Preliminary Study on the Evaluation System of Technological Innovation Index for the Central Enterprises of International First-class Enterprises

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Abstract: The State-Owned Assets Supervision and Administration attached great importance to the construction of technological innovation capabilities of central enterprises, and clearly proposed to study the evaluation index system of technological innovation capabilities of central enterprises, carry out evaluation of technological innovation indexes, and guide and encourage enterprises to upgrade the level of technological innovation. Technological innovation has become a powerful driving force for continuously promoting the scientific development of central enterprises. It is of great significance for accelerating the improvement of the level of technological innovation of central enterprises to carry out the evaluation of central enterprises' technological innovation index, establish an effective mechanism to guide technological innovation of all departments, and provide scientific decision-making basis for technological innovation of central enterprises. The core of this research revolves around the technology innovation index of central enterprise for building a world-class enterprise. First, systematically sort out the characteristics of technological innovation in world-class enterprises. Second, analyze the characteristics of technological innovation of central enterprises and the shortcomings of current state-owned enterprises' technological characteristics compared with first-class enterprises. Third, build a technology innovation index evaluation system of world-class enterprises.

1. World-class Enterprise Technology Innovation Characteristics
World-class companies are a group of companies that can quickly adapt to and even lead the global technology wave. Innovative capabilities, especially breakthrough technological innovation capabilities, are the key elements to the core competencies of world-class companies. An important reason for world-class companies to maintain excellent competitive performance over the long term is to effectively grasp the technological opportunities to overcome technological bottlenecks, lead design innovation and build new technology tracks, and flexibly apply strategies such as architecture innovation, disruptive innovation and new market innovation to carry out technological breakthrough. World-class companies are not only good at technological innovation, but also able to effectively transform technological innovation capabilities into corporate profitability and market competitiveness.

At present, domestic and foreign academic institutions, consulting companies and other related institutions have evaluated the world-class enterprises mainly including "Fortune", "Business Weekly", "Forbes", "Sustainability Report" evaluation system, McKinsey "International First-Class Enterprise" evaluation system, the world's three major quality award evaluation systems (including the Deming Application Prize, the Baldrige National Quality Award Program and the European Foundation for Quality Management Global Excellence Award), and the “Four Strong and Four Excellent” and the
State-owned Enterprise Performance Evaluation System proposed by the State-Owned Assets Supervision and Administration. Among them, the Industrial Research and Development Investment Scoreboard issued by the European Commission’s Joint Research Centre and the European Research Corporation is relatively well-known to technological innovation evaluation. And the top 100 global innovations released by Clarivate Analytics, which uses Derwent's unique patent data, tools and technology to select the most innovative institutions in the world by taking into account factors such as research and development (R&D) capabilities, intellectual property protection and business success. The listed institutions have made outstanding achievements in technological innovation and patent protection. More importantly, these patents have high originality, wide market coverage, lots of opportunities for derivative inventions and broad business prospects.

2. Analyses on the Characteristics of Technology Innovation of Central Enterprises

Analysis of the characteristics of central enterprises' scientific and technological innovation helps to build a scientific and technological innovation index evaluation system for first-class enterprises. Overall, the typical characteristics of current state-owned enterprises' technological innovation are as follows.

(1) The central enterprise R&D system is characterized by multiple levels and dispersion. Central enterprises generally have multi-level R&D systems. Affected by the management level of the group, most central enterprises have established multi-level R&D organization structure. In other words, they established direct research institutes at the headquarters level to conduct joint research on key technologies, and set up R&D institutions within the first-level (or even third- and fourth-level) industrial subsidiaries to support business development needs. There are also some central enterprises that have dispersed R&D institutions in their subordinate industrial subsidiaries. There are no direct research institutes at the headquarters level, and enterprises in the fields of business services and raw materials adopt this structure.

(2) Through performance appraisal, incentive policies, special funds, multi-channel financing and other initiatives, the central enterprises have gradually established a safeguard mechanism to promote the continuous increase of investment in innovation. In recent years, the company has achieved steady growth in innovation expenditures. Most central enterprises incorporate R&D investment into the performance appraisal of corporate leaders, and incorporate the completion of each company's technology investment into the annual subsidiary business evaluation indicators. However, the level of innovation investment of central enterprises needs to be improved. The sources of innovation funding are mainly limited to the internal group or rely on government support, and lack of market-based financing channels such as banking and social capital. There is no multi-level innovative financing channel, and it is unable to provide convenient financing conditions for innovation activities at all stages of the innovation chain, which restricts the development of enterprise innovation activities to a certain extent.

(3) At present, there is a general lack of effective customer demand management in the technological innovation system. Most central enterprises often manage the customer's needs passively. They only accept the demand from the customer, or collect or discovering the demand after the competitor releases the new product. There are limited ways and channels for collecting customer needs, lack of good management of the collected requirements, lack of judgment on the classification, priority, and necessity of requirements, and lack of effective tracking of demand realization. The implementation of requirements cannot be tracked and measured during the development process, often until the product is delivered.

3. Construction of the evaluation system of the central enterprises' scientific and technological innovation index for the world's first-class enterprises

3.1. Thoughts on the construction of scientific and technological Innovation
There are many evaluation criteria for the enterprise scientific and technological innovation index. Correspondingly, the metrics of different industries and different enterprises are also different. It is the theoretical basis of scientific design innovation index evaluation system to make clear the structure or constituent elements of enterprise scientific and technological innovation index. Enterprise scientific and technological innovation activities rely on complex and highly dynamic interactions between multi-dimensional elements, with their inherent logical processes, and ultimately manifested in the output of science and technology, and ultimately in the development of enterprises. It is the source of power for enterprises to gain sustainable competitive advantage. In general, the composition of the scientific and technological index should be able to be accommodated in several dimensions of the indicator system. The resource base is the cornerstone of the existence of world-class enterprises, and it is also the starting point for enterprises to carry out technological innovation. The innovation and development of an enterprise requires many types of resource elements to support it. Its growth process also manifests itself in the dynamic and balanced development of existing resource utilization and new resource development. Therefore, it is closely related to the technological innovation capability and competitiveness of enterprises. Dynamic capabilities are the driving force behind technological innovation in world-class companies. Only by continuously improving the core capabilities that enterprises rely on to survive, and constantly looking for a combination of innovative growth point and dynamic environment, the company can always maintain efficiency and last a long time. Scientific and technological achievements are equivalent to compasses and pilot maps, which define the scope of resources choices for enterprises and finalize the ability to be upgraded. Results-oriented needs to be flexible in order to meet the environment in which the company is located, and to speed up the speed of the company into a leading industry with half the effort. It can be said that the company is among the world-class guarantees. The technological innovation of international first-class enterprises has many meanings and values. In addition to the measurement of competitiveness, enterprises also need to be responsible for other stakeholders, assume responsibility for this, and promote indicators such as national social innovation-driven development.

From the perspective of the foundation of scientific and technological innovation resources dimensions, enterprise scientific and technological innovation needs many types of resource elements to support, and its innovation and development process is also manifested in the dynamic and balanced development of existing resource utilization and new resource development. From the perspective of the dynamic capabilities of technological innovation dimensions, world-class enterprises as a collection of capabilities, its organizational management activities of construction, accumulation, integration and reshaping capabilities will ultimately determine the competitive advantage of enterprises. From the perspective of innovation-oriented orientation dimensions, different types of enterprises can innovate according to their individual needs according to their individual differences, and adjust their innovation strategies according to their strategic goals. From the perspective of technological innovation dimensions, the performance of scientific and technological innovation is the result of the implementation of the whole process of technological innovation of enterprises. It is reflected in the technological progress and an economic benefit brought by technological innovation of enterprises, showing the combination of technological innovation capability of enterprises how effective is it.

3.2. Central Enterprise Technology Innovation Index Evaluation System
The metrics should be able to cover the main features of all world-class enterprise technology innovations. World-class companies rely on complex and highly dynamic interactions between multidimensional elements to achieve sustainable competitive advantage, and the source of their competitive advantage should be accommodated in several dimensions of the indicator system. From the perspective of resource-based dimensions, the development of world-class enterprises requires many types of resource elements to support them, and its growth process is also reflected in the dynamic equilibrium development of existing resource utilization and new resource development. From the perspective of dynamic capabilities dimensions, world-class enterprises as a collection of
capabilities, their organizational management activities of building, accumulating, integrating and reshaping capabilities will ultimately determine the competitive advantage of enterprises. From the perspective of strategic flexibility dimensions, compared with other companies, the world-class enterprise has a significant advantage in that it can dynamically adapt to externally changing environments and based on its own environmental factors and the correct understanding of internal resources and capabilities, in order to achieve the company's long-term goals constantly revise and update the corporate development strategy, thus forming a suitable strategic orientation to guide business management activities. In particular, those world-class companies with international competitiveness have successful international strategies. From the perspective of value orientation dimensions, the individual differences of world-class enterprises will be fully demonstrated. Value creation can be built around different objects according to the needs of enterprises at different time points, and can vary with the company's goal orientation and task differences.

Adopting the core components of the four dimensions of enterprise technology innovation capability as the basic framework of the company's overall scientific and technological innovation capability evaluation index system, that is constructing evaluation indicators from four dimensions: basic resources, dynamic resources, innovation achievements, and innovation and effectiveness.

Table 1: Central Enterprise Technology Innovation Index System

| First level index | Two level index       | Three level index                                                                 |
|-------------------|-----------------------|----------------------------------------------------------------------------------|
| Basic resources   | Investing resources   | Research and development fees                                                    |
|                   |                       | Science and technology personnel investing                                       |
|                   |                       | Research and development of assets and equipment and other assets                 |
| Knowledge resource|                       | Talent equivalent density                                                        |
|                   |                       | Number of leading talents per 100 employees                                       |
| Entrepreneur      |                       | Decision-making capacity                                                         |
| resources         |                       | Innovation capacity                                                              |
| Dynamic resource  | Technology management | Innovation strategy                                                              |
|                   |                       | Innovative mechanism                                                             |
| Support guarantee |                       | Research and development technology                                              |
|                   |                       | government policy                                                                |
| Innovation        | Outcome output        | Patent possession                                                                |
|                   |                       | National Science and Technology Progress Awards                                   |
|                   |                       | Technical standard number                                                        |
|                   |                       | Undertake major projects in the country                                           |
| Innovation        | Innovation efficiency | Innovative product competitiveness                                               |
|                   |                       | The proportion of sales of innovative products                                   |
|                   |                       | Innovative product unit cost                                                     |
|                   |                       | Key technology breakthrough capability                                             |
|                   |                       | Science and technology progress contribution rate                                 |
|                   |                       | Research and development rate                                                    |
| Innovation        | Social benefit        | The role of innovative products in the rational use of resources                   |
|                   |                       | The role of innovative products in improving the state of the environment         |
|                   |                       | User acceptance of innovative products (user or market satisfaction)              |
|                   |                       | Driving role for socially relevant products                                       |
| Innovation and    | Economic benefit      | Innovative product sales (transfer) income (or revenue from technological innovation) |
| effectiveness     |                       | Innovative product creation rate                                                 |
|                   |                       | Innovative product profit tax rate                                               |
|                   |                       | Technological innovation brings an increase in output value                       |
4. Summary
The index evaluation of the central enterprises' construction of the scientific and technological innovation index evaluation system of the world-class enterprises tends to construct a quantitative index system. The evaluation index system is mainly based on the intensity index, but the index with smaller value is the total indicator. Compared with the total-type indicators, the intensity-type indicators can reduce the influence of scale factors and can truly reflect the quality level. However, it cannot comprehensively summarize the actual situation of enterprise science and technology innovation, and it needs to be combined with the aggregate indicators for evaluation. At present, the State-owned Assets Supervision and Administration Commission divides central enterprises into three categories. Different types of central enterprises and central enterprises in different industries have different characteristics of technological innovation. Therefore, when defining indicators, it is necessary to fully consider the differences between enterprises and adopt classification evaluation or index treatment. The way to reduce the impact of differences. Different industries have different requirements for innovation, and the evaluation needs to consider the differences in the industry in which the company is located.

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