Research on Evaluation of the Coordinated Business Development of Large State-Owned Energy Enterprises

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Abstract. Large state-owned enterprises (SOEs) generally face the challenge of business diversification. In the new era, with new ideas and new requirements, these enterprises are placing more emphasis on focusing on their main responsibilities and businesses, improving quality and efficiency, as well as industry collaboration. This research takes the large state-owned energy enterprise A as an example, and conducts an empirical evaluation of the coordinated development of its main and secondary businesses by using SPSSRO data analysis software. Based on the problems found in the evaluation, the research aims to improve the efficiency and effectiveness of business development, and proposes relevant measures to promote the coordinated development of focusing on the main responsibilities and businesses from aspects such as business direction, investment scale, and institutional mechanisms.

Keywords: Coordinated Development, Indicator System, AHP analysis based on SPSSPRO

1 Introduction

The party and the state have put forward the positioning of "six strengths" for state-owned enterprises, requiring the enhancement of the competitiveness, innovation capability, control capability, influence, and risk resistance of state-owned economy, and making state-owned capital stronger, better, and bigger. The 20th National Congress of the Communist Party of China emphasized the need to accelerate the optimization and restructuring of the state-owned economy, promote the strengthening, improvement, and expansion of state-owned capital and state-owned enterprises, and enhance the core competitiveness of enterprises. Through reform and innovation, efforts are made to promote qualitative change, efficiency change, and dynamic change of state-owned capital and state-owned enterprises, thereby enhancing their core competitiveness. This is not only the basic requirement for preserving and increasing the value of state-owned assets but also the strategic positioning for state-owned economy to play a greater role in leading innovation-driven development, promoting coordinated regional development, and safeguarding national economic security.

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Large state-owned enterprises currently have diversified businesses. In the new era and under new ideologies and requirements, they are more focused on their primary responsibilities and main business, emphasizing quality improvement, efficiency enhancement, and industrial synergy. Focusing on primary responsibilities and coordinating development is very important, which are mutually unified and mutually promoting[1][2][3]. Focusing on primary responsibilities provides a "center of gravity" for coordination, and coordination provides stronger "centripetal force" for focusing on primary responsibilities. The development of primary responsibilities and main business means that business should follow its inherent positioning, proceed in the correct direction and path, and continuously fulfill its inherent mission.

1.1 Literature Review

Regarding the overall concept of post-investment evaluation for enterprises, some scholars have conducted research on this. Chen Qinqin et al. [4] believe that the post-evaluation of equity investment in state-owned enterprises mainly includes two types: process evaluation and effect evaluation, specifically including target evaluation, implementation process evaluation, project performance evaluation, and development capability evaluation. The main evaluation methods include the comparative method (including chronological order, multidimensional comparison with industry benchmarks or competitors) and the success degree evaluation method (weighting evaluation indicators related to the implementation process and effects of investment projects according to their importance, scoring them, averaging the weighted scores, and finally determining the level); similarly, Shang Jingqun et al. [5] suggest that the post-investment evaluation of state-owned enterprises can be divided into four evaluation dimensions: decision-making and implementation, post-investment management, comprehensive benefits, and sustainability development. Chen Sihui et al. [6] also believe that the post-evaluation of investment projects by state-owned enterprises mainly includes evaluation of decision-making processes, execution processes, implementation effects, and project sustainability.

Regarding the overall framework of the post-investment evaluation system for enterprises, Zhou Shanzhong et al. [7] suggest that the post-evaluation of investment projects in state-owned energy enterprises mainly includes five aspects: post-target evaluation, post-process evaluation, post-benefit evaluation, post-impact evaluation, and post-sustainability evaluation, with procedures including clarifying the evaluation objects, establishing evaluation indicator systems, determining evaluation methods, conducting comprehensive evaluations, verifying whether the comprehensive evaluation results are consistent with reality, explaining evaluation conclusions, and proposing solutions. Yang Yang [8] believes that the post-investment evaluation system for investment projects can be evaluated from four dimensions: investment, workload, capacity, and economic benefits. Shao Keyi [9] suggests that the post-investment evaluation system for state-owned public service enterprises can be established from four aspects: technology, finance, society, and risk control.

Regarding the specific measurement of the post-investment evaluation system, Yang Bingfeng [10] of State Grid Shanghai Electric Power Company believes that the post-evaluation system for provincial major grid engineering investment projects can start from five major directions: economic benefits, operation management, construction management, social benefits, and environmental benefits, with different subdivisions and score weights for each aspect. Lei Chuanli et al. [11] used the Analytic Hierarchy Process (AHP) to establish a post-evaluation model using Y company's investment project in Hunan Power as an example. Fu Yingxin et al. [12] used the logic framework method and the success degree evaluation method to conduct post-investment evaluation of a mining construction project. Li Duankai [13] and others have provided a detailed set of post-evaluation methods and indicators for power investment projects, integrating multiple methods such as Analytic Hierarchy Process (AHP), Matter-Element Extension (MEE), Comprehensive Quantitative (CQ), and drawing on the advantages of various industries such as traditional post-evaluation, risk assessment, and credit rating, to construct a Matter-Element Extension Comprehensive Quantification Analytic Hierarchy Process (AHP-MCQ) post-evaluation method. It is divided into several aspects: pre-decision indicator system, engineering construction indicator system, production operation indicator system, and project benefit indicator system.

1.2 Research Design

(1) Establishing Evaluation Index

Based on previous research, following the principles of focusing on core responsibilities, emphasizing input-output effectiveness, grasping common features, and highlighting business characteristics, an evaluation index system is constructed from six dimensions: safety quality, service quality, low-carbon green, technological innovation, operational efficiency, and business benefits. Fourteen secondary evaluation indexes are established, composed of 26 sub-indicators, including seven common evaluation indexes reflecting common features and 19 characteristic evaluation indexes reflecting business characteristics (Tabel 1).

Table 1. Coordinated Development Evaluation Index System Focusing on Core Business

Level 1 indicators	Level 2 indicators	Level 3 indicators
Safety Quality	*Safety Level* *Risk Prevention*	Safe working level Regulatory risk prevention Comprehensive operational risk prevention
Quality of service	*Customer service* *Service strategy*	Satisfaction with the main business of service Service external customer satisfaction Strategic emerging business growth rate
Low-carbon and green	*Energy consumption level* *Green and low-carbon contributions*	Energy intensity Scale of green financial services The scale of "dual carbon" business revenue
Scientific and technological innovation	*Investment in scientific research*	R&D investment intensity Online rate of financial services

	Ability to innovate	The level of transformation of scientific research achievements The level of promotion of overseas standards Annual growth rate in the number of patents granted
Operational efficiency	*Labor efficiency* *Business efficiency*	Labor productivity of all employees Synergistic efficiency of industry and finance The quality of overseas asset operations Quality and efficiency of business operations Quality and efficiency of platform operation
Business benefits	*Revenue level* *Cost control* *Profitability* *Operational risk*	Growth rate of operating income Proportion of revenue outside the system Proportion of revenue from strategic emerging businesses Cost expense ratio Return on equity Risk Asset Ratio Debt-to-asset ratio

(2) Models and Data Analysis Software

Part of the indicators are generated from experts scoring. The AHP analysis is used to calculate the judgment matrix constructed by multiple experts, find the weight of each index and conduct the consistency test.

The pairwise judgment matrix was calculated to obtain the maximum eigenvalues and their corresponding eigenvectors:

$$W_k = \left(w_1^{(k)}, w_2^{(k)}, w_3^{(k)} \cdots w_n^{(k)}\right)^T \tag{1}$$

The vectors are normalized so that the sum of each data is equal to 1 and the feature vectors are available. These data represent the relative weight of the same level factor in the matrix to the upper level factor, i. e., hierarchical single ranking.

consistency check. The hierarchical single-sorting results do not represent the final results and need to be tested for consistency. The consistency procedure is checked as follows:

First, the consistency index is calculated. The calculation formula is as follows:

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{2}$$

Where λ max represents the maximum eigenvalue and n is the order of the matrix. CI=0, indicating complete consistency; CI is approximately 0, with relatively satisfactory consistency; the larger the CI, the more serious the inconsistency.

Secondly, the average stochastic consistency index RI was calculated. The RI index averaged the eigenvalues of the pairwise judgment matrix for multiple times, and the values of RI corresponding to different orders are different, as shown in Table 2.

Table 2. Judging the matrix order and the corresponding mean random consistency index value

order	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Finally, the consistency ratio CR is calculated by the following formula:

$$CR = \frac{CI}{RI} \tag{3}$$

In general, only CR <0.1. At this point, the corresponding values in the feature vector can be normalized to represent the relative weights. Otherwise, the pairwise judgment matrix can only be reconstructed to calculate from scratch until it passes.

1.3 Computing of Expert Empowerment

Finally, it is not enough to simply weighted average all the experts on the respective weight vector, and it is necessary to empower the actual judgment ability of each expert. In order to obtain the weights of each expert, it can be measured by comparing the consistency of the weight vector and the judgment matrix given by each expert. The weights of the experts are defined as follows:

$$\lambda_K = \frac{\frac{1}{CI^k}}{\sum_{i=1}^{n} \frac{1}{CI^i}} \tag{4}$$

In the above equation, the weight of expert k, and n is the number of experts. That is, the vector of expert weights is obtained.

$$U = (\lambda_1 \quad \lambda_2 \quad \lambda_3 \quad \lambda_4 \quad \lambda_5)^T \tag{5}$$

The final weight result is obtained by combining the weight of expert empowerment and the weight of each index.

$$w_i = \sum_{k=1}^{m} \lambda_k \times w_i^{(k)}, \quad i = 1,2,3,\cdots,n \tag{6}$$

According to the above equation, the final weight vector of.

$$W = (w_1, w_2, w_3 \cdots w_n)^T \tag{7}$$

In this research, we use Scientific Platform Serving for Statistics Professional (SPSSPRO), a professional data coding and analyzing software to conduct AHP analysis, which has been applied in many evulation research. Based on the core capabilities of data processing and analysis algorithms, SPSSPRO provides data analysis services which can be widely used in scientific research, business, data mining, questionnaire surveys and other fields.

1.4 Results and Discussion

This study selects data from Company A in 2022 for analysis. Company A is a large state-owned energy enterprise. In addition to its core energy business, it also engages in finance, international operations, new energy vehicles, research and consulting, among other businesses. Each business segment has its own characteristics, but their inherent mission is the same: to closely focus on core responsibilities and effectively fulfill strategic and foundational support roles. At the request of Company A, we only present the results of the evaluation on technological innovation and safety quality, and we have de-identified the data of Company A, not showing specific numbers.

(1) Evaluation Results of Technological Innovation

Overall, the indicators can be grouped into two aspects for evaluation: research investment and innovation capability, with different emphases across various businesses. Research investment primarily evaluates expenditure in the research field. Innovation capability focuses on the digitization rate of financial business lines, transformation of research results, promotion of overseas standards, and patent applications, among other abilities. The specific definitions and evaluation criteria for each indicator are shown in Table 3.

Table 3. Evaluation indicators of scientific and technological innovation

Evaluation dimensions	Level 2 indicators	Level 3 indicators	paraphrase
Scientific and technological innovation	*Safety Level Risk Prevention*	R&D investment intensity Online rate of financial services The level of transformation of scientific research achievements The level of promotion of overseas standards Annual growth rate in the number of patents granted	Research and Development (R&D) expenditure intensity = Total R&D expenditure / Total revenue * 100. The online scale of financial business segment / Total scale of financial business segment Annual growth rate of intellectual property operation income The promotion status of Chinese standards overseas Number of newly authorized patents in the year / Number of newly authorized patents in the previous year

Regarding research investment, among the 16 subsidiary companies involved in international operations, consulting services, and telecommunications, there are significant differences in the intensity of research and development funding investment among them, as illustrated in Figure 1.

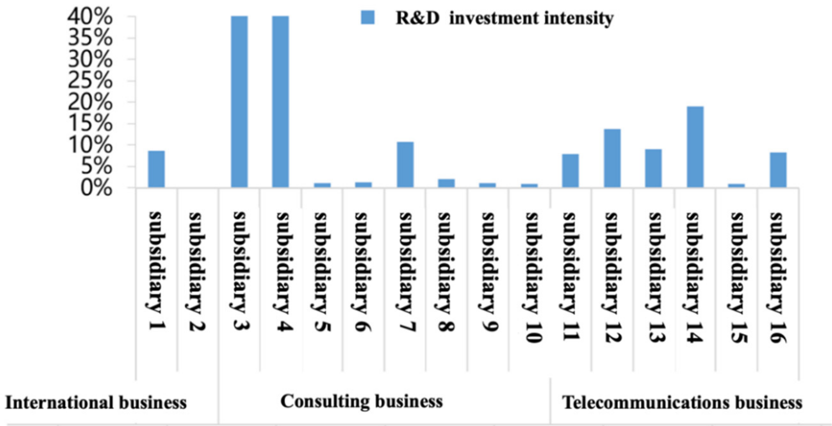

Fig. 1. Investment in scientific research

In terms of innovation capability, the digitization rate of financial business lines has not reached 100%, there are difficulties in the application of overseas standards promotion, the growth rate of knowledge property rights operation income has significantly declined, and the growth rate of annual authorized patents is relatively low.

Firstly, it is suggested that Company A continues to optimize its technological innovation layout. Coordinate efforts to enhance the intensity and precision of technological innovation investment. Increase efforts to cultivate platform-oriented, key supportive businesses, and strategic, scalable technological products, guided by market and business demands, to produce more intellectual property achievements that can enhance core competitiveness.

Secondly, it is recommended that Company A intensify efforts in result transformation. Each subsidiary should optimize and improve the structure of patent indicators, accelerate the cultivation of top-notch research teams and young scientific and technological talents, and comprehensively utilize methods such as patent priority examination and pre-examination in the field of high-tech industries to strengthen the quality review of patents. Facilitate the integration of supply and demand for core technologies, realize the "development-application" synergy of innovative achievements, effectively enhance the efficiency of result transformation, and promote the transformation of major original achievements and breakthroughs in key technologies into advanced productive forces.

(2) Evaluation Results of Safety Quality

Safety quality is evaluated from the aspects of intrinsic safety and risk prevention. Safety assurance primarily evaluates the level of intrinsic safety, including four aspects: production safety, integrity and anti-corruption safety, operational safety, and social responsibility risks. The evaluation criteria are shown in Table 4.

Table 4. Evaluation indicators of scientific and technological innovation

Evaluation dimensions	Level 2 indicators	Level 3 indicators	paraphrase	Scoring principles
Safety Quality	*Investment in scientific research*	Safe working level	Refers to occurrences of production safety, integrity and anti-corruption safety, operational safety, and social responsibility risks.	expert scoring by AHP method
		Regulatory risk prevention	Assessment of the achievement status of state-owned asset supervision requirements, financial regulatory requirements, and corporate financial business management requirements.	expert scoring by AHP method
	Ability to innovate	Comprehensive operational risk prevention	Evaluation of the comprehensive risk prevention level in various aspects such as system, compliance, review, and internal control.	expert scoring by AHP method

Regarding research investment, there are 24 subsidiary companies involved in financial, international, consulting, and telecommunications businesses.

In terms of intrinsic safety, as illustrated in Figure 2, the overall safety assurance level of each unit is relatively high, with an overall score of 97 points or above, and an average score of 99.9 points. In terms of risk prevention, the overall level of risk prevention of each unit is relatively high, with an overall score of 92 or above, and an average score of 99.2.

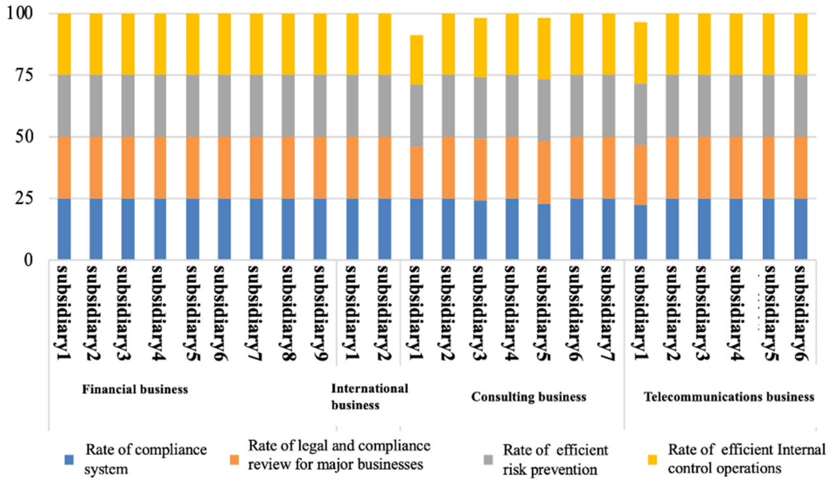

Fig. 2. Risk prevention assessment results

2 Conclusion

Firstly, it is recommended that Company A vigorously prevent intrinsic safety risks. Implement various requirements to strengthen safety control at the operational sites, effectively enhance the prevention of personal safety risks, especially by strengthening production safety training and management for outsourced labor and construction teams. It's crucial to tightly manage operational safety, ensuring strict decision-making and operational management for holding and joint venture companies to prevent financial security risks.

Secondly, strengthen risk prevention and compliance management. Increase the scrutiny of regulations, major decisions, and other legal compliance aspects. Enhance audit inspections and oversight mechanisms, improve risk assessment and monitoring systems, and refine contingency plans for major risks. Establish a closed-loop corrective mechanism, strengthen the tracking and rectification of issues, and manage issue resolution through a closed-loop system covering issue discovery, rectification requirements, and rectification verification. Fully implement rectification work upon issue discovery, ensuring comprehensive risk alerts and rectifications. Strengthen the integration of industry regulations, embedding compliance management requirements into key aspects of business management to fully integrate business operations with compliance reviews.

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