Research on Risk Assessment of Government Investment Projects Based on AHP Model

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Abstract. [Purpose/Meaning] There are many risks and threats in the process of government investment project construction. Correct understanding and evaluation of these risks is the basis of improving the security ability. [Method/process] From the perspective of risk sources, through the empirical analysis of urban park construction projects in Y city, the main risk sources of government investment projects are identified. Through analyzing the interdependence of indicators, the AHP structure model is established, and the index weight is calculated. [Outcome/conclusion] This paper constructs a risk assessment index system of government investment projects, including 5 first-level indicators and 14 s-level indicators, including environmental risk, economic risk, technical risk, management risk and government risk. Among them, management risk is the most important, followed by technical risk, government risk, economic risk and environmental risk. And government turnover risk, government offside management risk, contract management risk are all very important factors, so we need to focus on these factors.

Keywords: government investment project · construction agent · risk assessment · AHP model · Y city park

1 Introduction

In recent years, with the sustainable and stable development of national capital construction, the scale of agent investment projects in our country has been gradually expanded. However, due to the imperfect system of agent construction system and many uncertain factors in the risk management of government investment, the risk management of agent construction projects is not effective. As an important stage of risk management, risk assessment is to determine the impact of engineering risks and risk disposal on the system by comprehensively considering the nature of risks, the objectives of risk management and the bearing capacity of risk subjects on the basis of risk identification.[1] In the assessment process, the impact of risks on the system needs to be quantified to determine which risks and opportunities need to be addressed, which are acceptable and which can be ignored. Therefore, this article focuses on the Y city park project as an example, using the AHP model to carry out qualitative and quantitative analysis and

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evaluation of the risk of government investment projects. The conclusion is expected to provide scientific theoretical guidance and beneficial exploration for other government investment projects.

2 Research Status

At present, many scholars at home and abroad have made a lot of discussions on the risk assessment of construction projects, but there are great differences in research perspective and methods. Huang Xianqing [2] identifies and classifies various risk factors in the implementation of the construction agent project by means of questionnaire, Dephil method and failure tree method, constructs corresponding risk evaluation model, and compares and evaluates various risks in the implementation of the construction agent project. Xie Meng [3] chooses the corresponding project risk index and adopts the fuzzy comprehensive evaluation method, which provides a simple and feasible method for the project risk management. Wang Hua [4] and others have found out from engineering practice that there are problems such as great risks and poor benefits in government-invested construction projects. Based on these problems, COWA operator is used to evaluate and forecast the early warning risk level of construction projects, and its rationality and effectiveness are verified by examples. Shaolin [5] fuses fuzzy mathematics with the theory of grey system, constructs a kind of grey fuzzy evaluation method, and applies it to the risk evaluation of government construction project, thus evaluates and analyzes the quality risk of construction project. Xie Liang [6] puts forward the viewpoint of evaluating the risk severity and overall risk level of engineering projects, and constructs the evaluation model of BP neural network, and obtains good results in practice, which lays a foundation for the follow-up risk evaluation. Li Yi [7] uses RBS method to study the risk early-warning level of agent construction target, and constructs a mathematical model by combining the probability risk assessment method and the grey correlation degree.

Generally speaking, the research on government investment project risk assessment in our country is still immature and has not formed a unified research method. Therefore, this paper uses AHP to explore the risk factors of government investment projects, at the same time, taking Y city park construction projects as an example, looking for key control points to provide scientific theoretical guidance for risk assessment of government investment projects.

3 Principles and Steps of AHP Method for Evaluation of Agent Construction Risk of Government Investment Projects

3.1 Fundamentals of AHP

Analytic Hierarchy Process (AHP) is a decision-making method which divides the ultimate goal into several factors related to decision-making according to the requirements, and divides the factors related to decision-making into goal level, criterion level and factor level, so as to classify complex decision-making problems into grass-roots factor analysis. [8].

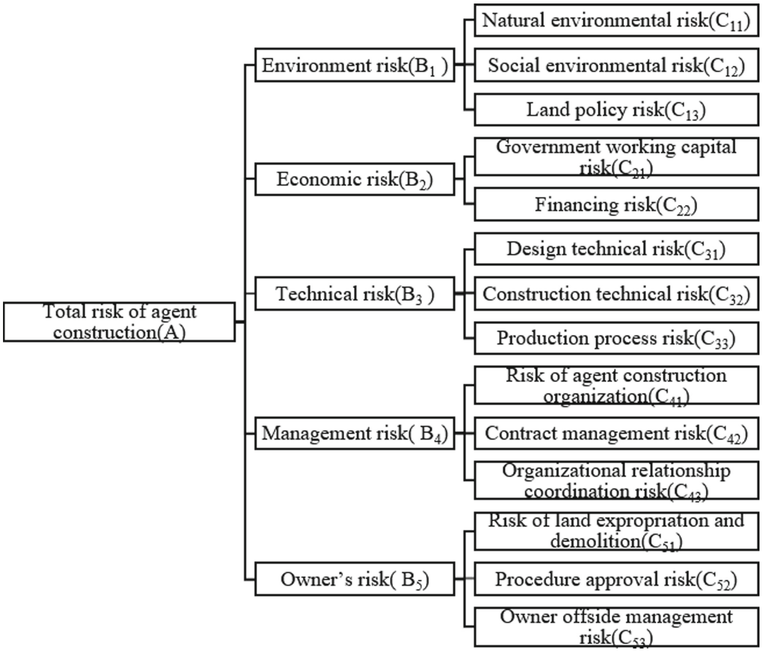

Fig. 1. Structure chart of risk assessment model

3.2 Establishment of Evaluation Index Hierarchy Model and Index System

According to the specific problems, the recursive structure of project risk evaluation index is established, and the hierarchical diagram of evaluation system is formed. The standard factors at all levels shall be determined by means of questionnaire survey, and the hierarchical index system shall be established according to the level structure of the criterion layer and the scheme layer to form the structure chart of the evaluation index system (see Fig. 1).

3.3 Determination of Index Weight by AHP Method

3.3.1 Construct Judgment Matrix to Determine Weights

Starting from the target level, judge and compare its indicators level by level, and use the data of the expert questionnaire to construct a hierarchical judgment matrix according to the hierarchical structure. Sadi's scale 1 to 9 (see Table 1) is selected as the scoring standard, among which Q_{ij} is the scale value and Q_i and Q_j are two risk factors at the same level.

3.3.2 Calculate the Weight Vector of Indicators at Each Level

According to the expert survey data, determine the importance score of the first-level index, construct the first-level indicator judgment matrix $A - B$, which corresponds to

Table 1. Scaling Meanings of Q_{ij} in Judgment Matrix

Scale	Connotation
1	The former is as important as the latter.
3	The former is slightly more important than the latter.
5	The former is obviously more important than the latter.
7	The former is more important than the latter.
9	The former is far more important than the latter.
2,4,6,8	Mean value of two adjacent matrices

the target layer A, and the standard layer B corresponds to the indicator layer C, and obtain the second-level indicator judgment matrix $B_i - C$.

The first step is to calculate the numerical product M_i of each row of the judgment matrix:

$$M_i = \prod_{i=1}^{n} b_{ij}, i = 1, 2, 3 \cdots n \tag{1}$$

The second step is to calculate the Nth root of M_i:

$$W_i = \sqrt[n]{M_i} = \sqrt[n]{\prod b_{ij}} \tag{2}$$

The third step is to normalize the vector A:

$$W_i = \frac{W_i}{\sum_{j=1}^{n} W_j} \tag{3}$$

The fourth step is to calculate the maximum eigenvalue of the judgment matrix:

$$\lambda_{\max}=\sum_{\mathrm{i}=1}^{n} \frac{AW_i}{nW_i} \tag{4}$$

3.3.3 Judgment Consistency Test

In order to avoid data deviation due to excessive subjective factors of experts obtained through expert questionnaires, it is necessary to perform a consistency test on all weight values.

The first step is to calculate CI:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{5}$$

Table 2. The index *RI* of mean random consistency

n	3	4	55	6	7	8	9
RI	0.58	0.94	1.12	1.24	1.32	1.41	1.46

The second step is to calculate RI, as shown in the Table 2:
The third step is to calculate CR:

$$CR = CI/RI \tag{6}$$

When it indicates that the judgment matrix passes the consistency test, otherwise the judgment matrix is not a consistency matrix and needs to be corrected appropriately.

3.3.4 Hierarchical General Sort

Using the results of all single sortings in the same level, it is possible to calculate the weight of the importance of all factors of that level for the previous level. It needs to be done in a layer-by-layer order from top to bottom, and for the second level below the top level, the single order of the hierarchy is the total order.

3.4 Overview of Y City City Park Project

The Y City Urban Park Agency Construction Project is located in the central area of the old city of Y City, which is an ecological leisure construction project, with a total land area of 440,000 square meters and a total investment of 270 million yuan (excluding demolition and relocation fees). The project construction site is a hilly mountain, and the planning and design is an urban sports and leisure park integrating ecological scenery, viewing, recreation, fitness and leisure with the theme of bicycle leisure and experiential sports.

3.5 Risk Assessment of Y City Park Agency Construction Project Based on AHP Model

3.5.1 Use the AHP Method to Determine the Weight of Risk Factors

In order to determine the weight of each risk factor in the risk evaluation model of the Y City Urban Park project, experts in the industry were invited to score the importance of risk factors according to their project management experience, and the scoring results of experts were summarized and analyzed by analytic hierarchy, and finally the importance weight of risk factors was obtained. Using analytic hierarchy to determine the weight of risk factors, the specific steps are as follows.

3.5.1.1 Construct Risk Judgment Matrix
By comparing the importance of each index by the expert scoring method, the judgment matrix of project risk factors under the agency construction mode of government investment projects is obtained, and the judgment matrix is as table-to-table (Table 3, 4, 5, 6, 7 and 8).

Table 3. Judgment matrix of total risk (A) of government investment projects

A	B_1	B_2	B_3	B_4	B_5
B_1	1	1/3	1/4	1/5	1/3
B_2	3	1	1	1/3	1/3
B_3	4	1	1	1	2
B_4	5	3	1	1	1
B_5	3	2	1/2	1	1

Table 4. Environmental risk (B_1) judgment matrix

B_1	C_{11}	C_{12}	C_{13}
C_{11}	1	1/2	1/3
C_{12}	2	1	1
C_{13}	3	1	1

Table 5. Economic risk (B_2) judgment matrix

B_2	C_{21}	C_{22}
C_{21}	1	3
C_{22}	1/3	1

Table 6. Technical risk (B_3) judgment matrix

B_3	C_{31}	C_{32}	C_{33}
C_{31}	1	1/6	1/4
C_{32}	6	1	2
C_{33}	4	1/2	1

3.5.1.2 Calculate the Weights and Sort them

By calculating the weight of the risk indicators according to the analytic hierarchy method, the total ranking of the risk indicators is finally obtained, and the calculation is shown in the Table 9.

Table 7. Management risk (B_4) judgment matrix

B_4	C_{41}	C_{42}	C_{43}
C_{41}	1	1/5	1
C_{42}	5	1	2
C_{43}	1	1/2	1

Table 8. Government risk (B_5) judgment matrix

B_5	C_{51}	C_{52}	C_{53}
C_{51}	1	1/2	1/5
C_{52}	2	1	1/3
C_{53}	5	3	1

Table 9. Ranking table of risk indicators

Primary Indicator B_i	B_i layer weight	Sort	Secondary Indicator C_{ij}	C_{ij} layer weight	Sort
Environmental risk B_1	0.06205	5	Natural environment risk C_{11}	0.1692	11
			Social and environmental risk C_{12}	0.38737	6
			Land policy risk C_{13}	0.44343	5
Economic risk B_2	0.1526	4	Government working capital risk C_{21}	0.7500	1
			Financing risk C_{22}	0.2500	9
Technical risk B_3	0.2657	2	Design Technology Risk C_{31}	0.0898	14
			Construction technical risk C_{32}	0.58763	4
			Production process risk C_{33}	0.32339	7

(*continued*)

Table 9. (*continued*)

Primary Indicator B_i	B_i layer weight	Sort	Secondary Indicator C_{ij}	C_{ij} layer weight	Sort
Manage risk B_4	0.30129	1	Agency construction organization risk C_{41}	0.12827	12
			Contract management risk C_{42}	0.59538	3
			Organizational relationship coordination risk C_{43}	0.27635	8
Owner risk B_5	0.21837	3	Risk of land acquisition and demolition C_{51}	0.12202	13
			Procedure approval risk C_{52}	0.22965	10
			Government offside management risk C_{53}	0.64833	2

3.5.1.3 Consistency Test

The maximum eigenvalue of determining matrix A can be approximated by the following formula:

$$\lambda_{\max}=\sum_{i=1}^{n}\frac{AW_i}{nW_i}$$

AW_i represents the i component of the AW. The consistency test calculated by AHP software is:

Discriminant matrix of $A-B$, consistency ratio CR = 0.047

Discriminant matrix of B_1-C, consistency ratio CR = 0.016

The discriminant matrix of B_2-C is a second order matrix and therefore a completely consistent matrix, CR = 0

Discriminant matrix of B_3-C, consistency ratio CR = 0.009

Discriminant matrix of B_4-C, consistency ratio CR = 0.005

Discriminant matrix of B_5-C, consistency ratio CR = 0.003

Therefore, all the judgment matrices listed above pass the consistency test.

4 Conclusion

In this paper, the AHP model of government investment projects on behalf of risk assessment, and Y city park construction projects as an example for specific analysis and application, concluded that: from the weight point of view, the management of risk in the process of government investment projects on behalf of the largest impact, followed by technical risk, followed by risk from the government, funds, environmental risk. Among the 14 underlying indicators, the risk of government working capital with the highest weight, 0.7500, and the design technical risk with the lowest weight, 0.0898. Therefore, the construction agent shall, in the process of project construction, take reasonable measures to avoid, mitigate, transfer and accept risks, focus on preventing economic risks and risk factors in risk management, and strengthen the management and control of other risk factors to promote the smooth progress of the project.

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