



Uphold Fundamental Principles and Break New Ground: Adaptive Governance Process of Megaproject Innovation

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Abstract. The sustainable value of harmony between humans and nature is central to addressing the double - edged sword of megaproject innovation. Using the Dujiangyan Water Conservancy Project (Dujiangyan) as a case study, the research explores the adaptive governance process, mechanisms and theoretical connotation of megaprojects. The findings reveal that: Megaproject innovation follows the adaptive governance framework of “project tradition - technological innovation - governance expansion - value delivery”. Supported by technological and institutional traditions, this process unleashes technological innovation through social governance and defines technological application boundaries via ecological governance, forming a path from social to ecological governance. Furthermore, in the interplay of tradition and innovation, major project innovation relies on the stability from the fundamental principles (Shouzheng) and the change of governance behaviors. In this context, the principles continuously guide innovation practices through the three dimensions of goal guidance, spiritual incentives, and law regulation.

Keywords: Megaproject innovation; Adaptive governance; Uphold fundamental principles; Sustainable value; Case study

1 Introduction

Megaprojects, especially those with significant infrastructure projects, are characterized by large-scale investment, long operational cycles, and strong public attributes[1]. With the unprecedented rapid development of production capability following the Industrial Revolution, the contradictions between human civilization and natural resources as well as the ecological environment have been increasingly intensified. Therefore, in the face of the sustainable development challenges, how to achieve sustainable value through innovation is not only the expectation of current practitioners in the field of megaprojects but also the responsibility of Chinese project management scholars in the new era.

Innovation in megaprojects is a crucial practice for creating and sustainably delivering value[2]. However, the inherent uncertainty and risk associated with innovation activities mean that not all project practices can generate value[3]. Responsible innovation, which considers both the positive and negative aspects of innovation, provides a foundation for re-conceptualizing innovation governance that reflects social values and responsibilities[4]. Governance should be rooted in specific national conditions, institutional, and cultural contexts[5]. The concept of “Uphold Fundamental Principles and Break New Ground” (Shouzheng Innovation), based on Chinese traditional culture, offers a new interpretative basis for exploring the adaptive governance and sustainable value of innovation in megaprojects.

Based on this, the research focuses on the question of “How to conduct adaptive governance in megaproject innovation”. By addressing this question, this research constructs an adaptive governance model for megaproject innovation, analyzes the mechanisms and functions of technological innovation and governance expansion, and explores the “good governance” concept and Shouzheng Innovation connotations in this process.

2 Literature Review

Essentially, megaprojects are innovation activities based on goal locking[6]. Unlike general corporate innovation, they extend beyond corporate boundaries, involving more complex innovation processes and elements[3]. Prior studies from an element perspective have highlighted that megaproject innovation is essentially a one-off, temporary, and unique organizational process[6]. However, when the temporary nature of organizations prevents transferring prior project experience and knowledge to subsequent projects, “vertical innovation islands” emerge [7]. Thus, for a long-term megaprojects, it's necessary to analyze their innovation process from a traditional perspective.

The core of adaptive governance is adjusting strategies according to environmental changes to promote positive interactions among elements. Governance now focuses not only on economic growth and innovation efficiency but also on expressing public value and encouraging innovation subjects to fulfill their social responsibilities[8]. Responsible innovation, which combines innovation's positive and negative aspects, offers a foundation for re-imagining innovation governance that reflects social values and responsibilities[4]. However, traditional responsible innovation is often seen as a contradictory concept. The “Shouzheng Innovation” concept, rooted in Chinese culture[9], provides a new basis for exploring adaptive governance and sustainable value in megaproject innovation. Yet, there is a lack of systematic research on the connotations of Shouzheng Innovation within the context of megaprojects.

3 Methodology

This study employs a qualitative research method that combines historical analysis with case study. First, as the research object spans a long-time domain, a rigorous method for organizing historical evidence and citing sources has been established. Second, the

research question focuses on innovation management and practices in major projects from the perspective of adaptive governance. It requires attention to the “how” of governance behaviors and processes. Case studies can more effectively uncover the theoretical logic behind the phenomena[10].

3.1 Case Selection

This research chooses the Dujiangyan as the research object for the following reasons. Firstly, it is the only “living” large-scale ecological water conservancy project in China so far, which has the extreme characteristic of mining new phenomena and theories. In addition, it has undergone innovation and value expansion across different historical contexts, offering a practical sample for examining the adaptive governance of mega-projects. Lastly, the research team is based in Chengdu and has forged a close cooperative partnership with the Dujiangyan Water Conservancy Development Center.

3.2 Data Collection

To ensure the scientific nature, completeness and reliability of the research data, this research adopts multiple channels and diverse methods to collect data for cross verification. The data sources include:(1) Historical literature, covering major events of Dujiangyan.(2) Project documents, such as construction and annual repair management systems, and development plans.(3) Interviews, including discussions with domestic water conservancy research experts and in-depth face to face interviews with managers at different levels.(4) Participatory observations, including on-site visits to material heritage sites, and inspections of the operation of main channels, reservoirs, etc.

3.3 Data Analysis

Given the diversity and complexity of data sources, this research combines historical text analysis and grounded analysis for data analysis. The specific steps are as follows:

First, obtain the chronological partitioning of historical events. Based on the major events recorded in the Dujiangyan Annals, the research divided the case into two key phases:The first phase is the formation of traditions (251 BC-1949);The second phase is the innovation and development of Dujiangyan (1950-2023).

Second, apply the Grounded Theory method to uncover the deeper data structures. Using the sequence of critical events as a guide, analyze data from literature, artifacts, expert interviews, and on-site investigations. Adopt a the first-order/second-order structured data analysis methodology to demonstrate the links between data and newly derived concepts, thereby forming theoretical dimensions. The data structure is shown in next chapter.

4 Case Analysis

4.1 Project Tradition: Inheritance and Transmission

Project tradition is some mature theoretical and empirical knowledge formed through channels and mechanisms such as information transfer, knowledge exchange, experience inheritance and engineering culture accumulation during long-term project activities.

The technological tradition is technical knowledge that has been accumulated and repeatedly verified during the long-term practice of project participants, and can be divided into explicit craft traditions and implicit technical laws. Explicit craft traditions include professional knowledge on project components, and technologies formed during creation and operation. Implicit technical laws refer to the experience-based skills of traditional craftsmen. To this day, the law-based understanding of “going with the flow and adapting to local conditions” still offers guidance for Dujiangyan operations.

The institutional tradition originates from the repeatable and identifiable organizational behavior patterns formed by project participants through long-term practice, and it includes explicit institutional traditions and the implicit project spirits. Regarding explicit institutional traditions, the value maintenance of the Dujiangyan in an unstable environment is attributed to the inheritance of the stable three-tier management system and the annual repair system. Implicit project spirit includes values and spirituality based on past organizational cultures, etc., and are related to specific contexts.

4.2 Technological Innovation: Technology Empowerment

After 1949, modern technology began empowering projects, shifting them from the traditional formation to the innovation stage.

(1) Perception of Technology Risk

As the core responsible participant, the management institution of Dujiangyan motivates and guides project technological innovation through its understanding of traditional technique defects and new technology risks (The codes are detailed in Table 1). Traditional techniques, despite being adapted to the that times, had significant shortcomings and couldn't meet the demands of rapid development. Consequently, managers introduced modern project technologies and carry out technological innovations, which led Dujiangyan into a phase of climactic and rapid development.

Table 1. Typical examples about perception of technology risk.

First-order concepts	Typical examples
Defect of traditional technology	“Before 1949, bamboo cages and pebbles have been used to build the weir, but they are not durable.”
Abuse of new technology	“Fish mouth Reservoir Project Called Off because of heritage conservation and functionality issues.”

However, during the introduction of modern technologies, participants in megaprojects also face the misuse of new technologies caused by insufficient awareness of technical risks. For example, construction of the Fish Mouth Power Station, officially began in 1958 and was halted and dismantled in 1961. During its initial construction phase, unresolved issues emerged: the annual sediment load of nearly 10 million cubic meters from the upper Min River easily silted up the reservoir. History proves that megaprojects defying natural and technical principles cannot endure.

(2) Practices of Systematic Innovation

Due to the integration nature of megaprojects regarding innovative elements, the innovation paradigm has evolved from the “element view” to the “system view”[6]. The management institution of Dujiangyan carried out systematic innovation practices in the irrigation area while partially reconstructing the water - diversion project (The codes are detailed in Table 2. To address the long-term issue where the old irrigation area only irrigated the Chengdu Plain on both sides of the Min River, leaving water sources under -utilized, it adopted a systematic innovation combining plain direct irrigation and hilly- area storage irrigation. Using the mountainous conditions, it formed a new expanded irrigation area that combines water diversion and storage.

Table 2. Typical examples about practices of systematic innovation.

First-order concepts	Typical examples
Coordinated management	“Building water storage and irrigation systems to provide systematic irrigation to both hills and plains.”
Preventive Control	“The Leidui and Bottle Mouth of Dujiangyan were thoroughly reinforced with concrete.”

Evidently, in the interaction between project system and nature system, technology empowerment should adhere to the principles of natural laws, achieving alignment with nature at a higher level. This approach benefits humanity while striving to exert positive effects on nature. For instance, compared to the Fish Mouth Power Station, the construction of hilly-area storage and irrigation reservoirs exemplifies engineering layouts and design choices tailored to regional characteristics. Through a coordinated operational system, these projects achieve context-sensitive outcomes in the modern era. The balance between human demands and the preservation of nature’s intrinsic value lies at the core of the enduring success of the Dujiangyan irrigation system.

4.3 Governance Expansion: From Society to Ecology

The external institutional environment and technology empowerment further activate the adaptive adjustment and innovation of traditional institutions.

(1) Social Governance

Social governance shows adaptive features of government leadership and public participation. In the early 1950s, the drought - prone areas east of Chengdu Plain's Long Quan Mountains and the hilly areas of eastern Sichuan were short of water, creating many impoverished groups. Faced with the social responsibility of project expansion and poverty alleviation to achieve social justice, the management institution of

Dujiangyan, as the governance entity, met the new social demands by creating more inclusive value through streamlined hierarchical management and military-civilian co-operation. The codes are detailed in Table 3.

Table 3. Typical examples about social governance.

First-order concepts	Typical examples
Streamlined hierarchical management	“Establish a three-tier professional management structure consisting of bureaus, divisions, and stations.”
Military-civilian cooperation	“In the 1950s, the policy of work-for-relief, universal mobilization, and labor-based remuneration was adopted.”

However, while technology empowerment and social governance enable rapid value expansion, they increasingly reveal disruptive impacts on ecosystems. For example, since the 1980s, Chengdu’s industrial development, population growth, and rising living standards have led to increased discharge of industrial and domestic wastewater. It is evident that expanding agricultural, industrial, and domestic water demands increasingly encroach upon ecological water requirements for natural rivers and urban systems, while mutual infringement between values intensifies.

(2) Ecological Governance

The scarcity of water resources is gradually highlighted, but the urban industrial water, domestic water use has increased significantly, the damaging impact of engineering development on the water environment has exceeded the carrying capacity of the existing ecosystems, and gradually exposed the traditional management institutions and methods of non-adaptation.

Driven by water scarcity and urban high-quality development, ecological governance further promotes the sustainable delivery of value. The codes are detailed in Table 4. From a vertical perspective, a multi-level organizational structure has formed, ranging from the general public, grassroots managers to senior decision-makers, achieving coordination among governance at different levels. From a horizontal perspective, the three-tier management entities have gradually expanded to include diverse collaborators such as water-using enterprises, cultural and tourism organizations, tourists, and the media.

Table 4. Typical examples about ecological governance.

First-order concepts	Typical examples
Integrated reform	“Integrate management offices and stations into the development center for unified management.”
Introduction of market mechanisms	“Establishing a trading platform and exploring the water rights trading and circulation model”
Cultural cultivation of the public	“Enhance public awareness of water-saving practices via media outreach.”

4.4 Value Delivery: Sustainable Expansion

(1) Functional Value Transition

Under the influence of technology and social demands, the dominant functional value has been constantly changing and iterating, reflecting the demands of the times. On the one hand, the project has been empowered by technology to deliver more robust support functions, such as the continuous reinforcement of flood control and the development of hill - area storage irrigation. On the other hand, the release of social and technological productivity has also led to the decline of certain functions. With the improvement of transportation in Sichuan and the rise of rail and air transport in the 20th century, the shipping and timber - floating functions gradually declined and even disappeared.

(2) Socio-ecological Value Leap

Under the evolution of functional values, Socio-ecological values have achieved significant leaps. The most visible manifestation is the rapid expansion of irrigated areas. The surge in socio-economic value has played a vital role in urban economic growth and social stability. Concurrently, in the modern era, the ecological value of the megaproject has gradually become prominent. The construction of the Dujiangyan fundamentally improved the urban and rural ecological environment of the Chengdu Plain.

5 Conclusions

5.1 Adaptive Governance Model for Megaproject Innovation

The adaptive governance framework constructed in this paper reveals that sustainable value creation depends on the interplay of tradition inheritance - technology drive - governance expansion (Fig. 1). Firstly, project traditions provide stability to the governance system and ensure that innovations do not subvert the core functional values of the project. Secondly, technological innovation and governance innovation constitute a two-way driving mechanism. The former breaks through the efficiency bottleneck through technology empowerment, while the latter reconfigures the governance boundary through adaptive expansion. In this process, social governance focuses on the coordination of the short-term demands of contemporary pluralistic subjects, while ecological governance expands the scope of vision to the maintenance of system resilience and intergenerational distribution of resources, which is a vertical deepening of the governance hierarchy and ensures the sustainability of value. Therefore, the governance framework of modern megaprojects needs to go beyond the limits of the traditional project cycle and be orientated towards the long-term survival of public goods.

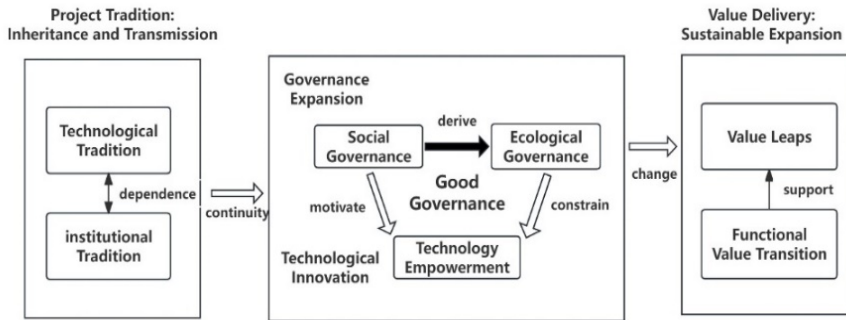


Fig. 1. Adaptive Governance Model of Megaproject Innovation

5.2 The Connotation of Shouzheng Innovation in the Adaptive Governance Process of Megaprojects

In the context of megaprojects, the principle of “Shouzheng and innovation” can be deconstructed into a theoretical framework of ‘value rationality - instrumental rationality - institutional rationality’.

Goal-calibrated development direction. Taking public interest and intergenerational equity as the value orientation, the goal shift of innovation is constrained to ensure that technological empowerment always serves the sustainable survival of human society.

Laws set scientific boundaries. Based on the laws of nature and the inherent logic of engineering science, the ‘feasible domain’ of innovation is constructed to allow technological breakthroughs while avoiding systemic risks.

Culture shapes the ethics of practice. Transform the core spirit of tradition (e.g., craftsmanship, ecological wisdom) into the cultural genes of modern governance, and resist the erosion of engineering ethics by utilitarianism through institutional design and organizational identity.

6 Research Contributions and Implications

6.1 Theoretical contributions

First, The research develops an adaptive governance model for megaproject innovation, exploring the dynamic interplay between governance expansion and technological innovation from the perspective of technical and institutional elements. It reveals the black box of the innovation process from traditions to value delivery. Second, by examining the adaptive governance process for megaproject innovation, the research analyzes the interaction between the stability and change nature of Shouzheng Innovation. Unlike previous studies, Shouzheng, provides targets, incentives, and constraints for innovation, while innovation in turn promotes Shouzheng.

6.2 Practical Implications

The study offers three main practical insights for modern megaprojects. First, in technological innovation, it is crucial to enhance project management and cultural development to guide technology towards good. Second, in social governance, social equity and inclusive development should always be the core of social responsibility governance. Third, in ecological governance, it is important to actively innovate management approaches and explore multi-channel control involving the government, market, and culture to achieve sustainable value across intragenerational and intergenerational.

6.3 Future Research Perspectives

The study is a qualitative analysis. Future research could adopt a multi-stakeholder perspective and use quantitative methods to test the relationships among the key elements of the governance framework.

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