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Risk Assessment of Engineering Construction Projects Based on AHP- Fuzzy Evaluation

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Abstract

The engineering construction project has the characteristics of huge amount of investment, long construction cycle and many risk factors. In the process of planning, construction and operation, they are affected and restricted by many factors, and the consequences of risks are relatively serious. Taking H welding workshop construction project as an example, this paper makes an in-depth analysis of the risk influencing factors of the engineering construction project, and comprehensively uses the hierarchical analysis method and fuzzy evaluation method to make a more scientific and in-depth analysis of the risk of the project. After practical application verification, this method overcomes the difficulty of the risk assessment index of complex and difficult to quantitative evaluation of engineering construction projects, and provides a new method for the scientific management of engineering construction projects.

Keywords: Project Construction Project;AHP; Fuzzy Evaluation

1. Preface

In the whole process of construction and development, the engineering construction project has the characteristics of large investment amount, long construction period, high complexity, and many risk factors. [1-2]. There are many risk points in the planning, construction, operation and other links, and the consequences of risks are relatively serious [3]. In addition, with the continuous development of society and economy, people's demand for industrial project construction is more and more urgent, the scale and number of industrial construction projects are increasing, and the risks of engineering projects show a diversified trend. Therefore, it is of great significance and value to strengthen risk management research and improve the level of project risk control [4]. Based on the characteristics of engineering construction project, with H welding workshop construction project as an example, combined with the actual situation of the project, integrated use of hierarchical analysis and fuzzy evaluation method, fully consider the subjective and objective rights of risk factors, heavy problem, the more scientific and in-depth analysis of the risk, in order to realize the scientific control of engineering construction project [5-7].

2. Risk assessment of H welding workshop construction project

2.1Construction and weight calculation of the risk evaluation index system

(a)Determine the risk evaluation index system

According to the risk identification and analysis of the construction project of the H welding workshop, combined with the construction principle of the construction project risk index, the evaluation system level of the project is divided into three levels: target layer, criterion layer and index layer, as shown in Table 1.

Table 1 Risk evaluation index system of welding workshop construction project

Target layer	Criterion layer	Indicator layer
Risk assessment system for H welding workshop construction project	Design riskB1	Design errorB_{11}
		Design ChangeB_{12}
	Economic RiskB2	Financial Risk B_{21}
		Risk of Engineering Budget DeviationB_{22}
		Financing RiskB_{23}

		Personnel Management RiskB_{31}
	Managing RiskB3	Quality Management RiskB_{32}
		Security Management RiskB_{33}
		Risk of project approval B_{41}
	External riskB4	Land acquisition riskB_{42}
		Environmental Assessment RiskB_{43}

(b)Determine the weight of the risk evaluation indicators

After the risk evaluation system of H welding workshop construction project is determined, relevant experts are invited to evaluate and score all factors of the criterion layer, and then the evaluation matrix of each risk factor is obtained (shown in Table 2).

Table 2. Evaluation matrix of various factors in the criterion layer

B	B1	B2	B3	B4
B1	1	1.8	2.3	1.2
B2	0.56	1	1.35	0.78
B3	0.43	0.74	1	0.32
B4	0.83	1.28	1.67	1

It is expressed as

$$\boldsymbol{R} = \left(r_{ij}\right)_{4\times4} = \begin{pmatrix} 1 & 1.8 & 2.3 & 1.2 \\ 0.56 & 1 & 1.35 & 0.78 \\ 0.43 & 0.74 & 1 & 0.32 \\ 0.83 & 1.28 & 1.67 & 1 \end{pmatrix}$$

The weight of each factor in the criterion layer was calculated using SPSS data analysis software

$$\boldsymbol{W} = \left\{w_1, w_2, w_3, w_4\right\} = \left\{0.365, 0.2138, 0.1443, 0.2769\right\}$$

By calculating CR=0.0329<0.1, the consistency test passed, and the calculated weights met the requirements.

Using the same method, obtain the weight parameters of the evaluation indicators and influencing factors for each criterion layer corresponding to the indicator layer

The eigenvectors and their corresponding normalization results are used to obtain the evaluation of the insurance management system for the H welding workshop construction project.The weights of each price indicator factor are shown in Table 3.

Table 3 Weight of the risk index system of the welding workshop construction project

Target layer	Criterion layer	weight	Indicator layer	weight	Comprehensive weight
Risk assessment system for H welding workshop construction project	Design riskB1	0.365	Design errorB_{11}	0.35	0.1278
			Design ChangeB_{12}	0.65	0.2372
	Economic RiskB2	0.2138	Financial Risk B_{21}	0.4327	0.0935
			Risk of Engineering Budget DeviationB_{22}	0.1456	0.0313
			Financing RiskB_{23}	0.4113	0.0879
	Managing RiskB3	0.1443	Personnel Management RiskB_{31}	0.2588	0.0375
			Quality Management RiskB_{32}	0.3322	0.0479
			Security Management RiskB_{33}	0.409	0.0597
	External riskB4	0.2769	Risk of project approval B_{41}	0.1408	0.0389
			Land acquisition riskB_{42}	0.3479	0.0966
			Environmental Assessment RiskB_{43}	0.5113	0.1417

It can be concluded from Table 3 that from the criterion level, the risk of welding workshop construction project risk management system weights from small to large, which is management risk, economic risk, external risk and design risk. In terms of the specific aspects of risk management (index layer), the top three with a greater impact on the risk management of welding workshop construction projects are the design change risk 0.2372, environmental evaluation risk 0.1417 and the risk of design error 0.1278, among which the project budget deviation is 0.0313, personnel management 0.0375 and the importance of approval risk 0.0389 are low. Therefore, when considering the construction of risk management, different measures should be taken to prevent it.

2.2 Fuzzy comprehensive evaluation

(a)Establish a collection of evaluation objectives

Through the hierarchical structure of the risk management evaluation index system of the H welding workshop construction project, the corresponding factor set B of the fuzzy comprehensive evaluation can be determined as follows:

First-level evaluation element set

$\boldsymbol{B}=\left\{B_1,B_2,B_3,B_4\right\}$ =(design risk, economic risk, management risk, external risk);

Secondary evaluation element set

$\boldsymbol{B}_1=\left\{B_{11},B_{12}\right\}$ =(design error, design change)

$\boldsymbol{B}_2=\left\{B_{21},B_{22},B_{23}\right\}$ =(financial risk, engineering budget deviation, financing risk)

$\boldsymbol{B}_3=\left\{B_{31},B_{32},B_{33}\right\}$ =(personnel management, quality management, safety management)

$\boldsymbol{B}_4=\left\{B_{41},B_{42},B_{43}\right\}$ =(approval of project initiation, land acquisition and use, environmental assessment)

(b)Establish an evaluation set

Based on the actual situation of the welding workshop, determine the evaluation set for the current status of project construction risk management $\boldsymbol{V}=\left\{V_1,V_2,V_3,V_4,V_5\right\}$ =(extremely low, low, average, high, extremely high).The corresponding values are (1, 2, 3,4, 5).

(c)Establish a fuzzy evaluation matrix R

Using the expert scoring method, invite several experts to assess project construction risks based on the prescribed evaluation level Score the rows, and then use mathematical and statistical methods to process the evaluation data to obtain the corresponding vectors. according to the fuzzy evaluation matrix R1, R2, R3, R4 is obtained by evaluating each indicator based on the expert scoring results.

$$R_1 = \begin{pmatrix} 0.05 & 0.36 & 0.28 & 0.31 & 0 \\ 0 & 0.29 & 0.42 & 0.26 & 0.03 \end{pmatrix}$$

$$R_2 = \begin{pmatrix} 0.2 & 0.4 & 0.3 & 0.1 & 0 \\ 0 & 0.35 & 0.2 & 0.45 & 0 \\ 0 & 0.26 & 0.32 & 0.42 & 0 \end{pmatrix}$$

$$R_3 = \begin{pmatrix} 0.35 & 0.25 & 0.35 & 0.05 & 0 \\ 0 & 0.43 & 0.38 & 0.19 & 0 \\ 0 & 0.4 & 0.3 & 0.2 & 0.1 \end{pmatrix}$$

$$R_4 = \begin{pmatrix} 0 & 0.4 & 0.2 & 0.35 & 0.05 \\ 0 & 0.35 & 0.2 & 0.45 & 0 \\ 0 & 0.3 & 0.3 & 0.3 & 0.1 \end{pmatrix}$$

We can conclude that the fuzzy comprehensive evaluation vector Di is corresponding to the risk factor Bi:

$$D_1 = W_1 \times R_1 = \begin{pmatrix} 0.35 & 0.65 \end{pmatrix} \times \begin{pmatrix} 0.05 & 0.36 & 0.28 & 0.31 & 0 \\ 0 & 0.29 & 0.42 & 0.26 & 0.03 \end{pmatrix}$$
$$= (0.0175, 0.3145, 0.371, 0.2775, 0.0195)$$

$$D_2 = W_2 \times R_2 = (0.0875, 0.3362, 0.2938, 0.2825, 0)$$

$$D_3 = W_3 \times R_3 = (0.0906, 0.3711, 0.3395, 0.1579, 0.0409)$$

$$D_4 = W_4 \times R_4 = (0, 0.3315, 0.2511, 0.3592, 0.0582)$$

According to the calculation results, the risk management evaluation matrix R for the H welding workshop construction project can be obtained.

$$R = \begin{pmatrix} 0.0175 & 0.3145 & 0.371 & 0.2775 & 0.0195 \\ 0.0875 & 0.3362 & 0.2938 & 0.2825 & 0 \\ 0.0906 & 0.3711 & 0.3395 & 0.1579 & 0.0409 \\ 0 & 0.3315 & 0.2511 & 0.3592 & 0.0582 \end{pmatrix}$$

Based on the above evaluation results, it can be concluded that the risk management status of the H welding workshop construction project is evaluated,As shown in Table 4:

Table 4. Risk Management Status Evaluation Indicators for H Welding Workshop

Construction Projects

Criterion layer	extremely low	low	average	high	extremely high
Design riskB1	0.0175	0.3145	0.371	0.2775	0.0195
Economic RiskB2	0.0875	0.3362	0.2938	0.2825	0
Managing RiskB3	0.0906	0.3711	0.3395	0.1579	0.0409
External riskB4	0	0.3315	0.2511	0.3592	0.0582
Comprehensive evaluation	0.0382	0.3220	0.3167	0.2839	0.0291

According to the principle of maximum membership, it can be concluded that the evaluation level of the risk management status of the H welding workshop construction project is relatively low risk, and the acceptance criteria are acceptable. However, the external risk level of the criterion layer is relatively high, which requires attention, strengthened prevention, and the development of monitoring measures.

3. Conclusion

Engineering construction projects are influenced and constrained by various factors in various stages such as planning, construction, and operation. This article is based on the characteristics of the H welding and assembly workshop construction project, and adopts the fuzzy evaluation method to construct a risk assessment index system. Combined with the actual situation of a specific project, the risk of the project is analyzed and evaluated.

Effective risk management measures can mitigate the impact of related risks during project implementation, but they cannot completely eliminate objective risks. Therefore, it is crucial to apply risk management concepts to project management, strengthen risk identification and prevention in the project management process, and enhance dynamic identification and monitoring of risks in the project management process. It is necessary to constantly supervise relevant parties, strengthen risk prevention and control awareness, prepare risk response plans, and take effective measures to prevent the occurrence of risks.

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