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RESEARCH ARTICLE

RESEARCH ON THE SAFETY EVALUATION OF THE WHOLE PROCESS OF THE POWER DISTRIBUTION PROJECT OF H ELECTRIC COMPANY

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Abstract

As an important part of the power system, power distribution engineering projects play an important role in expanding the scale of the power grid and optimizing the structure of the power grid. However, there are many potential safety hazards in the safety management of power distribution projects, which seriously threaten the safety of people's lives and property, and may also cause a series of social problems. Only by effectively solving the problems of safety management can we better build power distribution projects. This paper studies the safety evaluation of the whole process of power distribution engineering projects of Shandong Henghe Electric Co., Ltd. (hereinafter referred to as "H Electric Company"), and adopts more abstract concepts such as "high" and "medium" to evaluate the rationality of the factors, which will help H Electric Company to effectively reduce the occurrence of safety accidents. With the continuous development of the times, the safety management of power distribution engineering projects has put forward higher and higher requirements for project participants. In view of the importance and particularity of power distribution engineering projects for economic development, in-depth research on the safety evaluation of power distribution engineering projects provides a useful reference for the project safety management of enterprises in the same industry.

Introduction:-

Power construction units need to find efficient safety management strategies, reduce or eliminate hidden dangers in power distribution projects, and further improve the safety management level of the project. In the early days of its establishment, H Electric Company focused on the production of power equipment products and provided electrical equipment products to customers. With the change of market demand, customers quickly tend to choose suppliers who provide turnkey services for power distribution projects, that is, power companies are required to not only provide electrical equipment products, but also provide integrated construction services. At the end of 2018, H Electric Company actively adjusted its strategy, recruited professional project management personnel, set up a construction team, and handled the power construction qualification to adapt to the changes in market demand. The company first

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contracted some small power industry expansion and distribution projects, and gradually accumulated certain project management experience. However, with the increasing scale of power distribution projects, the normative requirements for the professional ability and safety management of the construction team are also getting higher and higher. From 2019 to 2023, H Electric Company has had a number of safety accidents in power distribution engineering projects, resulting in 3 injuries and economic losses of more than 900 thousands yuan.

There are many safety management problems in the power distribution project of H Electric Company, which not only affect the smooth progress of the project, but also pose a serious threat to the company's brand image and long-term development. In this context, in order to ensure the smooth progress of the project, ensure the safety of life and property, improve the quality of the project and the company's efficiency, it is necessary to carry out in-depth improvement of the safety evaluation of the existing power distribution project. In this paper, this paper focuses on the safety assessment of the whole process of the power distribution project of H Electric Company.

The 10kV distribution room project of a certain city's traditional Chinese medicine hospital is a distribution engineering project undertaken by H Electric Company in 2023. This article uses this project as an example to verify the feasibility of fuzzy assessment in the entire process of safety management for distribution engineering projects.

1.2 Objective of the study

Through the analytic hierarchy process and fuzzy evaluation method, the strategy of safety evaluation of the whole process of the power distribution project of H Electric Company is proposed, so as to enhance the effect of safety management, reduce the occurrence of safety accidents of H Electric Company, and protect the life and health of employees and the property safety of the company.

This paper takes the power distribution project of H Electric Company as a case study to guide enterprises in the same industry to pay attention to the importance of safety assessment in the whole process of the project, and promote more power construction units to establish a sound safety assessment mechanism for power distribution projects, so as to improve the safety management level of projects in the same industry.

2.0 Literature Review

Scholars such as Guimarães (2022) in Brazil have proposed that there are more and more relevant risk factors that are demonstrated even without direct participation in the survey. In addition, it was found that government agencies generally do not review their own hazard control actions, limiting their potential improvements. This suggests that businesses and government agencies need to adopt a new paradigm for risk and accident analysis and work together to adopt a systematic approach to safety improvement.

Rodina (2019) of Omsk State University in Russia summarizes the risks arising from the generation of electricity from alternative energy sources such as solar, wind, hydroelectric engineering, which are based on the ebb and flow of the tide, the use of biomass power plants, etc. At the same time, a rapid diagnostic tool for alternative power engineering risks is proposed to confirm the economic feasibility of the investment. The results of risk assessment application of alternative power engineering reduce the level of information uncertainty associated with the transition to new energy sources or the diversification of energy supply.

Mwewa et al. (2021) in South Africa have proposed that small contractors need management strategies to implement occupational health and safety performance in their projects to reduce accidents, injuries, deaths, and illnesses. The success factors of a management strategy are considered to be of great benefit to improving safety performance. Evaluating the success factors of management strategies to improve safety performance in the Zambian power sector, using a quantitative approach, data was collected using a questionnaire from 246 respondents representing company owners, managers, project managers and construction representatives representing projects in the power sector, with a response rate of 70.3%. Using descriptive and inferential statistics as data analysis methods using exploratory factor analysis, success factors were summarized into three structural categories of safety performance, namely compliance and workplace processes, policy and human resource development, and leadership and social responsibility.

Scholars such as Daroń (2019) in Poland analyzed accident data from the 2012-2017 study period, provided a brief overview of the internal health and safety inspection activities carried out by companies on a regular basis, and also analyzed the activities to improve the occupational health and safety management system in the selected study entities. Introducing the scale and type of activities in the field of improving health and safety and included in the company's business strategy, analysis based on the data allows for a comprehensive assessment of the health and safety management system of employees.

Scholars such as Kosterev (2019) at the National Technical University of Ukraine have devised a fuzzy model for estimating the allowable level of risk for emergencies in the power system, which takes into account criteria such as the lowest possible level of risk, the impact of meteorological conditions, and errors on the part of power system operators. In this case, the main factors affecting the operational reliability of the grid can be considered to assess the risk level of the emergency. The results obtained from the fuzzy model help to reliably assess the acceptable level of risk for emergencies in the power grid. Depending on the size of the risk, an informed decision can be made about the expediency of taking steps to reduce this risk. This makes it possible to organize the preventive management of emergency risks in the grid and take effective measures to reduce them.

Chinese scholar Ma Lei and others (2023) proposed that in view of the pivotal role of the power industry and the critical importance of grid reliability, it is imperative to strengthen the safety management of power supply enterprises. Solving this problem requires taking proactive measures to prevent and mitigate power production accidents, minimize safety risks, and reduce the occurrence of grid failures. This study takes the safety production risk management of electric power enterprises as the research object, and explores the application of risk management theory in power production, transmission and distribution. The first step in power engineering safety risk management is to accurately and comprehensively identify risk factors. Only when these factors are effectively identified can risks be properly analyzed and controlled. Focusing on the identification of safety production risks in electric power enterprises, the literature research method and expert interview method were used to identify the safety production risks in the field of electric power engineering. The study assessed the potential risks in the operation of real-world utilities and described methods for safety risk assessment and control in the power sector.

Chinese scholar Wang Yiting (2024) proposed that in the construction of power engineering in the distribution network, it is necessary to establish a safety system that can effectively solve various problems in the actual application process. First of all, it is necessary to strengthen the technical training of staff. Relevant personnel must have strong professional skills, a sense of responsibility and rich experience to ensure that the whole team can perform the corresponding functions well; Secondly, it is also very important to strengthen the management level of construction personnel quality management, so as to ensure that all aspects of power engineering construction can complete the task in accordance with the specified requirements, so as to effectively reduce the probability of safety accidents; The last point is to establish and improve the emergency plan, and in the actual operation process of the power distribution network, once there is a safety incident, the relevant personnel must take corresponding measures to deal with it as soon as possible.

Chinese scholar Li Shilin (2024) proposed to use the fuzzy comprehensive evaluation method to evaluate the level of construction safety management of Company Z's project, and analyze the evaluation results accordingly. Then, on the basis of the evaluation results, combined with the interview method, the main problems of construction safety management of Company Z project were identified, and it was found that the enterprise had problems such as unreasonable safety organizational structure, imperfect safety management system, and relatively weak safety awareness, and the main reasons for these problems were the difficulty in the innovation of enterprise organizational structure, the backward safety production management model and the lack of a good safety culture atmosphere. Finally, based on the existing problems, the improvement countermeasures for the construction safety management of the project of Company Z are proposed.

Chinese scholar Ding Yan and other scholars (2020) have proposed that in the field of electric power, construction technology and safety management play a decisive role in the smooth development of electric power engineering. Among them, technology is the foundation of power engineering, and safety management is the guarantee to improve the operation efficiency of power engineering. Actively studying advanced construction technology and continuously strengthening project safety management are issues that electric power engineering units have been exploring. The development and application of power engineering should be analyzed and elaborated from the perspective of technology and safety management, various problems should be identified, and corresponding suggestions, measures, and methods should be put forward.

Safety risk management is a very important part of power project renovation and construction management, which plays a very important role in effectively controlling engineering accidents, reducing engineering risks, and improving safety management. Risk management in power engineering projects is a process of managing the various potential and uncertain risks that may arise through the use of appropriate management methods, which involves activities to identify, assess, plan and control project risks, minimize or eliminate the impact of adverse events, and improve the probability of project success. Through risk management, potential risks can be effectively dealt with, and corresponding preventive measures and emergency measures can be taken to ensure the smooth progress of power engineering projects. This study combines the research and impact of risk assessment techniques in the whole process of construction of power engineering projects, uses them to solve uncertain problems, analyzes the correlation between random events, and gives a complete probability evaluation result, which can be extended to other similar projects.

In terms of project process safety assessment research, foreign scholars design fuzzy models to estimate the allowable risk level of emergencies in the power system, and the main factors affecting the reliability of power grid operation can be considered to assess the risk level of emergencies. On the basis of the evaluation results, combined with the interview method, the main problems of the company's project construction safety management are identified, and the safety problems of the enterprise are found, and the main reasons for these problems are the difficulty in the innovation of the organizational structure of the enterprise, the backward safety production management mode and the lack of a good safety culture atmosphere. This paper plans to learn from the domestic scholar Song Jian's application of fuzzy evaluation method to construct a safety evaluation index system and obtain the corresponding risk assessment level, so as to prepare for each stage of the project.

3.0 Research Methods

3.1 Study the Specifics

Based on the understanding of the importance of safety management of power distribution projects in the current power industry, and the need for the safety evaluation of the whole process of the distribution projects of H Electric Company, the research direction is established. Carry out extensive literature and accident research, and collect relevant research results on the safety management of power distribution projects at home and abroad, including theoretical basis, practical cases, successful experience, etc. Through the comprehensive analysis of these literatures, we can understand the research status and frontier trends in this field, and provide theoretical and methodological references for the subsequent research on H Electric Company.

Through the company's daily management and field research, first-hand information is obtained, and the actual situation of the company's power distribution projects is analyzed. Conduct in-depth analysis and research from multiple perspectives, follow the practical principles, apply analytic hierarchy process and fuzzy evaluation method, and put forward specific evaluation strategies. Finally, the research results are summarized.

3.2Research Methods

There are many research methods for safety evaluation in the whole process of power distribution engineering projects, and this paper adopts the following:

(1) Literature research method By collating and analyzing the literature on the safety evaluation of power distribution projects at home and abroad, the current research status and development trend are understood, and the theoretical basis and reference basis for this research are provided.

(2) Field investigation method through the company's daily management to obtain first-hand information, on-site inspection of the power distribution project site of H Electric Company, and experts, management personnel, technical personnel and other construction personnel to have a deep understanding of the actual situation of safety management.

(3) Analytic hierarchy process Combined with the relevant theories of analytic hierarchy process, the main influencing factors affecting safety management are determined in view of the safety risks in the implementation process of power distribution projects, and the weights are determined at a deep level, so as to further construct the risk evaluation index system.

(4) fuzzy evaluation method many factors in the evaluation of the electric power construction process will be affected by external factors and the subjective consciousness of the evaluators, it is difficult to quantify a variety of factors, and more abstract concepts such as "better" and "general" can be used to evaluate the rationality of these safety factors, so as to provide a basis for the improvement of safety management.

The above methods can effectively evaluate and improve the safety management of the whole process of the power distribution project of H Electric Company.

3.3Theoretical Basis

3.3.1Theory of Risk Identification and Prevention and Control of Engineering Projects

The risk identification and prevention and control management of engineering projects includes the analysis of risks in project management activities, the preparation of special plans for project risk management, the identification of risks that may cause the project objectives to get out of control through experience, and after analysis, the probability and scope of each risk factor are quantitatively scored according to certain standards, and the list of hazards of the entire project is obtained accordingly, corresponding measures are formulated to supervise and manage the hazards. A hazard source, also known as a risk point, is an item or state with potential energy and dangerous release, which forms a hidden danger of a safety accident under specific conditions, and has a greater possibility of causing a safety accident.

3.3.2Theory of Whole-Process Evaluation of Safety Management

The purpose of the whole-process safety assessment of the project is to discover, analyze and predict the risk points, harmful factors and possible dangers, degrees and consequences existing in the process of project management, and put forward reasonable and feasible safety countermeasures and guidance measures for hazard monitoring and accident prevention, so as to achieve the purpose of reducing losses and increasing efficiency. The safety assessment of the whole process of the project is systematically controlled from the whole process of the project, and the optimal plan for making the system safe is established, which provides a basis for management decision-making and creates conditions for the standardization of safety technology and management.

4.0Analysis OfThe Current Situation and Problems of Safety Management of Power Distribution Engineering Project of H Electric Company.

In recent years, an important measure of H Electric Company in the safety management improvement of power distribution projects is to systematically evaluate the key indicators in the safety management process of power distribution projects, and then conduct safety assessments on the overall project, find out the safety weak links, and make preparations for all stages of the construction of the project.

1) *4.1 Construction of the Safety Assessment System for the Whole Process of the Project*

By analyzing the results of the identification of risk points in the project one by one, the safety assessment of the power engineering project is constructed to evaluate the whole process of power construction. Analyze the relationship between risk factors, and find out the problems that may affect safety in a certain link in the construction process of power distribution projects, so as to determine the cause of the accident. The construction process of power distribution projects can be divided into three stages: preparation stage, construction stage, acceptance and rectification. The degree of risk occurrence in the construction stage of power distribution projects is evaluated by fuzzy evaluation method.

The company's management organizes the establishment of an evaluation expert group, which is composed of the company's general manager, heads of various departments and safety management personnel. Clarify the overall goal of safety management of power distribution engineering projects, as well as safety assessment indicators such as equipment reliability, construction quality, personnel quality, and environmental factors, and ensure that each index has a clear definition and measurement standards for subsequent data collection and evaluation. In the form of convening an expert group meeting, fill in the "Investigation Form on Risk Factors of Power Distribution Engineering Projects", and preliminarily form a safety assessment model for power distribution engineering projects, as shown in Figure 4-1.

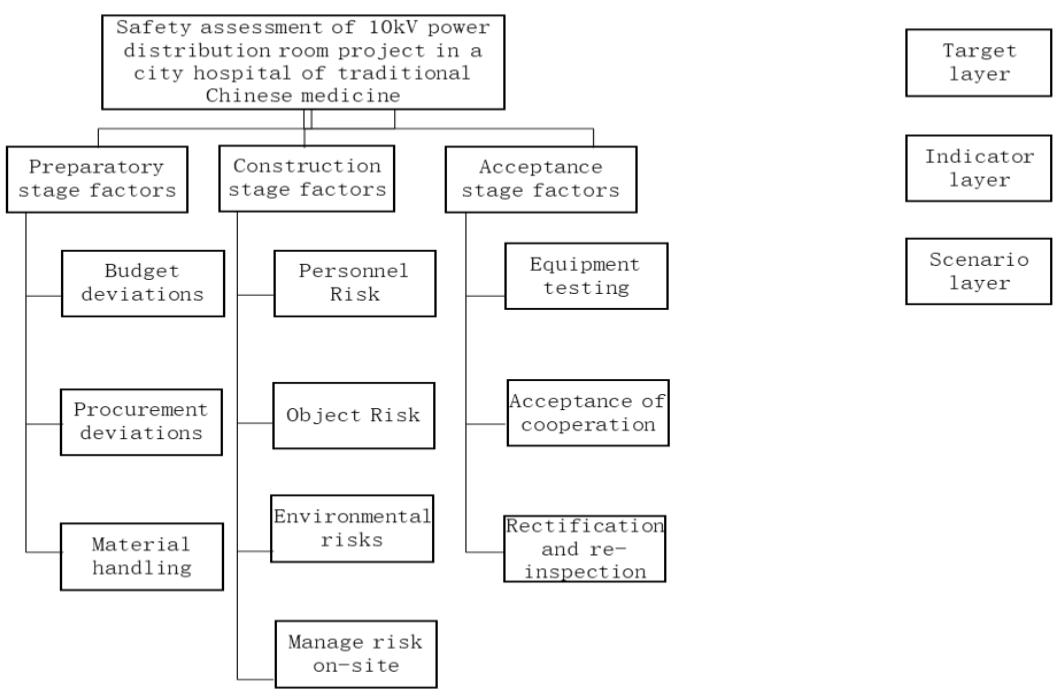

Figure 4-1: Safety assessment model diagram of a 10kV power distribution room project in a municipal hospital of traditional Chinese medicine

On the basis of the above safety assessment model, the safety assessment index system of the 10kV distribution room project of a city hospital of traditional Chinese medicine is established, as shown in Table 4-1 below.

Table 4-1:Safety evaluation index system of 10kV power distribution room project in a city hospital of traditional Chinese medicine

target	Level 1 indicators	Level 2 indicators
Safety evaluation index system of 10kV power distribution room project of a city hospital of traditional Chinese medicine	Preparatory Phase Factor B1	Budget deviation C1 Procurement deviation C2 Material Handling C3
	Construction Stage Factor B2	Personnel risk C4 Object risk C5 Environmental risk C6 Site Management Risk C7
	Acceptance Phase Factor B3	Equipment test C8 Acceptance fit C9 Rectify and re-test C10

Referring to the established safety assessment index system of the 10kV power distribution room project of a city hospital of traditional Chinese medicine, 10 copies of the "Project Risk Index Weight Questionnaire" were issued to 10 expert groups such as the general manager of the company, heads of various departments, and safety management personnel, and 10 copies were effectively recovered, and the A-layer risk judgment matrix was obtained according to the scoring results, as shown in Table 4-2.

Table 4-2: Layer A risk judgment matrix

Risk assessment A of the 10kV power distribution room project of a city hospital of traditional Chinese medicine	Preparatory Phase Factor B1	Construction Stage Factor B2	Acceptance Phase Factor B3
Preparatory Phase Factor B1	1	1/3	2
Construction Stage Factor B2	3	1	3
Acceptance Phase Factor B3	1/2	1/3	1

The second-level judgment matrix of factors in the preparatory stage, construction stage, and acceptance stage is shown in Table 4-3, Table 4-4, and Table 4-5.

Table 4-3：Risk judgment matrix at the factor layer in the preparatory stage

Preparatory stage factors	Budget deviations	Procurement deviations	Material handling
Budget deviations	1	2	1/2
Procurement deviations	½	1	1/2
Material handling	2	2	1

Table 4-4：Risk judgment matrix of factor layer in construction stage

Construction stage factors	Personnel Risk	Object Risk	Environmental risks	Manage risk on-site
Personnel Risk	1	2	3	4
Object Risk	½	1	2	2
Environmental risks	1/3	1/2	1	1/3
Manage risk on-site	¼	1/2	3	1

Table 4-5：Risk judgment matrix at the factor layer in the acceptance stage

Acceptance stage factors	Equipment testing	Acceptance of cooperation	Rectification and re-inspection
Equipment testing	1	1/2	1/4
Acceptance of cooperation	2	1	1/3
Rectification and re-inspection	4	3	1

Next, the weight of risk indicators is calculated on the A-layer indicator judgment matrix, and the product of each element in N rows is calculated:

M_1=1×1/3×2=2/3

M_2=3×1×3=9

M_3=1/2×1/3×1=1/6

Then, find the nth power root of M:

$\overline{W}_1=(M_1)^{1/3}=(2/3)^{1/3}$=0.8736

$\overline{W}_2=(M_2)^{1/3}=(\mathbf{9})^{\mathbf{1/3}}$=2.0801

$\overline{\boldsymbol{W}}_{\mathbf{3}}=(\boldsymbol{M}_{\mathbf{3}})^{\mathbf{1/3}}=(\mathbf{1/6})^{\mathbf{1/3}}$=0.5503

Then, the vectorW=（$\overline{\boldsymbol{W}}_{\mathbf{1}}$、$\overline{\boldsymbol{W}}_{\mathbf{2}}$、$\overline{\boldsymbol{W}}_{\mathbf{3}}$）is normalized:

$\sum \boldsymbol{W}\,\boldsymbol{i}=\overline{\boldsymbol{W}}_{\mathbf{1}}+\overline{\boldsymbol{W}}_{\mathbf{2}}+\overline{\boldsymbol{W}}_{\mathbf{3}}$=0.8736+2.0801+0.5503=3.5040

$\boldsymbol{W}_{\mathbf{1}}=\overline{\boldsymbol{W}}_{\mathbf{1}}/\sum \boldsymbol{W}$=0.8736/3.5040=0.2493

$\boldsymbol{W}_{\mathbf{2}}=\overline{\boldsymbol{W}}_{\mathbf{2}}/\sum \boldsymbol{W}$=2.0801/3.5040=0.6842

$\boldsymbol{W}_{\mathbf{3}}=\overline{\boldsymbol{W}}_{\mathbf{3}}/\sum \boldsymbol{W}$=0.5503/3.5040=0.1570

The weight vector is obtained as W=(0.2493,0.6842,0.1570), and then the maximum eigenroot "$\boldsymbol{\lambda}_{max}$" of the judgment matrix is calculated:

（AW）$_{\mathbf{1}}$=1×0.2493+1/3×0.6842+2×0.1570=0.7914

（AW）$_{\mathbf{2}}$=3×0.2493+1×0.6842+3×0.1570=1.9031

（AW）$_{\mathbf{3}}$=1/2×0.2493+1/3×0.6842+1×0.1570=0.5097

$\boldsymbol{\lambda}_{max}$=（AW）$_{\mathbf{1}}$/（$\mathbf{3}\times\boldsymbol{W}_{\mathbf{1}}$）+（AW）$_{\mathbf{2}}$/（$\mathbf{3}\times\boldsymbol{W}_{\mathbf{2}}$）+（AW）$_{\mathbf{3}}$/（$\mathbf{3}\times\boldsymbol{W}_{\mathbf{3}}$）

=0.7914/0.7479+1.9031/2.0526+0.5097/0.4710=3.0675

The consistency test was carried out, CI=（$\boldsymbol{\lambda}_{max}$-n）/（n-1）=（3.0675-3）/（3-1）=0.0338, and RI=0.58 was found according to the RI value table of the random consistency index (see Table 4-6 below).

Table 4-6：RI values of the random consistency index

n	1	2	3	4	5
RI	0	0	0.58	0.90	1.12

CR=CI/RI=0.0338/0.58=0.0583, 0.0583<0.1 were obtained, indicating that the consistency met the requirements. Table 4-7 shows the judgment matrix and relative weight vectors.

Table 4-7：Risk judgment matrix and relative weight vector of layer A

Risk assessment A of the 10kV power distribution room project of a city hospital of traditional Chinese medicine	Preparatory Phase Factor B1	Construction Stage Factor B2	Acceptance phase factor B3	Relative weight vectors
Preparatory Phase Factor B1	1	1/3	2	0.2493
Construction Stage Factor B2	3	1	3	0.6842
Acceptance phase factor B3	1/2	1/3	1	0.1570
Consistency checks	λ_{max}=3.0675 CR=0.0583<0.1，Meet conformance requirements			

In the same way, according to the above calculation methods, the judgment matrix and relative weight vectors of the secondary indicators of the factors in the preparatory stage, the construction stage and the acceptance stage are obtained, as shown in Table 4-8, Table 4-9 and Table 4-10.

Table 4-8: Risk judgment matrix and relative weight vector of factor layer in the preparatory stage

Preparatory Phase Factor B1	Budget deviation C1	Procurement deviation C2	Material Handling C3	Relative weight vectors
Budget deviation C1	1	2	1/2	0.3111
Procurement deviation C2	½	1	1/2	0.1951
Material Handling C3	2	2	1	0.4938
Consistency checks	λ_{max}=3.0537 CR=0.0464<0.1，Meet conformance requirements			

Table 4-9 : Risk judgment matrix and relative weight vector of factor layer in the construction stage

Construction Stage Factor B2	Personnel risk C4	Object Risk C5	Environmental risks C6	Site Management Risk C7	Relative weights vector
Personnel risk C4	1	2	3	4	0.4745
Object Risk C5	½	1	2	2	0.2536
Environmental risksC6	1/3	1/2	1	1/3	0.1041
Site Management Risk C7	¼	1/2	3	1	0.1677
Consistency checks	λ_{max}=4.2051 CR=0.076<0.1，Meet conformance requirements				

Table 4-10 : Risk judgment matrix and relative weight vector of factor layer in the acceptance stage

Acceptance phase factor B3	Equipment test C8	Acceptance fit C9	Rectify and re-test C10	Relative weight vectors
Equipment test C8	1	1/2	1/4	0.1570
Acceptance fit C9	2	1	1/3	0.2493
Rectify and re-test C10	4	3	1	0.5936
Consistency checks	λ_{max}=3.0536 CR=0.0462<0.1, Meet conformance requirements			

Therefore, the weight of the risk index of the 10kV distribution room project of a city hospital can be obtained, as shown in Table 4-11.

Table 4-11:Weights of risk evaluation indicators for the 10kV power distribution room project of a city hospital of traditional Chinese medicine

Overall goal	Level 1 indicators	Single sorting Weight metrics	Secondary indicators	Single sorting Weight metrics	Total sort weight metric
Risk management of 10kV power distribution room project in a city hospital of traditional Chinese medicine	Preparatory Phase Factor B1	0.2493	Budget deviation C1	0.3111	0.0776
			Procurement deviation C2	0.1951	0.0486
			Material Handling C3	0.4938	0.1231
	Construction Stage Factor B2	0.6842	Personnel risk C4	0.4745	0.3247
			Object risk C5	0.2536	0.1735
			Environmental risk C6	0.1041	0.0712
			Site Management Risk C7	0.1677	0.1147
	Acceptance Phase Factor B3	0.1570	Equipment test C8	0.1570	0.0246
			Acceptance fit C9	0.2493	0.0391
			Rectify and re-test C10	0.5936	0.0932

The risk weights of the first-level indicators are ranked from heavy to light: construction stage factors, preparatory stage factors, and acceptance stage factors; The secondary indicators of the construction stage factors are ranked from heavy to light: personnel risk, object risk, site management risk, and environmental risk. The secondary indicators of the factors in the preparatory stage are ranked from heavy to light: material transportation, budget deviation, and procurement deviation; The secondary indicators of the factors in the acceptance stage are sorted from heavy to light: rectification and re-inspection, acceptance cooperation, and equipment test; According to the total ranking results, it can be concluded that the more important influencing factors in the secondary indicators are ranked from heavy to light: personnel risk, object risk, material transportation, on-site management risk, rectification and re-inspection, budget deviation, environmental risk, procurement deviation, acceptance cooperation, and equipment test.

2) 4.2 Optimize the Implementation Steps of the Fuzzy Evaluation Method

Through the above analysis of the results of risk identification in the project, the safety assessment of the whole process of the power engineering project is constructed to evaluate the whole process of power construction. Analyzing the interrelationship between risk factors and conducting research from the perspective of engineering construction can also find a certain link that may exist in the construction process, so as to determine the cause of the accident. The construction process of power distribution projects can be divided into preparation, construction, acceptance and other stages.

Review the objectives of risk management of power distribution projects to ensure that the safety assessment indicator system is closely related to the objectives. According to the above, the first-level index construction stage factors (B2), preparatory stage factors (B1) and acceptance stage factors (B3) of the 10kV distribution room project of a city hospital of traditional Chinese medicine; The secondary indicators of the construction stage factors are: personnel risk, object risk, site management risk, and environmental risk. Secondary indicators of factors in the preparatory stage: material transportation, budget deviation, procurement deviation; The secondary indicators of the factors in the acceptance stage are: rectification and re-inspection, acceptance cooperation, and equipment test; Key indicators such as construction stage factors (B2) are directly affected by factors in the preparatory stage (B1) (such as material transportation), and acceptance stage factors (B3) may amplify the risk of construction stage factors (B2) (such as the risk of injury caused by personnel stepping on the soles of their feet in the process of rectification and re-inspection). Invite 10 power engineering experts (including project managers and safety engineers) to conduct on-site inspections of the 10kV power distribution room project of a city hospital of traditional Chinese medicine, and provide them with construction logs, environmental monitoring and other data. 10 copies of the "Project Risk Indicator Membership Questionnaire" were issued to each expert, and the index weight and risk level were scored. 10 scoring sheets were effectively received, and the scoring results are summarized in Table 4-12 below.

Table 4-12: Summary of the investigation of the membership degree of the risk index of the 10kV power distribution room project of a city hospital of traditional Chinese medicine

Level 1 indicators	Level 2 indicators	High risk	Higher risk	Moderate risk	Low risk
Preparatory Phase Factor B1	Budget deviation C1	0.1	0.1	0.5	0.3
	Procurement deviation C2	0.1	0.2	0.6	0.1
	Material Handling C3	0.1	0.3	0.3	0.3
Construction Stage Factor B2	Personnel risk C4	0.1	0.2	0.7	0
	Object risk C5	0.2	0.3	0.4	0.1
	Environmental risk C6	0.2	0.2	0.6	0
	Site Management Risk C7	0.1	0.1	0.5	0.3
Acceptance phase factor B3	Equipment test C8	0.1	0.4	0.4	0.1
	Acceptance fit C9	0.1	0.3	0.4	0.1
	Rectify and re-test C10	0.2	0.3	0.3	0.2

Establish a set of factors, so that U={U1,U2,U3 }={Preparatory stage factors, construction stage factors, acceptance stage factors}. Then, an alternative set was established, and a fuzzy evaluation matrix was established according to the evaluation results, so that the alternative set V={V1,V2,V3,V4}={high risk, high risk, medium risk, low risk}. The risk assessment level is high risk (0.8-1.0, shutdown for rectification, expert intervention), high risk (0.6-0.8, special rectification, weekly review), medium risk (0.4-0.6, special rectification, monthly review), and low risk (0-0.5, routine monitoring). According to Table 4-12, the fuzzy relationship matrix is established, and the results of the fuzzy relationship matrix are as follows:

$$R_{\mathrm{B1}}=\begin{bmatrix}0.1 & 0.1 & 0.5 & 0.3\\ 0.1 & 0.2 & 0.6 & 0.1\\ 0.1 & 0.3 & 0.3 & 0.3\end{bmatrix} R_{\mathrm{B2}}=\begin{bmatrix}0.1 & 0.2 & 0.7 & 0\\ 0.2 & 0.3 & 0.4 & 0.1\\ 0.2 & 0.2 & 0.6 & 0\\ 0.1 & 0.1 & 0.5 & 0.3\end{bmatrix} R_{\mathrm{B3}}=\begin{bmatrix}0.1 & 0.4 & 0.4 & 0.1\\ 0.1 & 0.3 & 0.4 & 0.1\\ 0.2 & 0.3 & 0.3 & 0.2\end{bmatrix}$$

In the next step, the comprehensive evaluation of the secondary indicators of the factors in the preparatory stage, the construction stage and the acceptance stage was carried out respectively:

$$B_{\mathrm{u1}}=[0.3111 \quad 0.1951 \quad 0.4938]\times\begin{bmatrix}0.1 & 0.1 & 0.5 & 0.3\\ 0.1 & 0.2 & 0.6 & 0.1\\ 0.1 & 0.3 & 0.3 & 0.3\end{bmatrix}=[0.1000 \quad 0.2182 \quad 0.4207 \quad 0.2609]$$

$$B_{u2}=[0.4745 \quad 0.2356 \quad 0.1041 \quad 0.1677]\times\begin{bmatrix}0.1 & 0.2 & 0.7 & 0\\0.2 & 0.3 & 0.4 & 0.1\\0.2 & 0.2 & 0.6 & 0\\0.1 & 0.1 & 0.5 & 0.3\end{bmatrix}=[0.1322 \quad 0.2032 \quad 0.5728 \quad 0.0739]$$

$$B_{u3}=[0.1570 \quad 0.2493 \quad 0.5936]\times\begin{bmatrix}0.1 & 0.4 & 0.4 & 0.1\\0.1 & 0.3 & 0.4 & 0.1\\0.2 & 0.3 & 0.3 & 0.2\end{bmatrix}=[0.1593 \quad 0.3157 \quad 0.3406 \quad 0.1593]$$

According to Table 4-11, it can be seen that the weight of each risk evaluation index of the first-level index of the risk management of the 10kV distribution room project of a city hospital is $A_U=[0.2493 \quad 0.6842 \quad 0.1570]$, and the membership degree vector of the first-level index risk evaluation index is:

$$R=\begin{bmatrix}B_{U1}\\B_{U2}\\B_{U3}\end{bmatrix}=\begin{bmatrix}0.1000 & 0.2182 & 0.4207 & 0.2609\\0.1322 & 0.2032 & 0.5728 & 0.0739\\0.1593 & 0.3157 & 0.3406 & 0.1593\end{bmatrix}$$

Therefore, the comprehensive risk evaluation vector of the 10kV distribution room project is calculated as follows:

$$B=A\times R=$$

$$[0.2493 \quad 0.6842 \quad 0.1570]\times\begin{bmatrix}0.1000 & 0.2182 & 0.4207 & 0.2609\\0.1322 & 0.2032 & 0.5728 & 0.0739\\0.1593 & 0.3157 & 0.3406 & 0.1593\end{bmatrix}$$

$$=[0.1404 \quad 0.2430 \quad 0.5052 \quad 0.1406]$$

For the analysis of the results of the fuzzy comprehensive evaluation method, the comprehensive evaluation vector $B=[0.1404 \quad 0.2430 \quad 0.5052 \quad 0.1406]$ of the 10kV distribution room project is obtained, that is, the high risk score is 14.04%, the high risk score is 24.30%, the medium risk score is 50.52%, and the low risk score is 14.06%.

In the same way, the scoring results of the first-level index layer are as follows (the same is true for the evaluation method of the second-level indicator layer):

Preparatory stage factor $B1=\max[0.1000 \quad 0.2182 \quad 0.4207 \quad 0.2609]=0.4207$

Construction stage factor$B2=\max[0.1322 \quad 0.2032 \quad 0.5728 \quad 0.0739]=0.5728$

Acceptance stage factor $B3=\max[0.1593 \quad 0.3157 \quad 0.3406 \quad 0.1593]=0.3406$

According to the principle of maximum membership, the risk levels of factors in the preparatory stage, construction stage and acceptance stage can be assessed as medium risk, medium risk and low risk.

3) *4.3 The assessment results promote the implementation of risk prevention of engineering projects*

The reliability of the evaluation results is verified by comparing them with the actual project situation. If it is found that there is a large deviation between the assessment results and the actual situation, the application of the fuzzy evaluation method should be adjusted in time. Apply the evaluation results to the whole process of project management, guide project decision-making and the implementation of improvement measures, and continuously improve and optimize the project safety management process and methods. Get timely feedback on assessment results and collect opinions and suggestions from project managers and stakeholders. According to the feedback, the application of the fuzzy evaluation method was continuously optimized to improve the practicability of the evaluation. The fuzzy evaluation method can effectively deal with the uncertainty in power distribution engineering projects, provide a comprehensive safety assessment, and help identify and prevent potential risks. Project safety assessment often involves factors that are difficult to quantify, such as unsafe behaviors of personnel, environmental changes, etc. The fuzzy evaluation method uses the membership function to process these fuzzy information and provide more realistic evaluation results. Through the fuzzy comprehensive evaluation, the weak links of safety management in the project are identified, which provides a basis for formulating improvement measures and preventing risks, so as to optimize the preparation of management at all stages of the project.

5.0 Conclusions and Limitations

Through the investigation and analysis of the power distribution project of H Electric Company, several problems in the current safety management were found, and the safety evaluation strategy was systematically proposed. In terms of process control, establish a safety assessment mechanism for the whole process of project management, and disco ver and eliminate potential safety hazards in time. Through the research on the safety evaluation of the whole proces s of the power distribution project of H Electric Company, this paper not only provides a practical safety managemen t strategy for H Electric Company, but also provides a useful reference and reference for enterprises in the same indu stry. With the implementation of these strategies and measures, it is beneficial for H Electric Company to comprehen sively improve the safety management level of power distribution projects, effectively reduce the incidence of safety accidents, ensure the safety of construction personnel's lives and property, consolidate the foundation of the compan y's sustainable development, and improve the quality and efficiency of the project.

The innovation point of this research will be to specifically study the safety evaluation of the whole process of the po wer distribution project of H Electric Company, and refine the theory and practice of project safety management to t he field of power distribution engineering from the fields of construction engineering, municipal engineering, power engineering, etc., so that the scientificity and reliability of the research results can be guaranteed. The research result s are not only applicable to H Electric Company, but can also be used as a reference for other companies in the same industry. Due to the limitation of time and resources, this study failed to conduct a long-term follow-up evaluation o f the implementation effect of safety evaluation strategy, and future research can be further improved in this regard.

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