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The Optimization of Power Transmission and Transformation Project Management System under the Information Situation

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Abstract

Based on the computer network management, the power transmission and transformation project management system has been improved to achieve the optimization of the project information management system. First, the development of power transmission and transformation project management information system at home and abroad is studied, and the related literature is classified and summarized. Second, the development and application status of infrastructure management information system implemented by state grid corporation of China are described. Based on the analysis of the application status, the problems existing in the system application process are refined. According to the optimized management system, the consistency test and matrix normalization are carried out respectively, and the weight coefficient matrix A of evaluation index in construction stage is obtained. The weight coefficient matrix of the whole index evaluation system is A={0.2493,0.5936,0.1571}, and weight coefficient matrix in "construction stage" is A1={0.3422,0.1541,0.1770,0.2533,0.0735}. In view of the main factors, effective measures have been formulated to optimize the application of infrastructure management information system, and further clarify the application process of the system. Combined with the management practice of power transmission and transformation projects of power supply companies in the state grid, the implementation effect of system application optimization method is verified, and the application of infrastructure management information system of power transmission and transformation project is strengthened, which ensure the integrity, timeliness and accuracy of engineering information data, promote the in-depth integration of system application and actual business, and effectively promote the informatization process of power grid infrastructure.

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1. INTRODUCTION

In today's society, information technology has the characteristics of strong penetration and rapid development, and the engineering project is more complex, which lead to the project management information is very rich, showing new characteristics. In short, in modern engineering project management, project management informatization is one of the important means to improve the economic and social benefits of construction projects.

The informatization of project management system not only means the use of computers in the process of project management. First, based on the possibility provided by information technology, it can timely and effectively deal with the information that needs to be processed in the process of project management, which greatly reduces the repeated work and necessary work of different departments for project information processing. Second, project management informatization can be also used for timely supervision and information feedback, so that the organization of project engineering activity process is more scientific, which can correctly guide the development of project management activities, so as to improve the automation level in the process of project implementation [1].

The development and popularization of information technology is the construction and promotion of information network and information superhighway, which pushes human

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society irreversibly into the era of knowledge economy. At the same time, the application of Internet and e-commerce technology in the field of project management has promoted the innovation and development of project management theory, and realizing the informatization of project management has undoubtedly become the inevitable trend of the development of the times [2]. The core competitiveness of power grid construction project management increasingly depends on the application of information technology and the development of information resources. The level of project management informatization not only directly affects the economic benefits of power enterprises, but also affects the overall competitiveness of the country in the world [3].
The research of project management information system is mostly qualitative analysis and empirical single aspect research, and it has not been summarized and refined to form a comprehensive application system optimization method system [4]. The general concept, function realization and development trend of project management information system in the world are described in detail. Combined with the application status and application mode of management information system in practical engineering project management, it is pointed out that the application of management information system has far- reaching significance in modern engineering management.
Although in the power supply company's power grid construction project management, the power transmission and transformation project infrastructure management information system implemented by state grid corporation of China has always been adopted, there are still some problems in infrastructure information management [5]. Therefore, it is necessary to study the function and application effect of the new system platform, and on this basis, collect and sort out the needs and suggestions of power supply companies in the promotion and application of infrastructure informatization, so as to achieve the goal of optimizing the application of infrastructure management information system for power transmission and transformation projects.

2. METHOD

2.1 Informatization situation

Informatization is a new productivity, which is mainly an intelligent tool and historical process based on computer network. Informatization has its own characteristics and functions, which requires the ability of information acquisition, transmission, nursing, regeneration and utilization. Informatization plays an important role in today's society, which can promote information exchange and knowledge sharing to a great extent. It can not only increase the quantity of the economy, but also promote the qualitative change of the economy, and finally promote the economic and social transformation in terms of quality and quantity [6]. The concept of informatization can be understood from four aspects: informatization is a relative concept; it is a concept in dynamic development; it is a gradual process; it is the product of technological revolution and industrial revolution; it is a new productivity and also a new science and technology with the most vitality and high permeability [7]. There are many elements of informatization, as shown in Figure 1.

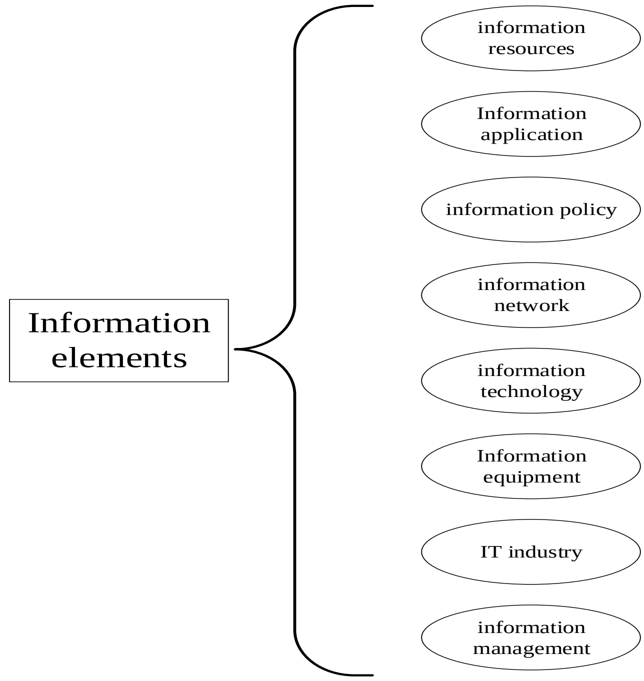

Figure 1 Elements of informatization

Engineering project informatization mainly includes two aspects. One is the hardware condition of informatization, and the other is the software condition of informatization. The hardware condition of China's current engineering project management informatization is not far behind that of western developed countries, but there is a big gap in the software of project management informatization. From the software point of view of engineering project management system, engineering project management informatization has experienced the following stages, and certain results have been achieved in each stage, as shown in Table 1.

Table 1 Engineering project informatization stage

Stage	Software system	Application area
The first stage	Centralized project management information system based on mainframe computer	Large scale national defense projects; Civil engineering projects
The second stage	Desktop Project Management Information System Based on personal computer	Energy; Traffic; Water conservancy; Electric power
The third stage	Project management training of project management information platform based on PIP	Wider application fields
The fourth stage	Project collaborative management platform based on network technology	All Internet resources are fully connected, realize the comprehensive sharing of resources and information.

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2.2 Information management system of power transmission and transformation project and its existing problems

The establishment of project management information system is the premise of high-quality project completion. A project information management system has the general characteristics of general information system, and Figure 2 shows its overall mode.

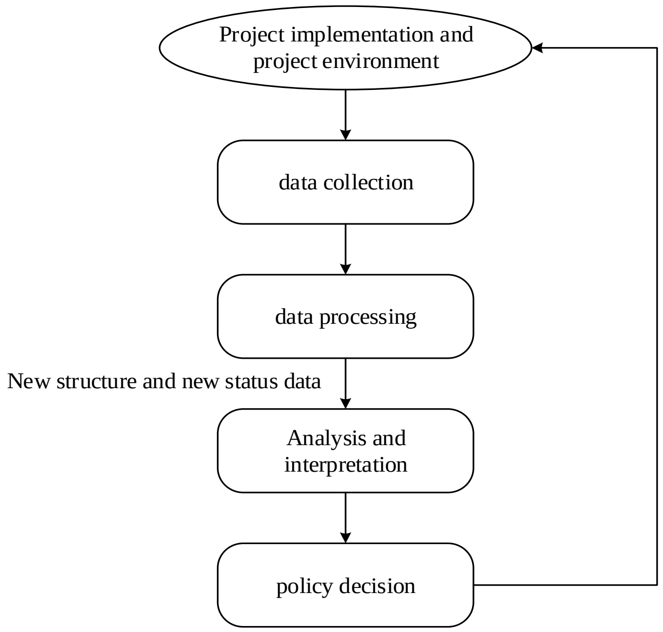

Figure 2 Schematic diagram of overall mode of information management system for power transmission and transformation project

Due to the increasing demand for electric power, there are more and more engineering projects which are more and more complex, the application scope of the system is constantly expanding, the system application functions are constantly updated, and the work of daily operation and maintenance of system data are also increasingly large, so it is difficult to realize the comprehensive application of information system, let alone ensure the accuracy, timeliness and integrity of system data [8]. Therefore, the problems existing in the application of the system are analysed, which mainly show in the following aspects.

(1) The application scope of the system is more and more extensive. However, in the development planning department, the characteristics of extensive management of decision-making process still does not change, which leads to the gap between the actual node of power transmission and transformation project construction and the system milestone plan, and then leads to the distortion and failure of information transmission and management.

(2) The scale of management investment is huge and there is not enough practical experience in the management of complex process engineering projects, and the professional, precise and standardized project management ideas have not been formed, which makes some projects become mere formality in the application of information system.

(3) In the process management of the project, there is no convergence process with the whole project life cycle as the main line through each branch. The same project is still managed by multiple personnel and different departments according to the specialty between units, and the project manager responsibility system is not strictly implemented, so there is a problem of weak synergy.

(4) The application of the system starts late and there are many misunderstandings.

(5) The system needs to deal with a huge amount of data, and the system response error often occurs, but the targeted solutions and control measures cannot be classified and shared to the management information system [9].

In order to ensure the overall quality of infrastructure projects, improve work efficiency and management level, improve economic benefits, and successfully complete the budget needed for the completion of projects, it is extremely necessary to optimize and study it by the infrastructure management information system of power transmission and transformation projects.

2.3 System application process optimization model

In order to effectively sort out the application process of infrastructure management information system for power transmission and transformation projects, it is necessary to design the system application process optimization model by adopting the determined optimization design method on the basis of closely combining with the actual application of infrastructure management information system and aiming at the influencing factors of system application process. The comprehensive management ability of infrastructure department is mainly reflected in the management system construction and system construction of the department, while the participation team is mainly reflected in having no way of dealing with the complicated application operation process and fear of difficulties. This is the starting point, and the system application process optimization model is constructed, as shown in Figure 3.

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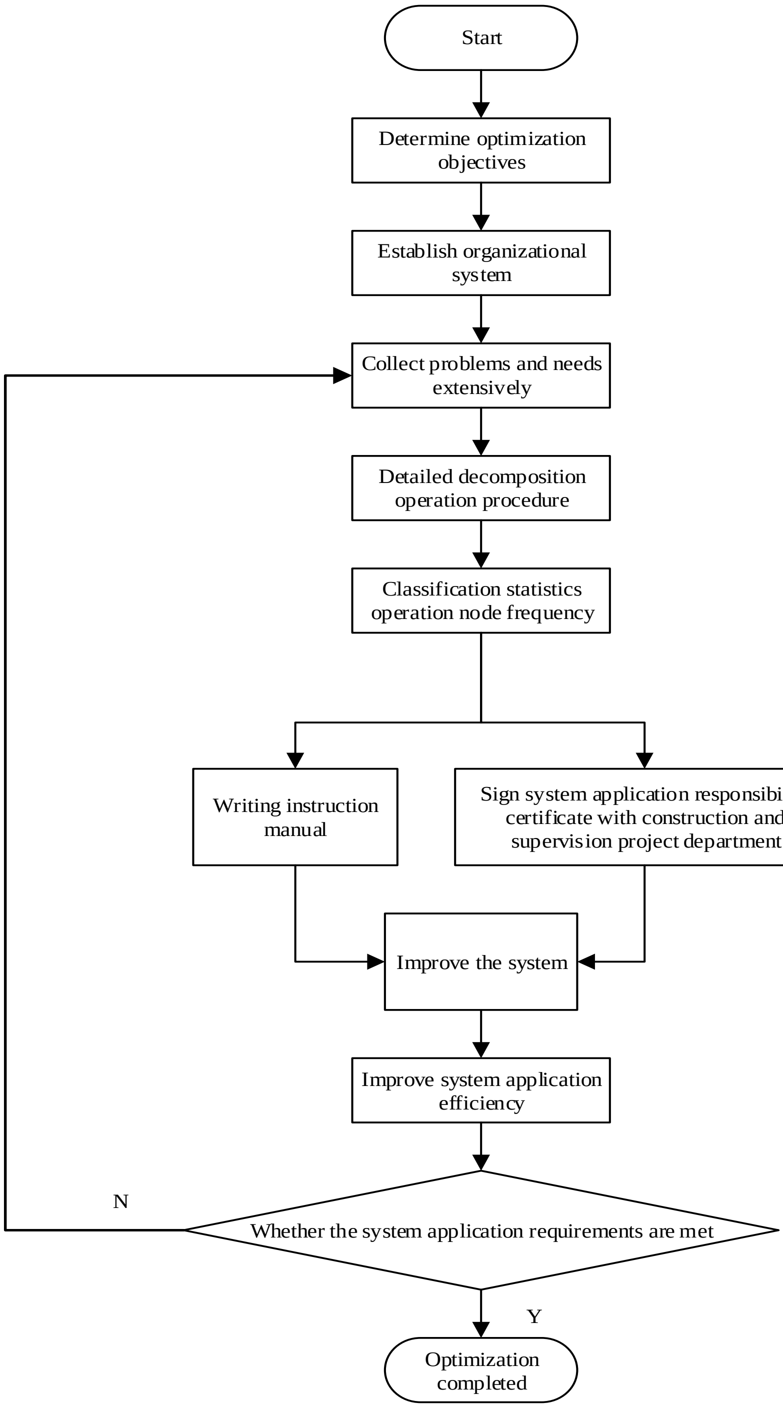

Figure 3 System application process optimization model

According to the principle of "setting up stage by information technology and performing by various specialties", the details of standardized operation nodes are divided into five specialties: project management, safety management, quality management, technical management and cost management [10]; according to the nature of the process, it is divided into two categories: functional process and engineering management application process. Among them, the functional process mainly includes data reporting and engineering adjustment of provincial companies; the application process of project management mainly includes application level, stage, operation time limit, operation frequency and specific data. Since some nodes of the functional process are automatically triggered by the system or pushed by the provincial company at a specific time, which is mainly the responsibility of provincial company or municipal company. Only the process of "no shutdown on major holidays" of safety management module is involved in the on-site project department [11]. Therefore, it is no longer described. The project management application process is sorted out by specialty according to the levels of project department and construction stages, and the main contents are described. According to the professional division and the operation node of construction sequence, the project management application process is divided into three stages: to be built, under construction, completed and put into operation. According to the construction stage, the operation nodes are sorted out, and the operation nodes of project management, safety management, quality management, technical management and cost management are summarized and counted. The number of operation nodes of project management specialty is the largest and the system function requirements are the most complex. Therefore, only project management specialty is taken as an example, and the subdivision method of operation nodes is described. There are 53 operation nodes in project management specialty. Figure 4 shows the distribution of business process and operation nodes.

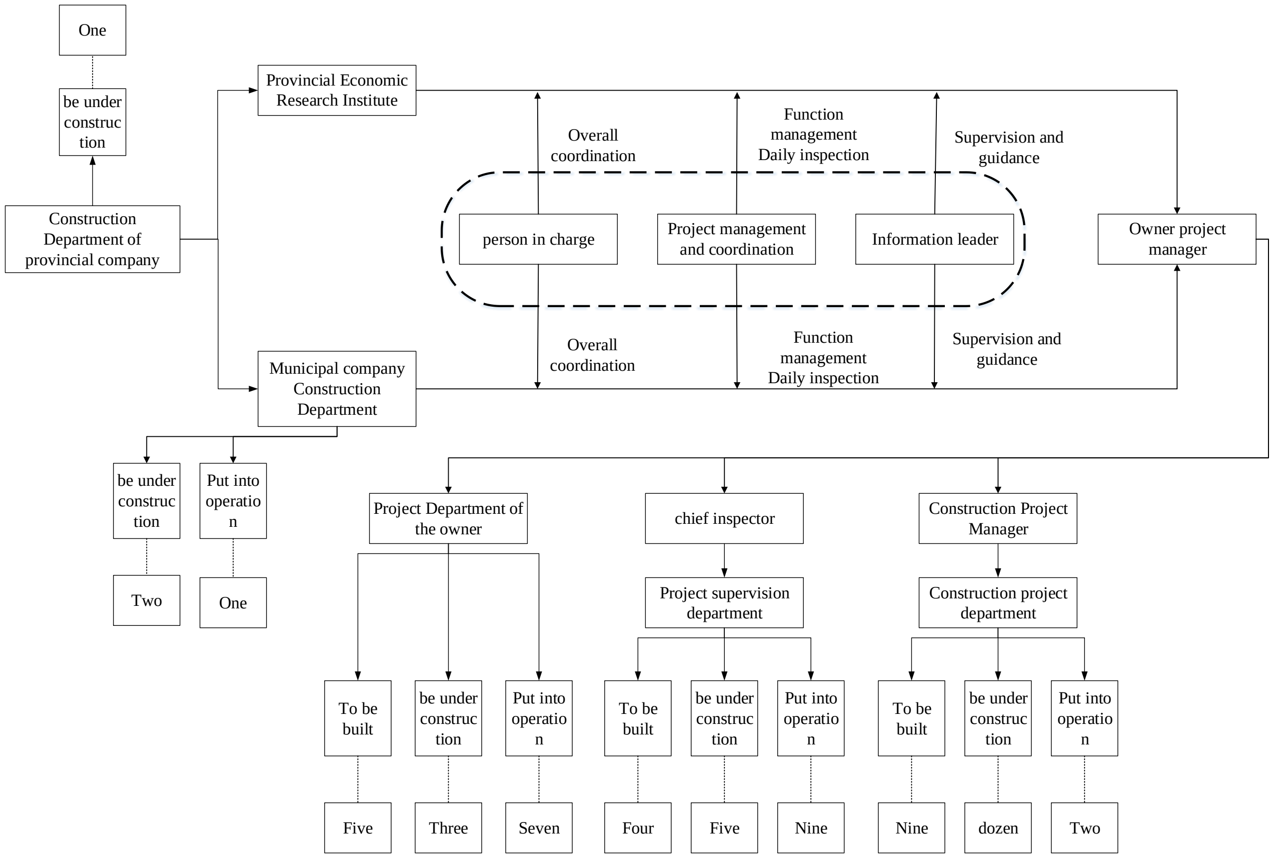

Figure 4 Business process and operation node distribution of project management specialty

2.4 Application evaluation of optimization system in construction management stage

According to the construction nature of the project, the set of design comprehensive evaluation factors U={safety and reliability U1, maintainability U2, expandability U3, economy and environmental protection U4, implementability U5, recyclability U6, and optimal life cycle cost U7}. Among them, U1={route scheme optimization U11, insulation design reliable U12, weather and environmental impact U13, protection strengthening measures U14}; U2={route selection U21, equipment and material selection U22, convenient location and traffic U23}; U3={included in the government planning U31, reduce repeated power cut and sent U32}; U4={main material selection u41, foundation selection U42}; U5={standardized application of results U51, general equipment selection of U52}; U6={efficient utilization of resources U61, resource recycling U62}; U7={coordination of function and cost U71, scheme optimization selection U72}.

In this project, to establish the fuzzy evaluation index system of the whole life cycle design of transformer substation engineering, the principle of weight calculation should be clarified first. First, cost is the direct performance to test the implementation effect of the whole life cycle, which is relatively important as the optimal index of life cycle cost. In addition, according to the construction situation of the project, as the core of the power transmission and transformation project, the transformer substation has high requirements on the technical standards of equipment and facilities, and has a large amount of maintenance and repair workload in the later stage. Therefore, the proportion of construction cost, labor cost and overhaul and technical transformation cost required in the construction process and follow-up is high, so the importance of safety, reliability and maintainability in the application of comparison matrix is high [12, 13]. In addition, the expansibility of the building has a great impact on the cost of expansion and reconstruction in the later stage, and it is also given more importance consideration in the weight calculation. According to the principle determined by the above weight, the design evaluation comparison matrix of the project is obtained.

$$Z = \begin{bmatrix} 1.0000 & 3.0000 & 3.0000 & 3.0000 & 3.0000 & 3.0000 & 0.5000 \\ 0.3333 & 1.0000 & 3.0000 & 4.0000 & 3.0000 & 3.0000 & 0.5000 \\ 0.3333 & 0.3333 & 1.0000 & 3.0000 & 3.0000 & 3.0000 & 0.5000 \\ 0.3333 & 0.2500 & 0.3333 & 1.0000 & 0.5000 & 0.5000 & 0.5000 \\ 0.3333 & 0.3333 & 0.3333 & 2.0000 & 1.0000 & 3.0000 & 0.3333 \\ 0.3333 & 0.3333 & 0.3333 & 2.0000 & 0.3333 & 1.0000 & 0.3333 \\ 2.0000 & 2.0000 & 2.0000 & 2.0000 & 2.0000 & 3.0000 & 1.0000 \end{bmatrix} \tag{1}$$

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Consistency detection: under normal circumstances, in order to avoid the inconsistency or contradiction of the matrix itself, the consistency test should be carried out when the judgment matrix is compared.

When the comparison matrix is strictly consistent, the positive and negative matrix Z becomes a consistent matrix. For a consistent matrix, the following conditions should be satisfied, as shown in equation 1.

$$b_{ii}=1,\ \ b_{ij}=\frac{1}{b_{ji}},\ \ b=\frac{b_{ik}}{b_{kj}},\ \ i,\ j,\ k=1,2,3.......,\ n \tag{2}$$

The weight of comparison matrix is calculated. The calculation methods of index weight mainly include square root method and sum method. The sum method is used for calculation here. The steps are as follows.

Each column of the comparison matrix is normalized.

$$\bar{b}_{ij}=b_{ij}\Big/\sum_{k=1}^{n}b_{kj}\,(i=1,2,...,n) \tag{3}$$

The comparison matrix normalized by column is summed by row. It can be obtained that:

$$\overline{W}_i=\sum_{j=1}^{n}\overline{b}_{ij}\,(i=1,2,...,n) \tag{4}$$

The vector $\overline{W}=\left[\overline{W}_1+\overline{W}_2+...\overline{W}_n\right]^T$ is normalized.

$$W_i=\overline{W}_i\Big/\sum_{i=1}^{n}\overline{W}_i\quad(i=1,2,...,n) \tag{5}$$

Then, $W=\left[W_1,W_2,...,W_n\right]^T$ is the feature vector.

3. RESULTS AND DISCUSSION

3.1 Evaluation index weight of construction management after system optimization

Equations (2) ~ (5) are used to check the consistency and normalize the matrix respectively to obtain the weight coefficient matrix A of the evaluation index in the construction stage. The weight coefficient matrix of the whole index evaluation system is A={0.2493,0.5936,0.1571}, and weight coefficient matrix in "construction stage" is A_1={0.3422,0.1541,0.1770,0.2533,0.0735}. The above first level factor index is the target layer, and the weight value of each index is calculated respectively, and then the construction stage evaluation table of power transmission and transformation project is established, as shown in Table 2.

Table 2 Evaluation table of construction stage

	First level evaluation index	Secondary evaluation index	Weight value		
			A	A_1	A_{12}
construction stage	people	Staff work	0.59	0.34	0.25
		Personnel status			0.75
	Mechanics	Mechanical operation		0.15	0.75
		Mechanical technology level			0.25
	Material Science	Material quality		0.18	0.75
		Material cost usage			0.25
	Method	Operation of organization		0.26	0.61
		Implementation effect of construction organization design			0.27
		Implementation of construction specifications and standards			0.12
	Environmental Science	Natural environment		0.07	0.25
		Cultural environment			0.75

The five evaluation grades of the evaluation system V=V={V1,V2,V3,V4,V5}={excellent, good, general, poor, very poor}, and the corresponding sub vector C={C1,C2,C3,C4,C5}={100,80,60,40,20} are set.

3.2 Application of management in construction stage of power transmission and transformation project

According to the above methods, the owner's project department organizes 10 experts from the construction management department of the power supply company, the operation and maintenance department of the power supply company and the supervision project department to participate in the project construction evaluation and scoring. Experts evaluate and score the secondary indexes of the first level index, and each secondary index has a total of 10 items of score. The final score of the secondary index is obtained by arithmetic mean. Through in-depth calculation of the indexes, the index evaluation scores of the construction stage are obtained as follows.

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Table 3 Scoring table of power transmission and transformation project in construction stage

	First level evaluation index	Weight value	Secondary evaluation index	Weight value	Score				
					Great	Good	General	Bad	Terrible
Construction stage	people	0.34	Staff work	0.25	0.4	0.2	0.3	0.1	0
			Personnel status	0.75	0.3	0.3	0.2	0.1	0.1
	Mechanics	0.16	Mechanical operation	0.75	0.6	0.3	0.1	0	0
			Mechanical technology level	0.25	0.3	0.1	0.1	0	0.5
	Material Science	0.18	Material quality	0.75	0.1	0.2	0.4	0.3	0
			Material cost usage	0.25	0.4	0.3	0.3	0	0
	Method	0.25	Operation of organization	0.62	0.5	0.2	0.2	0.1	0
			Implementation effect of construction organization design	0.26	0.5	0.3	0.1	0.1	0
			Implementation of construction specifications and standards	0.12	0.4	0.3	0.3	0	0
	Environmental Science	0.07	Natural environment	0.25	0.6	0.3	0.1	0	0
			Cultural environment	0.75	0.5	0.2	0.2	0.1	0

The fuzzy evaluation vector B_i of each evaluation index is obtained. The fuzzy relation matrix R^2 of each evaluation index in construction stage is composed of B_i.

$$R^2 = \begin{bmatrix} 0.325 & 0.275 & 0.225 & 0.1 & 0.075 \\ 0.525 & 0.25 & 0.1 & 0 & 0.125 \\ 0.175 & 0.225 & 0.375 & 0.225 & 0 \\ 0.4883 & 0.23856 & 0.18488 & 0.08828 & 0 \\ 0.525 & 0.225 & 0.175 & 0.075 & 0 \end{bmatrix} \tag{6}$$

Fuzzy analytic hierarchy process comprehensive evaluation B^2 of construction preparation stage is obtained.

$$B^2 = R^2 \times A_1 = \{0.3865,\ 0.2483,\ 0.2220,\ 0.1060,\ 0.0371\} \tag{7}$$

Comprehensive evaluation results w is:

$$W^2 = B^2 \times C = 0.3865\times100 + 0.2483\times80 + 0.2220\times60 + 0.1060\times40 + 0.0371\times20 = 76.822 \tag{8}$$

The comprehensive evaluation value of this stage is 76.822, which reaches the level of good evaluation level, so the overall evaluation is "good". It can be seen that the power transmission and transformation project management system is well applied in the construction stage, which shows that the requirements of various regulations and specifications are well implemented in the whole construction stage of power transmission and transformation project, the equipment operation and power supply load are in good condition, and the project can better meet the management requirements in terms of construction link control of human, machine, material, method and environment. However, the gap between the comprehensive evaluation score and the boundary value is very small, and it is necessary to analyze the individual relatively low score indexes, summarize the existing problems, and give sufficient enrichment and improvement in time.

4. CONCLUSION

At present, there are still many problems in the management of power grid infrastructure projects in China, which need to be improved and adjusted constantly. The construction management of power transmission and transformation project is a systematic project, and there are many problems in the existing management methods. At present, the best way to solve these problems is to build a perfect power grid infrastructure management information system. The optimization of infrastructure management information system method in power transmission and transformation project construction is the research focus and difficulty of this study. Infrastructure management information system is applied to the whole process of power construction project management. The application effect and existing problems are analyzed, and feasible optimization countermeasures are proposed to promote the sound development of power transmission and transformation engineering construction of power supply company. Power transmission and transformation project infrastructure management information system is the comprehensive embodiment of the normalization, standardization and specialization of infrastructure business management. The application of the system is closely related to the actual business. They are in real-time contact, support and reflect each other, reflecting the dialectical relationship between action and reaction. To improve the application level of the system is to enhance the overall management level. The improvement of the overall management level will promote the better application of the system.

2) Generally speaking, the infrastructure management information system of power transmission and transformation project is not only an information system, but also a comprehensive management means. Making good use of it is also a challenge to management ideas and basic management of various projects. In the informatization situation, the optimization of power transmission and transformation project management is analyzed systematically, which is of great significance to the actual power project engineering. However, the gap between the comprehensive evaluation score and the boundary value of the project is very small. There are still some deficiencies. In the future, some relatively low score indexes will be analyzed, the existing problems will be summarized, and sufficient enrichment and improvement will be given in time for more in-depth discussion.

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