Theoretical Guidance System for Ultra-high Voltage Engineering Construction Adapted to External Environment

Liyu Xia*, Jiaping Han, Wan He, Lanjun Xu

State Grid Energy Research Institute, Beijing, 102209, China

*Corresponding author: xialiyu@sgeri.sgcc.com.cn

Abstract. Ultra high voltage engineering is an important carrier of the new energy supply system. Modern management theory provides systematic management methods and tools that can help power grid companies better collaborate with external entities. The goal should be to promote high-quality development of ultra-high voltage construction, and modern management theories should be widely applied. This article is based on a new stage and establishes a theoretical guidance system for the construction of ultra-high voltage engineering that adapts to the external environment, ensuring the smooth progress of the project. Research the interdisciplinary and high-quality collaboration between internal and external departments in the field of ultra-high voltage engineering construction, discuss the resource allocation among multiple ultra-high voltage projects during the same period, analyze and solve current problems, and plan for long-term development in a dialectical relationship.

Keywords: Ultra-high Voltage Engineering, External Environment, Collaborative Development, Theoretical System.

1 Introduction

The construction of ultra-high voltage projects involves multiple fields and departments, including planning, urban construction, land and resources, transportation, railways, water conservancy, forestry, agriculture, and local governments. The above-mentioned external entities have different rights and responsibilities in the construction of the power grid. By establishing collaborative mechanisms, strengthening communication and cooperation, and emphasizing the balance of interests, the smooth progress of the project can be ensured. Modern management theory provides systematic management methods and tools that can help power grid companies better collaborate with external entities to ensure the smooth progress of projects. Combining management theory with the practice of ultra-high voltage construction has a significant driving effect on the development of management theory. Not only has it promoted innovation and development in management theory, enriched its application scenarios, promoted interdisciplinary integration, but it has also enhanced the practical value of management

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theory. Therefore, modern management theories should be actively introduced and applied in cross disciplinary and internal external cooperation in the construction of ultra-high voltage, providing strong guarantees for the smooth progress and sustainable development of ultra-high voltage construction.

Zhao et al. (2022) focused on the practice of the Luoshan Yangtze River Great Leap Ultra High Voltage Project and proposed that collaboration between industry, academia, research, and application is one of the key factors in leveraging the long function of the industrial chain [1]. Yang et al. (2018) studied the risk collaborative governance mechanism of sponge city construction projects from the perspective of urban sustainable development [2]. Liu et al. (2023) analyzed the dynamic evolution process of resource providers and receivers in collaborative innovation decision-making from the perspective of resource sharing among collaborative innovation entities [3]. Qi et al. (2021) summarized the experience of government enterprise collaboration in the pilot project of whole process engineering consulting [4]. Zhu et al. (2023) proposed a linear engineering project collaborative governance framework based on stakeholder theory, and proposed a collaborative governance path centered on fully respecting the interests and demands of all stakeholders [5]. Lin et al. (2023) used the theory of collaborative governance combined with the successful experience of road excavation management in Shenzhen as an example to establish a collaborative governance framework for construction project road excavation based on SFIC theory [6]. Fu et al. (2024) summarized important measures in the early stage of project integration collaborative management, including the construction of an integrated management system, a systematic collaborative mechanism, and a comprehensive linkage management model [7].

With the goal of enhancing cross disciplinary and internal external collaboration in ultra-high voltage construction, establish a theoretical guidance system for ultra-high voltage engineering construction that adapts to the external environment. At the cross disciplinary collaboration level, the main consideration is how to achieve higher quality collaboration in the entire lifecycle of ultra-high voltage engineering, including construction and planning, design, and operation. At the level of internal and external collaboration, the main consideration is how the construction of ultra-high voltage engineering can adapt to the external environment and better play its functional role. At the level of regional balance, the main consideration is how to scientifically allocate resources among multiple ultra-high voltage projects during the same period. At the level of time balance, the main consideration is how to iteratively enhance the management capabilities of ultra-high voltage engineering construction over time, and how to comprehensively address current issues and plan for long-term development.

2 Management Theory of Cross Disciplinary Collaboration in Ultra-high Voltage Engineering Construction

The cross disciplinary collaboration in the construction of ultra-high voltage engineering requires the use of the full life cycle theory to guide each profession to adhere to a

systematic thinking approach to the connection of work in each stage, the use of stakeholder theory to guide each profession to adhere to a win-win thinking approach to the balance of interests among all parties, and the use of risk management theory to guide each profession to adhere to a bottom line thinking approach to the prevention and control of various types of risks.

Using the theory of the entire life cycle to guide various majors to adhere to systematic thinking. The theory of full lifecycle management is a systematic approach and perspective used to evaluate and manage various aspects and impacts of products, services, projects, or systems throughout their entire lifecycle, emphasizing comprehensive factor management that considers all stages from product or service design and manufacturing to use, maintenance, retirement, and disposal. Full lifecycle management requires a unified management philosophy, objectives, organizational leadership, and management rules from the perspective of the entire project formation, operation, and exit process. The entire lifecycle of ultra-high voltage engineering involves stages such as planning, design, construction, operation, renovation, and retirement. Each preceding stage has a significant impact on the subsequent stages, and it is necessary to adhere to systematic thinking and consider the work of each stage in a coordinated manner. Using the full lifecycle theory, starting from the entire lifecycle of ultra-high voltage engineering, we aim to align the goals of each stage of construction, unify the management models and methods of various units, facilitate effective communication and exchange of information, optimize the work of each stage from a professional integration perspective, and ultimately achieve the predetermined goals.

Using stakeholder theory to guide various professions to adhere to a win-win mindset. Stakeholders refer to all individuals and groups who can influence the achievement of an organization's goals, or are affected by the process of an organization achieving its goals. Stakeholder theory refers to the management activities carried out by business managers to comprehensively balance the interests and demands of various stakeholders. This theory holds that the development of any company cannot be separated from the input or participation of various stakeholders. Enterprises pursue the overall interests of stakeholders, not just the interests of certain entities. The survival and development of enterprises depend on the quality of their response to the interests of various stakeholders. This comprehensive decision-making approach helps companies better balance the interests of all parties, achieve a win-win situation, and enhance their market competitiveness and investor attractiveness. The various stages of the entire life cycle of ultra-high voltage engineering require the joint participation of various professions such as planning, design, construction, and production. It is necessary to clarify the relationships between various professions and balance their interests. Using stakeholder theory, comprehensively considering the interests and requirements of various stakeholders, responding to the opinions and suggestions of various professions with high quality, reaching consensus on construction goals based on the opinions of various professions, and promoting high-level investment in various professions throughout the life cycle of ultra-high voltage engineering.

Using risk management theory to guide various majors to adhere to bottom line thinking. Risk management theory holds that risks are inevitable, but by taking appropriate measures, organizations can reduce uncertainty and better respond to potential

negative impacts, including risk identification, risk assessment, development and implementation of risk response strategies, as well as continuous monitoring and adjustment. Risk management theory emphasizes effective management throughout the entire lifecycle of risks to maximize the protection of organizational interests. Risk management theory mainly addresses minimizing the probability of adverse events occurring in uncertain environments and minimizing their negative impacts when they occur. Theory focuses on establishing a comprehensive risk awareness culture, identifying potential risk sources through systematic risk analysis, evaluating their impact and likelihood, and developing appropriate risk response strategies. The risks and hidden dangers of ultra-high voltage engineering may lie in stages such as planning, design, construction, operation, renovation, and retirement, and it is necessary to establish a bottom line thinking for eliminating and preventing risks at each stage. Using risk management theory, fully understand the chain negative effects that a single risk may cause from the perspective of the entire life cycle of ultra-high voltage engineering, carry out risk identification and assessment, develop closely connected risk response plans and management measures, and respond to the uncertainty of risk occurrence with the certainty of prevention and control measures.

3 Management Theory of Internal and External Coordination in Ultra High Voltage Engineering Construction

The environmental situation in which ultra-high voltage engineering construction is located continues to change, and the external entities of the related company system are complex and diverse. It is necessary to use macro environmental analysis methods to analyze the external situation faced by the engineering construction, and use situational analysis methods to clarify the advantages and disadvantages of the company's management of engineering construction.

Using macro environmental analysis methods to assess the external situation of ultra-high voltage engineering. The macro environmental analysis method is mainly used to evaluate the external environment in which a company operates, usually including four core areas: politics, economy, society, and technology. This method can help companies understand the opportunities and threats they face, and thus make more effective strategic decisions. The PEST analysis method is the most commonly used tool in macro environmental analysis, which evaluates the external environment of a company by analyzing environmental factors from four aspects: political, economic, social, and technological. PESTEL analysis method is an extension of PEST analysis method, which adds environmental and legal factors on the basis of the original four factors, and comprehensively considers various aspects of the external environment of the enterprise. The ultra-high voltage itself has the characteristic of a large individual scale, and due to different policies, fields, scenarios, etc., each ultra-high voltage project faces unique political, economic, social, technological, environmental, legal and other environments. For every ultra-high voltage project, it is necessary to use macro environ-

mental analysis methods to comprehensively assess the external situation it faces, especially severe situations such as government regulation, natural disasters, material supply, and external interactions. Scientific response strategies should be formulated in the early stages of ultra-high voltage project construction.

Use situational analysis methods to identify the strengths and weaknesses of the management team. The situational analysis method is widely used in enterprise strategy formulation, competitor analysis, project planning, and other occasions. Based on the internal and external competitive environment and conditions, it lists various major internal strengths, weaknesses, external opportunities, threats, etc. that are closely related to the research object through investigation and arranges them in a matrix form. Using the idea of system analysis, various factors are matched and analyzed to derive a series of corresponding conclusions, which usually have a certain degree of decision-making power. The situational analysis method can help enterprises or individuals clarify their own strengths and weaknesses, seize external opportunities and threats, and thus formulate more scientific and reasonable strategies and plans. Every ultra-high voltage project is associated with numerous external entities, including the government, design institutes, construction teams, equipment manufacturers, etc. It is necessary to clarify the company's position in the game with these entities. For each ultra-high voltage project, it is necessary to use situational analysis methods to comprehensively assess the strengths, weaknesses, and opportunities and threats faced by the construction management team, and develop strategies for interacting with external entities from the perspective of strengthening subject positioning and functional roles.

4 Management Theory of Regional Balance and Time Balance in Ultra High Voltage Engineering Construction

In the unconventional development stage, multiple ultra-high voltage projects need to be constructed at the same time, and the limited construction element resources in the time dimension form competition. It is necessary to use resource allocation theory to guide the company's overall allocation of various resource elements, achieve fair distribution and efficient utilization. In the historical process of ultra-high voltage engineering construction, the construction experience of previous projects has important reference significance for existing engineering construction. The resource utilization and institutional mechanisms of existing projects will also have an impact on future projects. It is necessary to apply dynamic capability theory to guide the iterative improvement of ultra-high voltage construction management capabilities, and apply sustainable development theory to guide the establishment of a future vision for ultra-high voltage construction management.

Use resource allocation theory to guide companies in managing and allocating various resource elements. As analyzed earlier, the essence of resource allocation is to maintain the optimal proportion and value orientation of scarce resources, improve resource utilization efficiency, and meet people's growing material and cultural needs. In the process of resource allocation, the principles of efficiency and fairness should be

followed, and efficiency should be given priority over fairness, or fairness should be given priority over efficiency, or both should be emphasized. For multiple ultra-high voltage projects constructed by the company during the same period, it is not only necessary to achieve optimal allocation of existing resources, but also to focus on breaking the boundaries of the total amount of resources to create more resources. When using resource allocation theory to guide the balance of resources among multiple ultra-high voltage projects at the company level, it is necessary to combine two methods: planned allocation and market allocation, with the goal of maximizing the overall economic and social benefits of the company, minimizing overall cost investment and risk losses, and paying more attention to the principle of fair resource allocation to form a good construction pattern for ultra-high voltage projects.

Applying dynamic capability theory to guide the iterative improvement of ultra-high voltage construction management capabilities. Dynamic capability refers to the elastic ability of an organization to quickly launch products, effectively grasp changing business opportunities, and continuously establish, adjust, and restructure its internal and external resources and intelligence to achieve competitive advantage. The dynamic capability theory is a theoretical framework for how enterprises can adapt to rapidly changing environments, create and maintain competitive advantages, aiming to explain how enterprises can obtain sustained competitive advantages in dynamic, complex, and uncertain environments. The dynamic capability theory emphasizes that a company's products, services, organizational structure, management processes, and corporate culture should continuously innovate and change to adapt to changes in the external environment. In the rapidly changing market environment, enterprises must have the ability to innovate quickly and respond in real time. They should quickly combine their advantages by building blocks, adapting to existing resources and capabilities through acquisition, restructuring, and combination, in order to form new competitive advantages. The company has successfully constructed multiple ultra-high voltage projects and accumulated rich construction experience, fully absorbing and flexibly applying construction experience to dynamically enhance the construction capacity of existing projects. Applying dynamic capability theory to guide the acquisition, restructuring, and combination of existing experience and capabilities in ultra-high voltage engineering construction, dynamically iterating to form new capabilities that are suitable for current ultra-high voltage construction management, will continue to enhance the theoretical height and capability level of ultra-high voltage engineering construction management.

Applying sustainable development theory to guide the management of ultra-high voltage construction and establish a future perspective. The main goal of sustainable development theory is to address a series of serious issues facing society, including climate change, resource depletion, ecosystem collapse, and social inequality. Along with economic development, it is necessary to reduce environmental pollution and resource waste, improve resource utilization efficiency, and enhance social fairness and inclusiveness. The principles of sustainable development theory emphasize meeting current needs without compromising the ability of future generations to meet their own needs, encouraging comprehensive consideration of social, environmental, and economic factors to ensure the long-term preservation of resources and ecosystems, and

achieving harmony between economic growth, social equity, and environmental protection. The construction of ultra-high voltage projects requires a significant investment of resources, taking into account the impact on the ecological environment and the influence of existing management systems and construction models on subsequent engineering construction. Guided by the theory of sustainable development, the company's ultra-high voltage engineering construction takes into account the sustainable and high-quality supply of resources, personnel, equipment and materials. In the formulation of the system, the relationship between current and long-term planning is coordinated to maintain the long-term coordination between the production relationship and productivity of ultra-high voltage engineering construction.

5 Conclusions

This article analyzes the dialectical relationship between modern management theory and the practice of ultra-high voltage construction, and reviews the results of research on multi-agent collaboration mechanisms in engineering construction. Based on the new stage of development, a theoretical guidance system for ultra-high voltage engineering construction that adapts to the external environment has been established. In terms of cross disciplinary collaboration, it is necessary to apply the full lifecycle theory, stakeholder theory, and risk management theory. In terms of internal and external collaboration, it is necessary to utilize macro environmental analysis methods and situational analysis methods. In terms of regional and temporal balance, it is necessary to use resource allocation theory, dynamic capability theory, and sustainable development theory.

The theoretical guidance system established in this article can guide the construction departments of ultra-high voltage engineering to carry out cross disciplinary and internal and external collaboration. This theoretical system is based on the professional standards of ultra-high voltage construction, and fails to discuss the collaborative relationships between various entities from a global perspective such as the country, industry, and enterprises. Next, we can consider further improving the theoretical system and analyzing the mechanism of ultra-high voltage engineering construction serving the high-quality development of the country and the energy industry.

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