ISSN 2616-5902 Vol. 8, Issue 10: 67-72, DOI: 10.25236/AJBM.2026.081009

# Research on Optimizing Enterprise Comprehensive Budget Management with Big Data Empowerment

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***Abstract:*** *As a crucial management tool for enterprises to coordinate resource allocation and achieve strategic objectives, comprehensive budget management has seen increasing limitations in its traditional operational methods—particularly in data foundation, forecasting accuracy, execution monitoring, and evaluation—against the dual backdrop of heightened operational uncertainty and accelerated digital transformation. Big data, characterized by massive volume, diverse types, rapid access, and high application value, provides technical support for budget management through multi-source data integration, intelligent forecasting, real-time monitoring, and multi-dimensional analysis. Based on a review of relevant theories and policies on big data and comprehensive budget management, this paper analyzes the mechanism of big data's empowerment in comprehensive budget management from a closed-loop perspective encompassing budget formulation, execution, analysis, and evaluation. It identifies practical challenges in enterprises regarding data foundation, formulation methods, execution monitoring, and assessment criteria. Subsequently, it proposes optimization pathways such as building a budget data hub, introducing intelligent forecasting models, advancing business-finance integration and dynamic monitoring, expanding multi-dimensional analysis and performance evaluation, strengthening organizational safeguards, and enhancing data governance. These recommendations aim to provide insights for improving the efficiency and effectiveness of comprehensive budget management in the big data era.*

***Keywords:*** *big data; comprehensive budget management; business-finance integration; digital transformation; management accounting*

## 1. Introduction

Comprehensive budget management is a management control method that enterprises use to make budget arrangements for their various activities such as business operations, investment activities, and financial activities over a certain period. It integrates and optimizes enterprise resources and enhances operational efficiency through comprehensive management functions such as planning, coordination, control, motivation, and evaluation. It is also an important means to promote enterprises to achieve their development strategies. With the rapid development of China's digital economy, the state has continuously guided enterprises to strengthen digital thinking, build integrated digital platforms, and enhance the integration and data communication throughout the entire process to form data-driven intelligent decision-making capabilities. Big data, as a data collection that is characterized by large capacity, diverse types, fast access speed, and high application value, has been established as a national strategic resource. Under this background, how to embed the value orientation and technical capabilities of big data into the entire process of enterprise budget management has become a topic of common concern in the practical and theoretical fields.

From a practical perspective, traditional comprehensive budget management has long relied on historical experience and static annual data, and generally faces problems such as inaccurate prediction of budget targets, lack of real-time update mechanisms for budget preparation, delayed response in budget execution monitoring, and insufficient comprehensiveness of budget analysis dimensions. The limitations in aspects such as data caliber, strategic transmission, dynamic adjustment, and departmental collaboration have become more prominent in the context of increasing uncertainty in the business environment. The inherent defects of the traditional budget system in data collection, logical formulation, and execution supervision make it difficult to meet the new requirements of enterprise scale expansion and complex operations. Big data's technical features such as data integration and real-time processing can change the generation method of budget information at the data foundation level, providing a

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possibility for the transformation of budget management from experience-driven to data-driven. The core question this paper attempts to answer is: How can big data empower comprehensive budget management of enterprises? What are the mechanism of action, practical obstacles, and optimization paths? Regarding this issue, this paper adopts an analytical approach combining normative research and case studies. Based on the review of existing research, it constructs an analytical framework of "enabling mechanism - practical problems - optimization path" to provide systematic references for the digital practice of enterprises' budget management.

## 2. Literature review and research orientation

The academic and business communities have accumulated certain knowledge regarding the integration of big data and comprehensive budget management. At the system construction level, Liu Jiwen et al. analyzed the driving mechanism of big data on enterprise comprehensive budget management, pointing out that big data, in terms of technology and efficiency, has promoted budget management to move from "partial comprehensiveness" to "overall comprehensiveness", and designed a budget management system framework driven by big data [1]. At the technical application level, Zheng[2] explored the reconfiguration effect of big data and cloud accounting on the enterprise budget management system, proposing to integrate internal and external data through a data hub, implement dynamic prediction using time series analysis and regression models, establish an elastic budget model and a collaborative formulation mechanism for all employees, and support strategies such as upgrading intelligent computing equipment, cultivating cross-domain teams, digital approval processes, and data profiling decision-making mechanisms. At the digital transformation path level, Cheng et al. [3] studied the implementation path of enterprise comprehensive budget management digital transformation, while Jiang [4] explored the application value of cloud accounting in comprehensive budget management in the era of big data. Meanwhile, based on contingency theory and data-driven decision-making logic, relevant studies further analyzed the mechanism of data integration, predictive analysis, process automation, and collaborative decision-making in budget management, and paid attention to strategic myopia risks caused by algorithm deviations and model dependence.

By integrating the existing achievements, it can be found that existing research mostly starts from technical application or a single link, or focuses on the design of the system framework, but lacks a systematic review from the perspective of the budget management loop on the mechanism of big data enabling budget management, and pays limited attention to the corresponding relationship between practical obstacles and optimization paths. This paper, based on previous research, according to the management model definition of the Ministry of Finance for comprehensive budget "all-round, all-process, all-staff participation", examines each link of budget preparation, execution, analysis, and assessment within a unified framework, and focuses on analyzing the mechanism of big data embedding in each link, the common obstacles faced by enterprises when implementing it, and the corresponding optimization measures, striving to form incremental understanding in the corresponding relationship of "mechanism - problem - path".

## 3. Analysis of the mechanism of big data enabling comprehensive budget management in enterprises

Comprehensive budget management is a dynamic management throughout the entire process. Its operational quality depends on the completeness of the data foundation, the scientificity of the forecasting method, the timeliness of the execution monitoring, and the objectivity of the assessment and evaluation. The empowerment of big data on budget management does not simply add technical tools on top of the existing processes, but rather reshapes the operational logic of each link of budget management by changing the generation, transmission, and utilization methods of information. This reshaping is based on two fundamental judgments: Firstly, the essence of budget management is to make forward-looking arrangements for resources under uncertain circumstances, and its decision-making quality highly depends on the sufficiency and timeliness of information, and big data precisely can expand the scope of information acquisition and improve the speed of information processing; Secondly, comprehensive budget management emphasizes all-round, full-process, and all-staff participation, and its effective operation requires the formation of a stable and smooth data loop among all links. The traditional decentralized information organization method is difficult to support such collaboration, while the data integration and sharing capabilities of big data provide conditions for building a unified budget information foundation. Based on this, the empowerment of big data on comprehensive budget

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management is mainly reflected in the reengineering of the operational logic of the four links of preparation, execution, analysis, and assessment.

### *3.1 Rebuilding the foundation of budget preparation through multi-source data integration*

The starting point of budget preparation is the accurate judgment of enterprise resources and business environment, which relies on sufficient and consistent data. Traditional budget preparation mostly relies on the end-of-year piecing together of multiple internal data from the finance department, and cross-departmental and cross-system information is difficult to be integrated. Big data integrates structured data from internal production, sales, inventory, finance, etc. of the enterprise through the construction of a unified master data standard and data warehouse, and introduces external information such as market price indices, industry prosperity, and policy regulations, so that business events can enter the budget model according to the same rules. The value of this process does not lie in simply increasing the data volume, but in reducing multiple interpretations of the same business fact, enabling budget preparation to be based on stable and traceable data, and creating conditions for the scientific determination of budget targets.

### *3.2 Intelligent prediction enhances the scientificity of budget targets and preparation*

The accuracy of budget target setting directly affects the rationality of resource allocation. Traditional budgets mostly rely on the previous year's base and subjective experience for estimation, lacking quantitative grasp of the correlation between multiple factors. The predictive analysis capabilities of big data technology provide new method support for budget target setting. Enterprises can use algorithms such as regression analysis, machine learning, and time series to identify and analyze the correlation and weights of key variables affecting revenue, cost, and cash flow, generate quantitative predictions, and combine sensitivity analysis and scenario simulation to reveal the range of changes under different assumptions. With this mechanism, budget targets can better reflect market trends and business reality, shifting budget preparation from experience-driven to data-driven, and enhancing the scientificity and forward-looking nature of the targets.

### *3.3 Real-time monitoring ensures dynamic budget execution*

The key point of the budget execution link lies in promptly identifying deviations and dynamically adjusting resource allocation. Traditional budgets are based on an annual cycle, and execution monitoring mostly relies on periodic reports after the event, making it difficult to capture anomalies in a timely manner. Big data technology continuously collects and updates business data, supports real-time monitoring and feedback of budget execution status, and through algorithms such as outlier detection and association analysis, can sensitively sense anomalies in the execution process and promptly adjust deviations. Combined with rolling budgeting and flexible budgeting methods, the budget cycle can be shortened from annual to quarterly or monthly, and real-time data updates are triggered by market changes, enabling business development to maintain dynamic matching with budget targets, significantly enhancing the adaptability of budget execution to uncertainty.

### *3.4 Multi-dimensional analysis enhances the objectivity of assessment and evaluation*

The traditional approach to budget assessment and evaluation mainly relies on financial indicators, with a relatively limited dimension, making it difficult to comprehensively reflect the operational quality and strategic orientation. With the support of big data, non-financial dimensions such as customers, internal processes, and learning and growth are incorporated into the budget analysis and evaluation system. Through the integrated analysis of financial and business data, correlation models between revenue and customer traffic, cost and production efficiency, etc. are established, and the impact of business indicators on the financial budget is clarified. At the same time, enterprises can connect to industry databases for peer benchmarking, and combine time series analysis to identify seasonal fluctuations and business cycle patterns, so that the budget evaluation is based on multi-dimensional, objective, and comparable data, providing better support for performance assessment and resource reallocation decisions.

Based on the above analysis, the empowerment of big data for comprehensive budget management runs through the closed loop of "preparation - execution - analysis - assessment", and its logic can be summarized as: data integration consolidates the foundation, intelligent prediction optimizes the goals,

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real-time monitoring strengthens execution, and multi-dimensional analysis improves evaluation. This logic provides a reference for enterprises to identify the actual shortcomings of budget management and optimize key points.

## 4. The main problems in the current comprehensive budget management of enterprises

Although the application value of big data is increasingly prominent, from the perspective of enterprise practice, most enterprises still have problems that are not compatible with the data-driven model in terms of data foundation, preparation methods, execution monitoring, and evaluation, which restricts the effectiveness of comprehensive budget management.

### *4.1 Weak data foundation and fragmented business and financial data*

Data is a prerequisite for the digital transformation of budget management, but the data foundation of many enterprises is still relatively weak. The internal financial and business systems of the enterprise operate independently, with inconsistent master data standards. The same business fact may have multiple perspectives in different systems; Insufficient external data acquisition and integration, resulting in relatively limited information available for budget preparation. The fragmentation of business and financial data has led to budget preparation relying on departmental reporting and manual summarization, making it difficult to ensure the timeliness, consistency, and completeness of data, and also laying hidden dangers for subsequent budget analysis and assessment.

### *4.2 Budget preparation is mainly based on experience, with insufficient prediction accuracy*

A considerable proportion of enterprises' budget preparation still follows the basic logic of "adding adjustment to the previous year's base", which limits their ability to cope with changes in multiple factors and market uncertainty. Once the budget target is determined, it becomes relatively fixed and lacks a mechanism for dynamic adjustment with environmental changes, which can easily lead to a disconnect between the budget and actual operations. The lack of a single forecasting method and quantitative tools has led to insufficient scientificity in setting budget goals, resulting in a common problem of long budget preparation cycles and difficult adjustments.

### *4.3 Delayed monitoring of budget execution and lack of dynamic adjustment mechanism*

Traditional budget execution monitoring relies on regular financial reports, and there is a time lag in information transmission, making it difficult for managers to detect deviations in a timely manner and take corresponding measures. The budget adjustment process is cumbersome, the approval chain is long, and there is insufficient flexibility. When facing external shocks such as market fluctuations and changes in raw material prices, resource allocation is difficult to respond quickly. The budget execution of some enterprises still remains at the level of "managing results", lacking real-time tracking and early warning of the process, making it difficult to balance the constraints and flexibility of budget execution.

### *4.4 The assessment and evaluation dimensions are single, lacking analysis of the integration of business and finance*

Enterprise budget assessment is often based on the completion of financial indicators, with insufficient attention paid to non-financial dimensions such as customers, processes, and growth. The evaluation results are difficult to fully reflect the quality of operations and strategic contributions. Budget analysis often stays at the financial level of data listing, lacking in-depth exploration of business driving factors, making it difficult to answer the question of "what are the business reasons behind indicator changes", resulting in limited guidance of assessment on business improvement. The disconnect between assessment data and business data also weakens the objectivity and traceability of budget evaluation.

The above issues are interrelated and mutually reinforcing: weak data foundation restricts the scientificity of prediction, monitoring lag amplifies execution deviation, and single evaluation weakens feedback value. This systemic defect determines that big data empowerment is not a partial repair of a certain link, but a systematic optimization that requires collaborative promotion from multiple aspects such as data governance, technology application, and organizational collaboration.

ISSN 2616-5902 Vol. 8, Issue 10: 67-72, DOI: 10.25236/AJBM.2026.081009

## 5. The optimization path of big data enabling comprehensive budget management for enterprises

In response to the aforementioned practical issues, enterprises should base themselves on their own digital foundation and business characteristics, and systematically promote the application of big data in comprehensive budget management from the dimensions of data, methods, processes, evaluation, and guarantee. It should be noted that the starting points of digitalization vary greatly among different enterprises: enterprises with better digitalization can directly promote the in-depth application of intelligent prediction and real-time monitoring, while small and medium-sized enterprises with weak digitalization should follow a progressive logic of integrating data first, optimizing processes next, and gradually introducing model analysis to avoid blindly pursuing technological advancement without considering the actual situation. Based on this, this article proposes the following optimization paths from the three levels of foundation, application, and guarantee.

### *5.1 Strengthen the foundation of data governance and build a budget data middle platform*

To solve the problem of weak data foundation, the key lies in establishing a unified data governance system and a budget data middle platform. Enterprises should unify the standards of main data such as customers, products, organizations, projects, and accounting subjects, clarify the ownership and update rules of data from each system, break the barriers between business and finance data, and achieve orderly integration and interconnection of internal and external data. On this basis, it is relying on the data middle platform, the indicators and historical data assets required for budgeting should be accumulated, and the processes of data collection, cleaning, storage, and access should be standardized, so that each step of budget preparation, execution, and analysis can be based on consistent and traceable data. Data governance is not a one-time technical project, but should be continuously iterated as a regular institutional arrangement.

### *5.2 Introduce intelligent prediction models to enhance the scientificity of goals and budgeting*

In response to the problem of insufficient prediction accuracy, enterprises should promote the transformation of budget goal determination and budgeting towards data-driven. Based on the complexity of business and the degree of external fluctuations, predictive methods such as regression analysis, time series, and machine learning can be introduced to implement dynamic prediction for key indicators such as revenue, cost, and cash flow, and through sensitivity analysis and multi-scenario simulation, provide elastic space for budget goals. It should be emphasized that the output of algorithms should be used as input for management judgment rather than as a replacement, and managers still need to combine strategic choices, abnormal events, and information not covered by the model for judgment, avoiding falling into blind reliance on the model.

### *5.3 Promote the integration of business and finance and implement dynamic monitoring throughout the process*

To make up for the lag in execution monitoring, enterprises should embed big data monitoring capabilities into the entire process of budget execution. By integrating business systems and financial systems, the enterprise can establish a real-time monitoring and early warning mechanism for budget execution, set thresholds for key indicators, and issue timely alerts and support attribution analysis once deviations arise. Combined with rolling budgeting and flexible budgeting approaches, the model shortens the budget cycle and streamlines the budget adjustment process, enabling dynamic updates of resource allocation in response to market fluctuations. Accordingly, budget management realizes the shift from “result-oriented control”to“process-oriented control”, preserving execution constraints while improving flexibility.

### *5.4 Expand multi-dimensional analysis and assessment evaluation*

In response to the problem of a single assessment dimension, enterprises should build a multi-dimensional budget analysis and evaluation system combining financial and non-financial indicators. From the financial perspective, the framework incorporates indicators covering customer, internal process, learning and growth dimensions. By integrating business and financial data, it constructs an association model linking business indicators and financial budgets to deeply explore the underlying business drivers behind indicator fluctuations. Meanwhile, industry data are adopted for peer benchmarking, and time-series and trend analyses are applied to identify business patterns. This approach

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enables more objective and comprehensive budget evaluation and provides better guidance for business improvement and resource allocation.

### *5.5 Improve organizational support and talent team building*

The implementation of big data empowerment cannot be separated from the support of the organization and talent. Enterprises should cultivate a composite team with the ability of financial analysis and algorithm modeling, and enhance the digital literacy and data management capabilities of business personnel. At the organizational level, a cross-departmental budget coordination mechanism should be established to clarify the responsibilities of the finance, business, and technology departments in data supply, system construction, and budget management. This will break down departmental barriers and form a budget management pattern where business, finance, and technology collaborate. The management team should integrate the data-driven concept throughout the entire budget decision-making process, providing organizational support and resource backing for digital transformation.

### *5.6 Strengthening technical risk prevention and data security governance*

The empowerment of big data brings about efficiency improvements, but it also accompanies risks such as data security, algorithm bias, and model dependence. Enterprises should establish a sound data security management system, clearly define data access rights and classification rules, and ensure the safe and compliant use of financial and operational data. For algorithmic bias and strategic myopia risks in predictive models, they should be constrained through fairness tests, model audits, and manual reviews to prevent precise numbers from masking incorrect judgments. During the implementation process, enterprises should adopt a phased implementation strategy, starting with the easier tasks and progressing gradually, covering from points to areas, and reasonably controlling the pace of transformation and risk management based on their own digitalization foundation.

## 6. Conclusion

Big data provides important technical support and value orientation for the optimization of comprehensive budget management in enterprises in the new era. This paper takes the closed-loop of budget management as the analytical framework, systematically examines the mechanism of the role of big data in enabling comprehensive budget management, analyzes the practical obstacles faced by enterprises in the aspects of data foundation, budget preparation, execution monitoring and assessment evaluation, and proposes corresponding optimization paths. The research shows that the empowerment of big data on comprehensive budget management runs through the entire process of preparation, execution, analysis and assessment, and its essence is to consolidate the foundation through data integration, optimize the goal through intelligent prediction, strengthen execution through real-time monitoring, and enhance evaluation through multi-dimensional analysis. Enterprises should, under the policy background of the country promoting digital transformation, base themselves on their actual situations, take data governance as the foundation, intelligent prediction as the engine, dynamic monitoring as the guarantee, and multi-dimensional evaluation as the guidance, and gradually promote the digital transformation and upgrading of comprehensive budget management. This paper mainly adopts the normative research method, and the proposed paths still need to be empirically tested with specific enterprise samples, which provides a direction for subsequent research. The differences in data availability and digital transformation degree at the enterprise level may also lead to different optimization priorities for enterprises of different scales and industries. The heterogeneity of this issue needs to be further explored.

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