Risk Analysis of Real Estate Project Based on Fuzzy Comprehensive Evaluation

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Abstract. Real estate projects have the problems of long development cycle and high uncertainty, which lead to many uncertain risks in the process of project development. From the perspective of developers, this paper identifies and analyses the risks in the four stages of the life cycle of real estate projects, namely, the decision-making stage, the planning and design stage, the construction implementation stage, and the investment and operation stage, and then uses the fuzzy comprehensive evaluation based on the analytic hierarchy process to comprehensively evaluate the investment risk factors in each stage of real estate projects. This paper establishes a scientific and systematic risk prevention security system to ensure that the project development work can be carried out smoothly according to the expected objectives, and provides research methods and experience for the follow-up investment of similar residential real estate projects.

Keywords: Risk analysis, real estate project, fuzzy comprehensive evaluation

1 Introduction

With the economic growth, the rapid development of China's real estate industry and the acceleration of urbanization, people's demand for housing is no longer satisfied as long as it is a house to live in, but more considering the environment, property and supporting facilities. Real estate is no longer as simple as building a house, it has become a complete industrial chain. The real estate industry is directly related to economic growth, employment rate and people's livelihood [1]. High investment and high return are the first impression of the real estate industry, in fact, the real estate industry relies more on comprehensive strength, professional ability and high-tech barriers. The characteristics of the real estate industry determine that there are not only operational risks, financial risks, but also market risks and policy risks in the operation of real estate enterprises. Therefore, many risk attributes determine that the real estate industry faces various uncertain risk factors in its operation [2]. Especially after the domestic real estate market has entered the stage of rapid development, due to the lack of a sound market mechanism, it is impossible to guarantee the balanced development of the market, and there are no laws and regulations involving all aspects, it is difficult to carry out

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development of the market, and there are no laws and regulations involving all aspects, it is difficult to carry out supervision work, and there is a serious lack of credit, in the face of such an environment, it has brought more uncertainties to the smooth development of real estate enterprises. The special attributes of real estate itself make it always face various risks during its development, so risk management is far more difficult for real estate enterprises than other industries. If the risks existing in real estate enterprises cannot be analysed, the possibility of risk events in real estate enterprises will increase.

The application of fuzzy comprehensive evaluation method and other research methods in the whole life cycle risk management of real estate projects further enriches and perfects the content of the research system, and the further optimization of the system is conducive to providing more targeted judgment methods and coping ideas for small and medium-sized enterprises in the risk identification of real estate projects. It provides more reference for the same type of real estate project risk management research. The risk analysis of real estate project based on fuzzy comprehensive evaluation method is helpful to improve the risk prevention awareness of the enterprise, strengthen the risk judgment ability of the enterprise, improve the risk management level of the development enterprise, and promote the healthy development of the real estate enterprise [3].

The thesis uses the method of literature review to collect relevant information, uses the fuzzy analytic hierarchy process to combine qualitative and quantitative methods, systematically introduces the real estate project and its risks, based on the analysis of risk factors, discusses the risk factors that may arise from various elements, and applies the methods of risk prediction and identification, relying on the research of the depth of the environment of the real estate project. Discuss the core risk factors of the project, sort out and summarize the previous risk research results, and finally put forward risk countermeasures for the project.

2 Risk Identification of Real Estate Projects

2.1 Identification Process

If we want to carry out risk management for real estate projects, we must first identify the risks that may exist in the project, identify the sources of risks by the personnel responsible for the relevant management work, find out the causes of risks, and then describe their characteristics and assess the impact caused by them. After the above work is completed, the risks are classified. Risk identification is particularly important in all aspects, and the accuracy of risk identification will greatly affect the accuracy and comprehensiveness of risk assessment and risk prevention [4]. The key factor affecting risk identification is the collection of relevant raw materials and data. Comprehensive and huge raw data is conducive to the comprehensiveness and accuracy of risk identification, and to the next step of risk analysis. At the current stage, the risk identification methods often used are expert survey method, questionnaire method, statistics and probability method. This paper uses the checklist method to identify the risk of real estate projects.

Checklist method refers to the listing of a form, in which the various risks that real estate development enterprises may face are filled in, and the identification personnel are responsible for carrying out the relevant inspection and verification work, so as to determine whether the enterprises have the various risks in the list, also known as the checklist method. Generally speaking, when choosing this inspection method, it is necessary to collect all the risk events experienced in the past and the causes of the risks into a table according to the risk factors such as technology-related information, product conditions, skills or deficiencies of employees in the environment where the real estate development enterprise is located, which may cover the following contents: the reasons for the previous success or failure of the enterprise; The development strategy of the enterprise; the status of human resources or financial management; the management of the procurement process of project development and operation; the description of products or services launched by the enterprise; the special skills of the relevant members of the enterprise; the available resources that can be used in the operation of the enterprise. The main feature of this method is that it is simple to operate and takes a short time, and it can identify some risks that other methods cannot identify [5].

2.2 Identification Results

Through extensive reading of the literature, we collected all the risk events experienced in the past and the causes of the risk into a table, and drew it in the form of a table, as shown in Table 1.

Table 1. List of risks for real estate projects

Level 1 indicator	Secondary indicators
U1 Risk in decision-making and project establishment phase	U11 national macro-control risk
	U12 market positioning risk
	U13 market economy environment risk
	U14 land price risk
	U15 regional consumption level risk
U2 Risk in planning and design stage	U21 financing risk
	U22 government support risk
	U23 project design risk
	U24 regional planning risk
	U25 cash flow risk
U3 Risk in construction and implementation phase	U31 construction technical risk
	U32 construction quality risk
	U33 construction safety risk

	U34 construction cost risk
	U35 construction organization risk
U4 Risk in investment promotion operation stage	U41 leasing marketing risk
	U42 operational management risk
	U43 urban supporting risk
	U44 industry competition risk
	U45 market supply and demand risk

3 Determination of the Weight Based on Analytic Hierarchy Process

3.1 Introduction of Analytic Hierarchy Process

In the 1970s, Thomas Setty, an American operational research scientist, proposed a comprehensive qualitative and quantitative analysis method called Analytic Hierarchy Process (AHP) to solve complex decision-making problems with multi-objective, multi-criteria or unstructured characteristics [6]. The analytic hierarchy process takes into account the essence of the problem, the influencing factors and their internal relations, and digitizes and mathematizes the decision-making process to provide a simple and convenient decision-making method. In addition, the analytic hierarchy process quantifies and systematizes the subjective judgment of decision makers, which makes up for the decision-making deviation caused by subjectivity to a certain extent. This method has been widely used in many fields. It can overcome the subjectivity of the data in the judgment matrix to the greatest extent, and make the final index weight have higher credibility. AHP allows the decision maker to decompose the problem into multiple levels and consider the factors of different levels comprehensively. This hierarchical structure can reflect the complexity and diversity of the problem, allowing decision makers to deal with the problem more flexibly; AHP allows decision makers to determine the relative importance of two factors by comparing them [7]. This comparison method does not depend on mathematical formulas, but depends on the subjective judgment of decision makers, so it can reflect the real preferences of decision makers; the results of AHP can be calculated through matrix operations, and can be intuitively expressed in the form of charts and so on, which is easy for decision makers to understand and accept.

3.2 Basic Steps of Analytic Hierarchy Process

1. Identify core issues and establish a hierarchical structure

When analyzing the engineering project, the relevant personnel should first determine the problems to be solved, put forward the objectives, and then find out the various factors affecting the objectives, and finally determine the hierarchical relationship.

2. Construct the hierarchical judgment matrix

Tectonic hierarchy judgment means that the factors in the tectonic hierarchy are from B1, B2, ⋯ To Bn, compare the importance with the factors in the previous level, and then describe the results in five levels according to the importance from low to high, and quantify the above five levels to obtain the judgment matrix. $A = (a_{ij})_{n\times n}$, namely:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1j} \\ \vdots & \ddots & \vdots \\ a_{i1} & \cdots & a_{ij} \end{bmatrix} \quad (1)$$

$a_{ij}(i, j = 1,2, \cdots, n)$To determine the element.

When constructing the judgment matrix, the most important content is to determine the risk index factors and the corresponding weights. Through the investigation of the existing real estate investment projects, the main risks of the real estate investment projects and the severity of the consequences caused by the corresponding risks are studied, and the risk index factors and the corresponding weights are initially determined; Several peer experts with rich experience are invited to review and confirm the index factors and weights proposed by the survey, and the final index factors and weights are obtained by averaging the weights given by the peer experts [8].

3. Single sorting and consistency test

First of all, the elements in the matrix A are directly summed and raised to the nth power. This method is actually the root method to find the eigenvector corresponding to the maximum eigenvalue of the judgment matrix A.$W = (\omega_1, \omega_2, \cdots, \omega_n)$, namely:

$$\omega_i = \sqrt[n]{\quad_{j=1}^{n} a_{ij}}(i = 1,2, \cdots, n) \quad (2)$$

Secondly, the feature vector is normalized, that is, the weight feature vector is obtained $W = (\omega_1, \omega_2, \cdots, \omega_n)$ The maximum eigenvalue of the matrix A is determined by solving the equation (3).

$$\lambda_{max} = \frac{1}{n} \quad_{i=1}^{n} \frac{(AW)_i}{\omega_i}(i = 1,2, \cdots, n) \quad (3)$$

In this paper, the quantitative index, namely the consistency index CI, is used to measure the inconsistency degree of the judgment matrix.

$$C_I = \frac{\lambda_{max}-n}{n-1} \quad (4)$$

Among them, the required $C_I = 0$ The judgment matrix is consistent. C_I The larger the value is, the higher the inconsistency degree of the judgment matrix is. In this paper, the random consistency index is used. R_I Measure the degree of inconsistency of the judgment matrix:

$$R_I = \frac{\lambda_{max}-n}{n-1} \quad (5)$$

Among, λ_{max} That is, the average number of the largest eigenvalues of multiple n-order positive reciprocal matrices, when the proportion of random consistency $C_R = C_I/R_I < 0.1$ The inconsistency of the judgment matrix is within the allowable range, otherwise, the judgment matrix A needs to be adjusted.

4. Check the consistency of total ranking and combination.

When checking the consistency of hierarchical general sorting and combination, the hierarchical general sorting shall check the consistency of combination layer by layer from the highest target layer to the lowest scheme layer. Suppose the consistency index is Ci, and the B layer contains n factors, that is, from B1, B2 to Bn is a hierarchical single ordering with respect to Ai, if the random consistency index is Ri, then B1, B2, ⋯ , the combined consistency index of Bn with respect to G is:

$$C_R = \frac{{}_{i=1}^{m} a_i C_i}{{}_{i=1}^{m} a_i R_i} \tag{6}$$

When CR < 0.1, the result of the hierarchical total ranking can be determined to have satisfactory consistency, otherwise, the judgment matrix needs to be adjusted again.

4 Determination of the Risks by Fuzzy Comprehensive Evaluation 4.1 Brief Introduction of Fuzzy Comprehensive Evaluation Method

Fuzzy comprehensive evaluation is an analysis method based on the theory of fuzzy mathematics. Fuzzy mathematics is a new subject developed in the past forty years. Its founder is Professor LA. Zadeh, a famous cybernetics expert in California University [9]. The mainstream of the development of fuzzy mathematics lies in its application, which provides a simple and effective method for people to study and solve those complex problems that are difficult to be described by precise mathematical relations. Because fuzzy concepts have found the description of fuzzy sets, the process of using concepts to judge, evaluate, reason, make decisions and control can also be described by fuzzy mathematics [10]. Fuzzy clustering analysis, fuzzy pattern recognition, fuzzy comprehensive evaluation, fuzzy decision-making and fuzzy prediction, fuzzy control, modelling information processing and so on are all fuzzy data. These methods constitute a fuzzy system theory and a dimension of speculative mathematics. Fuzzy comprehensive evaluation method is a comprehensive evaluation method for things with fuzzy characteristics through the construction of fuzzy sets [11]. It is a method that transforms qualitative analysis into quantitative evaluation according to the theory of membership, so as to make a comprehensive evaluation of things. The method has the characteristics of strong systematises and clear structure, and is suitable for solving the problems which are difficult to quantify and have fuzzy characteristics.

4.1 Basic Steps of Fuzzy Comprehensive Evaluation Method

Construction of factor set. Through fuzzy evaluation of real estate development projects, we determine the impact factors of real estate development projects. A systematic evaluation index system is established according to the identified risk factors, evaluation indexes and evaluation results. Where the set of constitutive risk factors U = {U1, U2, ··· ,Ui,··· , Un}, that is to say, the project has evaluation indexes of risk factors.

Creation of comment collection. The review set is created to set some evaluation criteria for the existing factor set, and then give the specific evaluation results of each factor according to these criteria. This paper divides the evaluation set into five levels, and the significance and specific requirements of each level are as follows: V = {very small, small, medium, large, very large}.

Very small risk-indicating that the impact of the risk on the project is very small and almost negligible;

Minor risk-indicating that the impact of the risk is manageable and no special action is necessary to deal with it;

Moderate risk-indicates that the risk may have some impact on the project, but the risk factor is not out of control, just pay attention to its changes;

High risk-indicates that the risk has a significant impact on the project, and when the risk situation is monitored in real time, the corresponding actions must be established and implemented immediately;

High risk-indicates that the risk will have a catastrophic impact on the project, and requires a response plan in advance and special personnel to monitor it at any time. In addition, we should formulate emergency countermeasures to deal with risks and minimize the losses caused by risks [12].

Establishing a membership degree matrix. Risk factors at the lowest level were scored according to different levels of indicators, ranging from 0 to 100. Through the average analysis of the scores of 10 experts, the risk attribution vector score of the project is obtained, and the various indicators of the project are evaluated. The membership function is used to comprehensively evaluate the impact factors, and the main factors of impact factor analysis are obtained. For those effective and important risk factors that reflect the actual situation of the project, UI (I = 1,2, ···, m), and determine its position (rij) in the evaluation, the single-factor evaluation set of risk factors UI = { ri1, ri2, ··· , rim }, which is a fuzzy set of evaluation sets. Therefore, the total evaluation matrix R = (rij) n × m can be constructed by the evaluation set of m risk factors, that is:

$$R = \begin{bmatrix} r_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & a_{nm} \end{bmatrix} = (r_{ij})_{n\times m} \qquad (7)$$

R is a fuzzy relation from the risk factor set U to the evaluation set V of the project.

According to this membership function, the vector value is determined by the percentage of the interval that a score falls into. For example, if an expert's average rating is between 90 and 100, then the indicator is an A. This represents a very high systemic risk. If the average score is between 80 and 90, the indicator is rated B, indicating that the system is risky. This means that in the vector calculation, these factors are scored (90-X)/10 on the high hazard range, and the score on the B hazard range is equivalent to the score on A hazard range. The corresponding fuzzy membership vector can be determined by using the membership function and the average expert score.

Comprehensive evaluation. For the weight W, a comprehensive evaluation can be obtained: B = W*R. The largest membership degree is the factor with the largest project risk.

Risk analysis. In the process of carrying out the project, we need to establish a higher awareness of risk prevention, and have a set of scientific and reasonable prevention strategies. In order to better promote the implementation of the project and effectively manage the above risk factors, corresponding risk prevention measures should be formulated for key risk indicators. In the stage of investment decision-making, we should strengthen the analysis and evaluation of market prospects, sources of funds, policy environment and other aspects in order to reduce the risks caused by the uncertainty of the external environment. In the stage of planning, design and bidding, we should strengthen the examination of the design scheme to ensure that it meets the commercial needs and meets the standards of safety, energy saving and environmental protection. In the construction stage, the project quality management should be strengthened to ensure that the construction quality meets the requirements, and emergency plans should be formulated to deal with emergencies. In the stage of rental and operation management, it is necessary to ensure the satisfaction of tenants, property service quality and customer experience, and to formulate contingency strategies to cope with market fluctuations and competition. In addition, in the whole process of project implementation, emerging risks should be constantly tracked and identified, and appropriate measures should be taken to reduce the impact of risks. Through the comprehensive implementation of the above measures, the commercial value of the project can be maximized and the risk level faced by each stage can be minimized.

5 Conclusions

This paper divides the risks of real estate projects into four stages for analysis, namely: investment decision-making stage risks, planning and design stage risks, construction and implementation stage risks, and investment and operation stage risks. On this basis, through literature analysis, on-site research, and experience summary, the risks in the above four stages are further divided into more risks. Fuzzy Analytic Hierarchy Process is a good combination of the two methods mentioned above. It integrates fuzzy mathematics, hierarchical structure, and trade-off comparison, providing scientific and effective support for decision-making. The advantage of Fuzzy Analytic Hierarchy Process is to simplify the judgment objective, achieve the transformation of decision-making to quantification, and then obtain a fuzzy consistency judgment matrix, and provide appropriate solutions for the problem of consistency in the judgment matrix.

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