Potential Risk Identification and Prevention of Large-scale UHV Construction Projects by Information Science

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Abstract—As China's power transmission technology matures, UHV transmission technology has shown the unique advantages in optimizing energy resources, air pollution controlling, and achieving sustainable human development. So UHV grid engineering practice has entered a rapid, large-scale development of new stage in our country. Under the background of large-scale construction, there are huge challenges for key resources and critical management processes. In this paper, the key process risk identification is carried out from the key management process by information science and date mining.

1. UHV PROJECT CONSTRUCTION SITUATION
In 2004, the State Grid Corporation of China proposed a primary strategic concept for building an ultra-high voltage power grid. Through a lot of research, demonstration and testing, engineering practice was formally started in 2006, and the first "Southeast Shanxi-Nanyang-Jingmen" UHV AC test demonstration project was started. In 2009, China's first UHV AC project was completed and put into operation, in 2010, China's first UHV DC demonstration project (Xiangjiaba-Shanghai Project) was completed and put into action. After ten years of unremitting efforts, State Grid Corporation of China has made comprehensive breakthroughs in UHV theory, technology, equipment, standards, etc., has overcome a series of global problems, and has mastered UHV core technology and complete equipment manufacturing capabilities with independent intellectual property rights. It occupied the commanding heights of the world's power transmission and transformation technology. Besides, with the advancement of strategies such as "One Belt One Road", interconnection, and global energy Internet, the State Grid Corporation's overseas UHV project tasks will gradually increase. The UHV development of State Grid Corporation has entered a new stage of large-scale construction. In the context of massive installation, helpful resources are tight, and risk points in all aspects of the projected increase. It is necessary to strengthen research and judgment and risk pre-control. Based on the risk identification results of the subject research, this paper uses the risk map method to carry out the quantitative evaluation of critical risks and proposes risk prevention and control measures.

In addition to the UHV as mentioned above projects, rural power grids, and distribution network upgrading and transformation projects, UHV supporting projects, pumped storage, and power adjustment projects will also be accelerated, and all levels of power grid construction will develop in a coordinated manner. Looking back at the development of the “Twelfth Five-Year Plan”, the State Grid Corporation’s total investment in power grid infrastructure is US$2,142 million, and the average annual
power grid investment is around US$42,840 million (as shown in the figure below). Around 71,400 million US dollars.

Figure 1. State Grid Corporation of China's power grid infrastructure investment

Besides, with the implementation of the "One Belt One Road" strategy, interconnection and global energy Internet, the construction tasks of the State Grid Corporation's overseas UHV projects will further increase. In short, large-scale UHV construction and continuous increase in power grid construction tasks will be the new normal. In the context of the massive development of UHV projects, in addition to the shortage of critical resources and the constraints of management capabilities, the risk points in each link of the project construction will increase significantly. Planning and scientific prevention and control must be carried out to prevent project construction risks and future safety stable operation risk. [1]

2. PROJECT RISK EVALUATION METHOD

Through comprehensive comparison and analysis of various methods such as expert scoring method, risk-reward method, decision tree method, risk equivalent method, production risk-oriented method, risk map method, analytical method, Monte Carlo simulation method, etc. (as shown in the figure below), according to the research The characteristics of the theme, we choose the risk map method for quantitative risk assessment. [2]

![Common risk assessment methods](image)

Risk map method: That is, to quantify the risk from two aspects: the importance of risk and the possibility of risk occurrence. The basic framework of the risk map is shown in the figure below. [3]
The quantitative assessment of risk is realized by questionnaire survey, and the specific method is Likert scale; according to the risk map framework, "risk importance" and "risk occurrence probability" are divided into five levels, and the corresponding meaning of each number is shown in the table below.

![Risk Map](image-url)

**Figure 3. Risk map**

Using the above risk evaluation methods, we conducted a quantitative risk evaluation based on the risk identification results.

### 3. IDENTIFICATION RESULTS OF POTENTIAL RISKS IN LARGE-SCALE CONSTRUCTION OF UHV PROJECTS

This paper adopts a four-step method for risk identification, namely risk decomposition, expert interviews, risk point listing, and specialist discussion and revision. The first step: risk decomposition. List all possible risk points based on theoretical analysis to form a preliminary risk list. Step 2: Expert interview. Combining the theoretical analysis of the potential risk framework, research and propose a list of questions, conduct expert interviews on specific issues, verify and correct the main risk points through discussions, and realize the first identification and screening of key risk points. Step 3: Integrated list of risk points. After completing the relevant risk interviews, the risk analysis framework designed by the research is used to regularize and analyze all risk points to form a new risk list consisting of specific risk points. Step 4: Experts discuss and modify. An expert seminar was held to discuss in detail the particular risk points of the third step, and the original risk list was revised based on expert opinions, and finally formed potential of 5 primary dimensions, 16 secondary dimensions, and 26 specific risk points. The list of risks is shown in the table below. The particular method is Likert scale; according to the risk map framework, "risk importance" and "risk occurrence probability" are divided into five levels, and the corresponding meaning of each number is shown in the table below.
| Number | First dimension | Secondary dimension | Key risk points |
|--------|----------------|---------------------|----------------|
| 1      | Design risk    | Path selection and change risk | People's self-protection awareness increases the difficulty of path selection |
| 2      | Design risk    | Path selection and change risk | The depth of the feasibility study leads to a higher risk of path changes in the initial stage. |
| 3      | Design risk    | Path selection and change risk | Path selection is greatly restricted by factors such as environmental protection, water conservation, and river crossing. |
| 4      | Design quality risk | Design quality risk | The degree of refinement of engineering design tends to decrease. |
| 5      | Equipment supply capacity risk | Equipment supply capacity risk | The main equipment/material market supply capacity is generally tight. |
| 6      | Equipment supply capacity risk | Equipment supply capacity risk | The essential materials/components of UHV leading equipment are highly concentrated, and they are subject to others. |
| 7      | Equipment supply capacity risk | Equipment supply capacity risk | UHV leading equipment/material suppliers are not enthusiastic about preparing for production in advance. |
| 8      | Equipment supply capacity risk | Equipment supply capacity risk | Large cargo transportation safety risks are higher. |
| 9      | Equipment supply capacity risk | Equipment supply capacity risk | It's not easy to maintain the high reliability of UHV leading equipment continuously. |
| 10     | Equipment supply capacity risk | Equipment supply capacity risk | Lack of a unified dispatching mechanism for essential equipment/materials of UHV projects. |
| 11     | Construction team risk | Construction team risk | Transmission and transformation companies rely on subcontractors too much. |
| 12     | Supervision team risk | Supervision team risk | The supervision team plays a limited role. |
| 13     | Owner management risk | Owner management risk | The excessive workload of employees at all levels of the company participating in the construction. |
| 14     | Owner management risk | Owner management risk | The provincial company lacks construction management personnel with UHV experience. |
| 15     | Owner management risk | Owner management risk | The enthusiasm for participation in the construction of national and provincial companies that do not transit through the border is not high. |
| 16     | External environmental risks | External environmental risks | The post-approval of soil and water conservation and environmental assessment increases the risk of future approval failure or adjustment changes. |
| 17     | External environmental risks | External environmental risks | The risk of external work resistance is more significant. |
| 18     | Construction safety risks | Construction safety risks | Cross-construction safety risks are more significant. |
| 19     | Construction safety risks | Construction safety risks | The line construction safety risk of UHV AC engineering is high. |
| 20     | Construction safety risks | Construction safety risks | The safety risk of UHV substation construction is high. |
Insufficient mechanized construction equipment brings higher safety risks.

The risks of starting, constructing, and managing projects in compliance with laws and regulations are increasing.

External attention and internal attention bring higher risks.

It is challenging to configure essential human resources across units in the construction of UHV projects.

More information demand subjects for UHV projects increase the difficulty of information management.

Insufficient testing and debugging capabilities of the provincial companies.

4. CONCLUSION AND SUGGESTION

This article uses a risk map method to carry out a quantitative evaluation for the critical management process risks in the large-scale construction of UHV projects. Through research, it is believed that under the background of massive development of UHV projects, there are prominent risk points of varying degrees of importance in design, equipment management, site management, test commissioning, and comprehensive management. Among them, the notable risks in the design process are path selection and change risks, and design quality decline risks; The significant risks in the equipment management link are the tight equipment supply capacity, the safety of Large cargo transportation, the continuous maintenance of equipment quality, and the coordination of resource allocation; The prominent risks in the on-site management link are the excessive dependence of the construction team on the subcontractor, the insufficient role of the supervision team, the shortage of the owner’s management team, external obstruction, and whether the construction safety complies with laws and regulations; The outstanding risk of the test and debugging link is the lack of analysis and debugging capabilities of the provincial company. The significant risks in integrated management are the risks of talent flow and information management.

Based on the above research results, the following suggestions are made for the State Grid Corporation to strengthen the risk prevention of the large-scale construction of UHV projects: first, attach great importance to risk prevention and control in each vital link, and strive to reduce the possibility of risk occurrence through effective prevention and control measures; second, Strengthen the strength allocation of owners’ management personnel and the construction of human resource allocation mechanisms; third, give full play to the professional management capabilities of directly affiliated units; fourth, strengthen material supply guarantees, and establish a unified material allocation mechanism; fifth, take adequate measures to actively guide suppliers to rationally improve, Utilize production capacity; sixth, optimize the allocation of construction, supervision teams, and construction equipment resources to assist them in improving their construction capabilities; seventh, accelerate the improvement of the test and commissioning capabilities of provincial companies; eighth, explore innovative ideas for project construction management models.

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