Research on Influencing Factors and Control Measures of Power Transmission Project Construction Progress

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Abstract. The construction of power transmission project has the characteristics of many points, long line, wide area, high cost and large investment, which also leads to many risk factors faced by power transmission and transformation construction, especially the risk factors of construction progress. Through the analytic hierarchy process, the factors affecting the construction progress are identified, and the fuzzy comprehensive analysis method is used to evaluate the risk. Based on the principle of maximum membership degree and objective reality, the overall progress risk of the power transmission project construction system is generally moderate, with policies and regulations being the biggest influencing factors. It is necessary to strengthen policy interpretation, intervene in advance, make scientific judgments, reserve appropriate margins, and actively communicate and coordinate with local companies and governments during the implementation process.

Keywords: power transmission project; construction progress; risk factors; analytic hierarchy process; fuzzy comprehensive analysis method; policies and regulations

1 Introduction

With the rapid development of the national economy, the demand for power resources in social production and life is increasing, and the requirements for power supply stability are also increasing, which poses a test for the construction of power transmission and transformation projects. The construction of power transmission project has the characteristics of many points, long line, wide area, high cost and large investment, which leads to high quality requirements and long construction period. At the same time, due to the field operation environment, there are many uncontrollable factors. Therefore, there are many risk factors faced by power transmission construction, especially the risk factors of construction progress, such as climate environment, personnel management, technical ability, geological factors, environmental protection policies and local government requirements. High quality and efficient project management is an important condition to ensure the high quality and high efficiency of power transmission and transformation project construction. At present, with the sig-

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nificant increase in the construction scale and quantity of power grid infrastructure projects, the investment scale is also constantly increasing, and the technical difficulty is significantly improving, resulting in a rapid upward trend of various uncertain risk factors. Risk management work has attracted the attention of all parties involved in the project. By delving into the risk factors present in power grid infrastructure projects and scientifically improving the level of project risk management, it helps management personnel effectively assess risks before making planning decisions, take corresponding avoidance measures, and further improve the economic and safety benefits of power grid projects. Therefore, it is urgent to analyze the influencing factors of power transmission and transformation project construction progress and explore effective measures to strengthen the control of power transmission and transformation project construction progress.

The theoretical research of schedule management in foreign countries was initially mainly from the perspective of optimizing project schedule, time and cost. In recent years, a new situation and new ideas have emerged in the research, which is based on the application of constraint theory, knowledge management, flexible management, key chain technology and earned value management[1-4]. The research on the theory of project schedule management started late in China, but in recent years, it has also explored the use of diversified research methods to gradually improve the traditional schedule management research, and has gained some effective research results[5-7]. Ma[8] analyzed and summarized the current situation of project schedule management, pointed out the advantages and disadvantages of management concepts such as restrictive factor theory and flexible management, and the research direction of computer technology in the field of schedule management application. Zeng[9] summarized and analyzed the application status of complexity science in engineering project management practice, systematically studied the complex characteristics in the implementation management of engineering projects, and established a project evaluation method based on AHP. On the basis of the existing research on construction management theory, Wu[10] proposed to fully integrate a variety of emerging information technologies to fill the lack of construction management methods and improve the level and efficiency of construction management. Overall, domestic and foreign experts and scholars have conducted in-depth exploration of engineering project management from different perspectives and used various analytical methods. These research results have played an important role in engineering project management. However, there are few literature that fully consider the internal and external influencing factors of power grid projects and explore the dynamics of risk management. Therefore, it is necessary to further conduct weight analysis on the factors affecting the progress of power grid projects, in order to provide reliable theoretical basis for risk identification and response measures in subsequent planning.

2 Identification of Influencing Factors

According to the source of risk factors, risk factors are summarized into two basic categories: external factors and internal factors. The external risk factors caused by the project environment have a wide range of influence. Internal risk is related to the project participants, which can be controlled by the project management team.

Further, from the nature of external factors, external factors are divided into two categories: policies and regulations, environmental risks, and so on; from the perspective of project participants, the internal factors are divided into two categories : owners and contractors. Due to the different roles of different participants in the construction project, the risks are also different, which can be further refined into 16 specific categories, as shown in Figure 1.

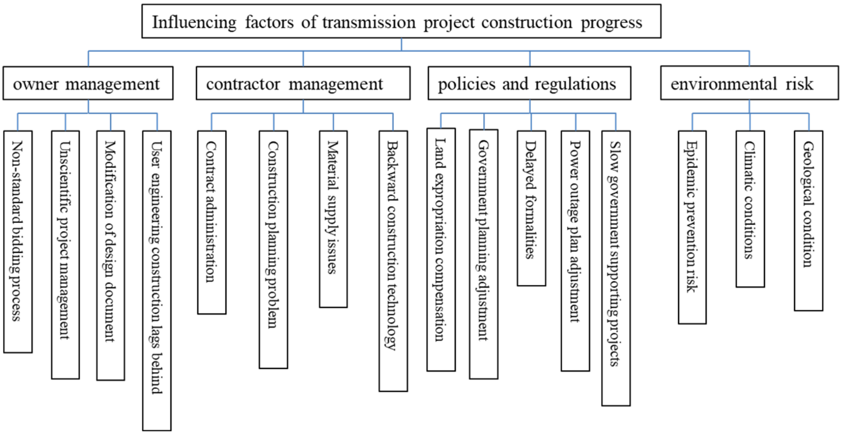

Fig. 1. Hierarchical diagram of risk assessment for the construction period of power transmission and transformation projects

3 Weight Vector Determination

The reason for choosing the AHP Fuzzy comprehensive evaluation model to evaluate the risks of power investment projects is that it simultaneously meets the following two requirements: (1) In the process of using the AHP to determine the weights of various evaluation indicators, evaluators only need to provide a qualitative description of the relative importance of each evaluation element, and then the weights of each evaluation element can be accurately obtained through the AHP. The AHP combines qualitative descriptions with quantitative calculations, which are based on rigorous scientific theories and will greatly improve the scientificity, accuracy, and effectiveness of evaluations.(2) When using the AHP Fuzzy comprehensive evaluation method for fuzzy comprehensive evaluation, it not only considers the influence of various factors on the evaluated object and integrates the opinions of multiple evaluation subjects, but also effectively solves various problems caused by the fuzziness of factors in the evaluation process. It can carry out scientific quantitative processing and organically combine qualitative evaluation with quantitative calculation, which is also conducive to improving the scientificity, accuracy, and effectiveness of the evaluation.

This section uses the Delphi method to score the four first-level indicators of owner management, contractor management, policies and regulations, environmental risks, and 16 second-level indicators through relevant experts. A total of 10 experts were invited to form a risk assessment team for the construction cycle of power transmission and transformation projects. The Delphi method was used to score each index, and the average value was finally summarized. The analytic hierarchy process was used to calculate the weight value of each index. Taking the weight value of the first-level index criterion layer as an example, first compare the two elements, and construct a comparative judgment matrix as shown in Table 1. Then the relative weight value is calculated by the square root method as shown in Table 2, and then the consistency test is carried out[11].

Table 1. Weight of criterion layer

Criterion Layer	Owner Management	Contractor Management	Policies and Regulations	Environmental Risk	Weight Value
Owner Management	1	3	3	5	0.512
Contractor Management	1/3	1	2	3	0.238
Policies and Regulations	1/3	1/2	1	3	0.1725
Environmental Risk	1/5	1/3	1/3	1	0.078

Using the same method, the weight values of 16 secondary indicators are obtained respectively, as shown in Tables 2 to 5.

Table 2. Weight Table of Owner Management

First grade indexes	Second grade indexes	Weight Value
Owner Management 0.512	Non-standard bidding process	0.261
	Unscientific project management	0.333
	Modification of design document	0.28
	User engineering construction lags behind	0.126

Table 3. Weight Table of Contractor Management

First grade indexes	Second grade indexes	Weight Value
Contractor Management 0.238	Contract administration	0.196
	Construction planning problem	0.24
	Material supply issues	0.245
	Backward construction technology	0.32

Table 4. Weight Table of Policies and Regulations

First grade indexes	Second grade indexes	Weight Value
Policies and Regulations 0.1725	land expropriation compensation	0.233
	Government planning adjustment	0.163
	Delayed formalities	0.198
	Slow Government Supporting Projects	0.099
	Power outage plan adjustment	0.307

Table 5. Weight Table of Environmental Risk

First grade indexes	Second grade indexes	Weight Value
Environmental Risk 0.078	Epidemic prevention risk	0.54
	Climatic conditions	0.163
	Geological condition	0.297

4 Establishment of Fuzzy Evaluation Matrix[12]

According to the evaluation level, the evaluation set H = (H1, H2, H3, H4, H5) = (very good, good, general, poor, very poor)

Establish evaluation matrix of power transmission and transformation project construction system.

Suppose that the fuzzy evaluation matrix is Kn, then Kn is shown as in (1).

$$K_n = \begin{bmatrix} K_{11} & K_{12} & \cdots & K_{1n} \\ K_{21} & K_{22} & \cdots & K_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ K_{n1} & K_{n2} & \cdots & K_{nn} \end{bmatrix} \tag{1}$$

Using the Delphi method, 16 secondary indicators were scored by experts, as shown in Table 6 to 9.

Table 6. Evaluation results of owner management risk factors

evaluating indicator	Evaluation results				
	very good	good	general	poor	very poor
Non-standard bidding process	0.1	0.4	0.5	0	0
Unscientific project management	0.3	0.3	0.4	0	0
Modification of design document	0.1	0.2	0.6	0.1	0
User engineering construction lags behind	0.1	0.3	0.5	0.1	0

Table 7. Evaluation results of contractor risk factors

evaluating indicator	Evaluation results				
	very good	good	general	poor	very poor
Contract administration	0.2	0.4	0.4	0	0
Construction planning problem	0.1	0.3	0.5	0.1	0
Material supply issues	0	0.2	0.5	0.3	0
Backward construction technology	0.1	0.4	0.5	0	0

Table 8. Evaluation results of policies and regulations risk factors

evaluating indicator	Evaluation results				
	very good	good	general	poor	very poor
land expropriation compensation	0	0.3	0.5	0.2	0
Government planning adjustment	0	0.2	0.6	0.3	0
Delayed formalities	0.1	0.3	0.5	0.1	0
Slow Government Supporting Projects	0	0.2	0.6	0.2	0
Power outage plan adjustment	0	0.3	0.5	0.1	0

Table 9. Evaluation results of environmental risk factors

evaluating indicator	Evaluation results				
	very good	good	general	poor	very poor
Epidemic prevention risk	0	0.1	0.6	0.2	0.1
Climatic conditions	0.1	0.3	0.5	0.1	0
Geological condition	0.1	0.3	0.4	0.2	0

Through the evaluation results table of the above factors, the evaluation results data are constructed into the evaluation matrix K1, K2, K3, K4 of each factor as shown in (2)

$$K_1 = \begin{bmatrix} 0.1 & 0.4 & 0.5 & 0 & 0 \\ 0.3 & 0.3 & 0.4 & 0 & 0 \\ 0.1 & 0.2 & 0.6 & 0.1 & 0 \\ 0.1 & 0.3 & 0.5 & 0.1 & 0 \end{bmatrix} \quad K_2 = \begin{bmatrix} 0.2 & 0.4 & 0.4 & 0 & 0 \\ 0.1 & 0.3 & 0.5 & 0.1 & 0 \\ 0 & 0.2 & 0.5 & 0.1 & 0 \\ 0.1 & 0.4 & 0.5 & 0 & 0 \end{bmatrix}$$
$$K_3 = \begin{bmatrix} 0 & 0.3 & 0.5 & 0.2 & 0 \\ 0 & 0.2 & 0.6 & 0.2 & 0 \\ 0.1 & 0.3 & 0.5 & 0.1 & 0 \\ 0 & 0.2 & 0.6 & 0.2 & 0 \\ 0.1 & 0.3 & 0.5 & 0.1 & 0 \end{bmatrix} \quad K_4 = \begin{bmatrix} 0 & 0.1 & 0.6 & 0.2 & 0.1 \\ 0.1 & 0.3 & 0.5 & 0.1 & 0 \\ 0.1 & 0.3 & 0.4 & 0.2 & 0 \end{bmatrix} \tag{2}$$

According to $M_i=A_i*K_i$, Through normalization, the comprehensive evaluation results of each factor can be obtained:

$$M_1 = A_1 * K_1 = \begin{pmatrix} 0.261 & 0.333 & 0.28 & 0.126 \end{pmatrix} * \begin{bmatrix} 0.1 & 0.4 & 0.5 & 0 & 0 \\ 0.3 & 0.3 & 0.4 & 0 & 0 \\ 0.1 & 0.2 & 0.6 & 0.1 & 0 \\ 0.1 & 0.3 & 0.5 & 0.1 & 0 \end{bmatrix} \tag{3}$$

$$= \begin{pmatrix} 0.1666 & 0.2981 & 0.4947 & 0.0406 & 0 \end{pmatrix}$$

Similarly, the comprehensive evaluation results of other factors can be obtained respectively :

$$M_2 = \begin{pmatrix} 0.095 & 0.328 & 0.481 & 0.096 & 0 \end{pmatrix} \tag{4}$$

$$M_3 = \begin{pmatrix} 0.053 & 0.273 & 0.525 & 0.149 & 0 \end{pmatrix} \tag{5}$$

$$M_4 = \begin{pmatrix} 0.046 & 0.192 & 0.524 & 0.184 & 0.054 \end{pmatrix} \tag{6}$$

Finally, the comprehensive evaluation result of the system can be obtained :

$$M = A * K = \begin{pmatrix} 0.512 & 0.238 & 0.1725 & 0.078 \end{pmatrix} * \begin{bmatrix} 0.167 & 0.298 & 0.495 & 0.041 & 0 \\ 0.095 & 0.238 & 0.481 & 0.096 & 0 \\ 0.053 & 0.273 & 0.525 & 0.149 & 0 \\ 0.046 & 0.192 & 0.524 & 0.184 & 0.054 \end{bmatrix} \tag{7}$$

$$= \begin{pmatrix} 0.12 & 0.292 & 0.499 & 0.084 & 0.004 \end{pmatrix}$$

According to the principle of maximum membership degree, the risk degree of the system is general. There are many places with certain risks that need to be improved. For example, there are some hidden dangers of progress lag in the bidding management, construction material management and construction technology of the owner. Among them, the risk sources with large hidden dangers need to be continuously monitored and rectified in time, so as to improve the progress level of the project system and reduce the probability of progress lag.

5 The Results of Evaluation Weight

The following evaluation results can be obtained by using the principle of maximum membership degree[13], as shown in Table 10.

It can be seen from the table that the maximum membership degree of the whole project system is 0.499, and the comprehensive risk level is grade III (general). The specific analysis is as follows :

(1) The maximum membership degree of owner management factors is 0.494, and the comprehensive risk level is general. By analyzing the evaluation results of owner management factors, it can be seen that the risk of design change factors in owner factors needs to be further reduced, and the level of bidding management and project

team management is generally acceptable. The lag of user engineering construction requires the owner management unit to further strengthen coordination and overall arrangement.

Table 10. Evaluation results of various factors of project system

Evaluation results	very good	good	general	poor	very poor
Owner Management	0.167	0.298	0.494	0.041	0
Contractor Management	0.095	0.328	0.481	0.096	0
Policies and Regulations	0.053	0.273	0.525	0.149	0
Environmental Risk	0.046	0.192	0.524	0.184	0.054
Owner Management	0.12	0.292	0.499	0.084	0.004

(2) The maximum membership degree of the contractor factor is 0.481, and the comprehensive risk level is general. By analyzing the contractor factor evaluation results table, it can be seen that there are great constraints on material supply. It is necessary to strengthen coordination with suppliers, make overall planning in advance, and ensure that materials can be supplied on time ; contract management and construction technology are relatively good ; the construction work plan needs to be further optimized to achieve comprehensive management and control by means of pre-prediction, in-process control and post-adjustment.

(3) The maximum membership degree of policy and regulation factors is 0.525, and the comprehensive risk level is general. By analyzing the evaluation results of policy and regulation factors, it can be concluded that the three managements of government planning adjustment, land expropriation compensation and government supporting projects need to be strengthened, especially the government planning adjustment needs to be strengthened. It is necessary to strengthen communication and coordination with the government planning department and perform the suspension procedure in time for the adjustment project.

(4) The maximum membership degree of environmental risk factors is 0.524, and the comprehensive risk level is general. By analyzing the evaluation results of environmental factors, it can be seen that the risk of epidemic prevention is the biggest factor restricting the progress of the project in the past three years. At the same time, climate factors such as cold winter and plum rain season are taken into account in the preparation of the schedule. For geological conditions, strengthen communication with exploration units.

6 Risk Management and Control Measures

Due to the large number of sub-items and large scale, there are many resources to be coordinated in power transmission and transformation projects, and various procedures are complicated. The project management company should intervene in advance and make scientific judgments. In the planning stage, it should combine the reasonable construction period and capital delivery plan, comprehensively consider various influencing factors, and reserve appropriate margins. In the implementation stage, in order to ensure the balanced start-up and balanced production of the full-caliber project, the constraints should be corrected in time, and finally the lean management and control of the schedule should be realized. In terms of policies and regulations, first of all, ensure that the construction of the project is in accordance with the law and compliance, and resolutely put an end to ' construction before approval ' ; secondly, carry out policy interpretation, advance intervention, make scientific research and judgment, reserve appropriate margin, and actively link local companies and local governments in the implementation process. In terms of economic and environmental risks, it is necessary to consider the country's political, policy, economic and social environment, so as to effectively predict the fluctuation of material prices in the market and formulate corresponding preventive measures. In terms of the owner's management ability, the construction unit needs to effectively achieve dynamic correction and scientific judgment in the process, and coordinate the allocation of material supply and the resource input of each participant. In terms of construction units, construction units need to establish a management system for the implementation of the schedule plan, implement target management, establish a regular meeting system, and introduce a system of reward and punishment for the construction period in order to ensure the enthusiasm of the work.

7 Conclusion

This article analyzes the factors affecting the construction progress of power transmission and transformation projects, establishes a construction progress risk assessment system and model, conducts risk assessment on the construction progress of power transmission and transformation projects, identifies the problems that affect the construction progress, and proposes corresponding rectification measures. Through research, the following conclusions have been drawn: the factors affecting the construction period management of power transmission and transformation projects can be divided into four categories: owner management, contractor management, policies and regulations, and environmental risks. Establish an evaluation table for each factor using the Delphi method and form an evaluation matrix. Using the weight value allocation set and evaluation matrix to calculate the progress risk assessment results of the subsystems, and based on these subsystem results, the overall evaluation result is calculated as Level III. There are many areas that need improvement, and the project has certain progress risks. Propose corresponding control measures for the risk level of each risk element during the evaluation process.

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