Research on the Construction and Application of the Original Innovation Performance Evaluation System for Provincial State-owned Enterprises: A Case Study of Enterprise A

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Abstract. In recent years, original innovation has become one of the important goals for the innovative development of provincial state-owned enterprises. However, the lack of evaluation tools has affected the high-quality development of their original innovation. Therefore, this article constructs evaluation indicators for the original innovation performance of provincial state-owned enterprises, determines the weights of the indicators using the analytic hierarchy process (AHP), and conducts an empirical analysis based on the data of Enterprise A from 2021 to 2023. The results show that Enterprise A's original innovation performance has been continuously improved, but further improvements are still needed in areas such as basic research and development investment and the reserve of high-level technological research and development projects.

Keywords: Original Innovation, State-owned Enterprise, Innovation Performance.

1   Introduction

In recent years, many science and technology-oriented state-owned enterprises have taken building the source of original technological innovation as one of their innovation work goals. As an essential part of China's state-owned economy, they have the responsibility and ability to play an active role in promoting original innovation. However, currently, a large number of provincial state-owned enterprises lack a correct understanding of their current status of original innovation, leading to the situation where "original innovation" remains only a slogan, and even cases of "chaotic innovation" occur. There is an urgent need for evaluation standards that meet the needs for original innovation in provincial state-owned enterprises to help them identify bottlenecks, and enhance their capabilities.

Currently, domestic and foreign scholars have achieved rich research results on enterprise innovation evaluation [1]. Coombs believes that innovation performance can

measure the effectiveness of R&D personnel's innovative activities and is a key indicator reflecting the results of enterprises' R&D investment and process learning [2]. Lawson et al. pointed out that enterprise strategy, resource allocation capabilities, creativity, and thinking management are critical factors that affect enterprise innovation performance [3]. Chen Jin and others from Tsinghua University constructed an evaluation index system for the technological innovation capabilities of world-class enterprises from five dimensions: innovation decision-making capabilities, innovation support capabilities, innovation ecological capabilities, innovation breakthrough capabilities, and innovation leadership capabilities [4]. Zhou Kexin et al. established evaluation indicators to measure the independent innovation capabilities of central enterprises from four aspects: innovation input, innovation output, continuous innovation, and innovation ecological environment [5]. Overall, the academic community has reached a basic consensus on the key evaluation indicators that affect enterprise innovation performance. However, most of the research targets are focused on foreign enterprises, world-leading enterprises, or central enterprises, and further research on the evaluation system for provincial state-owned enterprises' original innovation performance still needs to be carried out.

Therefore, based on previous research and combined with the task requirements of original innovation for provincial enterprises, this article proposes an evaluation system for the original innovation performance of provincial state-owned enterprises. Furthermore, an analysis of the original innovation performance of Provincial Enterprise A from 2021 to 2023 is conducted, clarifying the current status and existing problems of Enterprise A's original innovation, and proposing suggestions for improvement.

2   Construction of the Evaluation Index System for the Original Innovation Capability of Provincial State-owned Enterprises

2.1   Evaluation Indicator System

Based on academic research, enterprise innovation evaluation can be broadly conducted from four dimensions: "Innovation Management," "Innovation Foundation," "Innovation Investment," and "Innovation Output." Provincial enterprise original innovation falls into the category of enterprise innovation activities, so the aforementioned four indicators are selected as primary indicators. Meanwhile, considering the exploratory, uncertain, and resource-consuming nature of original innovation, this article combines the latest policy measures of the government and other entities for the original innovation of provincial state-owned enterprises, selects 19 secondary indicators, and constructs an evaluation indicator system for the original innovation of provincial enterprises, as shown in Table 1.

Table 1. Evaluation Indicators for the Original Innovation Performance of Provincial Enterprises

No.	Primary Indicators	Secondary Indicators	Weight/ %
1	Innovation Management	Enterprise Original Innovation Strategy Mechanism	0.7
2		Enterprise Talent Recruitment and Training System	0.8
3		Enterprise Innovation Incentive System	2.7
4		Enterprise Fault Tolerance and Exemption System	2.7
5	"Innovation Foundation	Number of Innovation Platforms (Cumulative)	0.8
6		Number of R&D Personnel	0.9
7		Proportion of R&D Personnel	1
8		Proportion of Doctors and Senior Professionals in R&D Personnel	3.4
9		Number of Leading Talents (Municipal Level and Above) (Cumulative)	6.8
10	Innovation Investment	Total Investment in R&D	4
11		R&D Investment Intensity	4
12		Per Capita Investment in R&D (R&D Investment / Number of R&D Personnel)	4
13		Proportion of Basic R&D Investment in Total R&D Investment	8.1
14	Innovation Output	Number of Provincial-level and Above Key R&D Projects (Ongoing)	4.2
15		Number of Valid Invention Patents (Cumulative)	2.5
16		Number of Standards (Cumulative)	5.2
17		Number of Provincial-level and Above Scientific and Technological Awards (Cumulative)	25.3
18		Number of First-time/First-edition/First-batch Products (Cumulative)	13.5
19		Main Business Revenue	9.4

The "Innovation Management" dimension covers aspects such as an enterprise's original innovation strategy, talent management, incentives, and fault tolerance and exemption systems. It serves as the guiding and regulating force for an enterprise's original innovation activities.

The "Innovation Foundation" dimension involves the enterprise's innovation platforms, the number of R&D personnel, the proportion of R&D personnel, the proportion of R&D backbones (doctors and senior professionals), and leading talents. It serves as the cornerstone of an enterprise's original innovation activities.

The "Innovation Investment" dimension primarily focuses on the enterprise's investment in original innovation activities, including the total amount of R&D investment, investment intensity, per capita investment, and the proportion of basic R&D investment. It is the fundamental driving force for original innovation capability.

The "Innovation Output" dimension evaluates the enterprise's high-quality R&D projects, invention patents, standards, scientific and technological awards, recognized

achievements, and revenues to reflect the actual effect of the enterprise's original innovation capability. The quality and quantity of innovation output are crucial indicators to measure the level of an enterprise's original innovation capability, and they are the most direct embodiment of the value of an enterprise's innovation activities.

3   Evaluation of Original Innovation Performance of Enterprise A

3.1   Data Source

The analysis data in this article are all derived from the internal data provided by Enterprise A. For the non-quantitative indicator data under the primary indicator "Innovation Management," the research team divided each indicator into five levels and invited three experts to score them. The average score of the experts was taken as the score for that indicator. The final scores of related indicators are shown in Table 2.

Table 2. Non-Quantitative Indicator Scores of Enterprise A

| Year	Enterprise Original Innovation Strategy Mechanism	Enterprise Talent Recruitment and Training System	Enterprise Innovation Incentive System	Enterprise Fault Tolerance and Exemption System
2021	2.7	3.3	3.3	0.0
2022	3.3	4.7	4.7	0.0
2023	5.3	7.3	5.3	4.7

3.2   Indicator Weights

In this paper, the Analytic Hierarchy Process (AHP) is adopted to calculate the weights of various indicators. The weight calculation results of indicators at all levels have passed the consistency check. The calculated indicator weights are shown in Table 1.

3.3   Data Processing and Analysis

In this paper, the extreme value method is adopted to perform non-dimensionalization processing on the data of each indicator, and the indicator weights are incorporated into the calculation. The results show that the original innovation performance scores of Enterprise A from 2021 to 2023 are 0.052, 0.351, and 0.877, indicating that the enterprise's original innovation performance has been continuously improving in recent years.

As shown in Figure 1, since 2022, Company A has continuously improved its original innovation system focusing on aspects such as achievement incentives and fault tolerance. The company has persisted in increasing R&D investment, and the proportion of R&D backbone personnel (holding doctorates or senior professional titles) has

been continuously increasing. These aspects are the main driving forces for the continuous improvement of the company's original innovation capabilities. From the perspective of innovation achievements, in the past three years, Company A has made breakthroughs year by year in the recognition of its first-batch materials and won the provincial science and technology progress award in 2023, demonstrating remarkable achievements in original innovation.
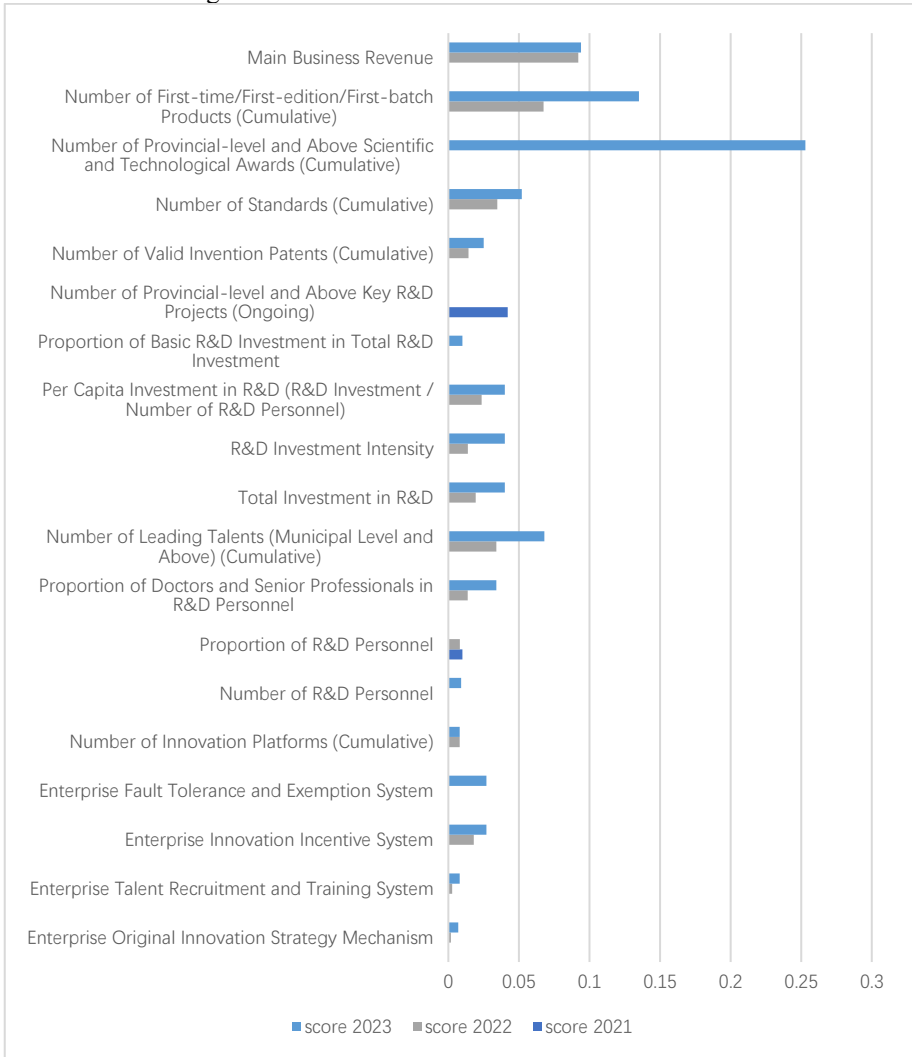
Fig. 1. Scores of Secondary Indicators of Company A from 2021 to 2023

At the same time, it should also be noted that Company A has not yet established a basic R&D investment mechanism, and the funding for basic R&D in the past three years has been zero. Moreover, there is a lack of high-level technological R&D project

reserves for key R&D projects at or above the provincial level, indicating that the sustainability of original innovation needs to be improved.

4   Conclusion

Based on the academic research results and the latest policy initiatives, this article has constructed a performance evaluation system for original innovation in provincial state-owned enterprises, and used the Analytic Hierarchy Process (AHP) to determine the weight of each indicator. Based on this, this article evaluates the original innovation performance of provincial state-owned enterprise A from 2021 to 2023. The results show that the proposed indicator system can reflect the current status of original innovation performance in provincial enterprises, providing academic references for further research in the field of original innovation in provincial enterprises. Meanwhile, this study also provides an effective tool for provincial enterprises to conduct original innovation performance evaluations.

From the perspective of enterprise A, in recent years, it has achieved remarkable achievements in areas such as system construction, R&D investment, R&D team construction, and original innovation outcomes, significantly improving its original innovation performance. However, the enterprise still has shortcomings in basic R&D investment and the reserve of high-level technology research and development projects, requiring further measures to improve.

Acknowledgment

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