

THE CONSTRUCTION OF PERFORMANCE MEASUREMENT SYSTEM FOR CENTRAL SOES' "AI+" INITIATIVES: A BALANCED SCORECARD PERSPECTIVE

MingZhu Dong*, ZhiBo Lei, YiFei Wang, QiYue Shi, BoShu Jia
School of Accounting, Beijing Wuzi University, Beijing 101126, China.
**Corresponding Author: MingZhu Dong*

Abstract: In 2024, the State-owned Assets Supervision and Administration Commission (SASAC) of the State Council launched the "AI+" special action for central SOEs (state-owned enterprises), aiming to help them achieve better development and play a greater role in artificial intelligence. How to evaluate the performance of these initiatives scientifically has become an urgent issue for both theory and practice. Conventional performance evaluation systems, which rely primarily on financial indicators, may fail to capture the long-term value, intangible contributions, and national strategic significance of AI technologies. Drawing on Balanced Scorecard (BSC) theory and incorporating the three missions of central SOEs, namely sci-tech innovation, industrial control and security support, this study constructs a multidimensional performance evaluation indicator system for the "AI+" initiatives of central SOEs. "AI+"-specific indicators covering data assets, model efficacy, value creation, and other aspects are designed across the Financial, Customer, Internal Process, and Learning and Growth perspectives. The indicator system is then applied to a case study of CRRC Corporation Limited (CRRC), using publicly available data from its 2025 annual report and sustainability report, and an "AI+" strategy map is developed. The findings suggest that an adaptively modified BSC can effectively overcome the limitations of conventional financial indicators in evaluating AI outcomes, providing a scientific basis for SASAC's assessment and supervision and for the optimization of management in central SOEs.

Keywords: Balanced Scorecard; "AI+" initiative; Artificial intelligence; Performance evaluation

1 INTRODUCTION

On 19 February 2024, the State-owned Assets Supervision and Administration Commission (SASAC) of the State Council convened a special work promotion meeting on artificial intelligence for central SOEs under the theme "AI Empowering Industrial Renewal", calling on central SOEs to achieve better development and play a greater role in the field of artificial intelligence. Since 2024, SASAC has organized the in-depth implementation of the "AI+" special action for central SOEs, and a large number of application scenarios have been built in multiple key industries, including energy, manufacturing, and telecommunications. Central SOEs are accelerating the layout and development of the AI industry, seeking to empower traditional industries with AI technologies and to cultivate new quality productive forces. In February 2025, SASAC convened a meeting to deepen the deployment of the "AI+" special action for central SOEs, issued the key implementation points for the "AI+" special action of SASAC-supervised central SOEs, formally launched the special work on the construction of strategic high-value scenarios, and explicitly set out the working direction of "giving greater prominence to application leadership, data empowerment, and intelligent computing foundations". As new-generation AI technologies represented by ChatGPT have aroused widespread enthusiasm across major Chinese and international media platforms, the innovative application of AI technologies has attracted growing attention, and the development of AI has received increasing national emphasis. However, as investment continues to expand, one core question has become increasingly prominent: how can the effectiveness of "AI+" initiatives be evaluated scientifically?

Performance assessment has been regarded as a key steering instrument for the business activities of China's central SOEs. Conventional performance evaluation relies mainly on financial indicators and can therefore hardly reflect the long-term value, intangible contributions, and strategic significance of AI in a comprehensive manner. As an important instrument for the performance management of state-owned enterprises, the Balanced Scorecard (BSC) can optimize performance assessment systems across the four perspectives of finance, customers, internal processes, and growth, thereby helping to improve the efficiency of performance management in state-owned enterprises. Scholars have applied the Balanced Scorecard to enterprises and conducted performance evaluation research through these four perspectives, moving beyond the traditional approach that examined financial data alone. Meanwhile, central SOEs bear both economic responsibilities and national missions; their AI investments should be judged not only by economic returns but, more importantly, by whether they contribute to sci-tech innovation, industrial security, and strategic support.

To this end, drawing on Balanced Scorecard theory, this paper constructs a multidimensional and operational performance evaluation indicator system tailored to the "AI+" initiatives of central SOEs. The research includes the following components: a distinctive theoretical framework is formed by incorporating the three missions of central SOEs, namely sci-tech innovation, industrial control and security support, into the four-perspective framework of the

Balanced Scorecard; a set of "AI+"-specific indicators covering data assets, model efficacy, value creation, and other aspects is designed; and an empirical examination is conducted with CRRC Corporation Limited (CRRC) as a typical case, together with a strategy map. This paper aims to provide a scientific basis for SASAC's assessment and supervision and for the optimization of management in central SOEs, so that AI initiatives advance from "being built" toward "being well used, effectively governed, and delivering visible results".

2 LITERATURE REVIEW

2.1 Performance Evaluation of Central SOEs

At present, domestic scholarship has produced relatively rich research findings on the performance evaluation of central SOEs. Existing studies concentrate on three main aspects: the construction of assessment indicator systems, the value functions of performance evaluation, and the application of performance evaluation methods, thereby providing ample theoretical support and practical reference for optimizing the performance management of central SOEs.

With respect to research on assessment indicator systems and the optimization of budget performance management, many scholars have drawn on the business and management practice of central SOEs to systematically review the evolution of the indicator system for the business performance assessment of central SOE leaders, together with the current development status and existing problems of performance assessment systems, and have proposed optimization paths. With regard to the evolutionary logic of assessment indicator systems, relevant studies have revealed the phased characteristics of the business performance assessment of central SOE leaders as it has gradually shifted from a single scale orientation toward quality-efficiency and functional-value orientations, with assessment content placing greater emphasis on national strategic requirements such as sci-tech innovation, industrial control, and security support [1]. Studies on the current situation, challenges, and countermeasures of budget performance management in central SOEs have analyzed its practical status, the difficulties encountered, and strategy suggestions, indicating that although central SOEs have achieved initial results in the organizational structure, operational processes, and implementation effects of budget performance management, they remain constrained by multiple challenges, including underdeveloped institutional mechanisms, insufficient scientific rigor of the performance evaluation system, lagging technical means, and inadequate personnel skills [2]. To address these problems, that study proposed strategies such as optimizing institutional mechanisms, improving the performance evaluation system, introducing advanced technologies and management tools, and attaching greater importance to personnel development [2]. From the perspective of the core value and application purpose of the performance evaluation system, the central objective of the budget performance evaluation system of central SOEs is to improve the efficiency of resource allocation so as to achieve high-quality enterprise development. As important pillars of the national economy, central SOEs undertake budget management of enormous scale covering multiple fields, yet problems such as uneven resource allocation and inefficient use of funds are common in traditional budget management modes. Therefore, by constructing a scientifically sound budget performance evaluation system, the utilization effects of budget funds can be quantitatively assessed and the resource allocation structure can be optimized, thereby ensuring the maximized utilization of limited resources [3].

In research on performance evaluation methods, Economic Value Added (EVA) and the Balanced Scorecard are the two mainstream tools most widely applied in the field of performance evaluation of central SOEs. From the EVA perspective, Wei and Song took a logistics central SOE, Enterprise T [4], as an example, analyzed corporate performance from the two aspects of traditional financial indicators and EVA evaluation, and put forward strategy suggestions; other studies have further examined the implementation difficulties and failure mechanisms of the EVA performance assessment institution in the practice of central SOEs, revealing deep-seated contradictions between institutional introduction and both organizational inertia and assessment-cycle mismatch [5]. From the Balanced Scorecard perspective, Wen took China Mobile's merger with China Tietong as an example and systematically evaluated the M&A performance of central SOEs through the four perspectives of finance [6], customers, internal operations, and learning and growth; Yang explored effective application paths of the Balanced Scorecard in enterprise performance assessment management [7]; Yao analyzed the specific practice of the Balanced Scorecard in the organizational performance management of state-owned enterprises [8]; and Xu constructed, at the theoretical level [9], a basic framework for the performance evaluation of large state-owned enterprises. In recent years, relevant studies have also extended the Balanced Scorecard framework to diversified scenarios such as the performance evaluation of mixed-ownership state-owned enterprises, providing strong evidence for the applicability and effectiveness of this multidimensional framework in the complex evaluation contexts of central SOEs [3].

2.2 The Balanced Scorecard

The Balanced Scorecard (BSC), proposed by Kaplan and Norton in the 1990s [10], translates corporate strategy into operational performance indicators through the four perspectives of finance, customers, internal processes, and learning and growth. The Balanced Scorecard broke away from the traditional practice of relying solely on financial indicators in performance evaluation; it analyzes and evaluates the operations and management of enterprises from multiple perspectives, translates organizational strategy into operational measurement indicators and target values, and enables a more comprehensive assessment of the enterprise [11]. Scholars have systematically reviewed and assessed the theoretical evolution of the Balanced Scorecard, pointing out that since its proposal in 1992 the theory has undergone continuous evolution from a performance measurement tool into a strategic management framework [10, 12].

In China, after many years of application, the Balanced Scorecard has been widely adopted by Fortune Global 500 companies and many large domestic state-owned enterprises. As an important instrument for the performance management of state-owned enterprises, the Balanced Scorecard can optimize performance assessment systems across the four perspectives of enterprise finance, customers, internal processes, and growth, thereby helping to improve the efficiency of performance management in state-owned enterprises [13]. Yao noted that large state-owned enterprises are important pillars of China's national economy and that the principles of the Balanced Scorecard can be applied [8], in combination with EVA (Economic Value Added) theory, to construct a performance evaluation indicator system for large state-owned enterprises. Wei and Song examined the performance evaluation systems of state-owned enterprises and introduced the basic content of the Balanced Scorecard performance evaluation system as well as the concepts of "balanced development" and "cause-and-effect chains" that it advocates [4]. In addition, Wen and Yang took specific state-owned enterprises as cases to study the construction and application of the Balanced Scorecard in enterprise performance evaluation systems [6-7].

Against the background of digital transformation, studies have indicated that enterprises can draw on the concept of the Balanced Scorecard to design key performance indicators across the four perspectives, thereby ensuring that strategic objectives are effectively decomposed and implemented. Scholars have evaluated the performance of enterprise digital transformation on the basis of the Balanced Scorecard, analyzing, from the four perspectives of finance, customers, internal processes, and learning and growth, the mechanisms through which digital transformation enhances enterprise performance [14]. In addition, Xu focused on state-owned enterprises and employed Balanced Scorecard tools from the perspective of the strategy map to design a performance assessment system for the managerial level [9].

2.3 Synthesis of the Literature

A synthesis of the above literature indicates that studies in China and abroad have demonstrated that the Balanced Scorecard can effectively remedy the deficiencies of traditional financial performance evaluation. Domestic research has tended toward localized adaptation and enterprise case applications, with extensive practical exploration devoted especially to technology enterprises and enterprises undergoing digital transformation. Nevertheless, existing research still exhibits the following shortcomings. First, performance evaluation research specifically targeting "AI+", a technology-driven emerging field, remains at an early stage: although some scholars have explored the construction of enterprise performance evaluation systems based on the improved Balanced Scorecard, their research objects are mostly general enterprises, and studies on the "AI+" initiatives of central SOEs are still relatively weak. Second, existing evaluations tend to emphasize "input-type" indicators while the exploration of "outcome-type" indicators remains insufficient, and they are still weak in incorporating China-specific elements such as data elements, AI governance, and sci-tech self-reliance. Third, central SOEs bear both economic responsibilities and national missions, yet existing research provides insufficient theoretical discussion and practical examination of embedding the three missions of sci-tech innovation, industrial control and security support into AI performance evaluation. On this basis, this paper constructs a dedicated performance evaluation indicator system that addresses the particularities of the "AI+" initiatives of central SOEs under the Balanced Scorecard framework and conducts an empirical examination with CRRC as the case, which carries important theoretical value and practical significance.

3 CONSTRUCTING THE "AI+" PERFORMANCE EVALUATION SYSTEM FOR CENTRAL SOES BASED ON THE BSC

As a strategic management tool, the Balanced Scorecard (BSC) translates corporate strategy into operational performance indicators across the four perspectives of finance, customers, internal processes, and learning and growth. The choice of the BSC as the basis for designing performance evaluation indicators for the "AI+" initiatives of central SOEs rests on three main considerations. First, the value contribution of AI is multidimensional in nature, encompassing economic benefits, enhanced technological capabilities, improved management efficiency, and strategic security assurance; a single financial perspective can hardly capture these aspects comprehensively, whereas the multidimensional framework of the BSC covers them precisely. Second, the "AI+" initiatives of central SOEs are not isolated IT projects but are closely bound up with overall corporate strategy, and the BSC makes it possible to decompose "AI+" strategic objectives into executable action plans layer by layer. Third, by accommodating both financial and non-financial indicators and both long-term and short-term objectives, the BSC can help overcome the short-term orientation of traditional financial evaluation and suit the long payback period characteristic of AI investment.

In light of the foregoing analysis, this study undertakes an adaptive transformation of the classical Balanced Scorecard. While retaining the four basic perspectives, it embeds the three missions specific to central SOEs—sci-tech innovation, industrial control and security support—into the evaluation content of each perspective. The embedding logic is as follows: the mission of sci-tech innovation is embodied mainly in the Learning and Growth perspective (independent controllability rate of core technologies; number of chokepoint technology breakthroughs, i.e., key technologies under foreign restrictions) and the Internal Process perspective (innovation output); the mission of industrial control is embodied mainly in the Customer perspective (industry ecosystem driving effect; market share of AI products) and the Financial perspective (share of AI-driven operating revenue); and the mission of security support runs through the Internal Process perspective (AI protection coverage rate of critical infrastructure) and the Financial perspective

(preservation and appreciation rate of state-owned capital invested in AI). Together these form a complete transmission chain of "mission anchoring—perspective embedding—indicator implementation."

In addition, all indicators are classified into three types. Foundational indicators (threshold requirements) examine whether the basic conditions for AI initiatives are in place, such as AI R&D investment intensity and AI talent share; steering indicators (direction guidance) orient enterprises toward strategic objectives, such as the share of AI-driven operating revenue, the number of chokepoint technology breakthroughs, and the AI penetration rate of business processes; and constraint indicators (red-line constraints) delimit risk bottom lines, such as the preservation and appreciation rate of state-owned capital invested in AI and the AI protection coverage rate of critical infrastructure. The three types together constitute a layered evaluation structure of "foundational assurance—directional guidance—bottom-line constraint." The indicator system for each perspective is constructed below.

3.1 Financial Perspective

The Financial perspective is the traditional core of the Balanced Scorecard, measuring the contribution of strategy implementation to financial performance. For the "AI+" initiatives of central SOEs, this perspective must attend both to the direct economic returns on AI investment and to the responsibility for the preservation and appreciation of state-owned assets (Table 1).

Table 1 Financial Perspective Indicators

Indicator	Definition	Calculation	Polarity
AI return on investment (ROI)	Measures the ratio of AI project investment to its direct economic output, reflecting the short-term financial efficiency of AI investment	Direct economic output of AI projects / Total AI project investment $\times 100\%$	Higher is better
Share of AI-driven operating revenue	Reflects the contribution of AI-related business to total revenue	Revenue generated by AI business / Total operating revenue $\times 100\%$	Reasonable range
Preservation and appreciation rate of state-owned capital invested in AI	Examines, from the capital contributor's perspective, the capacity to preserve the value of state-owned assets in the AI field	Book value of state-owned capital invested in AI at the end of the period / Book value of state-owned capital invested in AI at the beginning of the period $\times 100\%$	Reasonable range
AI cost optimization rate	Measures the reduction in operating costs achieved through AI adoption	(Operating cost before AI adoption – Operating cost after AI adoption) / Operating cost before AI adoption $\times 100\%$	Higher is better

Within the BSC-based evaluation system for central SOEs' "AI+" initiatives, the adoption of AI return on investment (ROI) as the core indicator of the Financial perspective reflects the combined effect of the inherent requirements of the BSC framework and the distinctive positioning of central SOEs. The AI ROI is not merely a financial indicator; it also functions as a strategic signpost. It helps dispel the "black hole" of AI investment by providing a quantitative yardstick for large-scale spending: given the enormous AI investment made by central SOEs, the AI ROI offers a clear answer to the question of whether that investment is worthwhile. It also contributes to balancing short-term performance against long-term strategy and curbing short-sighted behavior, since the assessment of central SOEs must accommodate both short-term indicators and long-term strategic goals. The value of the AI ROI lies in its ability to measure short-term cost reduction and efficiency gains while also evaluating long-term business-model innovation, thereby helping to reconcile the long-term nature of AI investment with short-cycle assessment.

The share of AI-driven operating revenue steers a qualitative leap from cost reduction toward efficiency enhancement. The assessment of central SOEs has traditionally placed heavy weight on cost control, yet the more essential mission of "AI+" is to open up new growth curves. This indicator can help prevent enterprises from confining AI to marginal cost cutting, guiding them instead to convert AI into market competitiveness for their core businesses and thus to shift the center of gravity of value creation. As a main force in developing new quality productive forces, central SOEs need to translate AI into concrete market returns; the indicator helps ensure that AI investment does not remain on paper but genuinely builds industrial control in strategic emerging industries.

The foremost responsibility of central SOEs is to safeguard the security of state-owned assets, and AI investment is characterized by high uncertainty and high sunk costs. Whereas the conventional return on investment looks to profits, the preservation and appreciation rate of state-owned capital invested in AI keeps watch directly on the principal. The indicator obliges enterprises, when venturing into frontier fields such as large models, to account rigorously for capital erosion, and it helps prevent the disguised loss of state-owned assets carried out in the name of "innovation." In the SASAC assessment framework, return on equity and the preservation and appreciation rate of state-owned capital are rigid red lines; embedding this indicator into the "AI+" evaluation therefore brings AI investment within the mainstream of oversight.

The AI cost optimization rate also bears on absorbing the substantial sunk costs of AI and defending the bottom line of current-period profits. Central SOEs' early investment in AI infrastructure is enormous, and the depreciation of fixed assets and the amortization of R&D expenditure can severely erode current profits. This indicator measures whether the tangible cost savings that AI generates in procurement, energy consumption, and operations and maintenance are sufficient to offset the earlier capital erosion, so that growth in total profit is not dragged down by AI investment. Many

central SOEs operate traditional asset-heavy businesses that face overcapacity and limited revenue-side growth; in such circumstances, cost optimization is a key lever for maintaining return on equity.

Notes on indicator design: the polarity of the preservation and appreciation rate of state-owned capital invested in AI is set as "reasonable range" rather than "higher is better" because an excessively high rate may signal insufficient AI investment, lagging investment progress, or a failure to establish an effective position in strategic emerging industries; in practice, the indicator should be interpreted in conjunction with AI investment progress and industry benchmark values. In addition, the AI ROI differs from the share of AI-driven operating revenue in that the former measures the output efficiency of AI investment (with investment as the denominator), whereas the latter measures the proportion of AI-empowered business scale (with total revenue as the denominator); the two are complementary. With respect to data collection, the former is aggregated at the project level and the latter at the business-unit level, and the two must be accounted for separately.

3.2 Customer Perspective

The Customer perspective reflects the value-creation capacity of central SOEs' "AI+" initiatives in market-oriented services, public services, and industrial leadership. As central SOEs combine the dual attributes of market-oriented business entities and public service providers, the evaluation of this perspective should encompass not only conventional indicators of customer satisfaction and market share but also indicators that embody their distinctive missions, such as public service response efficiency and the industry ecosystem driving effect (Table 2).

Table 2 Customer Perspective Indicators

Indicator	Definition	Calculation	Polarity
Customer satisfaction with AI services	Evaluates the extent to which AI adoption improves the end-customer experience, reflecting how effectively central SOEs' AI technology is deployed in market-oriented customer service scenarios	$\frac{\text{(Number of customers satisfied with AI services)}}{\text{Total number of customers surveyed}} \times 100\%$	Higher is better
Public service response efficiency	Captures the effect of AI empowerment in the area of public welfare, reflecting the capacity of central SOEs' AI applications to perform their duties in public service and livelihood-support scenarios	$\frac{\text{(Average processing time for public service items before AI enablement - Average processing time for public service items after AI enablement)}}{\text{Average processing time for public service items before AI enablement}} \times 100\%$	Higher is better
Market share of AI products	Measures the market competitiveness of central SOEs' AI products and services, reflecting the market-oriented business performance and market acceptance of their AI operations	$\frac{\text{(Sales of central SOEs' AI products/services in the target market segment)}}{\text{Total sales of comparable products/services in that segment}} \times 100\%$	Higher is better
Industry ecosystem driving effect	Evaluates the radiating and driving effect of central SOEs' AI adoption on upstream and downstream segments of the industry chain, reflecting their industrial leadership responsibility and industry-empowerment value	Weighted composite scoring based on the number of upstream and downstream enterprises engaged through AI adoption, the total output value of industry-chain collaboration projects, and similar aspects	Higher is better

Within the Customer perspective, customer satisfaction with AI services is the core indicator for measuring the market-oriented service value of central SOEs' AI initiatives. It directly reflects the extent to which AI technology improves the customer service experience and helps avert both the disconnection of AI R&D from market demand and the tendency to privilege technological investment over user experience. At the same time, customer satisfaction constitutes an important foundation for market competitiveness and customer loyalty, providing key support for the market promotion of central SOEs' AI products and the sustainable development of the related businesses.

Public service response efficiency reflects the dual attributes of central SOEs as both market-oriented operators and public service providers, a combination that distinguishes them from ordinary market enterprises. The indicator quantifies the empowerment effect of AI in livelihood-related services and tests whether AI adoption has genuinely improved the quality and efficiency of public services; it thereby operationalizes the core responsibility of central SOEs for public welfare and underscores the distinctive value orientation of their "AI+" initiatives in serving national strategies and safeguarding public interests.

The market share of AI products is the core quantitative yardstick of central SOEs' capacity to commercialize AI technology. It offers a direct measure of the market competitiveness of their AI products and guides enterprises to move AI technology from the R&D end toward market application, helping to resolve the persistent disconnect between technology development and commercialization. In addition, rising market share can generate scale effects that reduce operating costs and feed back into technology iteration and service upgrading, thereby promoting the sound development of AI businesses.

The industry ecosystem driving effect accords with the strategic positioning of central SOEs as pillars of the national economy and is a distinctive indicator that sets the performance evaluation of central SOEs apart from that of ordinary enterprises. It focuses on the capacity of AI technology to radiate benefits across upstream and downstream segments of the industry chain, reflecting the industrial leadership responsibility of central SOEs. By guiding central SOEs to rely on AI to drive the digital and intelligent transformation of whole industries, the indicator helps release both the industrial

and the social value of AI, strengthening the overall resilience and competitiveness of the industry chain while also fostering a high-quality industrial ecosystem for the development of their own AI businesses.

3.3 Internal Process Perspective

The Internal Process perspective reflects the extent to which "AI+" initiatives advance technological innovation, digital transformation, and operational efficiency. The core of central SOEs' "AI+" initiatives lies in empowering traditional business processes with artificial intelligence so as to raise innovation efficiency and operational performance. Indicator selection should accordingly proceed from the aspects of AI deployment coverage, security assurance, collaboration efficiency, and decision-making capability (Table 3).

Table 3 Internal Process Perspective Indicators

Indicator	Definition	Calculation	Polarity
AI penetration rate of business processes	Measures the coverage of AI technology across core business processes in production, operations, and management	Number of core business processes transformed with AI / Total number of core business processes $\times 100\%$	Higher is better
AI protection coverage rate of critical infrastructure	Evaluates the coverage of AI technology in security monitoring, risk early warning, and active defense for national critical information infrastructure	Number of critical infrastructure nodes equipped with AI-based intelligent protection systems / Total number of critical infrastructure nodes $\times 100\%$	Higher is better
AI-enabled supply chain collaboration rate	Reflects improvements in supply chain collaboration efficiency enabled by AI-supported information sharing, supply-demand matching, and logistics scheduling across upstream and downstream partners	Number of upstream and downstream partners collaborating through AI platforms / Total number of supply chain partners $\times 100\%$	Higher is better
Level of intelligent decision-making	Measures the depth and breadth with which AI models and big data analytics tools support management decision-making in scenarios such as business operations, investment, and risk control	Graded scoring: composite score (1–5) based on the number of AI-assisted decision scenarios and the adoption rate of AI-generated conclusions	Higher is better

The AI penetration rate of business processes is a steering indicator that directly portrays the progress of central SOEs' business transformation toward intelligent operations. First, it reveals the actual scope of AI deployment and helps prevent AI projects from remaining confined to small-scale pilots, thereby encouraging the integration of AI into day-to-day business. Second, it guides enterprises to apply AI to the redesign of traditional processes and to compress operating costs. Third, the intelligent upgrading of business processes is an important means by which the "AI+" initiatives reduce costs and enhance efficiency, sustaining continuous improvements in operational performance.

The AI protection coverage rate of critical infrastructure is a constraint indicator that carries central SOEs' responsibility for safeguarding national information security. First, it sets a security floor for intelligent transformation and tests the actual role of AI in security early warning and risk defense. Second, it presses central SOEs to advance intelligent construction and cybersecurity protection in step with one another, mitigating the risks of digital transformation. Third, it gives concrete expression to the distinctive mission of central SOEs in keeping critical infrastructure running smoothly and upholding national information security.

The AI-enabled supply chain collaboration rate is a steering indicator that matches the position of central SOEs as industry-chain leaders. First, it quantifies the effectiveness of AI in removing information barriers between upstream and downstream partners, enabling precise supply-demand matching and the early identification of supply chain risks. Second, it guides central SOEs to draw on AI to bring upstream and downstream enterprises along in parallel digital transformation, raising the overall efficiency of the industry chain. Third, it strengthens the risk-bearing capacity of the industry chain, supports its independent controllability, and releases the industrial value of AI.

The level of intelligent decision-making is a foundational indicator that represents the developmental requirements of modernized management in central SOEs. First, it captures the extent to which AI actually assists management decision-making, illustrating the improvements that data-driven modes offer over traditional experience-based decisions. Second, by drawing on big data analytics to anticipate problems, it reduces the bias and lag inherent in experience-based decision-making. Third, it moves central SOEs from experience-based management toward science-based governance and supports the continuous refinement of a modern corporate management system.

3.4 Learning and Growth Perspective

The Learning and Growth perspective reflects the influence of "AI+" initiatives on talent development, independent technological innovation, and long-term growth potential. The sustained advancement of central SOEs' "AI+" initiatives is inseparable from a high-caliber workforce and independently controllable core technology capabilities. Indicator selection should accordingly proceed from the aspects of technological self-reliance, innovative breakthroughs, resource input, and talent reserves (Table 4).

Table 4 Learning and Growth Perspective Indicators

Indicator	Definition	Calculation	Polarity
-----------	------------	-------------	----------

Indicator	Definition	Calculation	Polarity
Independent controllability rate of core technologies	Measures the proportion of key AI technologies independently developed and mastered by the enterprise among all key AI technologies in use, reflecting the capacity for independent AI technology innovation	Number of key AI technologies independently developed by the enterprise / Total number of key AI technologies applied by the enterprise $\times 100\%$	Higher is better
Number of chokepoint technology breakthroughs	Counts the key restricted core technologies in the AI field that central SOEs have successfully overcome	Cumulative number of key AI chokepoint technologies overcome during the year	Higher is better
AI R&D investment intensity	Measures the financial resources devoted to AI technology R&D, reflecting the enterprise's resource support for AI innovation	AI R&D expenditure / Operating revenue $\times 100\%$	Higher is better
AI talent share and growth rate	Reflects the scale of the enterprise's AI professional talent pool and the development trend of its AI workforce	AI talent share = Number of in-post AI professionals / Total number of employees $\times 100\%$; AI talent growth rate = (Number of AI professionals in the current period – Number of AI professionals in the previous period) / Number of AI professionals in the previous period $\times 100\%$	Higher is better

The independent controllability rate of core technologies is a steering indicator closely bound to the strategic goal of sci-tech self-reliance pursued by central SOEs. First, it provides a direct reading of the degree of autonomy in their AI technology and helps avert excessive dependence on external supply for key AI technologies. Second, it guides enterprises to keep deepening in-house technology development, thereby reducing the operational risks that external technology restrictions entail. Third, independently controllable AI technology forms the foundation on which central SOEs can pursue intelligent transformation over the long term and safeguards the steady advancement of the "AI+" initiatives.

The number of chokepoint technology breakthroughs is a steering indicator that foregrounds the innovation-related responsibility of central SOEs. First, it quantifies their innovation outcomes in key frontier areas of AI and shows plainly how effective their technical efforts have been. Second, it guides central SOEs to aim their research programs proactively at technological weak points, helping to close gaps in the domestic AI industry chain. Third, it promotes high-level independent development of the AI industry and is consistent with the national innovation-driven development strategy.

AI R&D investment intensity is a foundational indicator that represents the level of resource assurance for AI innovation. First, it gauges the priority an enterprise attaches to AI technology R&D and reflects its long-term innovation layout. Second, stable R&D investment is a necessary condition for technological iteration and the transformation of research outcomes. Third, it presses enterprises to keep channeling resources into AI innovation, providing the funding that underpins technological breakthroughs and talent cultivation.

The AI talent share and growth rate are foundational indicators focused on the talent underpinnings of intelligent transformation. First, they reflect the state of the AI professional talent pool, talent being the core element in AI innovation and deployment. Second, they guide enterprises to continuously recruit and cultivate AI professionals and to improve the talent pipeline. Third, an adequate AI workforce sustains the continued implementation and iterative upgrading of central SOEs' AI projects. To verify the applicability and operability of the proposed indicator system, the next section conducts a case study of CRRC Corporation Limited.

4 CASE ANALYSIS: CRRC

4.1 Company Overview

CRRC Corporation Limited (stock code: 601766) is a world-leading rail transit equipment manufacturer whose business spans railway equipment, urban rail transit and urban infrastructure, new industries, modern services, and international operations. In 2025, the company achieved operating revenue of RMB 273.063 billion, an increase of 10.79% year on year, while its net profit attributable to shareholders of the parent company and its net profit attributable to parent shareholders (excluding non-recurring items) both reached RMB 13.181 billion. The company has recorded simultaneous growth in revenue and net profit for three consecutive years, with operating performance improving steadily. By the end of 2025, the company's total assets stood at RMB 550.774 billion.

CRRC has adhered to its strategic positioning of "one core, two businesses, and first-class" and has built a "dual-track, dual-cluster" business layout encompassing rail transit equipment and clean energy equipment. In 2025, the company's railway equipment business generated operating revenue of RMB 123.608 billion, up 11.9% year on year, while its new industries business generated operating revenue of RMB 103.121 billion, up 19.39% year on year. The company's rail transit equipment revenue has remained the largest in the world.

4.2 Overview of CRRC's "AI+" Initiative

CRRC is a forerunner among central SOEs in the "AI+" initiative and has made remarkable progress in the field of artificial intelligence.

First, CRRC built the Zhuolun AI large-model technology brand and officially released it in September 2025. Zhuolun is an industrial AI large-model system independently developed by CRRC that deeply integrates scenarios across the entire chain of the equipment manufacturing industry, covering the full range of scenarios including design, manufacturing, operation, maintenance, and safety, and providing precise enablement for the digital and intelligent transformation of the industry. It is China's first industrial AI large-model system deeply integrated with scenarios across the entire chain of the equipment manufacturing industry.

Second, CRRC launched a series of scenario-based large models. In August 2025, Zhuolun-Jiuzhang, China's first industry-specific large model for the full life-cycle health management of rail transit vehicles, was officially released. Tailored to the business scenario of full life-cycle health management of rail transit vehicles, Zhuolun-Jiuzhang has initially produced a series of application outcomes covering vehicle health management, fault diagnosis, and maintenance support. In November 2025, Zhuolun-Jiangshu, China's first large model in the rail transit field for the simulation and analysis of operational processes and for production planning and scheduling, was officially released in Zhuzhou, Hunan Province. Iteratively trained on the basis of the Zhuolun large model, Zhuolun-Jiangshu is customized for core manufacturing scenarios such as intelligent production scheduling, dispatch optimization, process optimization, and quality inspection. In addition, CRRC released the Zhuolun-Linggou large model for the field of industrial intelligent design.

Third, CRRC gained authoritative recognition. The company passed the highest-level "Trustworthy AI" artificial intelligence dataset quality assessment of the China Academy of Information and Communications Technology (CAICT), becoming the first central SOE in the manufacturing industry to obtain the top rating. In 2026, the Zhuolun-Jiuzhang large-model scenario for the intelligent health management of rail transit vehicles was successfully selected as one of the strategic high-value scenarios for artificial intelligence among central SOEs.

4.3 BSC-Based Performance Evaluation

Based on the indicator system constructed in Section 3, this paper evaluates the performance of CRRC's "AI+" initiative from the four perspectives of the BSC. The main data are drawn from CRRC's annual report and sustainability report.

Because key data, such as the total investment in AI projects and an independent statistical scope for AI talent, are not disclosed separately, this evaluation adopts a combination of quantitative approximation and qualitative judgment to grade the key indicators. The criteria for each grade are as follows: Grade A (excellent) — outstanding performance, well above the industry average or achieving challenging targets; Grade B (good) — reasonable performance that meets basic expectations, with some room for improvement; Grade C (fair) — mediocre performance with gaps relative to expectations; Grade D (needs improvement) — insufficient performance that requires focused attention and improvement. On this basis, an overall grade is assigned to each of the four perspectives.

4.3.1 Financial perspective

In 2025, CRRC achieved operating revenue of RMB 273.063 billion, up 10.79% year on year, and net profit attributable to shareholders of the parent company of RMB 13.181 billion, up 6.40% year on year. The company's new industries business generated operating revenue of RMB 103.121 billion, up 19.39% year on year, accounting for 37.76% of total revenue. This growth rate far exceeded that of overall revenue, indicating that "AI+"-related new businesses, represented by clean energy equipment and the digital-intelligent industry, have become an important engine of corporate growth. International business accounted for 12.75% of revenue, and overseas revenue grew by 22.77% (see Figure 1).

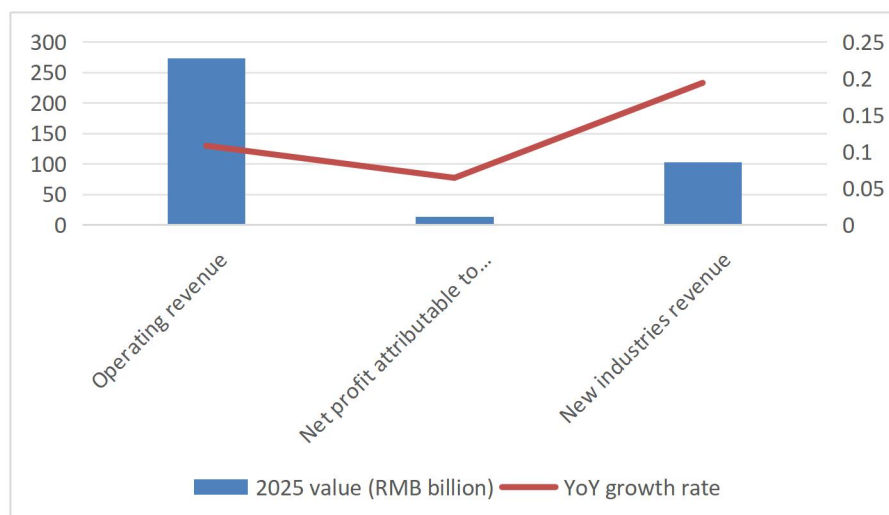


Figure 1 CRRC's Key Financial Indicators and Year-on-Year Growth in 2025 (Unit: RMB Billion)

In terms of return on AI investment, CRRC achieved significant cost reduction and efficiency improvement through applications such as the Zhuolun-Jiangshu large model: after adoption, the plan adjustment rate decreased by 40%, the trial-production preparation cycle was shortened by 20%, and production line flexibility improved by 15% (Source: Huasheng Online, 2025). In terms of R&D investment, the company's R&D investment in 2025 amounted to RMB 18.164 billion, accounting for 6.65% of operating revenue. Compared with the average R&D investment intensity of manufacturing central SOEs of approximately 3%–4% (Figure 2 takes the midpoint of this range, 3.5%), CRRC's intensity of 6.65% is significantly higher than the industry average (see Figure 2).

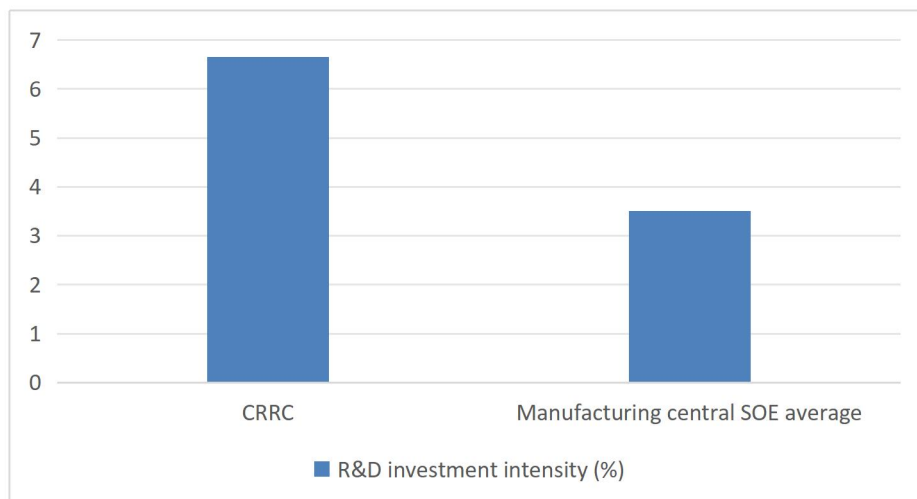


Figure 2 Comparison of R&D Investment Intensity Between CRRC and Manufacturing Central SOEs (2025, Unit: %)

Note: The industry average range is 3%–4%.

Based on the preceding data for the financial perspective, each indicator is graded item by item, with the results summarized in Table 5. The AI return on investment is rated B because total investment in AI projects was not disclosed and a precise ROI could not be calculated; the rating comprehensively considers the cost-reduction effects of the Zhuolun-Jiangshu large model (plan adjustment rate -40% and trial-production preparation cycle -20%; Source: Huasheng Online, 2025). The share of AI-driven operating revenue is rated A in view of the high growth of new industries revenue (+19.39%, accounting for 37.76%; Source: CRRC 2025 Annual Report). The preservation and appreciation rate of state-owned capital invested in AI is rated A because the company achieved simultaneous growth in revenue and net profit for three consecutive years, with asset security fully assured. The AI cost optimization rate is rated B because, although qualitative effects were observed, they were not converted into specific monetary amounts. The overall grade for the financial perspective is B+. Improvement direction: establish an independent accounting and disclosure mechanism for AI inputs and outputs.

Table 5 Evaluation of Core Financial Perspective Indicators

Indicator	Evidence	Grade
AI return on investment	Plan adjustment rate -40%, trial-production preparation cycle -20%, production line flexibility +15%	B
Share of AI-driven operating revenue	New industries revenue of RMB 103.121 billion (37.76% of total revenue, +19.39% year on year)	A
Preservation and appreciation rate of state-owned capital invested in AI	Simultaneous growth in revenue and net profit for three consecutive years; asset security fully assured	A
AI cost optimization rate	Cost reduction and efficiency gains demonstrated, but not converted into specific monetary amounts	B

4.3.2 Customer perspective

In terms of customer satisfaction with AI services, CRRC has improved the product quality and service level of its rail transit equipment through intelligent technologies, and major projects such as the CR450 EMU (electric multiple unit) train and the 600 km/h maglev train progressed smoothly. In terms of the market share of AI products, the company's rail transit equipment revenue has remained first in the world, and AI-empowered intelligent products have further consolidated its market-leading position. In terms of the industry ecosystem driving effect, CRRC has led or participated in the development of 28 international standards and, through the Zhuolun AI large-model system, has driven upstream and downstream enterprises along the industrial chain to jointly advance digital transformation, thereby fulfilling the industry-leading role of a central SOE. In terms of international market expansion, the company's newly signed orders reached RMB 346.1 billion in 2025, up 7.4% year on year; newly signed orders in international business amounted to approximately RMB 65 billion, accounting for 18.78% of all newly signed orders; and the order backlog at the end of the period stood at approximately RMB 357.1 billion, representing a growth rate of 12.26% (Figure 3).



Figure 3 CRRC's Order Situation in 2025 (Unit: RMB Billion)

Based on the preceding data for the customer perspective, each indicator is graded item by item, with the results summarized in Table 6. Customer satisfaction with AI services is rated B because public reports contain no dedicated survey data; the rating is tentatively inferred from the delivery quality of major projects. Public service response efficiency is rated A because Zhuolun-Jiuzhang covers the full life cycle of health management and enhances operation and maintenance support capabilities. The market share of AI products is rated A because the company's rail transit equipment revenue has remained first in the world and its international business grew by 22.77%. The industry ecosystem driving effect is rated A on the strength of the 28 international standards led by the company and newly signed orders of RMB 346.1 billion (+7.4%). The overall grade for the customer perspective is A-. Improvement direction: establish a dedicated survey mechanism for customer satisfaction with AI services.

Table 6 Evaluation of Core Customer Perspective Indicators

Indicator	Evidence	Grade
Customer satisfaction with AI services	Good delivery quality of major projects, but dedicated survey data not publicly disclosed	B
Public service response efficiency	Zhuolun-Jiuzhang covers the full life cycle of health management and enhances operation and maintenance support capabilities	A
Market share of AI products	Rail transit equipment revenue remains first in the world; international business +22.77%	A
Industry ecosystem driving effect	28 international standards led; newly signed orders of RMB 346.1 billion (+7.4%)	A

4.3.3 Internal process perspective

In terms of the AI penetration rate of business processes, CRRC has continuously promoted the implementation of the Zhuolun AI large-model system across all stages of the full life cycle of rail transit vehicles. Zhuolun covers the full range of scenarios including design, manufacturing, operation, maintenance, and safety; Zhuolun-Jiuzhang covers business scenarios such as vehicle health management, fault diagnosis, and maintenance support; Zhuolun-Jiangshu targets core manufacturing scenarios such as intelligent production scheduling, dispatch optimization, process optimization, and quality inspection; and Zhuolun-Linggou serves the field of industrial intelligent design.

In terms of the AI protection coverage rate of critical infrastructure, CRRC attaches great importance to the application of AI in the safety monitoring and risk early warning of rail transit equipment. The Zhuolun-Yujian large model and its associated agents have established a full-chain closed loop for core metro components, from precise fault identification to intelligent maintenance decision-making, while the Zhuolun-Yuzhi large model has built a "perception-analysis-decision-execution" closed-loop system covering five core functions: intelligent question answering, train operation monitoring, fault diagnosis, train operation analysis, and health reporting.

In terms of innovation output, the company filed 5581 new patent applications in 2025, of which 4506 were invention patents, accounting for 80.74%; the company also won one China Patent Gold Award, one Silver Award, and four Awards of Excellence (see Table 7).

Table 7 Innovation Output in 2025

Indicator	2025 Value
New patent applications	5581
Invention patents	4506
Proportion of invention patents	80.74%

Based on the preceding data for the internal process perspective, each indicator is graded item by item, with the results summarized in Table 8. The AI penetration rate of business processes is rated A because Zhuolun covers the full range of scenarios in design, manufacturing, operation and maintenance, and safety. The AI protection coverage rate of

critical infrastructure is rated A because Zhuolun-Yujian and Zhuolun-Yuzhi have established a full-chain closed loop from fault identification to decision execution. The AI-enabled supply chain collaboration rate is rated B because the coverage of AI collaboration was not disclosed. The level of intelligent decision-making is rated B because information on AI's auxiliary applications at the level of business decision-making remains limited. The overall grade for the internal process perspective is A-. Improvement direction: expand the coverage of AI collaboration in the supply chain and enhance the level of intelligent decision-making in management.

Table 8 Evaluation of Core Internal Process Perspective Indicators

Indicator	Evidence	Grade
AI penetration rate of business processes	Zhuolun covers the full range of scenarios in design, manufacturing, operation, maintenance, and safety	A
AI protection coverage rate of critical infrastructure	Zhuolun-Yujian and Zhuolun-Yuzhi achieve a full-chain closed loop from fault identification to decision execution	A
AI-enabled supply chain collaboration rate	Coverage of AI collaboration not disclosed	B
Level of intelligent decision-making	Limited information on AI's auxiliary applications in business decision-making	B

4.3.4 Learning and growth perspective

In terms of AI-related R&D investment, CRRC's R&D investment in 2025 amounted to RMB 18.164 billion, accounting for 6.65% of operating revenue; R&D investment increased from RMB 16.686 billion in the previous period to RMB 18.164 billion, an increase of 8.8% (see Table 9). In terms of the independent controllability of core technologies, CRRC has adhered to the independent development of the Zhuolun AI large-model technology brand; all large models in the Zhuolun series are independently developed, demonstrating the company's capacity for independent innovation in core AI technologies.

Table 9 R&D Investment in 2025

Indicator	2025 Value
R&D investment	RMB 18.164 billion (+8.8% year on year)
R&D investment intensity	6.65%

In terms of AI talent team building, as of the end of 2025, R&D personnel accounted for 15.39% of the company's total workforce, with a growth rate of 2.13%. The company attaches great importance to employee training: the employee training coverage rate reached 100%, average training time per employee was 92 hours, and employee satisfaction reached 99.18% (see Table 10).

Table 10 Workforce Development in 2025

Indicator	2025 Value
Proportion of R&D personnel	15.39%
Growth rate of R&D personnel	2.13%
Employee training coverage rate	100%
Average training hours per employee	92 hours
Employee satisfaction	99.18%

Based on the preceding data for the learning and growth perspective, each indicator is graded item by item, with the results summarized in Table 11. The independent controllability rate of core technologies is rated A because all large models in the Zhuolun series are independently developed and protected by complete intellectual property rights. The number of chokepoint technology breakthroughs is rated A on the strength of 4506 invention patents (accounting for 80.74%) and one China Patent Gold Award. The AI R&D investment intensity is rated A because RMB 18.164 billion (6.65%) is above the average level of central SOEs and grew by 8.8% year on year. The AI talent share and growth rate are rated B because no separate statistical scope for AI talent is available and the proportion of R&D personnel (15.39%) is used as an approximate substitute. The overall grade for the learning and growth perspective is A. Improvement direction: establish a separate statistical scope for AI talent.

Table 11 Evaluation of Core Learning and Growth Perspective Indicators

Indicator	Evidence	Grade
Independent controllability rate of core technologies	All Zhuolun-series large models are independently developed, with complete intellectual property rights	A
Number of chokepoint technology breakthroughs	4506 invention patents (80.74% of the total), one China Patent Gold Award	A
AI R&D investment intensity	RMB 18.164 billion (6.65%), above the central SOE average, +8.8% year on year	A
AI talent share and growth rate	No separate statistical scope for AI talent; proportion of R&D personnel (15.39%) used as an approximate substitute	B

5 CONCLUSIONS

Based on Balanced Scorecard theory and incorporating the three missions of central SOEs — sci-tech innovation, industrial control, and security support — this paper constructed a performance evaluation indicator system applicable to central SOEs' "AI+" initiatives and conducted an empirical examination using CRRC as a case. The main research conclusions are as follows:

First, traditional financial indicators are insufficient to comprehensively evaluate the long-term value and strategic contribution of AI. The Balanced Scorecard breaks away from the conventional practice of relying solely on financial indicators in performance evaluation and analyzes and evaluates corporate operations and management from multiple perspectives. By embedding national strategic requirements into the evaluation perspectives, the indicator system measures both economic benefits and strategic value, achieving an organic integration of economic performance and national missions.

Second, dedicated indicators designed around the characteristics of AI can effectively capture the complete value chain from technology R&D to scenario implementation. This paper classified indicators into three categories — foundational, steering, and constraint indicators — corresponding to threshold requirements, development directions, and red-line constraints respectively, thereby effectively addressing the core questions of what to evaluate and how to evaluate. The case of CRRC demonstrates that indicators such as R&D investment intensity, the proportion of invention patents, and the AI penetration rate of business processes can fairly comprehensively reflect a company's overall performance in its "AI+" initiative.

Third, the empirical examination based on the CRRC case demonstrates that the indicator system constructed in this paper has good applicability and operability. In 2025, CRRC achieved operating revenue of RMB 273.063 billion, up 10.79% year on year; new industries revenue grew by 19.39%; R&D investment reached RMB 18.164 billion (an intensity of 6.65%); and the company filed 5581 new patent applications (invention patents accounting for 80.74%). The company built the Zhuolun AI large-model technology brand and released a series of scenario-based large models, including Zhuolun-Jiuzhang, Zhuolun-Jiangshu, and Zhuolun-Linggou. A systematic evaluation of the group's "AI+" initiative across the four perspectives of finance, customers, internal processes, and learning and growth can comprehensively reflect the overall effectiveness of its AI applications. The strategy map further illustrates the progressive value-creation logic across the four perspectives, providing an analytical framework that other central SOEs can draw on.

The significance of this study is reflected at three levels. At the theoretical level, it extends the application boundary of the Balanced Scorecard to the emerging "AI+" context and enriches the theoretical system for the performance evaluation of central SOEs. At the practical level, it provides central SOEs with an operable performance management tool that can be directly applied to the project approval evaluation, process monitoring, and outcome assessment of "AI+" projects. At the societal level, by incorporating AI governance, supply chain security, and public service attributes into the evaluation scope, it encourages central SOEs to fulfill their social responsibilities in the process of digital transformation.

Future research can be deepened in the following directions: first, refining the calculation methods and data collection standards of each indicator to enhance the practical operability of the indicator system; second, expanding the scope of case validation to cover central SOEs in more industries and of more types; and third, exploring the introduction of quantitative methods such as the Analytic Hierarchy Process (AHP) and BP neural networks into the indicator weighting process to improve the objectivity and dynamic adaptability of weight determination.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

This research is supported by the 2026 College Student Innovation and Entrepreneurship Training Project of Beijing Wuzi University (Project Number: 202601040J056).

REFERENCES

- [1] Xu Hui, Liang Na. Evolution of the business performance assessment indicator system for executives of central SOEs in China. *Economist*, 2024(4): 258-260.
- [2] Gao Jiaping. Current status, challenges, and countermeasures of budget performance management in central SOEs. *China Market*, 2025(31): 96-99.
- [3] Yang Yue. A Balanced Scorecard-based performance evaluation system for state-owned enterprises. *Times Finance*, 2017(2).
- [4] Wei Jing, Song Shuhong. Performance evaluation of a logistics central SOE from the EVA perspective: a case of Enterprise T. *Times Economic and Trade*, 2025(9): 23-26.
- [5] Tang Guliang, Dai Tianjing. Why does the EVA performance assessment institution encounter resistance and failure? A multiple-case study of EVA adoption in central SOEs. *Proceedings of the 2013 Academic Annual Meeting of the China Accounting Society*, 2013.

- [6] Wen Zhaojing. BSC-based performance evaluation of central SOE mergers and acquisitions: the case of China Mobile's merger with China Tietong. *Finance and Economics*, 2018(4).
- [7] Yang Julin. Effective application of the Balanced Scorecard in corporate performance assessment management. *Huoli*, 2025, 43(7): 31-33.
- [8] Yao Bin. Application of the Balanced Scorecard in the organizational performance management of state-owned enterprises. *Modern Business Research*, 2024(11).
- [9] Xu Ming. Constructing a performance evaluation indicator system for large state-owned enterprises. *Human Resources Development of China*, 2006(7): 67-68.
- [10] Kaplan R S, Norton D P. The Balanced Scorecard: measures that drive performance. *Harvard Business Review*, 1992, 70(1): 71-79.
- [11] Meng Weixuan, Wang Dan, Liu Jin. Key points for optimizing the assessment and evaluation oriented toward the functional value of central SOEs. *Modern SOE Research*, 2024(3).
- [12] Liu Junyong, Duan Wenxuan, An Na. Review and outlook of academic studies on the Balanced Scorecard. *Accounting Research*, 2022(8): 121-134.
- [13] Xie Huashan. Application of and reflections on the Balanced Scorecard in SOE performance management. *Human Resources*, 2024(20).
- [14] Wu Lei. A Balanced Scorecard-based performance evaluation system for mixed-ownership state-owned enterprises. *Modern Business*, 2024(19).