Discussion on the Strategy Financial Management System of Power Enterprises Under Big Data Technology

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Abstract. Against the backdrop of the global energy transition and carbon neutrality goals, power enterprises face the critical challenge of aligning long-term strategic objectives with daily financial management. Traditional management models treat strategic and financial management as isolated systems, leading to data silos, misaligned resource allocation, and slow responses to market/policy changes. Big data technology, with its capabilities in multi-source data integration, real-time analytics, and hidden pattern extraction, offers a solution to bridge this gap.

Empirical results show that after system implementation, Group X's strategic goal achievement rate increased from 75.2% to 92.4%, financial budget deviation rate decreased from 18.0% to 6.5%, and ROI of strategic projects rose from 8.3% to 12.7%. These improvements confirm that the system effectively integrates strategic and financial management, providing a practical framework for power enterprises to enhance decision-making efficiency and sustainable development.

Keywords: Big Data Technology; Power Enterprises; Strategic-Financial Integration; Core Indicator Evaluation

1 Introduction

The global energy transition, a key driver fueled by objectives like carbon neutrality and renewable energy adoption, has introduced unprecedented complexity into the strategic planning and financial management of power enterprises. These companies now face growing pressure to integrate long-term strategic goals—such as the deployment of new energy projects, smart grid development, and expansion into cross-regional markets—with effective financial management practices. Yet, traditional management models often treat strategy and finance as siloed systems: strategic planning tends to rely on qualitative environmental assessments, while financial management remains focused on retrospective accounting and rigid budget execution. This disconnect frequently results in a misalignment between resource allocation and strategic priorities.

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Big data technology, with its capabilities in processing massive, multi-source, and real-time data, offers a critical solution to bridge this gap. Power enterprises generate enormous volumes of data daily, including operational data, financial data, and external data. Leveraging big data to integrate strategic and financial management can enable dynamic adjustment of strategies based on financial performance and real-time optimization of financial resources according to strategic needs. This study aims to explore the construction of a "Strategy + Financial" management system for power enterprises under big data technology, addressing the disconnection between traditional systems and providing a practical framework for improved decision-making and sustainable development[1].

2 Literature Review

2.1 Application Status of Big Data Technology in Enterprise Management

Big data technology has been widely adopted across industries to enhance management efficiency and decision-making accuracy. In retail, for instance, enterprises use customer behavior data mining to optimize product positioning and pricing strategies; in manufacturing, predictive maintenance models based on real-time equipment sensor data reduce downtime and operational costs. Core big data technologies such as distributed storage, stream processing (Apache Flink), and machine learning-based predictive analytics have become mainstream, enabling enterprises to process petabyte-scale data and extract actionable insights[2].

In the power industry, big data technology has predominantly been applied within operational contexts. For instance, smart grid systems utilize real-time load data to dynamically adjust power generation schedules, and wind power plants employ weather and operational data from turbines to forecast power output. However, these applications are largely confined to isolated operational modules, with limited integration into broader management domains—particularly the intersection of strategic and financial management. A significant gap exists in current research regarding how big data can dismantle data silos between strategic planning and financial systems, or how it can foster a data-driven synergy between long-term strategic goals and short-term financial execution

2.2 Research on Integration of Strategic Management and Financial Management in Power Enterprises

Academic research on the integration of strategic management and financial management has evolved around the core of "value-driven management." For general enterprises, scholars have proposed frameworks such as strategic financial management, which emphasizes aligning financial budgets, cost control, and risk management with strategic goals . Studies have also highlighted the role of comprehensive budget management as a bridge between strategy and finance, arguing that budget allocation should directly reflect strategic priorities [3].

3 Theoretical Foundations

3.1 Core Theories of Big Data Technology

The core theories of big data technology provide the technical basis for processing and applying the massive, multi-dimensional data generated by power enterprises. Data mining theory, a foundational component, includes techniques such as clustering, classification, and association rule mining. These techniques enable the extraction of hidden patterns from unstructured or semi-structured data.

The definition provided by the McKinsey Global Institute is: a large-scale collection of data that significantly exceeds the capabilities of traditional database software tools in terms of acquisition, storage, management, and analysis, characterized by massive data volume, rapid data flow, diverse data types, and low value density.

The strategic significance of big data technology does not lie in possessing vast amounts of data, but in the professional processing of these meaningful datasets. In other words, if big data is likened to an industry, the key to its profitability lies in enhancing its "data processing capability" and achieving "data value-added" through such processing.

From a technical perspective, the relationship between big data and cloud computing is inseparable, much like the two sides of a coin. Big data inherently cannot be processed by a single computer and must adopt a distributed architecture. Its hallmark lies in distributed data mining of massive datasets, yet it relies on cloud computing's distributed processing, distributed databases, cloud storage, and virtualization technologies.

3.2 Strategic Management Theories

Classic strategic management theories provide a framework for power enterprises to define strategic directions and decompose strategic goals into actionable financial objectives. Environmental analysis theories, such as SWOT analysis and Porter's Five Forces Model, help power enterprises assess internal strengths and weaknesses, as well as external opportunities and threats. This analysis is critical for power enterprises to formulate strategies such as shifting from thermal power to wind and solar energy.

Strategic-Weighted ROI is theoretically rooted in the strategic resource allocation theory which emphasizes that power enterprises should prioritize resource input into projects aligned with core strategic goals such as carbon neutrality. Traditional ROI only measures financial returns without considering the strategic value of projects, leading to misalignment between investment decisions and long-term energy transition objectives. For power enterprises, projects like wind and solar power development carry higher strategic weight due to their role in reducing carbon emissions, while thermal power retrofitting projects may have lower strategic weight as they are transitional. Strategic-Weighted ROI incorporates a strategic weight coefficient multiplied by the traditional ROI. This design ensures that projects with greater strategic significance receive more attention in investment evaluations, even if their short-term financial returns are slightly lower, thereby guiding financial resources toward strategic priorities.

4 Current Status and Problems of Power Enterprise "Strategy + Financial" Management Under Big Data

4.1 Current Status of Strategic Management and Financial Management in Power Enterprises

In terms of strategic management, power enterprises worldwide are prioritizing the energy transition and carbon neutrality goals. Many large power groups have adjusted their strategic layouts to increase investment in new energy projects. However, strategic planning in most power enterprises still relies heavily on qualitative judgments and historical experience rather than dynamic financial data support. For instance, the decision to invest in a new wind farm may be based on general market trends, without real-time analysis of financial indicators such as project profitability, capital costs, or potential subsidy changes.

4.2 Application Status of Big Data Technology in Power Enterprise Management

Big data technology has been increasingly applied in the operational of power enterprises, particularly in smart grid management and equipment maintenance. For example, smart grids collect real-time data on grid load, voltage, and user consumption patterns, using big data analytics to optimize power distribution and reduce energy loss. Power plants also use sensor data from turbines, generators, and other equipment to predict potential failures through big data-driven fault early warning models, minimizing unplanned downtime. These applications have significantly improved the operational efficiency and reliability of power enterprises [4].

4.3 Existing Problems in the Integration

The first major problem in integrating strategic and financial management lies in data fragmentation and standardization issues. Power enterprises typically generate strategic data from multiple sources and financial data from internal systems, with no unified data platform to integrate these datasets. Data standards also vary across departments: strategic data may use qualitative descriptors, while financial data relies on quantitative metrics, making it difficult to establish direct correlations between strategic inputs and financial outputs.

Beyond data fragmentation and standardization issues another critical gap in the integration of strategic and financial management lies in the lack of industry-specificity in existing evaluation indicators. Existing financial and strategic indicators often adopt a one-size-fits-all approach that fails to account for the unique operational context of power enterprises particularly the imperative of carbon neutrality.

These indicators do not incorporate carbon-related costs such as carbon tax payments expenses for carbon emission permits or potential penalties for exceeding emission limits which are becoming increasingly significant for power enterprises especially those with substantial thermal power assets. Without integrating such carbon costs the evaluation of project viability and resource allocation tends to underestimate the long-term financial risks of high-carbon projects and undervalue the strategic and financial benefits of low-carbon initiatives like wind and solar power development. This oversight further weakens the alignment between strategic priorities such as reducing carbon intensity and financial decision-making as the true cost and value of projects cannot be fully reflected in the existing indicator system making it challenging to establish accurate correlations between strategic inputs and financial outcomes.

5 Effectiveness Verification of the Management System

5.1 Case Application in a Large-Scale Power Enterprise

This study selected a large state-owned comprehensive power group as the case enterprise to verify the effectiveness of the big data-driven "Strategy + Financial" management system. Group X operates across multiple business segments, including thermal power, wind power, solar power, and smart grid services, with operations spanning 15 provinces in China. The group had previously invested in basic big data infrastructure for operational monitoring but faced challenges in integrating strategic and financial management—such as frequent budget overruns in new energy projects and misalignment between strategic renewable energy targets and financial resource allocation.

To address these issues, Group X implemented the "Strategy + Financial" management system proposed in this study over a 12-month period (January–December 202X). Key implementation steps included: 1) integrating strategic data and financial data into a unified big data platform; 2) developing core modules such as strategic budget linkage and real-time financial risk early warning for strategic projects; 3) training cross-departmental teams to use big data tools for joint decision-making. During the implementation, the system processed over 50 terabytes of data, including 3 years of historical financial records, real-time new energy generation data, and 200+ policy documents related to the power industry[5].

To address the specific architecture of the big data platform, Group X deployed a tiered hardware infrastructure tailored for high-volume data processing and real-time analytics. The platform's hardware components included 20 units of HPE ProLiant DL380 Gen10 servers (equipped with Intel Xeon Gold 6330 CPUs and 512GB DDR4 RAM each) to support distributed computing tasks, 4 sets of HUAWEI OceanStor Dorado All-Flash Storage systems (with a total capacity of 1.2PB) for low-latency data storage, and 2 Cisco Nexus 9300 switches to ensure high-speed data transmission between components. This hardware setup was designed to handle the concurrent processing of structured financial data, unstructured policy documents, and real-time operational sensor data without performance bottlenecks[6].

The software ecosystem of the big data platform was built to enable end-to-end data integration and analytics. For distributed storage, the platform adopted Hadoop Distributed File System (HDFS) to manage unstructured and semi-structured data and MySQL 8.0 for structured data storage. Apache Flink was deployed for real-time stream processing, allowing the platform to analyze incoming operational data within milliseconds. For batch processing of historical data, Apache Spark was used to generate aggregated insights for strategic decision-making[7]. Additionally, the platform integrated Tableau Desktop as the business intelligence tool to visualize processed data, enabling cross-departmental teams to access real-time dashboards for strategic budget adjustment and financial risk monitoring. The data flow within the platform followed a standardized pipeline: raw data from multiple sources was first collected via Apache Kafka, then transmitted to the unified processing layer for real-time or batch processing, and finally stored in the corresponding storage systems before being pushed to application modules for practical use[8].

To visually demonstrate the dynamic linkage between strategic inputs and financial outputs in the big data-driven "Strategy+Financial" management system, the following table takes "wind power target capacity increase" as an example. It disassembles the full data flow process—from the initial collection of strategic demands to the final generation of adjusted project budgets—based on the hardware and software architecture of Group X's big data platform, clearly reflecting how each technical module supports the conversion of strategic objectives into measurable financial decisions.

Table 1. Step-by-Step Data Flow Linking Wind Power Capacity Increase Target to Adjusted Project Budget

Stage Number	Stage Name	Strategic-Financial Data Content	Big Data Processing Technology	Stage Output
1	Strategic Input Collection	Wind power target capacity increase , existing wind farm capacity, regional wind resource data	Apache Kafka	Structured strategic demand dataset
2	Multi-Source Data Integration & Cleansing	Strategic demand dataset (Stage 1 output), historical wind power project cost data, current financial ERP data	Apache Flink, HDFS	Integrated strategic-financial dataset
3	Strategic-Financial Correlation Calculation	Integrated dataset (Stage 2 output), carbon tax rate, renewable energy subsidy standards, equipment depreciation rate	Apache Flink, Apache Spark	Preliminary project budget adjustment plan
4	Result Storage & Call Preparation	Preliminary budget plan (Stage 3 output), historical budget deviation records, strategic project priority weights	MySQL 8.0, HDFS	Stored budget adjustment scheme
5	Visualization Output & Deci-	Stored budget scheme (Stage 4 output), real-time capital flow	Tableau Desktop	Final adjusted project budget

sion Support	data, strategic goal completion rate	+visual decision dashboard

The data flow in Table 1 realizes the closed-loop conversion from strategic input to financial output through five sequential stages. In Stage 1, Apache Kafka ensures the real-time capture of strategic demands, avoiding delays in data transmission that often occur in traditional systems. Stage 2 integrates scattered strategic and financial data into a unified dataset, solving the "data silo" problem mentioned in Section 4.3. Stage 3 is the core of value conversion: by incorporating power industry-specific factors into the calculation, it ensures the budget plan aligns with both strategic goals and financial reality—this directly supports the reduction of Group X's financial budget deviation rate from 18.0% to 6.5%.

5.2 Evaluation of Core Indicators

To comprehensively measure the effectiveness of the big data-driven "Strategy + Financial" management system, five core indicators were selected based on the integration goals of strategic execution and financial management—covering strategic goal achievement, financial resource utilization, investment returns, risk control, and strategy-resource alignment. These indicators were quantified using Group X's operational and financial data from the pre-implementation period (January–December 202X-1, without the system) and the implementation period (January–December 202X, with the system), ensuring a direct comparison of the system's impact on key management outcomes [9].

To isolate the impact of external policy factors on the observed indicator improvements, this study conducted a parallel analysis of policy environments during the pre-implementation (202X-1) and implementation (202X) periods. Group X operates across 15 provinces, and a review of local and national power industry policies in these regions showed no new subsidy adjustments for renewable energy projects, no changes to carbon emission trading rules, and no revisions to grid connection standards during the 12-month implementation window. Additionally, a benchmark comparison with three other state-owned power groups of similar scale in the same regions revealed that their strategic goal achievement rates and budget deviation rates remained stable over the same period. This comparison confirms that external policy changes did not contribute to the significant improvements seen in Group X's core indicators.

To control for the influence of market-wide energy price fluctuations, the study incorporated energy price indices as control variables in the post-implementation data analysis. During the implementation period, thermal coal prices experienced a 5% month-on-month increase in Q3 202X, while on-grid prices for renewable energy remained unchanged as per long-term power purchase agreements. Group X mitigated potential cost impacts through pre-purchased coal inventory and long-term price contracts, and the adjusted analysis—accounting for these price fluctuations—showed that the reduction in financial budget deviation rate and the increase in strategic project ROI remained statistically significant. This indicates that the observed performance enhancements were driven by the implementation of the big data-driven management system rather than external energy price changes [10].

Table 2. Study text

Core Indicators	Pre-Implementation (202X-1)	Post-Implementation (202X)
Strategic Goal Achievement Rate (%)	75.2	92.4
Financial Budget Deviation Rate (%)	18.0	6.5
ROI of Strategic Projects (%)	8.3	12.7
Financial Risk Identification Lead Time (Days)	5.8	1.2
Resource Allocation Alignment with Strategy (%)	68.5	91.3

The data in the table 2 demonstrates significant improvements in all core indicators after the system's implementation, confirming the effectiveness of the big data-driven "Strategy + Financial" integration. First, the Strategic Goal Achievement Rate increased by 17.2 percentage points, primarily because the system used real-time financial data to adjust strategic execution dynamically—for example, reallocating funds from underperforming thermal power maintenance to high-priority solar projects when financial data showed lower-than-expected returns from thermal operations. Second, the Financial Budget Deviation Rate dropped by 11.5 percentage points, as the big data platform integrated strategic demand forecasts with budget planning, reducing over-budgeting for non-strategic items and under-funding for key projects.

6 Conclusion

This study focuses on addressing the disconnection between strategic management and financial management in power enterprises under big data technology, aiming to construct a cohesive "Strategy + Financial" management system. The research systematically resolves three core issues: first, the isolation of traditional strategic and financial systems, which leads to misaligned resource allocation; second, the underutilization of big data in breaking data silos and supporting dynamic integration; third, the lack of practical, industry-specific integration frameworks for power enterprises.

Through literature review, theoretical analysis, and case verification, the study achieves several key outcomes. First, it establishes a theoretical basis by integrating core big data theories and strategic management theories, laying the groundwork for system design. Second, it identifies critical problems in current power enterprise management, such as fragmented data standards and organizational silos between strategic and financial departments. Third, the case application in Group X validates the system's effectiveness: core indicators including strategic goal achievement rate, budget deviation rate, and strategic project ROI show significant improvements, demonstrating that big data enables real-time linkage between strategic execution and financial performance.

In addition to the established outcomes of theoretical framework construction and practical problem resolution this study further enriches the big data-driven Strategy + Financial management system through three key supplementary components. First the step-by-step data flow model linking strategic inputs to financial outputs realizes the visualization of strategy-finance linkage by mapping the entire process from specific strategic demands such as renewable energy capacity increase targets to corresponding financial outputs like adjusted project budgets through the unified big data platform's modules including data collection transmission processing and visualization thus breaking the invisible barrier between strategic planning and financial execution.

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