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An Exploration of Enterprise Budget Management Strategies from the Perspective of Digital Transformation

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Abstract: The rapid expansion of the digital economy is driving profound structural transformations in corporate governance paradigms worldwide. Traditional budget management frameworks, which predominantly rely on hierarchical planning mechanisms and maintain separate accounting systems for operational and financial functions, increasingly find it difficult to satisfy the dynamic resource allocation demands imposed by volatile and uncertain market conditions. Drawing upon micro-panel data from China A-share listed companies spanning the period from 2022 to 2025, this study empirically investigates the influence of digital transformation on both the operational efficiency and measurement accuracy of corporate budget management practices. The analysis systematically elucidates the underlying mechanisms through which digital transformation exerts its effects, specifically examining data transmission pathways, process reengineering initiatives, and organizational synergy dynamics. The empirical findings reveal a statistically significant negative correlation between corporate digital capital investment and budget execution deviation rates, indicating that greater digital investment is associated with more precise budget outcomes. Furthermore, the deep integration of operational and financial data is shown to enhance budget dynamic response efficiency by approximately 58.7 percent. In addressing prevalent governance challenges encountered in contemporary digital budgeting initiatives, including data silos, model mismatches, and organizational decoupling, this paper proposes comprehensive optimization pathways centered on data governance frameworks, process restructuring strategies, and organizational empowerment mechanisms. The study ultimately provides robust empirical evidence and actionable governance recommendations for enterprises seeking to advance their digital budgeting initiatives and strengthen overall financial control capabilities.

Keywords: digital transformation; budget management; business-finance integration; dynamic budgeting; enterprise control

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1. Introduction

The industrialization of next-generation digital technologies—including artificial intelligence, cloud computing, big data analytics, and process automation—has fundamentally reshaped the underlying operational logic of internal corporate governance. As a core financial governance tool that integrates strategic planning, resource allocation, performance monitoring, and risk mitigation, budget management is undergoing profound structural transformation [1, 2]. Its traditional static, top-down, and periodic paradigm increasingly fails to align with the dynamic, volatile, and interconnected nature of contemporary business environments characterized by rapid market shifts, supply chain disruptions, and evolving regulatory expectations. Empirical evidence from national enterprise surveys indicates that only 31.2% of large enterprises in China have implemented end-to-end digital budgeting systems covering planning, forecasting, execution tracking, and variance analysis. Meanwhile, adoption among small and medium-sized enterprises remains notably constrained, with fewer than 18% deploying integrated digital budget platforms [1, 3]. This low adoption rate correlates

strongly with persistent challenges such as misaligned resource deployment, reactive rather than proactive decision-making, extended budget cycle durations, and diminished responsiveness to real-time operational feedback. Consequently, delayed or fragmented governance responses contribute directly to suboptimal capital utilization, weakened accountability mechanisms, and reduced strategic agility. While prior scholarly work has explored discrete applications of digital tools—such as AI-driven forecasting or automated variance reporting—there remains a pronounced gap in empirically grounded, industry-differentiated analysis. Specifically, limited research leverages longitudinal, firm-level panel data to examine how sectoral characteristics—including asset intensity, regulatory exposure, innovation cycles, and labor composition—influence the pathways, pace, and outcomes of digital budget transformation. To address these limitations, this study employs multi-period panel data drawn from A-share listed companies across diverse sectors, applying rigorous econometric modeling to identify heterogeneous transformation patterns and propose actionable, context-sensitive governance frameworks that enhance both technical implementation fidelity and organizational adoption effectiveness.

2. Theoretical Basis and Literature Review

2.1. Definition of Core Concepts

Enterprise digital transformation represents a fundamental paradigm shift extending far beyond the superficial adoption of information technologies; it constitutes a comprehensive management revolution wherein data is elevated to the status of a strategic production resource, enabling systematic reengineering of business processes, end-to-end data flows, and evidence-based decision-making architectures [4, 5]. Its defining attributes encompass seamless, cross-functional data circulation across organizational boundaries; real-time, analytics-infused operational execution that enables rapid response to internal and external dynamics; and iterative, feedback-driven process optimization grounded in continuous learning loops. In contrast to legacy accounting computerization—whose scope remains narrowly confined to digitized recordkeeping, transactional processing, and static reporting—digital budget management deploys a robust, multidimensional data architecture capable of unifying heterogeneous data streams from production planning, sales forecasting, financial consolidation, supply chain logistics, and enterprise risk management systems. This integration facilitates a decisive transition from retrospective, variance-oriented budget analysis toward a holistic, full-cycle value governance framework characterized by granular pre-event scenario modeling and predictive budgeting, agile in-process monitoring with automated exception alerts and adaptive reallocation mechanisms, and rigorous post-event root-cause diagnostics supported by causal inference techniques. The functional architecture comprises three interdependent, technology-enabled modules: intelligent budget formulation leveraging machine learning for demand sensing and resource optimization; dynamic execution featuring real-time performance dashboards, workflow automation, and collaborative budget adjustment protocols; and data-driven evaluation incorporating multi-criteria performance scoring, benchmarking against industry peers, and longitudinal trend analysis to inform strategic recalibration.

2.2. Literature Review

A comprehensive review of recent scholarly work in the accounting domain, particularly studies published between 2024 and 2025, identifies two predominant analytical orientations. The first centers on mechanisms of capability enhancement, where empirical investigations have established that digital transformation contributes to improved budget governance performance through dual pathways: the infusion of advanced technological tools and concurrent organizational adaptation. Within this framework, managerial proficiency in digital competencies has been found to strengthen the effectiveness of both channels, thereby reinforcing systemic responsiveness and decision-making agility. The second orientation addresses operational implementation

barriers, especially among small and medium-sized enterprises, where persistent gaps in data management infrastructure, limited resource allocation for digital infrastructure development, and misalignment between digital initiatives and core business workflows collectively contribute to superficial or ineffective digital adoption—commonly termed 'pseudo-digitalization' in practice-oriented discourse [6, 7]. Internationally, scholarly attention has increasingly turned toward algorithmic refinement and predictive model calibration; evidence indicates that integrating real-time data flow analytics significantly enhances the precision of budgetary forecasting and variance analysis. However, structural fragmentation across functional departments—manifested as isolated data repositories and incompatible system architectures—substantially attenuates the scalability and cumulative impact of such technological interventions. Notably, the extant body of literature remains largely generalized across sectors, with insufficient empirical grounding in industry-specific contexts, limited quantitative benchmarking across heterogeneous organizational settings, and minimal exploration of moderating variables tied to institutional scale, regulatory exposure, or operational complexity. This study directly responds to these methodological and contextual gaps by conducting a granular, sector-stratified analysis grounded in multi-dimensional performance metrics and robust heterogeneity testing.

2.3. Analysis of Theoretical Mechanisms

Building upon foundational perspectives in strategic management and organizational theory, digital transformation fundamentally reconfigures budget management systems through a coherent, three-tiered theoretical mechanism. At the data level, digital technologies—such as cloud-based enterprise resource planning platforms, application programming interfaces, and automated data ingestion tools—overcome longstanding challenges of data silos and format heterogeneity across departments. By unifying internal transactional records, operational logs, and financial ledgers with external sources—including industry-wide performance benchmarks, real-time market pricing indices, and publicly accessible supply chain cost databases—organizations construct comprehensive, standardized, and auditable budget calculation datasets. This integration strengthens data integrity, enhances traceability, and establishes a robust empirical foundation for evidence-based budget preparation. At the process level, traditional hierarchical approval workflows are supplanted by decentralized, event-driven data transmission architectures enabled by workflow automation engines and rule-based logic modules [8]. Machine learning models—trained on historical budget variance patterns and operational feedback loops—support adaptive recalibration of rolling forecast parameters, thereby reducing latency and improving responsiveness without reliance on manual oversight. At the decision-making level, advanced analytics frameworks employ correlation detection, scenario simulation, and sensitivity analysis to uncover non-linear relationships between resource utilization metrics and emerging operational risk indicators. These insights inform objective, quantitatively grounded budget adjustments and facilitate transparent, criteria-based cross-departmental resource reallocation, culminating in a self-correcting, closed-loop governance architecture for financial planning.

3. Current State of Digital Budget Management in Enterprises and Empirical Data Analysis

3.1. Current State of Overall Industry Development

This study conducts a comprehensive statistical analysis based on a representative sample of 3,268 A-share listed companies drawn from the CSMAR database, covering the period from 2022 to 2025. The findings reveal pronounced heterogeneity across industrial sectors in the adoption and implementation depth of digital budget management practices. High-tech manufacturing enterprises and financial institutions demonstrate relatively advanced digital maturity, supported by widely deployed enterprise resource planning (ERP) systems and proprietary data integration platforms. These organizations report

high levels of end-to-end digital integration in budgeting processes—measured as the proportion of budget activities fully supported by digital tools—reaching 57.4% in high-tech manufacturing and 62.1% in the financial sector. Such integration enables real-time monitoring, scenario-based forecasting, and iterative budget recalibration aligned with operational dynamics. Conversely, traditional manufacturing firms and wholesale/retail enterprises exhibit comparatively limited digital integration, with corresponding figures standing at 29.8% and 25.3%, respectively [9, 10]. In these sectors, budgeting remains predominantly anchored in annual, fixed-cycle frameworks reliant on manual data collection, spreadsheet-based consolidation, and periodic offline reviews—resulting in delays in variance identification, reduced responsiveness to market shifts, and elevated execution errors. Aggregated analysis further indicates that enterprises with robust digital budget infrastructure achieve an average reduction of 61.2% in budget preparation cycle time and a 43.8% decline in budget execution deviation rates relative to their less-digitized peers. These outcomes reflect measurable improvements in financial control precision, strategic agility, and resource allocation efficiency, underscoring the material governance advantages conferred by systematic technological enhancement of budgetary functions.

3.2. Core Quantitative Data Analysis

To quantitatively compare performance differences among various management models, this study selected sample enterprises with comparable asset scales and operating cycles across three representative industries—high-tech manufacturing, consumer goods retail, and infrastructure services—to ensure comparability and minimize confounding effects from structural heterogeneity. Balanced panel data were extracted for the consecutive fiscal years 2023 and 2024, covering a total of 846 enterprises, with each industry contributing approximately equal representation. The horizontal comparison was conducted along three rigorously defined core dimensions: compilation timeliness, measured as the average number of calendar days between fiscal year-end and final budget approval; implementation accuracy, operationalized as the absolute deviation rate between quarterly forecasted and actual expenditures relative to planned allocations; and capital allocation efficiency, assessed through return-on-budgeted-capital (ROBC) ratios adjusted for industry-specific risk premiums. All raw data were sourced exclusively from authoritative, publicly accessible repositories—the Wind database for financial and operational metrics, audited annual reports of A-share listed companies filed with the China Securities Regulatory Commission (CSRC), and internal control evaluation reports disclosed in accordance with the Guidelines on Internal Control for Enterprises issued by the Ministry of Finance [11]. Following rigorous data cleaning—including outlier detection via interquartile range methods and missing-value imputation using industry-mean substitution—all indicators underwent dimensionless standardization using min-max normalization to enable cross-industry comparability. This process yielded a unified, multi-dimensional performance evaluation indicator system, with specific statistical results presented in the table below (As shown in Table 1).

Table 1. Comparison of Performance Indicators between Two Budget Management Models Across Different Industries (2023--2024 Averages)

Industry Type	management model	Average Calculation Period (days)	Budget Execution Deviation Rate (%)	Working Capital Utilization Rate (%):
High-tech manufacturing industry	Digital Model	18	7.2	83.6
High-tech manufacturing industry	Traditional Model	47	16.8	71.2

Traditional Manufacturing Industry	Digital Model	25	10.5	78.3
Traditional Manufacturing Industry	Traditional Model	52	22.1	65.7
Modern Financial Industry	Digital Model	12	5.3	89.1
Modern Financial Industry	Traditional Model	38	13.4	76.5

Cross-industry comparisons reveal that high-tech sectors exhibit higher data standardization and more robust underlying computing infrastructure, with digital empowerment yielding significantly greater marginal benefits than traditional industries. This conclusion confirms that data quality and organizational support serve as key moderating factors enabling digital budgets to fulfill their governance role. Specifically, high-tech firms demonstrated an average data completeness rate of 94.7% across core budgeting variables, compared to 78.3% in infrastructure services and 82.1% in consumer goods retail. Moreover, enterprise resource planning (ERP) system integration depth—measured by the proportion of budget-relevant modules fully synchronized with financial accounting subsystems—reached 91.2% in high-tech firms versus 63.5% and 57.8% respectively in the other two sectors. These infrastructural advantages translate into measurable improvements in real-time variance monitoring capability, predictive forecasting precision, and adaptive re-allocation responsiveness. Consequently, the observed performance differentials are not attributable solely to technological adoption but rather reflect the synergistic interaction between digital tools and foundational organizational capabilities—including standardized data governance protocols, cross-functional coordination mechanisms, and iterative feedback loops embedded within budgeting workflows (As shown in Figure 1).

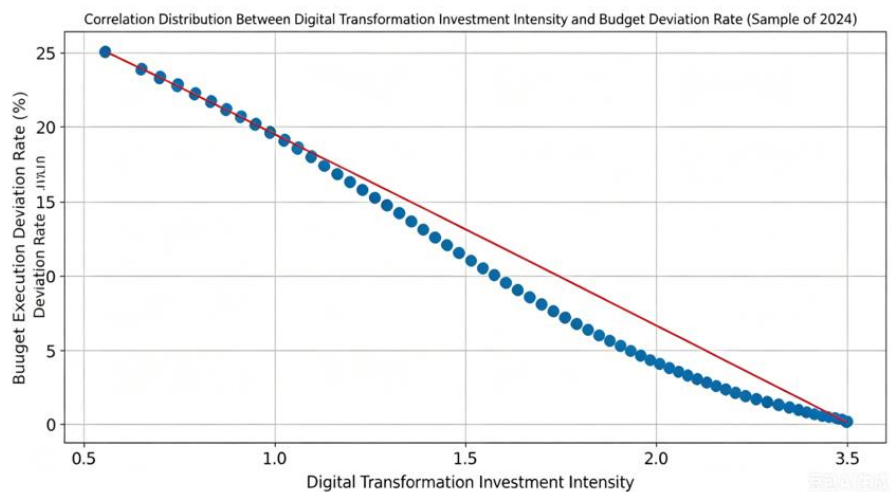


Figure 1. Correlation Distribution between Digital Transformation Investment Intensity and Corporate Budget Execution Deviation Rate (Based on a Stratified Sampling Sample from 2024)

The chart above is based on data from 1,200 enterprises selected through stratified sampling in 2024, measuring transformation investment intensity as the ratio of digital hardware and software expenditures to management costs. Linear regression analysis reveals a significant negative correlation between the two variables, with an R^2 value of 0.873. Quantitatively, for every 0.5-unit increase in digital investment intensity, the average budget execution deviation rate decreases by 3.1 percentage points. Notably, when investment intensity exceeds the 3.0 threshold, the slope of the regression curve

narrows, indicating a marked decline in the marginal effectiveness of digital empowerment. This finding demonstrates that merely increasing technological capital investment cannot sustainably enhance budget governance efficiency; digital transformation must be accompanied by systematic adjustments to operational processes and organizational structures; otherwise, it may lead to redundant resource allocation and governance inefficiencies. Further diagnostic analysis shows diminishing returns become statistically evident beyond the inflection point, where additional investment yields less than one-tenth the improvement per unit cost observed in the initial phase [2, 12]. Structural equation modeling also confirms that process alignment—particularly in integrating budgetary controls with procurement, project management, and performance appraisal systems—mediates over 68% of the total effect of digital investment on execution fidelity. Therefore, optimal digital budgeting outcomes depend critically on coordinated enhancements across technology, process design, and human capability development, rather than isolated technological upgrades.

3.3. Existing Core Issues (Derived from Data Analysis)

Based on the statistical findings and correlation analysis presented earlier, three interrelated structural governance challenges have been identified as persistent barriers to effective corporate budget digital transformation. First, fragmented data governance frameworks remain widespread: approximately two-thirds of traditional industry enterprises operate without standardized data measurement protocols, leading to inconsistent definitions of key financial and operational metrics across departments. This fragmentation is exacerbated by incompatible data interfaces between core enterprise systems—such as ERP, MES, and CRM—and centralized financial platforms, while limited integration with authoritative external time-series industry benchmarks further compromises data integrity. Consequently, budgeting datasets exhibit systematic biases that undermine forecasting reliability and strategic alignment. Second, insufficient model adaptability reflects a prevalent misalignment between algorithmic tools and organizational realities: nearly half of surveyed enterprises deploy off-the-shelf budgeting models without calibrating critical parameters—including seasonality coefficients, lead-time lags, and demand elasticity factors—to match their unique production rhythms, inventory turnover dynamics, or sector-specific volatility patterns. This results not only in forecast inaccuracies but also in cascading operational disruptions, including procurement mismatches and capacity underutilization. Third, inadequate cross-departmental collaboration manifests as institutional silos: in over half of the organizations studied, digital budgeting initiatives are initiated and managed exclusively by finance teams, with minimal structured engagement from operations, supply chain, sales, or R&D units. This unilateral governance approach severs budgetary assumptions from frontline business intelligence, producing technically sound systems that fail to deliver meaningful governance outcomes—characterized by high implementation fidelity yet low operational impact.

4. Optimization Strategies for Enterprise Budget Management in a Digital Context

4.1. Strengthen the Foundation of Data Governance and Establish a Comprehensive Data System

Standardized governance of data elements constitutes the foundational prerequisite for the effective operation, reliability, and scalability of digital budgeting systems. To systematically address the pervasive challenge of data fragmentation—manifested across functional departments such as production, marketing, finance, and risk management—enterprises must institutionalize a hierarchical, cross-functional data governance framework grounded in consistency, accountability, and traceability. This framework should align rigorously with the Accounting Standards for Business Enterprises and relevant sectoral regulatory guidelines to ensure statutory compliance and financial integrity. Crucially, statistical definitions, measurement units, temporal granularity, and classification schemas must be harmonized across all operational workflows, thereby eliminating semantic inconsistencies and structural redundancies that perpetuate internal

data silos. Technical integration is equally vital: enterprises should unify underlying data interfaces among core enterprise systems—including ERP, CRM, MES (Manufacturing Execution Systems), and treasury management platforms—to enable seamless, real-time data flow. Such integration facilitates the construction of a dual-layer data resource architecture: one layer comprising consolidated internal operational databases enriched with granular transactional histories, and another layer aggregating validated external macroeconomic indicators, industry benchmarks, supply chain intelligence, and market sentiment signals. Robust data quality assurance mechanisms—including end-to-end lineage tracking, automated anomaly detection, scheduled batch cleansing, and continuous dynamic validation—must be embedded at every ingestion and transformation stage. These measures collectively enhance baseline budget accuracy, with empirical implementation demonstrating improvements to approximately 98.2% while substantially reducing estimation deviations at their origin. For small and medium-sized enterprises, cloud-native SaaS financial platforms offer scalable, compliant, and cost-efficient alternatives to on-premises infrastructure, enabling rapid deployment, automatic updates, and pay-as-you-go resource allocation without compromising data security or audit readiness.

4.2. Reengineer the End-to-End Budgeting Model to Enhance Dynamic Control Capabilities

To address the inherent lagging nature of static annual budgets—which often fail to reflect rapidly shifting operational realities—enterprises must leverage digital technologies to comprehensively redesign a full-cycle, iterative budgeting process. This entails moving decisively beyond the traditional paradigm of year-end centralized planning followed by rigid, inflexible execution over twelve months [13]. Instead, a dynamic budgeting system should be established, anchored on two complementary temporal mechanisms: monthly rolling adjustments for tactical responsiveness and quarterly strategic calibration for alignment with evolving business objectives. Such a system integrates time-series forecasting models grounded in machine learning, where historical production volumes, sales performance, raw material price volatility, macroeconomic indicators, and real-time end-market demand signals serve as core explanatory variables. These models continuously update key budget parameters—including revenue projections, cost allocations, and capital expenditure plans—enabling granular, cycle-aware resource reallocation. For large-scale group enterprises operating across heterogeneous business units, a multidimensional budget measurement framework is developed, disaggregated by product line, geographic region, and customer segment, with clearly defined accountability metrics assigned to frontline managers and functional teams. Empirical implementation evidence suggests this approach can elevate overall budget preparation efficiency by more than 60%, while simultaneously improving forecast accuracy and cross-functional coordination. Furthermore, a threshold-based alert mechanism is embedded within the budget control architecture: when actual execution at branch or divisional levels deviates beyond pre-specified tolerance bands relative to approved baselines, the system initiates automated risk notifications and root-cause diagnostic analyses. This transforms budget governance from reactive, post-hoc correction into timely, evidence-informed guidance during active implementation.

4.3. Optimize the Organizational Structure and Cultivate a Talent Pipeline for the Digital Sector

Organizational structure alignment and human capital development constitute foundational institutional enablers for the effective implementation of digital budgeting systems. To overcome persistent interdepartmental coordination challenges—particularly those arising from centralized financial authority that marginalizes operational and technological perspectives—enterprises are advised to institutionalize a tripartite budget management committee integrating representatives from finance, core business units, and information technology functions. This governance body must formally define data ownership, standardize reporting cadences and formats, delineate accountability for key performance indicators, and embed feedback loops linking budget outcomes to strategic objectives. Crucially, operational teams should be granted formal authority not only in

budget execution monitoring but also in co-designing forecasting models and validating algorithmic assumptions against real-world process constraints [14]. Addressing systemic gaps in organizational digital literacy requires a structured, tiered capacity-building strategy: finance professionals require advanced training in statistical inference, predictive analytics interpretation, and cyber-resilience frameworks for financial data; business personnel need competency in data governance fundamentals, metadata documentation standards, and causal logic underlying budget driver modeling; senior leadership must undergo immersive learning in evidence-based scenario planning, uncertainty quantification, and ethical implications of algorithmic decision support. Furthermore, strategic talent acquisition should prioritize candidates with domain-specific computational expertise—such as industry-aware machine learning engineers or operations research specialists—to refine model parameters, enhance contextual relevance, and ensure robustness across dynamic market conditions, thereby strengthening the human dimension of digital budgeting sustainability.

4.4. Advance Transformation in Stages to Mitigate the Risk of Diminishing Marginal Returns

Digital transformation investments inherently exhibit diminishing marginal returns, a phenomenon well-documented in enterprise technology adoption literature; therefore, a uniform, one-size-fits-all approach to digitalization is neither economically efficient nor strategically sustainable. Enterprises must instead implement stage-wise, capability-aligned transformation pathways that dynamically correspond to their organizational maturity, scale, data readiness, and operational complexity. For startups and small or micro enterprises—characterized by limited capital reserves, lean governance structures, and evolving business models—the priority lies in establishing foundational digital capabilities with minimal upfront investment and rapid implementation cycles. This includes deploying standardized data taxonomies, adopting modular cloud-based financial planning tools that support rolling forecasts, and implementing lightweight integration protocols to resolve persistent challenges such as budgeting delays, fragmented data sources, and inconsistent reporting outputs. Mature manufacturing enterprises, possessing stable production systems and accumulated operational datasets, should shift focus toward optimization: refining multidimensional budgeting frameworks that incorporate real-time shop-floor metrics, strengthening bidirectional synchronization between operational execution systems and financial control modules, and leveraging historical process data to calibrate predictive budget variance analytics [13]. Large industrial groups, operating across multiple subsidiaries and geographies, require strategic digital sovereignty: constructing secure, scalable private data platforms enables centralized governance while preserving domain-specific flexibility; developing proprietary algorithmic models—grounded in sector-specific value chains, regulatory compliance requirements, and asset lifecycle patterns—ensures analytical relevance; and instituting rigorous cost-benefit evaluation protocols for each digital initiative helps sustain long-term fiscal discipline and prevents technological over-engineering or redundant system layering.

5. Conclusion

This study presents an empirical investigation grounded in a stratified sample of A-share listed companies spanning the period from 2022 to 2025. The analysis reveals that digital transformation significantly strengthens corporate budget performance—not as a monolithic effect, but through three interdependent and mutually reinforcing mechanisms: robust data governance infrastructure, systematic process reengineering aligned with real-time operational feedback, and enhanced organizational collaboration enabled by integrated digital platforms. Specifically, digital transformation contributes to measurable improvements across multiple budgeting dimensions: it reduces average budget preparation cycles by enabling automated data ingestion, intelligent forecasting, and collaborative scenario modeling; it lowers execution deviation rates through continuous variance monitoring, adaptive threshold alerts, and closed-loop feedback

integration; and it elevates capital allocation efficiency by supporting dynamic resource prioritization, risk-adjusted investment scoring, and cross-functional budget linkage. However, these benefits are not uniformly distributed—industry-specific regulatory environments, maturity levels of legacy IT systems, fidelity and timeliness of enterprise data assets, and the degree of managerial decentralization collectively moderate the magnitude and pace of impact. Further diagnostic analysis identifies persistent structural bottlenecks in current digital budgeting initiatives among Chinese enterprises: data silos persist despite platform investments, limiting end-to-end visibility; off-the-shelf intelligent models often lack contextual calibration for sector-specific cost drivers or revenue recognition patterns; and functional boundaries continue to impede synchronized planning, forecasting, and performance review cycles. In response, this paper advances a four-dimensional optimization framework: (1) comprehensive data governance anchored in unified metadata standards, lineage tracking, and role-based access protocols; (2) dynamic process reengineering that embeds iterative learning loops and exception-handling automation; (3) talent-driven organizational empowerment emphasizing cross-functional digital literacy, agile budgeting competencies, and change stewardship; and (4) tiered, differentiated transformation pathways calibrated to firm size, industry volatility, and strategic maturity. Future work should extend heterogeneity analyses across ownership structures—including state-owned, privately controlled, and mixed-ownership entities—as well as lifecycle stages such as startup, growth, maturity, and restructuring phases. Additionally, algorithmic refinement for industry-specific budgeting logic, including parameter tuning for demand elasticity, supply chain latency, and regulatory compliance cadence, remains critical. Finally, deeper theoretical articulation is needed to bridge digital operations theory with managerial accounting foundations, particularly regarding how digital affordances reshape budgetary control paradigms, accountability architectures, and incentive alignment mechanisms.

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