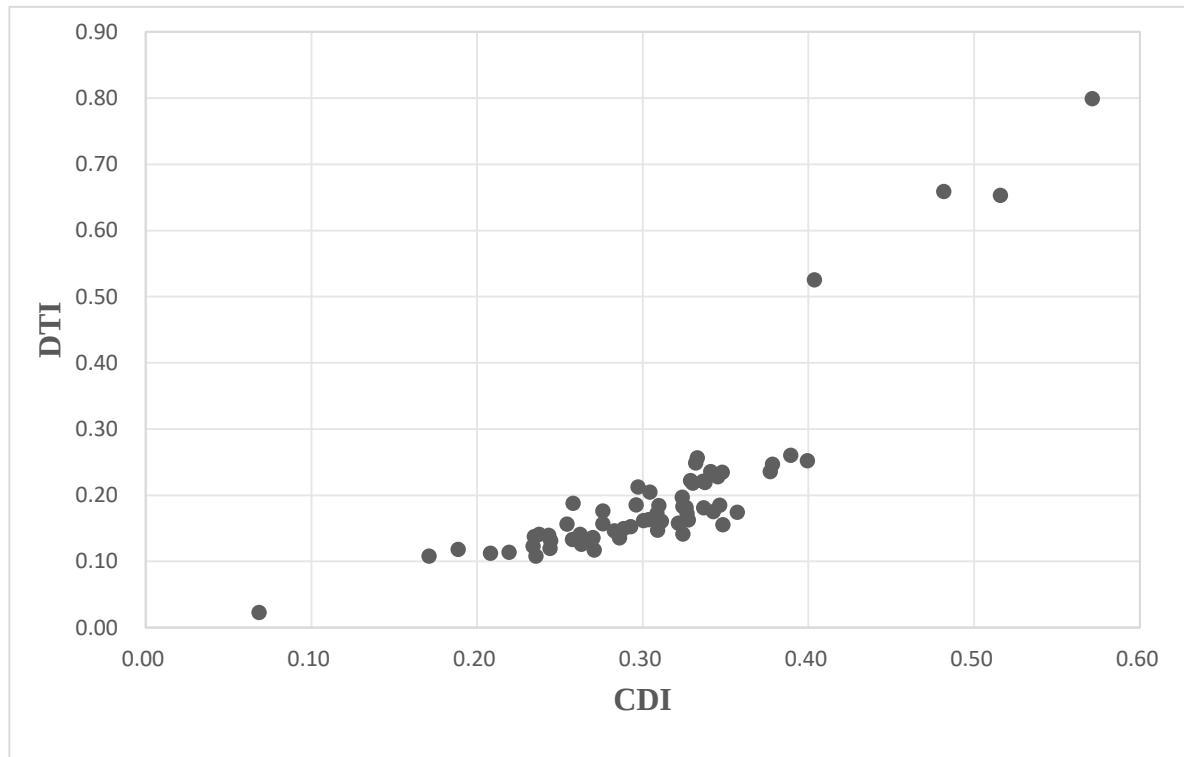


Table 6 Scatter visualization study on the impact of digital transformation on the comprehensive development of enterprises (Eastern Region).

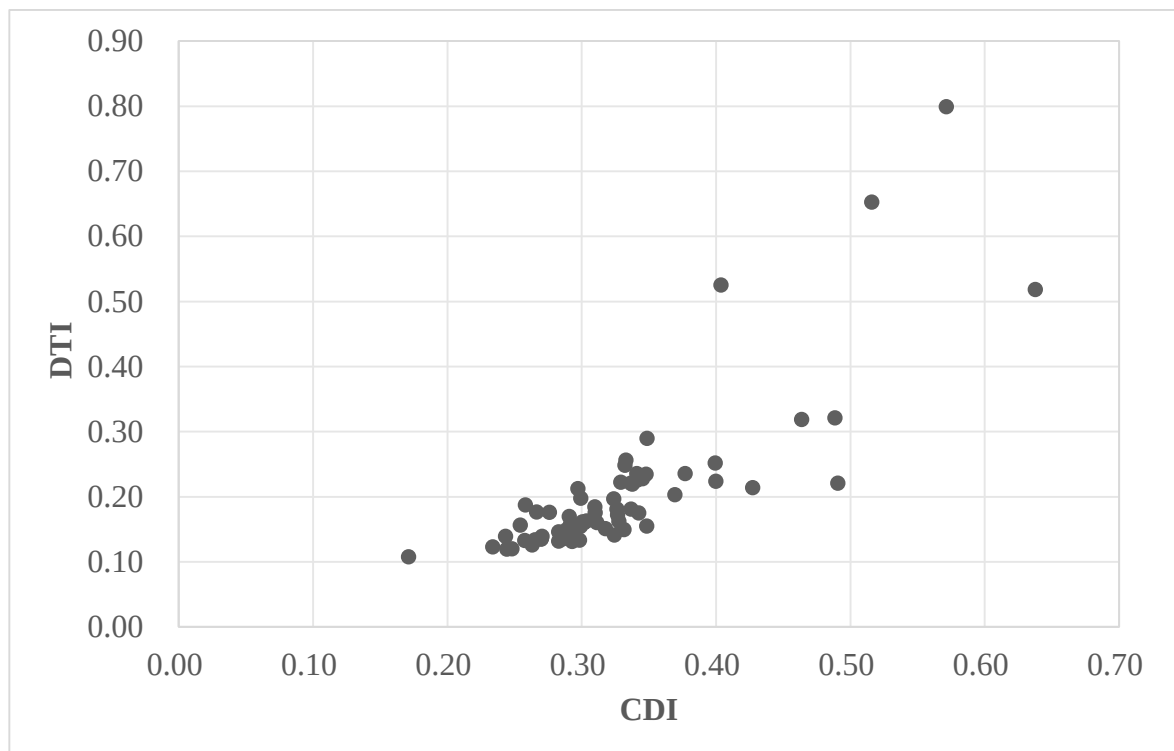
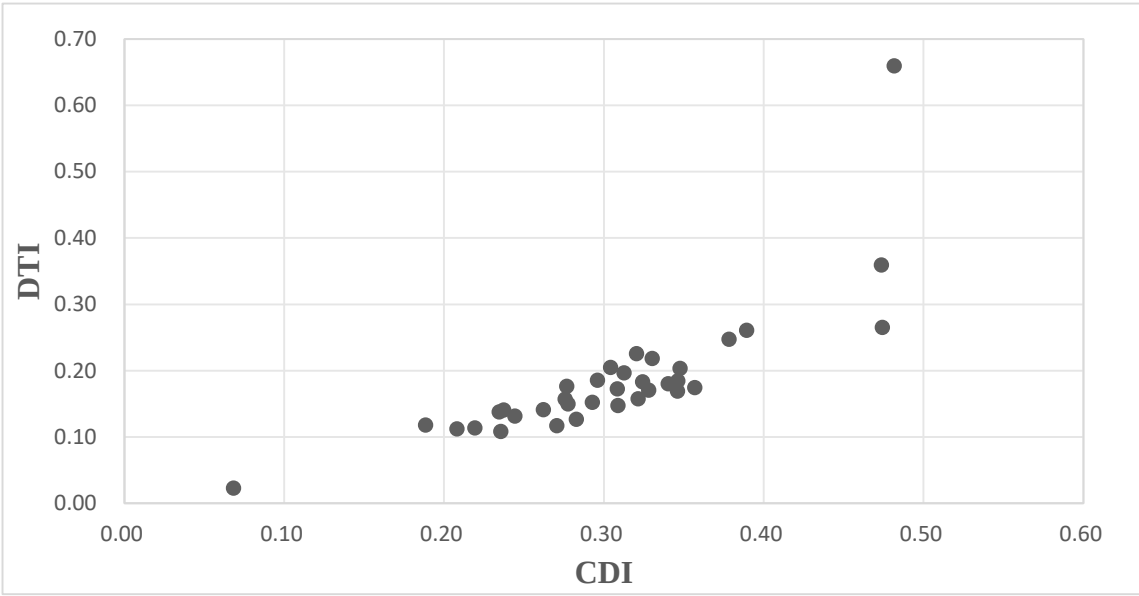


Table 7 Scatter visualization study on the impact of digital transformation on the comprehensive development of enterprises (Other Regions).



The empirical findings of this study provide robust evidence supporting digital transformation as a critical driver of comprehensive enterprise development, while simultaneously revealing important nuances regarding the conditions under which transformation initiatives yield optimal outcomes. The significant positive relationship between DTI and CDI ($\beta = 0.5345$, $t = 15.58$, $p < 0.01$) demonstrates that digital transformation substantially contributes to holistic enterprise advancement across multiple performance dimensions. This finding aligns with and extends the meta-analytic conclusions of Liang and Tian (2024), who identified innovation, operational performance, and capital market outcomes as key mechanisms through which digital transformation influences enterprise quality. The high t-statistic value indicates remarkable stability, suggesting that digital transformation effects are robust across diverse organizational contexts. The R^2 value of 0.7783 indicates that digital transformation, together with control variables, explains approximately 77.83% of the variance in comprehensive enterprise development. This substantial explanatory power suggests that the DTI construct effectively captures the essential dimensions of digital transformation that matter for organizational outcomes. However, the remaining 22.17% of unexplained variance points to additional factors, such as organizational culture, leadership quality, employee digital literacy, and external market conditions, that may also influence development outcomes but were not captured in this model.

The non-significant effect of geographic location (coefficient = -0.0089, $p = 0.2749$) represents one of the study's most striking findings, contradicting traditional assumptions about regional disparities in technological benefits. This suggests that digital transformation's advantages are largely democratized across geographic boundaries, challenging the conventional wisdom that eastern or more developed regions possess inherent advantages in leveraging digital technologies. This finding diverges from the contextual challenges identified by Kobusingye et al. (2025) in SMEs, where resource-constrained environments presented distinct obstacles to digital transformation success. Several explanations may account for this geographic neutrality: digital technologies and platforms are increasingly accessible regardless of physical location, with cloud computing, SaaS solutions, and digital infrastructure reducing traditional geographic barriers; the standardization of digital tools may enable enterprises in various regions to achieve

comparable implementation quality; and the sample composition, consisting of A-share listed companies, may represent organizations that have already overcome initial resource and infrastructure barriers, thereby minimizing regional differences. From a policy perspective, this finding suggests that government resources for promoting digital transformation need not concentrate disproportionately in traditionally advanced regions. Instead, policies supporting digital infrastructure, talent development, and financial assistance can be distributed more equitably, potentially reducing regional economic disparities.

The significant positive coefficient for registered capital ($\beta = 0.1989$, $t = 7.34$, $p < 0.01$) shows that financial resources remain fundamental to successful digital transformation and subsequent comprehensive development. This finding resonates with the resource allocation mechanisms identified by Tang and Zhang (2025), who demonstrated that digital transformation optimizes innovation factor allocation, a process requiring adequate financial investment. While smaller than the DTI coefficient, this effect is substantial and highly significant, suggesting that while digital transformation is the primary driver of comprehensive development, financial resources create enabling conditions that amplify transformation effectiveness. Enterprises with larger registered capital can invest more in advanced technologies, recruit specialized talent, develop robust digital infrastructure, and sustain longer transformation timelines, enhancing the depth and sustainability of digital initiatives. However, this raises equity concerns. If financial resources significantly facilitate digital transformation success, smaller enterprises or those in resource-constrained environments may face systemic disadvantages despite the geographic neutrality of digital benefits. This suggests a need for targeted financial support mechanisms, such as government subsidies, preferential lending programs, or venture capital initiatives, to enable smaller enterprises to undertake meaningful digital transformation.

The study identifies three critical implementation pathways. First, improving digital information utilization through intelligent decision support systems addresses the fundamental challenge of converting data availability into actionable insights. As Sun (2025) argues, enterprises must strengthen their capacity to accept, process, and apply digital information within digital trade environments. This pathway emphasizes that technology adoption alone is insufficient; organizations must develop complementary capabilities in data analytics, interpretation, and application. The emphasis on big data and artificial intelligence platforms reflects the current technological frontier in decision making support, but this requires more than technological investment; it necessitates organizational learning, process redesign, and cultural adaptation to evidence based decision making. Enterprises must train personnel in data literacy, redesign workflows to incorporate analytical insights, and foster cultures that value data driven over intuition based decisions.

Second, optimizing resource allocation with emphasis on innovation factors and digital talent directly addresses the talent shortage and insufficient R&D investment challenges identified in the introduction. This aligns with the findings of Wang et al. (2025c), who highlighted talent capacity and R&D investment as critical areas requiring policy attention in SME digital transformation. The specific focus on increasing R&D capital investment proportion and enhancing digital talent capacity reflects the understanding that digital transformation is fundamentally an innovation process requiring specialized expertise. However, this pathway faces challenges, particularly for smaller enterprises competing for limited talent in tight labor markets. Organizations may need to develop partnerships with educational institutions, create attractive work environments for digital professionals, and implement continuous learning programs to build internal capabilities over time.

Third, building digital transformation demonstration parks represents a strategic approach to organizational learning and capability development. Demonstration parks provide

tangible examples of digital solutions addressing specific pain points, create learning environments for employees, enable testing of new technologies before full scale deployment, and potentially foster collaborative learning among multiple organizations. This approach is particularly valuable for addressing the "cumbersome management processes" and "unclear responsibility divisions" identified as key challenges, as demonstration projects can model more efficient, digitally enabled organizational structures and workflows.

The findings both confirm and extend existing literature on digital transformation. The strong positive relationship aligns with Yu et al.'s (2024) energy sector findings and Liang and Tian's (2024) meta-analytic conclusions. However, this study's quantification of effect magnitude ($\beta = 0.5345$) provides more precise estimates, enabling better-informed investment decisions. The geographic neutrality finding contrasts with context-specific studies, such as Kobusingye et al.'s (2025) identification of resource constraint challenges in SMEs, potentially reflecting variations between developed and developing contexts, or between listed and unlisted companies. Further research across these dimensions would clarify when geographic factors significantly influence outcomes. The emphasis on financial resources resonates with Hoang's (2024) TOE framework findings, which identified organizational factors including management support and governance as critical adoption determinants. Registered capital may proxy for broader organizational capability, encompassing financial resources, management sophistication, strategic planning capacity, and institutional legitimacy.

Implications for theory development

The empirical findings of this study advance digital transformation theory through several significant contributions that refine existing frameworks and open new avenues for theoretical inquiry. First, the quantification of digital transformation's impact magnitude ($\beta = 0.5345$, $p < 0.01$) provides empirical precision that moves beyond qualitative assertions of positive relationships. This precise effect size enables theoretical models to incorporate specific parameters rather than directional hypotheses alone, facilitating more rigorous predictive modeling and cross-study comparisons. The substantial explanatory power ($R^2 = 0.7783$) validates the multi-dimensional index approach to measuring both digital transformation and comprehensive enterprise development, suggesting that composite constructs capturing technology adoption, investment intensity, and transformation outcomes more accurately represent the complexity of digitalization phenomena than single-indicator measures.

Second, the geographic neutrality finding challenges location-based contingency theories that have traditionally emphasized regional disparities in technological benefits. The non-significant regional coefficient ($p = 0.2749$) suggests that digital technologies may function as equalizing mechanisms that transcend geographic boundaries, at least among established enterprises with baseline resource thresholds. This finding calls for theoretical refinement of the Technology-Organization-Environment framework, specifically reconceptualizing environmental factors to distinguish between infrastructure-dependent and infrastructure-independent dimensions of digital transformation. The democratization of digital benefits across regions may reflect the maturation of digital infrastructure and cloud-based service models, suggesting that TOE framework applications should account for temporal evolution in technological accessibility. Future theoretical development should investigate boundary conditions under which geographic factors become salient versus neutral, potentially identifying critical resource thresholds or infrastructure requirements that mediate geographic effects.

Third, the significant role of registered capital ($\beta = 0.1989$, $p < 0.01$) enriches Resource-Based View applications by demonstrating that financial resources function as enabling

conditions rather than deterministic factors in digital transformation success. While the DTI coefficient is nearly three times larger than the registered capital coefficient, the latter's significance indicates that resource availability facilitates but does not substitute for strategic digital initiatives. This finding suggests a hierarchical resource model wherein financial capital enables acquisition of digital capabilities, but capability deployment effectiveness determines ultimate performance outcomes. Theoretically, this supports a two-stage model of digital transformation: resource acquisition (influenced by financial capacity) and resource deployment (influenced by strategic orientation and dynamic capabilities). This integration of RBV with dynamic capabilities theory provides a more nuanced understanding of how resources translate into competitive advantage through transformation processes.

Fourth, the study's multi-dimensional conceptualization of comprehensive enterprise development—spanning financial performance, innovation capability, scale strength, and digital empowerment—advances holistic measurement approaches in organizational performance theory. Traditional studies often examine single performance dimensions, potentially missing interdependencies and complementarities among outcome domains. The significant relationship between digital transformation and this composite development index suggests that digitalization creates value through multiple, potentially synergistic channels rather than isolated performance improvements. This finding supports stakeholder theory perspectives that emphasize balanced value creation across multiple constituencies and timeframes, as opposed to shareholder-centric financial metrics alone.

The 22.17% unexplained variance in the model identifies critical opportunities for theoretical extension. Future research should investigate organizational culture as a moderating variable, examining whether digital-friendly cultures amplify transformation effects; leadership characteristics, particularly digital literacy and transformational leadership styles among executives; employee capabilities beyond formal R&D personnel metrics, including digital literacy distribution across organizational levels; and external ecosystem factors such as industry digitalization intensity, supplier and customer digital maturity, and regulatory environments. These unmeasured factors likely interact with digital transformation initiatives to shape comprehensive development outcomes, suggesting potential for configurational theories that identify multiple pathways to successful digital transformation depending on specific combinations of organizational and contextual conditions.

Finally, the three identified implementation pathways—information utilization enhancement, resource allocation optimization, and demonstration park development—provide empirical grounding for process theories of digital transformation. These pathways represent distinct mechanisms through which digitalization influences organizational outcomes: cognitive (improved decision making through data), structural (resource reallocation toward innovation), and learning-based (capability development through demonstration). This mechanistic understanding enriches transformation process theories by identifying specific intermediate steps between technology adoption and performance outcomes, moving beyond black-box models that treat transformation as a direct input-output relationship. Future theoretical development should elaborate these pathways into stage-based or capability-maturity models that specify sequencing, interdependencies, and conditional effectiveness of different transformation approaches.

Implications for business and management practice

The research findings provide actionable guidance for enterprise managers, policymakers, and organizational decision-makers seeking to maximize returns on digital transformation investments while navigating implementation challenges. The primary practical implication stems from the substantial and significant relationship between digital

transformation and comprehensive enterprise development ($\beta = 0.5345$, $p < 0.01$), which provides compelling justification for prioritizing digital initiatives in strategic planning and resource allocation. For every one-unit increase in the Digital Transformation Index, enterprises can expect approximately a 0.53-unit increase in their Comprehensive Development Index, representing tangible improvements across financial performance, innovation capability, and operational effectiveness. This quantified relationship enables managers to conduct more precise cost-benefit analyses, moving beyond speculative assessments to evidence-based investment decisions. Organizations contemplating digital transformation can use this coefficient as a benchmark for projecting expected returns, adjusting for industry-specific factors and organizational readiness levels.

The geographic neutrality finding holds profound implications for strategic location decisions and resource distribution. The non-significant regional effect demonstrates that enterprises in less-developed or non-coastal regions can achieve digital transformation benefits comparable to those in traditionally advantaged eastern areas, provided they invest adequately in digital initiatives. This democratization of digital benefits suggests several practical strategies. First, enterprises in developing regions should approach digital transformation with confidence rather than defeatism, recognizing that geographic disadvantages in traditional industrial contexts do not necessarily translate to digital contexts. Second, organizations should prioritize investments in digital infrastructure, talent, and capabilities over physical relocation strategies, as the former appears more consequential for performance outcomes. Third, corporate location decisions can increasingly prioritize factors beyond traditional agglomeration advantages—such as cost structures, talent availability, quality of life, and regulatory environments—given that digital technologies enable geographically dispersed operations without performance penalties.

For policymakers, this finding suggests that regional development strategies should emphasize digital infrastructure and capability building across all regions rather than concentrating resources in already-developed areas. Government initiatives supporting broadband expansion, cloud computing accessibility, digital literacy programs, and technology transfer mechanisms can effectively reduce regional disparities by enabling enterprises everywhere to leverage digital transformation benefits. This represents a more equitable and potentially more effective approach to economic development than traditional strategies emphasizing physical infrastructure concentration in designated zones.

The significant role of registered capital ($\beta = 0.1989$, $p < 0.01$) provides critical insights for financial planning and resource mobilization strategies. While smaller than the digital transformation coefficient, this effect indicates that financial resources meaningfully enable transformation success by facilitating technology acquisition, talent recruitment, infrastructure development, and sustained implementation timelines. Practically, this suggests several priorities. Large enterprises with substantial registered capital should leverage their financial advantages aggressively, pursuing comprehensive transformation initiatives that smaller competitors may struggle to match. This includes investments in cutting-edge technologies like artificial intelligence and blockchain, recruitment of specialized digital talent, development of proprietary digital platforms, and longer-term transformation programs that may require multiple years before yielding returns.

Conversely, small and medium-sized enterprises must pursue strategic approaches that maximize impact within resource constraints. This includes focusing on high-impact, lower-cost digital solutions such as cloud-based SaaS platforms that minimize upfront infrastructure costs, collaborative partnerships with technology providers offering shared or subsidized solutions, phased transformation approaches that prioritize initiatives with fastest payback periods, and actively pursuing external funding sources including government grants, venture capital, and strategic partnerships with larger enterprises seeking supply

chain digitalization. Financial institutions and venture capitalists should recognize digital transformation readiness and strategic clarity as key indicators of SME growth potential, potentially justifying preferential lending terms or investment for enterprises demonstrating credible transformation roadmaps.

The three identified implementation pathways provide concrete action plans for operationalizing digital transformation. The first pathway—improving digital information utilization through intelligent decision support systems—requires organizations to move beyond data collection to data activation. Practical steps include implementing integrated data platforms that consolidate information from disparate systems, establishing cross-functional analytics teams combining domain expertise with data science capabilities, developing dashboard and visualization tools that make insights accessible to non-technical decision makers, creating feedback loops that evaluate decision outcomes and refine analytical models, and fostering data-driven cultures that value evidence over hierarchy or intuition in decision making. Organizations should conduct audits of existing data assets to identify high-value information currently underutilized, then prioritize analytics initiatives that address critical pain points or strategic opportunities. Decision support systems should focus on domains with highest strategic impact, such as customer intelligence for market expansion, supply chain optimization for cost reduction, or predictive maintenance for operational efficiency.

The second pathway—optimizing resource allocation with emphasis on innovation factors and digital talent—addresses the critical talent shortage identified as a primary transformation barrier. Organizations should implement comprehensive talent strategies including competitive compensation packages that reflect market premiums for digital skills, partnerships with universities and technical institutes for talent pipelines and continuing education, internal training programs that upskill existing employees in digital competencies, flexible work arrangements that attract digital professionals valuing autonomy and work-life balance, and innovation-friendly cultures that provide digital talent with meaningful challenges and professional growth opportunities. Regarding R&D investment, enterprises should establish clear targets for R&D expenditure as a percentage of revenue, aligned with industry benchmarks and strategic ambitions. However, investment quantity must be complemented by quality—ensuring R&D spending focuses on digital technologies and applications with clear strategic alignment, implementing stage-gate processes that evaluate projects rigorously while allowing experimentation, and creating mechanisms for translating R&D outputs into commercialized products and services.

The third pathway—building digital transformation demonstration parks—offers a practical approach to organizational learning and risk mitigation. Rather than enterprise-wide, big-bang implementations that risk massive disruption if unsuccessful, demonstration parks enable controlled experimentation with new technologies and processes. Organizations should identify specific business units, processes, or functions as demonstration sites based on criteria including strategic importance, receptiveness to change, measurability of outcomes, and representativeness of broader organizational challenges. These demonstration initiatives should follow structured methodologies: clearly defined objectives and success metrics, dedicated resources and executive sponsorship, systematic documentation of lessons learned, structured knowledge transfer mechanisms to disseminate insights across the organization, and explicit decision criteria for scaling successful demonstrations versus terminating unsuccessful ones. Demonstration parks are particularly valuable for testing emerging technologies whose benefits remain uncertain, piloting process redesigns that require behavioral change, and building organizational confidence and competence before broader rollout.

Organizations should also recognize that digital transformation is not a one-time project but an ongoing strategic orientation requiring continuous adaptation. The high explanatory power of the model ($R^2 = 0.7783$) notwithstanding, the remaining 22.17% unexplained variance suggests that factors beyond the measured variables influence outcomes. Managers should therefore complement quantitative digital investments with qualitative organizational development initiatives including change management programs that address employee concerns and resistance, leadership development ensuring executives possess digital literacy and transformation vision, cultural interventions that promote experimentation, learning from failure, and cross-functional collaboration, and regular strategic reviews that reassess digital priorities in light of technological evolution and market dynamics.

Finally, for industries and enterprises at earlier digitalization stages, the findings suggest that catching up remains feasible. The strong digital transformation coefficient indicates that organizations can achieve substantial development gains through systematic digitalization efforts, while the geographic neutrality finding demonstrates that late movers need not accept permanent disadvantage. However, the registered capital effect indicates that financial resources facilitate acceleration, suggesting that organizations should secure adequate funding before launching transformation initiatives rather than pursuing under-resourced efforts likely to yield disappointing results. Strategic clarity regarding transformation objectives, pathways, and resource requirements emerges as essential for converting digital investments into comprehensive enterprise development.

Conclusion and Suggestions

The Digital Transformation Index (DTI) demonstrated a significant positive impact on enterprise development, maintaining significance even after controlling for location and registered capital. This confirms that digital transformation is critical for improving management efficiency, innovating operations, and gaining competitive advantages. Location's impact was not significant, indicating that digital transformation advantages are largely unrestricted by geography, helping narrow traditional regional gaps. The significant positive coefficient for registered capital shows that sufficient funds are crucial for implementing digital transformation through technology investment, talent recruitment, and infrastructure development. Enterprises should deepen digital transformation through three paths: First, build intelligent decision-making systems using big data and AI platforms to optimize management processes. Second, optimize resource allocation by increasing digital talent capacity and R&D investment. Third, build digital transformation demonstration parks to analyze pain points and apply digital technologies.

Several limitations warrant consideration. First, the sample consists exclusively of A-share listed companies, limiting generalizability to smaller or privately-held enterprises. The cross-sectional 2024 data prevents causal inference; longitudinal analysis would strengthen causal claims. The DTI may not fully capture digital transformation's complexity, excluding dimensions like organizational culture, employee digital competence, or ecosystem partnerships. The quantifiable metrics may undervalue qualitative aspects such as organizational agility or innovation culture, which are crucial for long-term competitiveness.

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