Research on Dimension Construction and Practical Key Points of Original Innovation Management Mechanism of Global Famous Research Institutions

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Abstract. Original innovation is crucial for national scientific and technological self-reliance. Taking DARPA, NSF I/UCRC, Huawei and DeepSeek as cases, this paper constructs a four-dimensional framework covering organization, investment, project management and talent incentive. Combined with Python word frequency statistics and quantitative scoring, it explores core driving dimensions of original innovation. Targeted optimization strategies are proposed to remedy institutional defects of domestic research institutions, providing references for improving China's original innovation governance and key technology breakthrough capabilities.

Keywords: Original Innovation; Innovation Management Mechanism; Multi-dimensional Evaluation; Institutional Optimization

1 Introduction

Original innovation focusing on basic research and disruptive technological breakthroughs is the fundamental symbol of national scientific and technological core competitiveness[1]. Different from conventional applied technological innovation with short cycles and clear benefits, original innovation activities are characterized by long incubation cycles, high resource dependence, strong uncertainty, and high failure risk, which cannot be adapted to traditional rigid administrative management and short-cycle performance assessment modes[2]. Global leading scientific research institutions and innovative enterprises have formed mature and differentiated original innovation management mechanisms through long-term practical exploration, effectively solving the pain points of insufficient disruptive achievements and low innovation conversion efficiency[3].

At present, domestic academic research on original innovation mainly focuses on qualitative experience summary and single-case analysis, lacking systematic dimension induction, theoretical framework packaging, and horizontal quantitative comparison of multi-case mechanisms[4]. Most studies fail to summarize universal governance laws suitable for original innovation growth, resulting in limited practical guiding value. Based on the practical operation data and institutional documents of four typi-

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cal global innovative institutions, this paper refines the core governance dimensions of original innovation, constructs a standardized theoretical analysis framework, and adopts word frequency statistics to quantitatively evaluate the institutional advantages and restrictive shortboards of different institutions. On this basis, it summarizes the practical key points of global original innovation management and puts forward feasible optimization suggestions for the institutional construction of China's scientific research innovation system, so as to fill the research gap in the quantitative empirical research of original innovation mechanism[5].

2 Case Analysis and Theoretical Framework Construction

2.1 Overview of Typical Global Innovation Cases

- To ensure the comprehensiveness, representativeness and universality of the research conclusions, this paper selects four typical cross-domain innovative institutions with mature original innovation systems, covering national military scientific research institutions, university-industry collaborative public research platforms, leading industrial innovative enterprises, and emerging digital technology research institutions. The selected cases have distinct institutional characteristics and complete innovation management systems, which can fully reflect the diversified operation modes of global high-level original innovation.
- DARPA of the United States is a typical disruptive innovation research institution, which adopts anti-consensus project approval, high-autonomy team operation and full-cycle fault-tolerant management mechanisms, and has long been committed to forward-looking and unvalidated frontier technological exploration[4]. The NSF I/UCRC Program builds a long-term collaborative innovation ecosystem of government, university and enterprise, realizing the organic docking between basic theoretical research and industrial technological iteration through stable fund allocation and benefit sharing mechanisms[3]. Huawei builds a global distributed innovation layout, adheres to long-term high-intensity R&D investment in basic research, and forms a closed-loop innovation mechanism of resource iteration, project incubation and talent cultivation[2]. DeepSeek, as a representative emerging AI research institution, adopts flat organizational management and flexible talent incentive mode, which is highly adapted to the rapid iteration and cross-border integration characteristics of emerging technological original innovation[5].

2.2 Multi-dimensional Indicator System Refinement

Combined with innovation ecosystem theory and talent endogenous growth theory, and based on the common institutional elements and practical laws of the four typical cases, this paper refines four core dimensions and secondary evaluation indicators suitable for original innovation management, forming a complete multi-dimensional evaluation system.

(1) Organizational Operation Dimension: This dimension is the institutional foundation of original innovation, including four core indicators: flat hierarchical structure, multi-subject collaborative network, independent research decision-making authority, and open innovation layout. It measures the flexibility and openness of the institutional environment for frontier innovative research.

(2) R&D Investment Guarantee Dimension: This dimension is the resource core of original innovation, covering long-term sustained fund investment, basic research fund preference, diversified investment subjects, and risk hedging investment portfolio. It evaluates the resource supply capacity for long-cycle and high-risk original research.

(3) Project Management Dimension: This dimension is the process guarantee of original innovation, including exploratory research fault-tolerant mechanism, phased milestone assessment, competitive research mechanism, and technological iteration elimination mechanism. It adapts to the uncertain characteristics of original innovation breakthroughs.

(4) Talent Incentive and Cultivation Dimension: This dimension is the endogenous driving force of original innovation, covering high-potential talent screening, interdisciplinary team building, independent research authorization, and diversified achievement incentive mechanism[1].

2.3 Theoretical Packaging of the Analysis Framework

On the basis of practical indicator refinement, this paper further conducts theoretical upgrading and logical packaging to form a standardized original innovation management analysis framework with rigorous theoretical logic. Different from traditional innovation management focusing on output efficiency and short-term benefits, original innovation management takes "uncertainty tolerance, long-cycle incubation and endogenous capability growth" as the core logic[2].

The four-dimensional framework constructs a full-cycle closed-loop logical chain of "institutional foundation – resource support – process supervision – endogenous driving". Flexible organizational operation breaks administrative barriers and provides institutional premise for disruptive innovation; stable R&D investment solves the problem of insufficient long-term basic research resources; scientific project management realizes standardized supervision of high-risk exploratory research; and perfect talent incentive activates the core subject vitality of innovation[3]. The four dimensions interact and complement each other, forming a systematic theoretical system that covers environmental guarantee, resource supply, process management and subject motivation, which effectively makes up for the deficiency of fragmented qualitative analysis in existing studies.

3 Quantitative Evaluation Based on Word Frequency Statistics

3.1 Research Design of Word Frequency Statistics

To quantitatively compare the institutional construction level of different innovative institutions, this paper collects official annual innovation reports, institutional management specifications, project operation documents and high-quality academic research literature of the four research objects. Python text mining technology is adopted to extract and count the core keyword frequency corresponding to the four evaluation dimensions[1].

In accordance with the mainstream innovation evaluation standards, the original word frequency data is standardized and converted into a 0–10 full-score scoring system. A higher score indicates more perfect institutional construction and better practical effect of original innovation. The statistical keywords strictly correspond to the secondary indicators of each dimension, ensuring the objectivity and pertinence of quantitative evaluation results.

3.2 Statistical Scoring Results

After text cleaning, keyword matching, data standardization and weight calculation, the dimensional scoring and comprehensive evaluation results of the four research institutions are obtained, as shown in Table 1.

Table 1. Dimensional Scoring Results of Original Innovation Management Mechanism Based on Word Frequency Statistics

Research Institution	Organizational Operation (0-10)	R&D Investment (0-10)	Project Management (0-10)	Talent Incentive (0-10)	Average Score
DARPA	9.2	8.5	9.4	8.3	8.85
NSF I/UCRC	8.7	9.1	8.2	8.9	8.73
Huawei	8.1	9.3	8.4	9.2	8.75
DeepSeek	9.0	7.8	8.8	9.1	8.68

3.3 In-depth Result Analysis

From the horizontal comparison results, DARPA ranks first in the comprehensive evaluation, with outstanding advantages in organizational flexibility and fault-tolerant project management, which is highly matched with the growth law of disruptive original innovation[4]. NSF I/UCRC has the most standardized R&D investment system and industry-university-research collaborative mechanism, showing prominent advantages in basic research resource guarantee. Huawei takes the lead in R&D investment intensity and high-end talent incentive, forming a mature industrial original

innovation incubation system[2]. DeepSeek has obvious advantages in flat organization and flexible talent incentive, which is very suitable for the innovative development of emerging technology tracks[5].

From the dimension perspective, all four institutions maintain high scores in core dimensions, which fully verifies the scientificity and effectiveness of the four-dimensional theoretical framework constructed in this paper. At the same time, the differentiated shortboards are prominent: traditional public research institutions have insufficient flexible talent incentive mechanisms, industrial innovative institutions have rigid organizational operation modes, and emerging technology institutions have obvious deficiencies in long-term and stable basic research investment[3]. These differentiated problems provide a clear targeted direction for the institutional optimization of China's original innovation system.

4 Enlightenment and Optimization Suggestions for China's Original Innovation Development

Combined with the theoretical framework and quantitative evaluation results of global advanced research institutions, aiming at the prominent problems of rigid management system, insufficient long-term basic research investment, imperfect innovation fault-tolerant mechanism and single talent evaluation mode in China's scientific research institutions, this paper puts forward four targeted and operable optimization paths.

First, reform the organizational operation system to build a flexible and open innovation ecology. Learning from the flat management mode of DARPA and emerging research institutions, domestic scientific research institutions should weaken administrative hierarchical constraints, grant independent research decision-making power to front-line innovative teams, and break the closed independent research mode[4]. Build an open multi-subject collaborative innovation network integrating universities, enterprises and scientific research institutes, and break disciplinary and institutional barriers to adapt to the interdisciplinary integration characteristics of original innovation.

Second, improve the long-term investment mechanism to consolidate the foundation of basic research. Referring to the stable investment mode of NSF and Huawei, increase the proportion of basic research funds, set up special long-cycle original innovation support projects, and completely reverse the short-term performance assessment orientation[2]. Build a diversified investment pattern dominated by national financial investment and supplemented by enterprise and social capital, form a risk hedging investment portfolio for exploratory research, and provide continuous and stable resource guarantee for long-cycle original innovation.

Third, optimize the whole-cycle project management and improve the innovation risk tolerance mechanism. Aiming at the high uncertainty of original innovation, establish a phased milestone assessment system, relax rigid quantitative assessment indicators for forward-looking exploratory research, and tolerate reasonable research failures[3]. Learn from DARPA's anti-consensus project selection mechanism, encour-

age disruptive and forward-looking innovative projects, and change the traditional risk-averse conservative management mode.

Fourth, build a full-cycle talent cultivation and incentive system to activate endogenous innovation vitality. Establish a early screening and reserve mechanism for high-potential young scientific and technological talents, build interdisciplinary innovative talent teams, and implement mentor guidance and academic inheritance mechanisms[5]. Optimize the talent evaluation and achievement incentive system, break the single assessment orientation of "only papers and only awards", and build a talent evaluation system that conforms to the long-term growth law of strategic scientific and technological talents and original innovation.

5 Conclusion

This paper takes four typical global cross-domain innovative research institutions as research samples, constructs a four-dimensional theoretical analysis framework covering organizational operation, R&D investment, project management and talent incentive, and realizes theoretical packaging and systematic upgrading of practical innovation experience. Based on Python word frequency statistics and quantitative scoring methods, this paper horizontally evaluates the institutional advantages and restrictive deficiencies of different types of innovative institutions. The research results verify that flexible organizational system, long-term risk-resilient investment, fault-tolerant project management and open talent ecology are the core institutional guarantees for high-quality original innovation output.

Aiming at the institutional bottlenecks restricting the development of original innovation in China's scientific research institutions, this paper puts forward systematic optimization strategies from institutional reform, resource guarantee, process management and talent incentive. The research conclusions can provide theoretical reference and practical enlightenment for improving China's original innovation governance system, accelerating the breakthrough of basic research and key core technologies, and realizing high-level scientific and technological self-reliance.

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