Evaluation of Innovation Management of Major Projects

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Abstract. It is of great significance to evaluate the implementation effect of major engineering innovation management and summarize the successful or failed experience of major engineering innovation management for the smooth development of major projects in the future. We select the representative Beijing Shanghai high speed railway project, Ultra-high voltage project, Three Gorges project and Ten major aircraft project as examples to summarize the methods and effects of innovation management of major projects, and build the evaluation system of innovation management of major projects from two main dimensions of innovation management mode and innovation management mechanism to visually evaluate the effect of innovation management of major projects. The research results show that the evaluation system proposed by us has good applicability to major project innovation management, and visual display can reveal the evaluation results more intuitively.

1 Introduction

Since the 1950s, with the continuous improvement of social productivity, more and more large-scale major projects have been built. Human engineering is no longer limited to the previous civil engineering, there are a series of major projects such as aerospace engineering, nuclear weapons development engineering, missile development engineering. Compared with general traditional projects, major projects have distinct characteristics in management mode. The management mode adopted for major projects needs to be more comprehensive and specific. If an effective management mode cannot be found, the progress of the whole project will be hindered, and the characteristics of project quality and other aspects will not be guaranteed.

Major projects involve many organizations, departments, subjects and a large number of external project stakeholders. The project management is difficult and the professional technology is highly complex. In particular, innovation management is needed to ensure the smooth progress and substantive breakthrough of the projects. Innovation management originated from technology management in the early 1980s. It develops a comprehensive innovation management model based on the classification of key elements and non key elements, so as to reduce the risk and improve the efficiency of innovation. It is of great significance to evaluate the implementation effect of major project innovation management, summarize the successful or failed experience of major project innovation management, and study the characteristics, modes and mechanisms of major project innovation management for the smooth development of major projects in the future.

According to the four dimensions of business environments, research scopes, research problems and

main contents, innovation management can be divided into R&D management, technology innovation management, technology planning, strategic technology management and other schools. The R&D management school focuses on the management of R&D resources, mainly focusing on issues such as researchers, creativity, capital, and culture; the technological innovation management school focuses on managing innovation within the company, mainly researching technological inventions and technology realization; and the technology planning school focuses on technical analysis and Planning, mainly studying the analysis and planning of complex processes of technology development; The strategic technology management school focuses on the management and integration of technology and related aspects, and mainly studies the analysis and processing of all areas of technology evolution. The most famous researcher who studies the innovation management model is Roy Rothwell. His five-generation innovation management model classifies innovation management model by selecting two main elements of technology and market in the innovation system and summarizes the development of innovation management direction.

There are many views on the selection of key elements of innovation management and strong subjectivity in analysis. It can be classified into three categories: internal elements, external elements and implementation elements. The internal elements include strategy, technology, organization, market, system, management, culture, process, etc.; the external elements include environment, performance, etc.; the implementation elements include people and tools. Scientific innovation management mode will achieve the coordinated development among strategy, technology, organization and market, and produce the effect of collaborative innovation.

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2 Major project management innovation cases

2.1. Beijing Shanghai high speed railway project

Beijing Shanghai high speed railway is the first high-speed railway with the largest scale and the highest standard in China. It has the characteristics of high design standard, new system technology, large construction scale, many key and difficult projects, difficult quality control, high safety pressure, strict environmental protection requirements, and heavy collection and demolition tasks. As a national strategic major transportation project and major innovation project, Beijing Shanghai high speed railway project provides a safe, punctual, fast and comfortable transportation mode, provides a strong green and low transport capacity support for economic and social development, and creates a Chinese high speed railway brand with advanced technology, safety and reliability, and high cost performance.

In terms of organizational structure, a leading group was established to guide the construction of Beijing Shanghai high speed railway project, and coordinate and solve major problems in the construction; an office was set up under the leading group, which is mainly responsible for the daily affairs of the leading group; a Beijing Shanghai High Speed Railway Co., Ltd. was established as the project legal person to be responsible for the construction organization and management; and the general headquarters was set up to build a two-tier project organization system for specialized units such as overall exploration, supervision and construction. In terms of technical management, Beijing Shanghai high-speed railway project adheres to original innovation, integrated innovation and introduction, digestion, absorption and re innovation. Around high-speed railway construction technology, train control technology and high-speed EMU technology, it constructs an integrated innovation management system to realize the system innovation of complete set of high-speed railway technology. In terms of process management, focusing on process management, quality management and safety management, the project is promoted organically, orderly and integrated through institutionalization and standardization. In terms of risk control, the project has taken safety plan and emergency management, preparation and review of special safety plan, standardized on-site safety management, safety "red line" management, safety management information platform. In terms of resource guarantee, the project has selected or seconded nearly 100 construction management talents with rich experience and complete specialties, actively absorbed social funds to participate in the construction, and strengthened material and equipment management.

2.2. Ultra-high voltage project

According to the basic situation of reverse distribution of energy resources and load centers in China, State Grid

proposes to build a strong smart grid with Ultra-high voltage power grid as the backbone grid and coordinated development of power grids at all levels. The project has the characteristics of heavy technical research tasks, difficult design optimization and balance, great challenge of independent research and development, difficult overall coordination, high safety and reliability requirements. Ultra-high voltage project is of great strategic significance for ensuring energy security and reliable power supply, supporting the development of clean energy, promoting the progress of power science and technology, and upgrading the electrical manufacturing industry.

In terms of organizational structure, a three-level organizational structure composed of project leading group, provincial construction leading group and site headquarters is established. The project leading group is responsible for deciding major issues, and provincial construction leading group is responsible for coordinating the project construction within the scope of responsibility, and the site headquarters is responsible for the organization and implementation of the project construction site. In terms of technology management, relying on the project, adopting the collaborative mode of industry, University, research and application, restructuring and integrating the group's innovation resources, optimizing the functional positioning of each main body, and striving to promote joint tackling of key technologies. In term of process management, a control mechanism covering key links such as engineering design, equipment development, construction and construction is established to ensure the overall control of the project. In terms of strategic decision-making, an efficient decision-making system is established, which takes the interdisciplinary leading group as the core, internal and external research and demonstration as the support, and simulation as the basis. In terms of resource guarantee, the project innovates the material management mechanism, builds the talent reserve team, and adopts strict control and hierarchical supervision to ensure the legality and compliance of capital management.

2.3. Three Gorges project

The Three Gorges project is mainly composed of three parts: hub project, resettlement project and power transmission and transformation project. It is a key backbone project for harnessing and developing the Yangtze River. It is a complex system project involving science and technology, economic and social development, with outstanding characteristics of difficult innovation, long decision-making cycle, many construction teams and high ecological requirements. The Three Gorges project is the largest water conservancy project in the world, which has great comprehensive benefits such as flood control, power generation, shipping and water resource utilization.

In terms of organizational structure, the Three Gorges project Construction Committee of the State Council shall make decisions on the guidelines, policies

and major issues. The office of the Three Gorges Project Construction Committee of the State Council and relevant departments directly under the State Council implements the major decisions of the Committee. The Three Gorges Group Corporation of China, the State Grid Corporation of China, the government of Hubei and Chongqing Municipality undertake the responsibilities Specific implementation work. In terms of technical management, the technical route of "special research comprehensive demonstration continuous optimization" is put forward. The technical breakthrough mechanism of combination of original innovation and integrated innovation are adopted to tackle the problems in design, implementation and operation. In terms of process management, the project has innovated a series of important system innovations, such as construction management system, financing mechanism, investment control, and capital supervision. In terms of strategic decision-making, the scheme is constantly revised and optimized, and the dynamic evolution becomes the most significant feature. In terms of risk control, the project has implemented the "three control" mechanism of quality control system, schedule control system and cost control system. In terms of resource guarantee, the construction of the project attaches great importance to the scientific and technological training of personnel and the reasonable allocation of personnel, establishes a unique management system for the supply of materials and equipment.

2.4. Ten major aircraft project

According to the decision-making of the first generation of Chinese leaders, under the direct leadership of Shanghai Municipality and the strong support of the Ministry of aircraft industry and technology, the development of Ten major aircraft is a large-scale system engineering mainly carried out by Shanghai Aircraft Research Institute and Shanghai aircraft manufacturing plant in cooperation with the whole country. It has the characteristics of difficulty in tackling key problems through innovation and many teams participating in construction. The development of Ten major aircraft not only fills the gap that Chinese national industry could not manufacture large-scale aircraft before, but also makes China the fifth country in the world to independently develop 100 ton aircraft.

In terms of organizational structure, the development of Ten major aircraft is under the unified command of the central government, with Shanghai municipal competent department as the main body of project responsibility, with Shanghai Aircraft Research Institute and Shanghai aircraft manufacturing plant as the main body of implementation. In terms of technical management, the project has fully implemented the spirit of independent research and development, and has also tried its best to learn from the advanced technology and standards of western large-scale jetliner. Through sufficient design tests, it has exposed hidden dangers in advance, confirmed that the design is correct, and ensured the safety and reliability of the project. In terms

of process management, the project was started as a local aviation office, and even resisted the planning leadership of the Ministry of aviation industry, which led to low efficiency in task management. In terms of strategic decision-making, the technical leader of the project has great decision-making power, which makes the project seldom affected by political factors in the process. In terms of risk control, the project did not carry out risk transfer and loss control, resulting in a large number of brain drain, and the accumulated knowledge and experience, patent technology and new materials in the project were not inherited by future generations. In terms of resource guarantee, the project talents lack relevant knowledge reserve and technical experience, and the policy resources and investment given by the state to the project are not sustainable, and the interests of all participants are not coordinated.

3 Evaluation of major project management innovation

The promotion of major projects generally goes through the main stages of demonstration, R&D and construction, and generally has the characteristics of long decision-making cycle, difficult innovation, difficult organization and implementation, and many related coordination. The promotion of major projects generally goes through the main stages of demonstration, R&D and construction, and generally has the characteristics of long decision-making cycle, difficult innovation, difficult organization and implementation, and many related coordination.

Table 1. Evaluation system of major project management innovation.

Evaluation target	Primary index	Secondary index
Innovation management of major project	Management mode	Organizational structure
		Technical management
		Process management
		Owner's leading
	Management mechanism	Strategic decision-making
		Innovation breakthrough
		Incentive and constraint
		Risk control
		Resource guarantee

In the aspect of innovation management mode, the implementation of major projects needs to have strong owners and adopt a variety of administrative and market methods. Based on the systematic decomposition of

linear projects, a multi-level objective system, decision-making system, innovation system and organization system are established, which are coordinated organically to jointly support the high-quality realization of project objectives. In terms of innovation management mechanism, major projects often have national level strategic decision-making throughout the projects, unified deployment of scientific research planning and project innovation, incentive assessment system for project construction objectives, and efficient cooperative risk control guarantee mechanism.

Combined with the characteristics of innovation management of case projects, we construct the evaluation system of major project innovation management from two main dimensions: innovation management mode and innovation management mechanism. In terms of management mode, four modes are considered: organizational structure, technical management, process management and owner leading; in terms of management mechanism, five mechanisms are considered: strategic decision-making, innovation breakthrough, incentive and constraint, risk control, and resource guarantee.

Delphi expert scoring method is used to score the secondary indicators of four projects, and the method of Face graph is used for visual display. Among them, hair style represents organizational structure, hair length represents technical management, face height represents process management, face shape represents owner's leadership, eye height represents strategic decision-making, nose width represents innovation breakthrough, mouth width represents incentive and constraint, ear width represents risk control, and smile degree represents resource guarantee.

Fig. 1. Face graph of major project management innovation evaluation.

Figure 1 shows that the management innovation mode and mechanism of Beijing Shanghai high speed railway project, Ultra-high voltage project and Three Gorges project are significantly better than those of Ten major aircraft project, which can be used as a useful reference for management innovation of major projects.

4 Conclusion

Compared with the general traditional projects, the management mode of major projects has obvious characteristics, and the management mode and

mechanism adopted for major projects need to be more comprehensive and specific. It is of great significance to evaluate the implementation effect of major project innovation management and study the characteristics, modes and mechanisms of major project innovation management. We select the representative Beijing Shanghai high speed railway project, Ultra-high voltage project, Three Gorges project and Ten major aircraft project as examples to summarize the methods and effects of innovation management of major projects in terms of organizational structure, process control, innovation research, risk control and resource guarantee. The evaluation system of major project innovation management and the visual evaluation method we built are beneficial exploration of the evaluation method of major project management innovation.

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