Risk Assessment of PPP Expressway Project Based on Improved Fuzzy Evaluation Method

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Abstract
PPP expressway project has the distinctive characteristics of long construction period, public-private partnership, huge investment amount, etc. It is imperative to accurately assess the project risk. Firstly, a relatively comprehensive risk evaluation index system of PPP expressway project is constructed, and a fuzzy comprehensive evaluation model is constructed. Then the weight calculation method in the traditional model is optimized,The combination weighting method is used instead of the analytic hierarchy process with strong subjective consciousness. Taking the actual PPP expressway project as an example, it is proved that the evaluation result of this method is consistent with the actual project risk level, and it is feasible.

Keywords: *fuzzy evaluation; Highway project; Combination empowerment; risk assessment*

1.INTRODUCTION

Expressway project is a basic facility to enrich transportation ways and optimize transportation efficiency, which is of great significance to strengthen economic exchanges between regions. The expressway construction takes a long time, the construction environment is complex, the investment in technology and cost is large, and there are many risk factors, which increase the difficulty of project operation [1]. PPP (Public-private Partnership, Public-private partnership) mode expressway project effectively disperses the risks of project construction. In the project construction, private enterprises and state-owned enterprises cooperate to give full play to their respective strengths and share diversified risk factors of expressway construction. The functions of government services are fully demonstrated in the project, and the purchasing activities of private enterprises are transformed into the responsibilities of the government. Therefore, for the construction of PPP expressway projects,The most critical change of the government is the significant change of its functions [2]. Not only that, the efficiency of public resource allocation has been greatly improved, and it tends to be fair, and the value agglomeration of social capital operation has become prominent.

However, how to reduce the uncertain factors of PPP expressway project construction and accurately grasp the risks from project planning to construction is the difficulty of PPP expressway project construction at present. Based on the traditional fuzzy evaluation method, this paper focuses on optimizing the weight calculation method, and adopts the improved fuzzy evaluation method to scientifically evaluate the risk of expressway PPP project. Recognize the risks of scientific project construction.

2.APPLICATION OF IMPROVED FUZZY EVALUATION METHOD IN RISK ASSESSMENT OF PPP EXPRESSWAY PROJECT

2.1.PPP Expressway Project Risk Evaluation Index System Construction

According to the identification method of risk factors shown in Figure 1, the potential risks in the construction of PPP expressway projects are determined, and then the corresponding risk evaluation index system is constructed to ensure that the selection of evaluation indexes reflects the characteristics of PPP expressway projects to the greatest extent. It can be seen from the figure that the determination of risk factor set of PPP expressway project is divided into two steps [3]. The expert group adopted Delphi method and work breakdown structure method to discuss and get the final result.

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The first-level index of the evaluation index system finally determined in this study includes political risk, economic risk, market operation risk, project construction risk, and the second-level index system is detailed as follows.

2.1.1. political risks

PPP Expressway is a project with certain public attributes and economic growth value, which can effectively increase the frequency of regional economic exchanges and drive the activity of economic interaction, and is valued and supported by relevant government departments. In order to realize the goal of expressway construction to promote economic growth, it is necessary to build a good political environment to promote project construction. Improve the stability of expressway driving economic development [4]. If the situation in the area where PPP expressway project is located is turbulent and the construction environment is unstable, the highway project is likely to delay or even stop construction; If there are changes in preferential policies involving environmental protection, loan support and land expropriation, private investment enterprises will suffer serious economic losses; Another example, When the highway project involves the utilization of national natural resources, the highway project under construction is likely to be expropriated and utilized by the state, and there is a serious risk of shutdown; In addition, there are cases of government departments breaking the contract. Due to special reasons, the government is unable to continue to maintain the public-private partnership, voluntarily withdraws from the construction of expressway projects, and refuses to fulfill the corresponding construction obligations. It will cause serious losses to private enterprises. Based on the above analysis, the evaluation contents of political risk are summarized, including: political environment fluctuation risk, policy risk, government department default risk and project expropriation risk.

2.1.2. Economic risks

Economic investment is the main support of PPP expressway project construction, and economic risk assessment is the key part of PPP expressway project risk assessment. In the process of PPP expressway project construction, it is easy for the actual investment to exceed the budget, which increases the loss of project construction; As the construction time goes on, the currency will depreciate and inflate in different degrees, If the construction period of the project is prolonged indefinitely due to uncertain factors, the risk coefficient of inflation will increase, and the price of materials used in the project will rise linearly; Another important factor causing economic risks is the irregular change of foreign exchange. If the expressway construction project is not in China, we should pay more attention to this risk [5]. Thereby, The evaluation contents of economic risk are summarized as follows: the risk of investment exceeding budget, the risk of inflation and the risk of foreign exchange change.

2.1.3. Market operation risk

When a highway project is completed and put into operation, it still faces many dangers, such as the pricing of highway tolls, the local demand for this highway project, the existence of construction projects with the same attributes, and the threat coefficient to this project, all of which belong to the risk issues that should be considered in PPP highway construction. Therefore, it is determined,Under the market risk, there are three specific risk evaluation indicators: operation pricing risk, project market demand risk and project homogeneity risk.

2.1.4. Risk of project construction

The risks of project construction mainly include the following aspects: First, the change of design scheme. A perfect highway construction scheme needs to pay attention to details, rigor and science, and make clear plans and specifications for material use, process selection, capital budget and construction progress. Accurate design can effectively avoid budget overruns. Second, the risks existing in the project construction, Due to the long construction period of expressway, unexpected factors may delay the construction period at any time, such as personnel accidents, quality problems and so on. Third, the risk of construction technology. Reasonable selection of construction technology is the basic guarantee to optimize the construction efficiency of the project. Facing the complicated expressway construction project, Whether the construction technology is easy to realize, how much money is invested, and how mature the technology is, should be the key issues for decision makers to consider, so as to avoid the technical risks of expressway construction [6]. From this, it can be concluded that the risk of project construction includes three sub-indexes including the risk of project design change, the risk of project construction and the risk of technology application.

2.2. Construction of fuzzy evaluation model

Fuzzy comprehensive evaluation method is based on fuzzy mathematics, and the construction of fuzzy subset and membership function is the core of fuzzy mathematics, so it is also the main step to realize fuzzy comprehensive evaluation method.

Step 1. Build a set of factors that affect the evaluation object as shown in formula (1).

$$U=\{u_1,u_2,\mathrm{L}\ ,u_n\} \tag{1}$$

Among them, u Indicates different factors of object evaluation index.

Step 2: Complete U Factor to factor evaluation Y Fuzzy mapping is the essence of factor evaluation set construction, namely $f=U\to F(Y)$. Therefore, an evaluation set as shown in formula (2) is constructed:

$$Y=\{y_1,y_2,\mathrm{L}\ ,y_m\} \tag{2}$$

The fuzzy relationship between factors and evaluation sets is adopted. R Represented by f Derive; Then the fuzzy relation matrix R It is constructed as follows:

$$(R_{ij})_{n\times m}=\begin{bmatrix} R_{11} & R_{12} & \mathrm{L} & R_{1m} \\ R_{21} & R_{22} & \mathrm{L} & R_{2m} \\ \mathrm{M} & \mathrm{M} & \mathrm{M} & \mathrm{M} \\ R_{n1} & R_{n2} & \mathrm{L} & R_{nm} \end{bmatrix} \tag{3}$$

In the formula, the judgment membership degree of the ith factor to the jth factor is adopted R_{ij} Said, R_{ij} The calculation method is the ratio of the number of grade I evaluators to all evaluators.

Step 3: Build an evaluation index weight set as shown in formula (4):

$$A=\{a_1,a_2,\mathrm{L}\ ,a_n\} \tag{4}$$

Because different evaluation indexes have different evaluation results for the same evaluation object, the weight (weight coefficient) is used to describe the influence degree [7]of the indexes on the evaluation object. In the formula, the weighted values of the ith factors are adopted. a_n Said, weighting method is as follows:

$$\sum_{i=1}^{n}a_i=1 \tag{5}$$

Step 4: Calculate the result of fuzzy comprehensive evaluation. The specific method is shown in formula (6):

$$B=A\times R=\{a_1,a_2,\mathrm{L}\ ,a_n\}\times\begin{bmatrix} R_{11} & R_{12} & \mathrm{L} & R_{1m} \\ R_{21} & R_{22} & \mathrm{L} & R_{2m} \\ \mathrm{M} & \mathrm{M} & \mathrm{M} & \mathrm{M} \\ R_{n1} & R_{n2} & \mathrm{L} & R_{nm} \end{bmatrix} \tag{6}$$

$$=(b_1,b_2,\mathrm{L}\ ,b_m)$$

2.3. Improve the fuzzy evaluation model based on entropy weight method.

The traditional fuzzy comprehensive evaluation method is based on analytic hierarchy process (AHP) to determine the index weights, but the weights calculated by AHP have strong subjective color. To improve the accuracy of PPP expressway project risk evaluation, the traditional fuzzy comprehensive evaluation method is improved: firstly, AHP and entropy weight method are used to determine the weights, Then, the weights are calculated by combining them to reduce the interference of subjective randomness on the weights [8].

2.3.1. entropy weight method to determine the index weight

The process of calculating weights by AHP refers to the method adopted by Wang Jianlei in project risk research, and the principle of determining index weights based on entropy weight method is detailed as follows. Entropy weight method is an objective weighting method with high frequency. The steps to determine the index weight are as follows:

Step 1: Calculate the contribution degree of indicators in the evaluation system. When the multidimensional decision matrix is formula (7), the probability calculation method of evaluation indicators is shown in formula (8):

$$M=\begin{bmatrix} x_{11} & x_{12} & \mathrm{L} & x_{1i} & x_{1n} \\ x_{21} & x_{22} & \mathrm{L} & x_{2i} & x_{2n} \\ \mathrm{M} & \mathrm{M} & \mathrm{M} & \mathrm{M} & \mathrm{M} \\ x_{j1} & x_{j2} & \mathrm{L} & x_{ji} & x_{jn} \\ \mathrm{M} & \mathrm{M} & \mathrm{M} & \mathrm{M} & \mathrm{M} \\ x_{m1} & x_{m2} & \mathrm{L} & x_{mi} & x_{mn} \end{bmatrix} \tag{7}$$

$$h_{ij}=\frac{x_{ij}}{\sum_{i=1}^{m}x_{ij}} \tag{8}$$

In the formula, the evaluation index adopts x_{ij} Said, j The value of is (1,2,…,n), and the updated probability matrix is composed of normalized indexes.

Step 2: Define the information entropy of evaluation index as follows λ_{ij} Its function is to describe the contribution degree of the index to the target attribute. See formula (9) for the calculation method of this variable:

$$\lambda_{ij}=-\vartheta\sum_{i=1}^{m}h_{ij}\ln h_{ij} \tag{9}$$

In the formula, λ_{ij} The value range of is [0,1], and $\vartheta = \frac{1}{\ln m}$ 。

Step 3: The evaluation index weight calculation method is:

$$w_{ij}^{+} = 1 - \frac{\lambda_{ij}}{\sum_{j=1}^{n}\left(1-\lambda_{ij}\right)} \tag{10}$$

Step 4: Here, the risk evaluation score record form should be cited as the correction basis, and the weight value obtained by entropy weight method should be adjusted. See Formula (11) for the correction method:

$$w_{ij}'' = \frac{w_{ij}^{*} w_{ij}^{+}}{\sum_{j=1}^{n} w_{ij}^{*} w_{ij}^{+}} \tag{11}$$

Among them, the re-adjusted weight value of the ith index is adopted. w_{ij}'' Represent; The weight obtained by the j-th expert on the I-th index is adopted. w_{ij}^{*} Represent.

3.EMPIRICAL ANALYSIS OF PPP EXPRESSWAY PROJECT

In order to verify the effectiveness of this method in evaluating the risk of PPP expressway project, the H expressway construction project is taken as the research object of risk evaluation. The trunk line of highway H can reach 50.21Km, and it is estimated that 4.12 billion yuan will be invested in highway project construction, of which about two-thirds will come from bank loans. This highway construction project is a PPP model, so it is jointly funded by the government and private enterprises.

3.1. Construction of fuzzy comprehensive evaluation factor set

Based on the method of this paper, the index set of risk factors for H highway project construction is: u = {u1, u2, …, un} = {political risk, economic risk, market operation risk, project construction risk}. Level II risk evaluation indicators are: U1={ political environment fluctuation risk, policy risk, project expropriation risk, government department default risk },U2={ investment amount exceeds budget risk,Inflation risk, foreign exchange change risk },U3={ operation pricing risk, project market demand risk, project homogeneity risk },U4={ project design change risk, project construction risk, technology application risk}.

3.2. Calculation of weight index

Analytic hierarchy process (AHP), entropy weight method and index evaluation system are used to calculate the weight of PPP expressway project evaluation indexes, and then the evaluation indexes are combined and weighted, so as to improve the scientificity of the influence degree of indexes on evaluation objects. The index weight of H Expressway project based on formula (14) is shown in Table 1.

Table 1 H Index Weight of Expressway Project

Primary index	Weight	Secondary index	Weight
Political risk	0.21	Risk of political environment fluctuation	0.38
		policy risk	0.17
		Project expropriation risk	0.42
		Government department default risk	0.03
Economic risk	0.28	Risk of investment exceeding budget	0.37
		Inflation risk	0.21
		Foreign exchange risk	0.42
Market operation risk	0.36	Operational pricing risk	0.33
		Project market demand risk	0.42
		Project homogeneity risk	0.25
Project construction risk	0.15	Project design change risk	0.41
		Project risk	0.26
		Application risk	0.33

3.3. Membership Matrix Construction and Evaluation Results Analysis

In this study, a total of 4 experts in the investment field and construction field of expressway projects are invited to assign the degree of membership to this expressway project. Taking the first-class index as an example, the evaluation of this project by the expert group is shown in Table 2, and the corresponding degree of membership matrix is shown in Formula (15).

Table 2 Evaluation of this project by expert group (person)

First-class index factor	low	lower	common	tall	Higher

U_1	1	2	1	0	0
U_2	2	1	1	0	0
U_3	1	1	1	1	0
U_4	2	1	1	0	0

The above method is used to construct the membership matrix of each secondary index, and the fuzzy evaluation result of this project is calculated based on formula (6) by combining the weight and membership matrix of the primaryindex. $B = A \times R = (0.242, 0.612, 0.213, 0.113, 0)$ Based on the principle of maximum membership degree, it is determined that the risk assessment result of this PPP expressway project belongs to a "low" level, which is consistent with the actual risk degree of the project. The results show that this method can accurately evaluate the risk of expressway project, and the risk of the project construction is low from the perspectives of politics, economy, construction and market operation.It has certain investment and construction value.

4.CONCLUSION

PPP mode is applied to expressway construction projects, private enterprises have effectively exerted their capital advantages, and government departments have fully released their service functions, which is of great significance to the improvement of expressway project construction and the transformation of expressway modernization. In order to reduce the risk of PPP expressway project construction, this paper improves the fuzzy comprehensive evaluation method, Strive to accurately evaluate the risks of PPP expressway projects. The combination weighting method is used to calculate the weight of PPP expressway project evaluation index, which avoids the subjectivity of using AHP to obtain the weight in the past, and obtains a more objective project risk evaluation result.

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