Growing Properties Investment in Thailand Based on Fuzzy Analytic Hierarchy Process

Zhai Fan, Piang-or Loahavilai, Nopasit Chakpitak, and Tanarat Rattanadamrongaksorn

***Abstract*—Chinese people are growing their overseas properties investment under the background of the BRI policy. The economic activities of Thailand become increasingly a country for Chinese people to invest in Southeast Asia. The key features for the property investment success by involve the investment profit under the condition of controllable risk and identifying risk factors. Certainty several Chinese people made decisions on the purchase of real estate to improve investment in Thailand Even there are many kinds of difficulty such as establishing financial indicators and evaluating risk probability. We proposed to across the Chinese invest in property in Chiang Mai to improve the feasibility of the model by establishes an investment decision model. In this study involved the require of property investment need more opportunity to develop an effective based on new strategy to enhance three parameters analytic hierarchy process, sensitive factor analysis, and fuzzy analysis.**

***Index Terms*—Property investment, FAHP, decision-making model, fuzzy analytic.**

I. Introduction

With the migration and investment of new Chinese immigrants in Southeast Asian countries, Chinese real estate investment in Thailand has become "overheated". Unfamiliar with local laws and policies, blind investment, capital control and other factors bring varying degrees of risks to home buyers and investors [1]. Not only that, but traditional real estate investment decisions also often only use evaluation methods such as net present value method, investment payback period method and internal rate of return method, sometimes supplemented by uncertainty analysis such as break-even analysis, sensitivity analysis, and probabilistic analysis. However, these investment decision-making techniques are all single-factor or single-objective decision-making, and cannot adapt to the characteristics of multi-objective and multi-factor of real estate investment [2]. To avoid real estate investment risks, a multi-factor and multi-objective evaluation method combining qualitative and quantitative should be adopted to make scientific analysis and evaluation of various risk factors that may appear in the real estate investment process in order to make scientific decisions on real estate investment. The property real estate market is a significant factor in the economic development of all countries. Related to the real estate market, there is a lot of data distributed every day. As China's Belt and Road economic corridor project advances, Thailand's property market is also heating up [3]. The construction of the China-Thai railway will make it happen sooner from Kunming to Bangkok in recent, and also attracting more Chinese to invest in Thai property across the border. Chinese in Thai property market is often faced how to choose the investment of residential projects, how to effectively assess the investment risk of real estate projects, and to maximize the investment profit under the condition of controllable risk is an important link and difficulty in the decision-making of Chinese real estate investors. In the past the Chinese invest in property in Thailand there was two main decision-making methods: the first is from the perspective of risk factors, such as investment risk analysis. The risk is classified as policy risk, economic risk, legal risk, social risk, management risk. By finding out the key risk factors of all kinds of risks, establishing the risk judgment of the index system, ranking all kinds of risk factors. The disadvantage of this method is that it is not easy to reflect the profit and appreciation space of real estate investment, and the relevant data have more subjectivity, which is more suitable to identify the risks and their importance [4]. The second is from the perspective of financial indicators, such as sensitive factor analysis. Traditional value indicators such as net present value, internal income index can show the influence of uncertain factors on the economic benefits of real estate, and get the range of uncertain factors that can be allowed to invest real estate, so as to predict the risk of investment. But it does not show how likely this risk is to occur, and the probability of relative change for different uncertain factors of residential asset allocation is different. Two equally sensitive factors, in the same range of variables, may have a large probability of one occurrence and a small probability of the other occurring. Obviously, the influence of the former factor is very large, and the latter one is small, which cannot be solved by this kind of analysis method [5]. It is one-sided to measure the good and bad investment benefit and judge by the absolute value of investment return. From the perspective of property buyers, this paper uses the fuzzy analytic hierarchy process (FAHP) and sensitive factor analysis method to analyze the feasibility of Chinese buying properties in Chiang Mai. Through the analysis of sensitive index factors and the application model, outcomes the qualitative index is quantified to solve the problems of independence and correlation between indicators.

II. Establishing a Decision-Making Model for Residential Real Estate Investment

The investment decision of the real estate project mainly

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evaluates the value of investment from the project cost, the forecast of resale (rental) income and the project risk.

Investment risk usually consists of two main categories: the first is the same risk that investors face when purchasing different types of property, such as policy risk and social risk (for instance Covid-19, land price change, regional development risk); the second is the different risk that investors face when purchasing different types of property, such as economic risk (profit margin on sales or rental income, investment payback period and difficulty risk), market risk (such as policy adjustment, market supply and demand change) [6].

The Basic formula of the investment decision model of the real estate project is: $V_i=F_i/C_i \times P_i$, $_i$=1, 2, 3... m; Formula: V_i — value (refers to the realization of investment benefit factors and cost matching degree); F_i — function (refers to a series of factors to achieve investment benefits); C_i — costs (i.e. the total costs incurred during the investment); P_i — the risk probability of realizing investment benefits (cumulative probability of equal risk values in different categories, risk factors adopt the second type of risk factors. The formula shows the principle that the better use of different types of real estate resources (i.e. less input and higher output), The greater the probability of achieving the same acceptable risk value with the higher the project value.

The model uses fuzzy analytic hierarchy process to calculate the proportion of investment residential real estate benefit index, quantifies the data corresponding to the project Z_{in} (Z_{in} represents the $_n$ scheme of the $_i$ project), then calculates the function coefficient F_i、cost coefficient C_i of the project and the risk probability when realizing the equal risk value of the project benefit P_i, and finally calculates the value coefficient of the project. A project selection method is that the greater the Z_{in} value coefficient under the greater the investment value "equation (4)".

III. Case Study on Investment in Chiang Mai Residential Real Estate

For our research strategy to improve the result analysis step we involved 40 Chinese families whose purchased real estate in Chiang Mai. In general, the use of these families to invest residential property in Chiang Mai can be divided into self-housing and rental (while maintaining value and appreciation) accordingly, can also be defined as consumption and investment. Consumer buyers face a trade-off between buying and renting. For investors, the trade-off between investing their money in real estate or other channels. Income from investments in properties includes the sum of expected price increases and rental of rental housing.

A. Mathematical Model of Fuzzy Analytic Hierarchy Process

The decision-making process of real estate investment based on fuzzy analytic hierarchy process (FAHP) is based on the analysis and identification of its risk system, the establishment of risk evaluation index system, using analytic hierarchy process to determine the weight of each risk factor, and then use multi-factor fuzzy evaluation to determine the overall risk distribution of each scheme, finally according to the risk distribution of investment scheme optimization decision. This category of decision-making investment approach can not only overcome the shortcomings that can only measure a single risk in the past, but also take real estate investment as a system to measure its overall risk degree, provide a scientific basis for investment decision-making, and also provide theoretical guidance for effective selection of control measures, so as to achieve the purpose of scientific management of investment risk and reduce losses. Therefore, according to the thinking mode of the fuzzy analytic hierarchy process, this paper will establish the decision model of real estate investment risk as shown in Fig. 1.

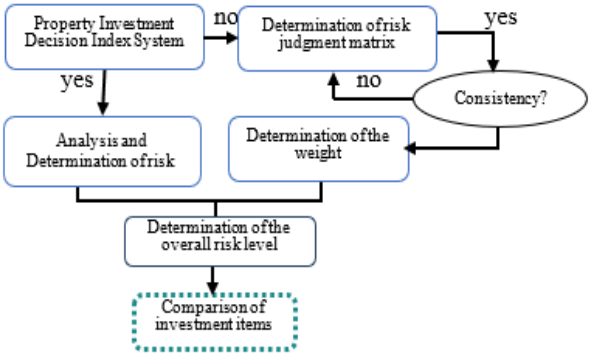

Fig. 1. Real estate investment risk decision model.

B. Determination of Evaluation Indicator System

Because there are many influencing factors of real estate investment risk, it is impossible to consider all the influencing factors in the comprehensive evaluation, but only select the main factors which are representative and independent of each other [7]. Therefore, taking the objective risk of real estate investment system as the evaluation object, according to the connotation of index factors and the degree of correlation between indicators, the target requirements are decomposed into four levels of target layer, criterion layer, index layer and scheme layer, and the hierarchical structure of real estate investment risk index system is established, as shown in Fig. 2:

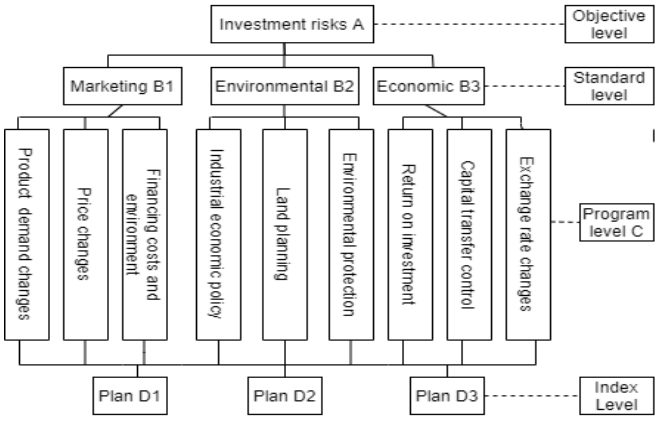

Fig. 2. Real estate investment risk indicators system.

C. Determination of the Weight of Each Risk Factor

After the establishment of hierarchical structure model of real estate investment risk index system, the subordinate

relationship between the upper and lower levels of each risk influencing factor has been established. In this way, the AHP can be used to sort the importance of risk assessment indicators at all levels and overall ranking. The procedure is as follows:

First, the elements of the upper layer are selected as the criterion, and the elements with dominant relationship in the next layer are compared by 1 to 9 scale method (as shown in Table I) to determine their relative importance, so as to establish the judgment matrix of fuzzy analytic hierarchy process. Should be paid more attention on the characteristics of the judgment matrix:

TABLE I: 1-9 SCALE METHOD

Scale bucket	1	3	5	7	9	2、4、6、8
Definition	Equally important	A little important	Obvious importance	Much more important	Extreme importance	Median value of two adjacent judgments

Second, the square root method (or sum product method) is used to determine the weight of each layer of factors, and according to the maximum characteristic root method, the consistency of the judgment matrix is tested to ensure the consistency of the criteria of each comparison judgment, and to prevent the subjectivity and one-sidedness of the judgment process [8]. Weight calculation and consistency test for each item on the basis of fuzzy analytic hierarchy process (FAHP), three types of properties (housing villa, condominium, housing villa + condominium) A、B、C purchased in different areas of residential property in Chiang Mai are analyzed, assuming the B of the project B_1-B_{10} and the influence percentage of risk is linearly distributed. The qualitative and quantitative data after fuzzy processing are used CIM series response model (1) and parallel response model (2) to calculate the probability of risk influence.

$$P(X_a = x_a) \tag{1}$$

$$\sum_{i=1}^{m} PX_1 = x_{i,1}, X_2 = x_a x - i,1 \tag{2}$$

$$= \sum_{i=1}^{m} P\ \mathrm{X}_1 = x_{i\ 1})P(X_{\ 2}=x_a x\ \text{-}_{\mathrm{i}\ 1}\ ) \tag{3}$$

$$x_a \text{ of them } = x_{1\ i} + \mathrm{x}_{2j;\ i}=1,2,\ ...m;\ _j=_i=1,2,\ ...m; \tag{4}$$

$$P\ (Xa = x_{\ a})$$

$$\sum_{i=1}^{m} P\ \mathrm{X}_1$$

$$x_{\mathrm{ai}}, X_{\ 2<}$$

$$x_{\mathrm{ai}}) + \sum_{i=1}^{m} P\ X_1 = x_{i,\ 1})\ P\ (X_{1<}\ x_{\mathrm{ai}}, X_2 = x_{\mathrm{ai}}) \tag{5}$$

In which $_i$ =1, 2, ... m;

Input the expected value of the original data into the real estate residential project risk assessment table and dimensionless the data. Finally, the calculation result is that the value coefficient of the project B is the largest, and the calculation result is consistent with the actual situation of the cases.

For example, the A risk index system for residential investment:

The analysis results show that the high-risk weight of the project C (housing villa + condominium) is the largest and the low risk is the least; the high risk of the scheme B (condominium) is equal to the low risk and is at a low level; the high risk of the project A (housing villa) is relatively high. However, real estate projects themselves are high-risk with high-return investment types [9]. Hence, in view of the above results and the characteristics of real estate investment risk, it is recommended to adopt the scheme B, that is the investment of advanced residential condominiums is a more appropriate choice.

D. Determination of the Overall Risk Level of Each Investment Program

Applying Fuzzy Algorithm and Using $S = W^{(n)}$oR calculation formula to determine the risk degree distribution of each program. The operation rules are weighted average fuzzy operators, that is, real multiplication and bounded sum.

E. Case Analysis of Chiang Mai

Now it is proposed to invest in a residential real estate project, with villa-type residential areas D 1、 senior residential areas D2、 ordinary residential areas D3 three feasible schemes. Based on the above decision models and evaluation procedures, each layer weight straight calculation and consistency test according to the analytic hierarchy process, each layer feature vector calculation (square root method) and consistency test results are shown in Table II.

TABLE II: ANALYSIS OF EIGENVECTORS FOR EACH LAYER

A	B1	B2	B3	B4	*Wf*	*W*	*BW*	A max	*CI*
B1	1	3	5	7	3.201	0.564	4.129	4.117	0.039
B2	1/3	1	3	5	1.495	0.263	4.100		
B3	1/5	1/3	1	3	0.669	0.118	4.104		
B4	1/7	1/5	1	1	0.312	0.055	4.135		
B1	**C1**	**C2**	**C3**	**C4**	***W***	***W***	***BW***	**A max**	***CI***
C1	1	2	5	9	3.080	0.514	4.094	4.105	0.035
C2	1/2	1	4	8	2.000	0.334	4.078		
C3	1/5	1/4	1	4	0.669	0.112	4.121		
C4	1/9	1/8	1	1	0.243	0.041	4.128		
B2	**C5**	**C6**	**C7**	**C8**	***Wf***	***W***	***BW***	**A max**	***CI***
C5	1	2	5	7	2.893	0.510	4.085	4.099	0.033
C6	1/2	1	4	6	1.861	0.328	4.077		
C7	1/5	1/4	1	3	0.622	0.110	4.116		
C8	1/7	1/6	1	1	0.298	0.053	4.119		
B3	**C9**	**C10**	**C11**	***Wf***	***W***	***BW***	**Amax**	***CI***	***CR***
C9	1	3	5	1.96	0.573	3.806	3.093	0.047	0.081
C10	1/3	1	2	0.90	0.263	2.971			
C11	1/5	1/2	1	0.56	0.164	2.503			
B4	**C1**	**C13**	**C14**	**CIS**	***Wf***	***W***	***BW***	**A max**	***CL***
C12	1	2	5	7	2.893	0.523	4.056	4.068	0.023
C13	1/2	1	3	5	1.655	0.299	4.030		
C14	1/5	1/3	1	3	0.669	0.121	4.091		
C15	1/7	1/5	1	1	0.312	0.057	4.096		

Calculation results show that the CR of each layer judgment matrix is less than 0.1, and its consistency is acceptable, so the weight of each factor relative to the total target is shown in Table III.

F. Determination of Fuzzy Matrix of Risk Factors in Each Scheme

According to the results of risk size V= {high risk, medium risk, low risk}, the risk adaptability of each scheme

is scored, and then the risk degree value of each factor is obtained on average, so that the multi-factor fuzzy evaluation matrix of each scheme can be obtained (see Table IV).

The analysis results show that the high-risk weight of the project C (housing villa + apartment) is the largest and the low risk is the least; the high risk of the scheme B (apartment) is equal to the low risk and is at the low level; the high risk of the project A (housing villa) is relatively high.

However, the real estate project itself is a high-risk high-return investment type. Therefore, in view of the above results and the characteristics of real estate investment risk, it is suggested to adopt a scheme B, that is, investing in high-class residential apartments are a more appropriate choice.

TABLE III: WEIGHT OF FACTORS RELATIVE TO TOTAL OBJECTIVE

	Bl	**B2**	**B3**	**B4**	**hierarchy c total ranking/(weight)**
	0.564	0.263	0.118	0.055	
Cl	0.514	0	0	0	0.290
C2	0.334	0	0	0	0.188
C3	0.112	0	0	0	0.063
C4	0.041	0	0	0	0.023
C5	0	0.51	0	0	0.1 34
C6	0	0.328	0	0	0.086
C7	0	0.11	0	0	0.029
C8	0	0.053	0	0	0.014
C9	0	0	0.573	0	0.068
CIO	0	0	0.263	0	0.031
CH	0	0	0.164	0	0.019
C12	0	0	0	0.523	0.029
C13	0	0	0	0.299	0.016
C14	0	0	0	0.121	0.007
C15	0	0	0	0.057	0.003

TABLE IV: MULTI-FACTOR FUZZY EVALUATION MATRIX (R_{D1},R_{D2},R_{D3})

Factorr weight	Progra	High risk	Medium Risk	Low risk	Progra D3	High risk	Medium Risk	Low risk
0.290	Cl	0.6	0.4	0	Cl	0	0.4	0.6
0.188	C2	0.3	0.4	0.3	C2	0.2	0.5	0.3
0.063	C3	0,4	0,3	0.3	C3	0.2	0.5	0.3
0.023	C4	0.4	0.3	0.3	C4	0.2	0.3	0.5
0.134	C5	0.7	0.3	0	C5	0.1	0.4	0.5
0.086	C6	0.2	0.3	0.5	C6	0.5	0.3	0.2
0.029	C7	0.7	0.3	0	C7	0.3	0.5	0.2
0.014	C8	0.5	0.3	0.2	C8	0.2	0.5	0.3
0.067	C9	0.3	0.4	0.3	C9	0.2	0.3	0.5
0.034	CIO	0.1	0.3	0.6	CIO	0.5	0.3	0.2
0.017	Cll	0.1	0.3	0.6	Cll	0.6	0.3	0.1
0,029	C12	0.2	0.3	0.5	C12	0.6	0.3	0.1
0.016	C13	0.4	0.3	0.3	C13	0.4	0.3	0.3
0.007	C14	0.2	0.4	0.4	C14	0.2	0.4	0.4
0.003	C15	0.3	0.2	0.5	C15	0.2	0.30	0.5
	SDI	0.44	0.35	0.20		0.19	0.40	0.41

IV. OVERVIEWS THE EVALUATION OF THE MODEL

A. The model is established from the perspective of investment value, risk size and risk probability at the same time, which overcomes the singularity of decision-making method for real estate investment projects and one-sidedness.

B. Scientific and systematic establishment of project benefit indicators through FAHP weight, avoiding the limitations of artificial subjective judgment.

C. In the model, the sensitivity analysis method and balance method are also used to make the data more scientific.

D. Combined with the characteristics of fuzzy mathematical model, a fuzzy mathematical risk analysis model is constructed. The qualitative factors which are vague, difficult to define and not easy to describe in language are quantified, and the independent and related problems between variables are solved.

V. CONCLUSIONS

The decision-making method of property investment based on fuzzy analytic hierarchical process can not only determine the influence degree of each risk factor of property investment and the risk distribution of the whole investment, but also determine the advantages and disadvantages of the multi-category scheme, and then optimize the investment scheme.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Authors A,B conducted the research and wrote the paper; Authors C,D analyzed the data. All authors had approved the final version.

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