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Using Big Data Analysis to Optimize the Financing Structure and Capital Allocation of Energy Enterprises

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Abstract: With the gradual development of big data technology, the application of big data technology has a certain impact on the financing structure and capital allocation of energy enterprises. Through data integration, the information big data platform establishes an intelligent data analysis model, which can more effectively optimize financing methods, accurately position investment directions, and promptly determine the location of investment risks. This paper aims at the problems of concentrated funds, investment deviation and low risk awareness of current energy enterprises, and proposes a big data aggregation approach to solve them, in order to improve the effectiveness of the company's financial management, achieve the goal of structural adjustment.

Keywords: big data analysis; energy enterprise; financing structure; capital allocation; risk early warning system

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1. Introduction

Due to the transformation and upgrading of the energy industry and the tight supply of capital, the traditional financing and capital allocation models have been unable to meet the rapidly changing demands of the current market. The greatest advantage of big data technology lies in its ability to collect a large amount of information, build models and make predictions and adjustments, providing enterprises with more accurate and efficient financial management support tools. The optimization of financing methods, the control of capital circulation, and the improvement of risk early warning systems through technological means are more conducive to enhancing the financial management efficiency and resource allocation efficiency of energy enterprises, thereby promoting the pace of intelligent financial systems in energy enterprises.

2. An Overview of the Functions of Big Data Analysis in Financing and Capital Allocation

2.1. Data Integration and Model Construction of Financing Structure

The construction of the financing structure requires the comprehensive and patterned application of multiple types of data information. In the big data environment, energy enterprises can collect various types of information such as internal financial records, external financial market data and macroeconomic data based on a single entry point, and build a comprehensive data structure based on the financing needs of the enterprise. In this process, the relationships of various debt structures, equity structures, financing costs and time orders are represented based on graph databases and relational databases, and the models for predicting financing costs are trained based on machine learning techniques (including random forests and support vector machines) to study and analyze the risk return rates in various financing methods [1]. The following Figure 1 shows the big data analysis framework for the financing structure and capital allocation of energy enterprises:

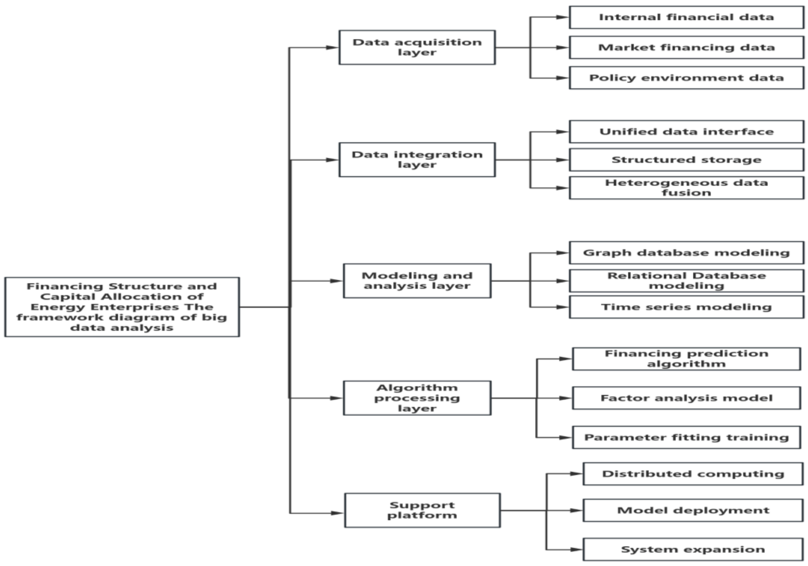

Figure 1. Big data Analysis framework for the financing structure and capital allocation of energy enterprises.

2.2. Real-Time Monitoring and Intelligent Allocation of Capital Flow

By adopting a big data platform to comprehensively grasp and record the flow of funds, the data flow record of fund information for business links such as project investment, cost expenditure, and repayment period is carried out. And by using stream computing frameworks such as Kafka and Flink, a time channel for monitoring fund changes with a response speed of seconds is constructed, achieving real-time traceability and presentation of fund flow information [2]. Meanwhile, the time series database and the visual analysis interface are connected to achieve precise positioning of the distribution of funds. By using linear programming algorithms and machine learning algorithms to allocate teaching resources, the marginal revenue of different business departments is evaluated, and the calculation results of the capital priority list are automatically obtained. Figure 2 below shows the technical framework for real-time monitoring and intelligent allocation of capital flows:

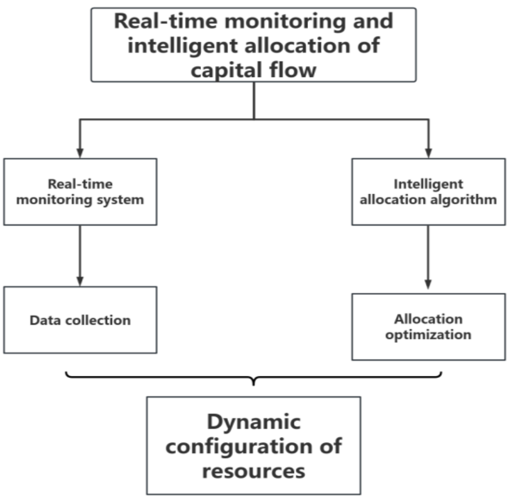

Figure 2. Technical framework for real-time monitoring and intelligent allocation of capital flow.

2.3. Multi-Dimensional Risk Identification Mechanism and Early Warning System

By taking advantage of the ability of big data to monitor external data widely and frequently and conduct internal data analysis, this system acquires and dynamically assesses risk characteristics in a model-oriented manner. In terms of data dimensions, the system can cover multiple dimensions of content such as macro indicator data, market price fluctuation data, energy trade statistics, internal cash flow and balance sheet data of the company, forming a set of risk factor matrices. In terms of risk identification, cluster analysis and outlier mining algorithms are applied to identify abnormal items and atypical data in the changes of indicators, further enhancing the sensitivity of early warning [3].

3. The Current Situation of Energy Enterprises' Financing and Capital Allocation under the Background of Big Data

3.1. Centralization of Financing Sources Compresses the Space for Capital Allocation

Energy enterprises generally have the problem of a single financing structure in the financing process [4]. The financing paths of most enterprises mainly focus on traditional bank credit funds and government subsidy funds, and rarely utilize the capital market, green financial products and multi-channel monetary capital flow paths of financing channels. In terms of the judgment of financing channels at the financial level, there is a lack of institutionalized diversified capital reserves and structural arrangements. The capital arrangements that need to be faced in different business environments are relatively delayed, resulting in a relatively high cost of capital circulation. The following Table 1 summarizes the structure of financing currencies for new energy enterprises from 2023 to 2024:

Table 1. Structure of Financing Currencies for New Energy Enterprises from 2023 to 2024.

Financing currency	The number of investment and financing events	Proportion (%)
Renminbi	3,121	96.8
Us dollar	73	2.3
Other currencies	29	0.9

Data source: IT Juzi's "2023-2024 China New Energy Investment and Financing Database Report".

As can be seen from Table 1, during the period from 2023 to 2024, the proportion of RMB financing in the total financing amount was 96.8%, while that of the US dollar and other currencies was only 2.3% and 0.9% respectively. This indicates that enterprises are highly dependent on a single currency market [5]. When exchange rates fluctuate and international financial policies change, the aggregation risk of enterprises will increase accordingly. It reduces the flexibility of enterprises in financing through different currencies and also limits the ability to introduce overseas capital. Table 2 below shows the regional distribution of financing for new energy enterprises from 2023 to 2024:

Table 2. Geographical Distribution of Financing for New Energy Enterprises from 2023 to 2024.

Region	The number of investment and financing events	Proportion (%)
Jiangsu	684	21.2
Guangdong	548	17.0
Zhejiang	428	13.2
Shanghai	389	12.1
Other regions	1,174	36.5

Data source: IT Juzi's "2023-2024 China New Energy Investment and Financing Database Report".

It can be seen from Table 2 that the investment activities carried out by the four eastern coastal provinces (Shanghai, Jiangsu, Zhejiang and Guangdong) account for 63.5% of the national total. From this, it can be seen that China's financial resources are relatively concentrated in the four eastern provinces and municipalities, which directly leads to the lack of sufficient investment sources in the central and western regions and the new economy sector, and further causes the lack of overall balance in capital allocation. And it further increases the cost of the enterprise's cross-regional capital operation system.

3.2. Weak Decision-Making Basis Makes It Difficult to Support Dynamic Adjustment

Most energy enterprises mainly use traditional financial reports and offline calculations for decision-making modeling in the financing process. At the technical platform level, there are still problems such as slow data processing speed, absence of feedback systems, lack of annual financing plan formulation and dynamic update modules. Meanwhile, the data among most enterprises have not been unified and standardized, and there are also phenomena such as interface segmentation and traceability difficulties in the decision-making data format. Some small and medium-sized enterprises have failed to establish automated modeling software. The selection of parameters overly relies on subjective experience, and the prediction results also have significant deviations. They are unable to conduct multivariate analysis using real-time rate of return, cost fluctuations, and marginal effects of assets, resulting in a disconnection between the investment direction of funds and actual performance. Table 3 below presents the data support for financing decisions of Chinese energy enterprises from 2023 to 2024:

Table 3. Data Support for Financing Decisions of Chinese Energy Enterprises from 2023 to 2024.

Enterprise type	The proportion of using real-time data systems	Use the proportion of the manual model	The proportion lacking data support
Large state-owned enterprises	45%	35%	20%
Medium-sized private enterprises	30%	50%	20%
Small start-up enterprises	15%	60%	25%

Data Source: 2023-2024 China Energy Enterprises Financing Decision-making Research Report (Energy Research Institute).

As can be seen from Table 3, Chinese energy enterprises show significant scale differences in their reliance on data support in financing decisions from 2023 to 2024. Among large state-owned enterprises, 45% adopt real-time data systems, which have the highest degree of data support. The proportions of real-time data usage by medium-sized private enterprises and small start-ups are 30% and 15% respectively. The problems of manual models and missing data are more prominent, reflecting that small and medium-sized enterprises still have significant shortcomings in digital decision support.

3.3. The One-Sided Investment of Funds Reduces the Efficiency of Resource Utilization

In terms of capital allocation, energy enterprises pay too much attention to traditional projects and developed projects, while investing less in new technologies and the development part. This leads to overly concentrated investment strategies, resulting in the loss of the possibility of optimal resource utilization and a reduction in the effectiveness of capital utilization. During the decision-making process, enterprises failed to comprehensively consider factors such as the project's rate of return, risk index, and the maturity of technology, and thus were unable to effectively determine whether the investment of funds was in line with the enterprise's development strategy and the real demands of the market. The following Table 4 summarizes the distribution of capital investment directions of Chinese energy enterprises from 2023 to 2024:

Table 4. Distribution of Capital Investment Directions of Chinese Energy Enterprises from 2023 to 2024.

Investment field	Investment amount (billion yuan)	Proportion (%)
Traditional energy projects	4,500	45
Clean energy project	3,000	30
Research and development of emerging technologies	1,000	10
Digital Transformation Project	800	8
Other	700	7

Data source: China Energy Enterprise Investment Analysis Report 2023-2024 (Energy Research Institute).

As shown in Table 4, from 2023 to 2024, the estimated investment scale of traditional energy projects is around 450 billion yuan, accounting for 45%. The estimated investment scale of clean energy projects is around 300 billion yuan, accounting for 30%. The estimated investment scales of other projects such as technological innovation and digital transformation are around 100 billion yuan and 80 billion yuan respectively, accounting for 10% and 8%. The remaining approximately 70 billion, accounting for 7%. It can be seen from this that at present, energy enterprises still tend to allocate funds to traditional energy projects, without attaching importance to technological innovation and digital transformation.

3.4. The Lag in Risk Perception Weakens the Foundation for Financial Stability

In the financial management information systems of many energy enterprises, a structural cognitive system that ADAPTS to high-frequency changing data has not been constructed. This leads to the inability of enterprises to promptly discover and assess existing risks during the process of fund raising and capital allocation. The lack of real-time information interfaces to connect macro factors with enterprise cash flow makes it difficult to rely on established models and interval range predictions for risk assessment, and it is hard to capture sudden situations and abnormal development processes in a timely manner. Meanwhile, the lack of a technical architecture and the absence of additional related analysis and correlation modules and prediction algorithms, etc., leads to the inability to establish a risk early warning system that can respond quickly. The following Table 5 tallies the deployment of risk management systems in Chinese energy enterprises from 2023 to 2024:

Table 5. Deployment of Risk Management Systems in Chinese Energy Enterprises from 2023 to 2024.

Enterprise type	The proportion of deploying the risk management system	The proportion lacking a risk management system
Large state-owned enterprises	60%	40%
Medium-sized private enterprises	35%	65%
Small start-up enterprises	20%	80%

Data source: 2023-2024 China Energy Enterprise Risk Management Research Report (Energy Research Institute).

It can be known from Table 5 that among large state-owned enterprises, 60% of the enterprises have established a risk management system, but still 40% of the enterprises have not established such a system. The proportion of medium-sized private enterprises that have established a risk management system is 35%, while the proportion that has not is 65%. Among small start-up enterprises, only 20% have established a risk management system, while 80% of the enterprises have not. This indicates that the smaller the scale of an enterprise is, the lower the configuration rate of the risk management system will be. It shows that there are serious deficiencies in the risk management of small and medium-sized enterprises, magnifying the financing risk and having a negative impact on the financial stability of the enterprise.

4. Optimization Path of Financing Structure and Capital Allocation for Energy Enterprises Based on Big Data

4.1. Introduce a Multi-Data Mechanism to Broaden the Space for Financing Channels

Introducing a multi-data mechanism and raising data through multi-dimensional channels is the key foundation for optimizing the financing structure and capital allocation of energy enterprises. By integrating the enterprise's own financial and economic data, industry loan interest rate information, government support policies and third-party rating reports, an overall credit profile of the enterprise is built to intelligently assess the matching degree of financing models from different channels. To achieve quantitative evaluation and matching recommendation, the system constructs the following financing demand scoring model:

$$S_i = \alpha_1 \cdot C_i + \alpha_2 \cdot R_i + \alpha_3 \cdot M_i + \alpha_4 \cdot P_i \tag{1}$$

Among them, S_i is the total evaluation score of financing route i, C_i is the cash liquidity indicator, R_i is the credit evaluation rating, M_i is the matching indicator of the current financing method market interest rate, and P_i is the policy fitness indicator. Its $\alpha_1 - \alpha_4$ are the weights of each indicator respectively. The values of the above indicators are obtained by training the historical successful financing results.

4.2. Establish an Intelligent Decision-Making System to Enhance the Flexibility of Structural Adjustment

Establishing an intelligent decision-making system is conducive to improving the flexibility of financing strategies for energy enterprises. The online optimization of financing elements such as financing amount, structural proportion and billing curve is achieved through multivariate analysis, prediction models, system simulation, etc. Dynamic asset allocation is achieved through the automatic adjustment of internal and external financial data, price changes, feedback information on fund usage and operational environmental factors. On this basis, by introducing the objective function of minimizing financing costs represented, a structural optimization model is established:

$$min\, Z = \sum_{i=1}^{n} x_i \cdot c_i \tag{2}$$

Among them, Z represents the total cost of allf financing projects, x represents the proportion occupied by specific projects, c represents the price paid for each investment, and n represents the types and quantities of all available sources of funds. This model employs linear programming techniques to adjust the prices and shares of different financial products within the optimal limits. The constraints will involve technical issues such as the maximum borrowing amount, risk limits, and matching of repayment periods.

4.3. Utilize Data Analysis to Optimize Investment Directions and Enhance the Efficiency of Capital Allocation

The selection of investment projects determines the efficiency of fund utilization and the high quality of output. By introducing big data analysis software, a cash flow arrangement model is formed by using multiple data such as project benefits, contribution rate of returns, useful life and feedback on benefit operation. Enterprises can build an algorithm model for the sequence of investment arrangements through historical investment projects, and conduct efficiency evaluations by using return prediction and resource occupation relationships, accurately determining the true value of each fund. To achieve the purpose of quantitative analysis, the following marginal benefit function of capital investment can be introduced:

$$E_j = \frac{R_j - C_j}{A_j} \tag{3}$$

Among them, E_j represents the marginal output of the capital input of project j, R_j represents the expected return of project j, C_j is the total cost of project j, and A_j is the actual amount of capital input. It is solved by the change in the net return per unit of capital output and is used to assist the system in sorting and screening the investable projects by input.

4.4. Build a Real-Time Early Warning Platform and Strengthen the Prevention and Control of Financial Risks

Establishing a real-time alarm system based on big data is of great significance for strengthening the financial health of enterprises. Efficient data collection, indicator change monitoring and intelligent anomaly judgment methods should be adopted to comprehensively monitor the changes in major factors such as financing structure, capital flow situation and solvency. The system collects various multi-source data, such as changes in interest rates, changes in assets and liabilities, and indicators of liquidity, etc. Under the influence and effect of these data, it has its own identification and hierarchical response effect on these data. The following comprehensive risk score model can be adopted to quantitatively describe the financial risk status:

$$F_s = \beta_1 \cdot V + \beta_2 \cdot L + \beta_3 \cdot D + \beta_4 \cdot R \tag{4}$$

Among them, F_s is the current financial risk rating, V represents the volatility coefficient of cash flow, L is the asset-liability ratio, D is the inverse variable of financing diversification, R represents the growth degree of financing costs, and $\beta_1 - \beta_4$ are empirical calibration coefficients. This system assesses the risk status based on real-time data. If the scoring result exceeds the set threshold line, a warning program will be initiated, and early warning information will be pushed to the finance department on the visual interface. Eventually, it realizes the processing mechanism of automated risk monitoring and response within the financial system.

5. Conclusion

In the context of big data technology, energy enterprises must adjust their financing structure and capital allocation strategies. By means of diversified information acquisition, building intelligent decision-making system platforms, optimizing investment portfolios, and enhancing predictive capabilities, they can improve their capital utilization and adjustment capabilities. By adopting data-driven analytical methods, we fully explore the technical issues existing in current financing arrangements and propose optimization paths, providing theoretical references and practical suggestions for energy enterprises to achieve more flexible financial management and digital and intelligent transformation.

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