



Research on Innovation Decision-Making Mechanism of Major Projects

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Abstract. Scientific and reasonable decision-making mechanism is an important guarantee to ensure the correct direction and path of major project innovation. This paper systematically analyzes the relevant theories and concepts of innovation decision-making and major project decision-making, puts forward the decision-making system of major project innovation and analyzes its connotation, and further puts forward the main structure, decision-making demonstration and decision-making methods of major project innovation decision-making, providing theoretical and methodological reference for major project innovation decision-making.

Keywords: Decision-making · Major project · Innovation

1 Introduction

Scientific and reasonable decision-making mechanism is an important guarantee to ensure the correct direction and path of major project innovation. In the 19th century, with the rapid development of engineering technology and organizational management level in the world, many major projects with huge scale, complex technology, difficult coordination and far-reaching impact have been completed, which further promoted scientific and technological innovation in relevant fields to make considerable progress.

Major projects generally include not only the innovation of important technologies, but also the development of major equipment and the first set of demonstration applications [1, 2]. They are important projects which have great influence on national comprehensive strength and even national security. Due to their characteristics of high technical complexity, large social impact, numerous participants, and difficult coordination, traditional management model and operation mechanism cannot be fully applicable to major project innovation.

In the process of major project innovation, the determination of technical routes, the design of key schemes, the allocation of key resources, the setting of objectives and other major issues are not only related to the success of innovation and the project, but also related to the long-term social value and impact of the project. Once there is a directional error, it will have a significant impact [3]. Based on the systematic analysis

of the relevant theories of decision-making, combined with the characteristics of major engineering innovation, this paper proposes a set of methodology applicable to major engineering innovation.

2 Research on the System of Innovation Decision-Making for Major Projects

Decision-making theory is the general name of the concepts, principles, theories which related to decision-making. The decision-making mechanism in the general sense usually refers to the mechanism that the decision-maker makes choices in the fields of production, operation, management or governance within the scope of authority granted, mainly including the establishment of the decision-making subject, the division of decision-making rights and responsibilities, decision-making organization and decision-making methods, etc.

Innovation decision-making refers to the process of organization design, selection and implementation of innovation objectives and innovation activity plans throughout the innovation process. The construction of innovation decision-making mechanism should focus on the basic principles of multidimensional, timeliness, hierarchical and strategic. The failure experience of innovation decision-making shows that the unclear and unsound innovation decision-making mechanism will lead to the fuzzy cognition of decision-making subjects, procedures and means [4].

Combined with the constituent elements of the general decision-making mechanism, the major project decision-making mechanism contains more complex and changeable elements, which can be generally divided into “decision-making environment, principles, objectives, subjects, information, organizations, methods, results, and decision-making evaluation.”

Through sorting out the relevant research on decision-making theory, decision-making mechanism elements, major project decision-making mechanism, innovation decision-making mechanism and so on, as shown in Fig. 1. The decision-making mechanism mainly focuses on the organization and coordination of decision-making contents, decision-making subjects, principles, process, methods, resources, results and other elements, and studies and explores how to more effectively promote the rational operation and coordination of various decision-making elements.

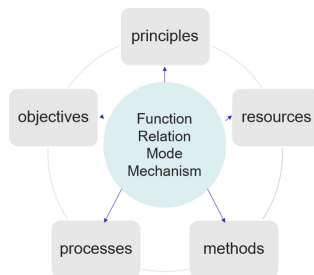


Fig. 1. Connotation of innovation decision-making mechanism for major projects

The objectives of major project innovation cover many aspects, such as politics, economy, society, security, technology, ecology, etc. It is necessary to judge and consider each objective through decision-making, so as to seek the best balance.

The complex characteristics and multiple objectives of major project innovation decision-making determine that this type of decision-making is highly complex, difficult, challenging and pioneering. The concept of major project innovation decision-making mechanism should be defined as “a series of operation modes or a set of operation mechanisms that define the main body, principles, objectives, processes, methods, resources and other elements of major project innovation decision-making and their internal relations under the major project innovation environment to ensure the scientific and orderly implementation of major project innovation decision-making”.

3 Main Structure of Major Project Innovation Decision-Making

3.1 Organizational Structure

The organization responsible for the implementation of major projects is the core body of innovation decision-making. With the support and authorization of the state or relevant government agencies, it integrates the top professional units in relevant fields, and leads the establishment of a closely coordinated innovation decision-making organization.

Generally, the company can act as the executive responsible organization, and under its unified leadership and command, focus on the four major areas of scientific research,

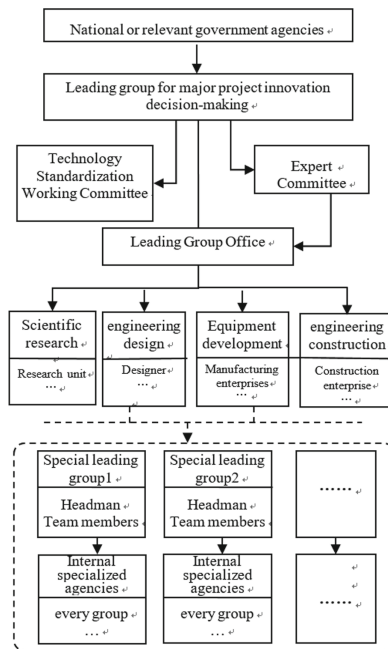


Fig. 2. Organizational structure of major project innovation decision-making.

engineering design, equipment development and engineering construction of major projects, and promote professional decision-making in an orderly manner, as shown in Fig. 2.

The government gives strategic and directional approval or guidance to support the owner's major project innovation decisions [5]. The Owner shall establish a leading group of major projects led by major leaders, and act as the highest innovation decision-making leading body of major projects, responsible for determining major innovation issues, such as major technical solutions and major thematic research results, and coordinating, guiding and promoting the implementation of decisions. An expert committee composed of internal and external experts in relevant fields has been established to be responsible for the review and control of major technical principles and technical schemes, and to ensure that major innovation decisions are scientific and reasonable. Establish the work committee of innovation technology standardization, strengthen the standardization formulation and achievement transformation of innovation technology, promote the summary and learning of innovation decision-making, and provide decision support for subsequent technological innovation. Establish a leading group office to be responsible for the service, management and supervision of the whole process of innovation decision-making. We will further establish a hierarchical decision-making and command system in the four major fields of scientific research, engineering design, equipment development and engineering construction, establish a special leading group to directly organize and decide the innovation work in various fields, and establish a special organization in charge of the main leaders within each innovation subject to be responsible for the relevant professional decision-making of the unit. Through overall organization and coordinated planning, a centralized, efficient, democratic and scientific decision-making mechanism will be formed to lay a solid foundation for promoting the innovation process of major projects.

3.2 Decision Demonstration

Strengthen the authoritative demonstration of major strategic decisions. The executive responsible unit invited academicians and industry senior experts to form a strategic decision-making advisory group. We will cooperate with scientific research, design, manufacturing, construction, associations, research institutes, universities and other units in major engineering-related industries to carry out comprehensive research. Actively solicit the opinions of government agencies, China Academy of Engineering and other top research institutions, industry associations and other units, and carry out special argumentation on relevant strategic decisions.

Promote the interaction between innovation and decision-making in key areas. The key fields of major engineering innovation, such as scientific research, engineering design, equipment development and construction, are closely related, complementary and mutually constrained. With the innovation process in various fields, they dynamically affect the boundary conditions of decision-making factors such as decision-making environment and decision-making object in other fields.

Implement step-by-step and hierarchical review and repeated research and demonstration. The objective requirement is to follow the prudent, careful, solid, penetrating, safe and reliable decision-making concept, and establish a fixed expert team in various

fields to review major innovation programs, important scientific research topics, and technical research topics step by step and level, and provide decision-making support in a reasonable and orderly manner, Strengthen repeated research and demonstration to ensure that the innovative decision-making of key links in various fields is promoted step by step in combination with priorities.

4 Innovative Decision-Making Process for Major Projects

4.1 Decision-Making Process

The major project innovation decision-making involves the sustainable development of the national economy and the major strategies of related industries. The national level has defined the necessary decision-making procedures through relevant laws and regulations. In order to ensure that the innovation decision-making is rigorous, compliant and fully scientific, the owner unit must make an overall plan and strictly follow the rigorous and standardized scientific procedures.

Major strategic innovation decisions are based on the regulation of relevant national decision-making procedures. First of all, carry out the necessity analysis and fully understand the important significance to national politics, economy, society and science and technology. Secondly, scientifically put forward the strategic concept of major engineering innovation, master the relevant development status, and initially conceive the system objectives of major engineering innovation. The third step is to carry out technical feasibility, equipment reliability, system safety, economic rationality and environmental friendliness analysis in an all-round, multi-angle and multi-round way. Finally, complete the selection and approval of major engineering innovation schemes with high quality, ensure that all decisions are scientific and accurate.

For important innovation decisions in various fields and links, on the basis of ensuring compliance with relevant laws and regulations and the decision-making procedures stipulated by the owner, we should pay attention to strengthening the combination of the general scientific decision-making process with the innovative decision-making attributes and relevant professional characteristics.

First, put forward key issues and determine innovation objectives. Ensure that correct innovation decision-making objectives are formulated after full investigation, discussion and demonstration. The second is to comprehensively analyze the problem and identify the key influencing factors. The third is to comprehensively consider the calculation and draw up a feasible plan. Fourth, scientific analysis and evaluation to select the best plan. In the major project innovation decision with multiple influencing factors, evaluate and select the best plan that can find the balance point among multiple objectives and multiple key impact indicators. Fifth, implement carefully and optimize feedback regulation. Re-verification will not only provide feedback to the initial innovation decision objectives, but also help to ensure the correctness in the next stage.

4.2 Decision Method

Major engineering innovation decisions often involve multiple disciplines, and need to comprehensively balance the relationship between local performance and overall

function, and between local interests and overall interests. The decision-making process is a dynamic evolution process of the coordination and integration of multiple thinking, multiple values and multiple objectives. Taking the overall optimal balance state as the goal, coordinating the relationship between the relevant boundary conditions of the key elements can help break through the bottleneck in performance, value or goal.

According to the characteristics of major project innovation decision-making, the corresponding system balance optimization decision-making model is constructed.

First, describe the three-dimensional structure of major project innovation decision-making. The major project innovation decision DM is divided into value dimension (objective dimension), logic dimension and expert dimension, which are represented by ternary sets, as shown in the formula. Each dimension contains multiple elements. The value dimension (objective dimension) is the core of major project innovation decision-making and the object of system balance optimization. The logical dimension implies the time series attribute and depicts the logical order of innovation decision-making. The expert dimension provides technical and intellectual support for the consultation and demonstration of major project innovation decisions.

$$DM = \{V, L, P\}$$

Secondly, measure the multiple values (multiple objectives) of major project innovation decisions. The decision makers' identification and judgment of multiple values or multiple objectives of major engineering innovation is a spiral evolution process, which is revealed by constructing a dynamic optimization simulation model. The multiple value (multiple objectives) MMDM of major project innovation decision is expressed as a triple, as shown in the formula.

$$MMDM = (V, O, R)$$

where, $V = \{v_1, v_2, \dots, v_n\}$ represents the variable set of multiple values (multiple objectives); O represents any yuan value; R represents a set that satisfies constraints between any meta-value or meta-target variables.

MMDM's meta-value or meta-target variable v_i is expressed as a function of time, and the dynamic evolution process of identification and measurement of multiple values (multiple objectives) of major engineering innovation decisions is determined in chronological order.

Balance and optimize the multiple values (multiple objectives) of major project innovation decisions. Through continuous information interaction and intelligent integration, the decision-making subject and expert demonstration group gradually form the initial scheme or conclusion, and then multiple experts interact and integrate their opinions.

Thirdly, determine the consistency of experts in major project innovation decision-making. Set the consistency measurement value of multiple experts' opinions as $\rho^{(i)}$, the consistency judgment threshold is $\theta^{(i)}$. If $\rho^{(i)} \leq \theta^{(i)}$, then the consistency condition is established and the interactive integration of opinions is completed. Otherwise, consider whether to modify the scheme. If the expert thinks it is not necessary to modify the scheme, the expert will adjust his judgment and then interact; If experts think it is necessary to modify the scheme, they should optimize and improve the scheme first, and then experts should put forward new judgments for the new scheme, and then carry

out interactive integration. In this way, until the experts agree, the system optimization scheme of multiple values (multiple objectives) of innovative decision-making is formed.

5 Conclusions

This paper puts forward a decision-making system suitable for major project innovation, analyzing its connotation, and puts forward the decision-making organization structure and decision-making procedure.

- (1) The major project innovation decision-making mechanism is a series of operation modes or a set of operation mechanisms that define the main body, principles, objectives, processes, methods, resources and other elements of the major project innovation decision-making, and ensure the scientific and orderly implementation of the major project innovation decision-making under the major project innovation environment.
- (2) The major project decision-making mechanism mainly includes decision-making environment, principles, objectives, subjects, information, organizations, methods, results, and decision-making evaluation.
- (3) The innovation decision-making of major projects should focus on strengthening the decision-making demonstration, and ensure the correctness of innovation objectives and methods through authoritative demonstration, interactive verification and iterative verification.

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