

A STUDY ON RISK WEIGHT USING FUZZY IN REAL ESTATE DEVELOPMENT PROJECTS

Sung Cho¹, Kyung-ha Lee², Yong Cho³ and Joon-Hong Paek⁴

¹ MS Candidate, Yonsei University, Seoul, Korea

² MS Candidate, Yonsei University, Seoul, Korea

³ MS Candidate, Yonsei University, Seoul, Korea

⁴ Professor, Yonsei University, Seoul, Korea

Correspond to sungcho@yonsei.ac.kr

ABSTRACT: Due to recession in real estate market, interest of risk analysis is increasing. Feasibility study in the first stage takes a great role in a project. There are not objectified tools which are able to cope with uncertainty of project, and feasibility study based on selected method of determinism does not include liquidity of weight risk. Also, shortage of consideration for subjective and atypical external factors causes inappropriate results. Therefore, this study proposes feasibility study model focused on risk factor influences in construction cost and sales cost. Considering effective level of cost based on objective risk factors and probable weight of risk by this model, real workers are able to bring correct and scientific decisions better than former method based on selective analysis of real estate development.

Keywords: Risk Weight; Fuzzy; Feasibility study; Real Estate Development

1. INTRODUCTION

In real estate project, it objects to produce profits by investing capital, and to get a cost effective result. But due to various factors and uncertainty, it is not easy to predict profitability, and thus it is difficult to analysis feasibility of project. The importance of feasibility analysis at the early stage of business can be explained as Figure 1[1], and it has an essential role at the early stage of the business.

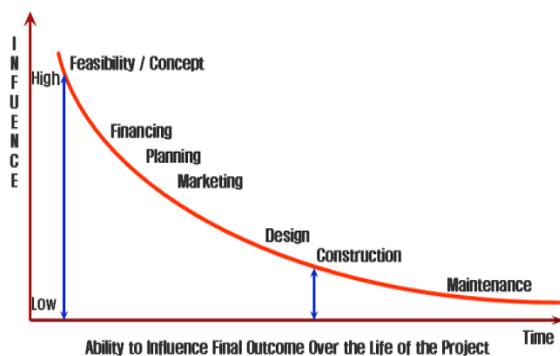


Figure 1. Project Influence

At the moment, most of project use financial analysis tool to measure risk and predict to result of the project. Not only weight of risk, but only risk by subjective and external factors influences largely to the project.

However, selected method is being used as a common tool of ordinary income analysis; nevertheless weight of risk itself is quite liquid and moves statistically. Project

analysis is about future weight of risk under incomplete circumstance based on uncertainty and variability. It is difficult to make a decision by substitute NPV or IRR for limited numerical value.[2]

Besides weight of risk, atypical and subjective factor also have influence on business, however, there is no valuation method to measure how weight of risk have influence on business in practice. Instead of a precise method, many studies rely on past experiences.

So far, real estate project has conceptual and complex model, and it simply analyze information from past projects, and thus it is difficult to make a decision. To solve this problem, offering an objective and practical feasibility analysis model based on probability financial analysis and atypical consideration.

This study focuses on residential and commercial complex which is having attention under urban center development.

First, theoretically review. At this stage, we set a concept by analyze the existing feasibility analysis methods.

Second, we deduce atypical risk at each stage of construction by analyzing existing studies, and make out objective chart throughout questionnaire and compare risk factors and weight of risk.

Third, based on real case of real estate project, we present the problems of selected determinism methods and compare it with fuzzy logics-MATLAB.

Fourth, building is objected feasibility model by analyzing atypical factor risks and risk weight analysis. It was focused on real estate project in apartment houses.

2. THE PRESENT CONDITION OF REAL ESTATE PROJECT

Real Estate project objects to increase the value of real estate by maximizing utility of real estate, including site procuring, raising business funds, and business planning, stabilizing benefits. Also, business steps of real estate development can be classified in 5 steps: (1) Pre-design; (2) Design; (3) Pre-Construction; (4) Construction; (5) Post-Construction. [3]

(1) Step: Electing Concept, Propriety Study, Financing Study, Real Estate Cost, Cash Flow, Responsibility of Project Risk. (2) Step: Basic design, Real drawing, Construction Plan, Value Engineering. (3) Step: Contract Plan, Out-Sourcing, Checking, Feasibility study. (4) Step: Start and Finish, Cost, Quality Control. (5) Step: Business Checking, Maintenance.[4]

3. FEASIBILITY ANALYSIS

3.1 Feasibility Analysis Methodology

Feasibility analysis in real estate development business means “A series systemic and synthetic process which analyzes institutional, legal, physical, technical, economical feasibility and viability for effective accomplishment of investment, development, and management of real estate.” Table 1 [5].

Table 1. Feasibility Study of Construction Company

Part		Contents
Basic Analysis	Place	Change of Real Estate Change of Surroundings
	Law	Law of Field Capacity, Parking Lot
	Market	Market Needs and Supply
	Commerce	Population, Traffic, Income
Marketing Analysis	Suitable Size	Population, Money, Traffic, Income, Urban Plan
	Sale Cost	District Housing Commerce Building Cost
	Estimation of Sale Rate	Former Housing The latest Sale cost
Cash Study	Income	Sale Cost
	Pay	Real Estate Fee, Work Cost, Management Fee
	Gains	NPV, IRR, Interest of Sale

3.2 Feasibility Analysis - Working Level Method

Feasibility study should be considered in terms of real cost, return, and cash in Real estate project. But these days only selected results based income and outcome only used to make decision. For example Excel(Microsoft Co.) sheet is used to make analysis based on only one cell

result. Spread sheet is used to make specific result based on selected method.[6]

This is the representative selected method and shows the relationship of parameter / result or parameter / parameter. But it has limitation of efficient data because of not treating variable weight of risk Table 2.

Table 2. Considered Parts of Real Estate Project

Part		
Real Estate cost	Purchase Price	Project site, Path, Consulting Cost
	Transfer Fee	Enrollment cost, Acquirement Cost
	Tax	Total land tax, District Education Fee
Constructi on Fee	Construction Fee	Removal fee, Path construction Fee
	Allotted charges	Gas utility Fee, District heating Fee, Electric Fee
Registratio n Fee	Bond	Bond Fee, City Train Bond
	Outsourcing Fess	Design, CM, Geometric, Traffic, Environmental Fee
	Tax	Traffic Tax, School Cost, Water Cost, Development Cost
Marketing Cost	Marketing Cost	M/H Site Fee, M/H Construction Fee, M/H maintenance fee (M/H:Model House)
Etc	Etc	Reserve fund, Main office fee, PF interest, PF commission
Financing Fee		
Maintenance Fee		Maintenance fee after construction Repair commission
Non-operating income		Marketing arrears, construction arrears

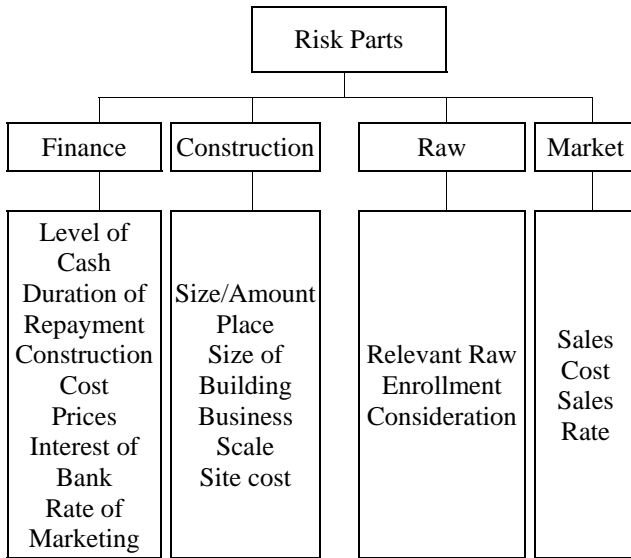
4. DERIVATION OF PROBLEM

Real estate project become the main job in Construction Company and objective, logical, and scientific analyses are required in project plan stage. But former theory is different from real case. When going project, risk is considered to make feasibility study. Feasibility study can be divided this parts. By considering Table 3[7], two problems can be found.

First, nowadays feasibility study just considers financial, economical facts and can't make objective method in uncertainty risk factors and weight of risk.

Second, financial analysis is not sufficient to show variable weight of risk and cash flow case in project. Because Excel (Microsoft Co.) sheet is used to make analysis based on only one cell result [8].

Table 3. Risk classification



5. FEASSIBILITY STUDY PROCESS

To reflect uncertainty of weight of risk, this part presents probable approach through statistical analysis. Reflecting the problem, the new feasibility analysis model is able to decide scientifically by reducing unreality of feasibility study process and objecting risk analysis process.

This process is accomplished by surveying experts, literature analysis, influence diagram, MATLAB analysis. (1)Project risk factor analysis → (2) Influence Diagram → (3) Weight of Risk analysis → (4) Risk factor

classification-by each section → (6) MATLAB analysis of construction and marketing risk factors → (7) Building a model

6. Survey Analysis

The survey of 30 construction companies, 30 developers, 30 CMer, and 20 Designers was conducted by this step. (1) Making atypical risk factors with study and research → (2) Making atypical risk factors with Study and research of papers → (3) Selecting atypical risk factors by survey of specialists in construction project development of Apartment and Stores[5 points measure] → (4) Surveying influence of atypical risk factors to process step → (5) Surveying cost of risk factors in each process → (6) Checking range of section by histogram [5 points measure] → (7) Checking probabilistic range by standard deviation and average value in graph. This process is accomplished by surveying experts, literature analysis, influence diagram, MATLAB analysis.

7. Analysis

7.1 Risk Analysis

Risk can lower profitability and spoil project. For successful operation of developing business, controllable and uncontrollable risks both should reflected and managed at decision making process.

Through influence diagram and survey, the factors which largely effect on business are extracted. After Influence diagram analysis, the parts are dived four parts which are construction, land cost, marketing, and PF. And specific factor is considered by interviewing professional in this sector.

Result of risk analysis is following to Figure 2. It is showed of the risk factors gradually detail A, B, C.

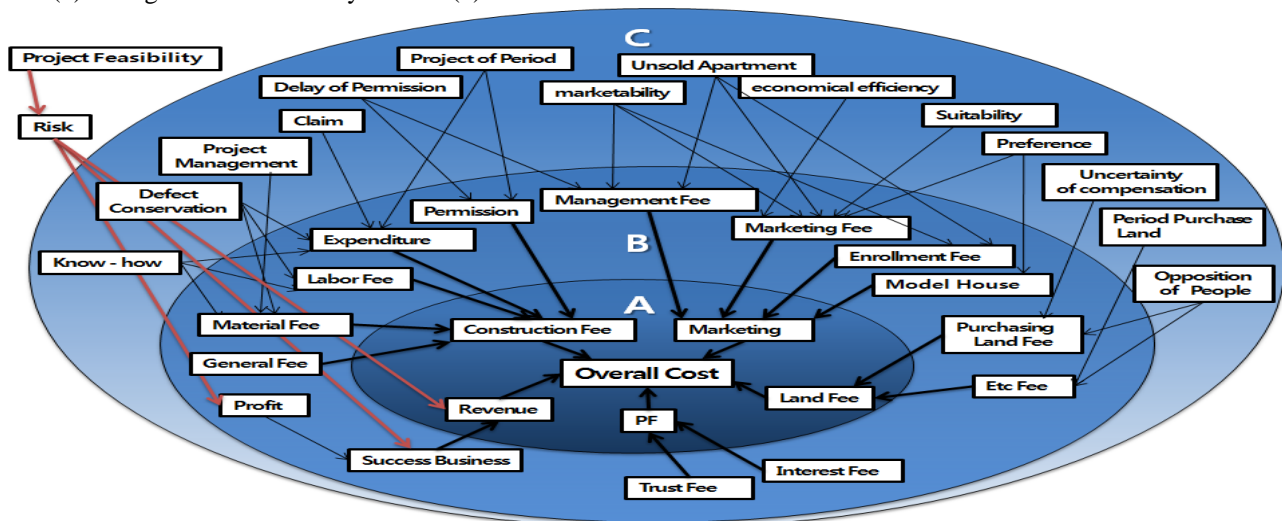


Figure 2. Influence Diagram

(A : Item of Expenditure B: Detail Cost C: Risk Factors)

7.2 Risk Analysis of Real Case

This part analyzes profitability of a real developing case by analyzing weight of risk on each business risk factors. This project outline is expressed as Table 4.

Table 4. Project Outline

Part	Contents	
Place	OOdong KuemCheon-Gu, Seoul	
Size of Place	18,066,16 m ²	
Business Size	16,408,30 m ²	
Construction Size	9,017 m ²	
Ration of Build to Land	55% / 787%	
Total Size	Upstair	141,857 m ²
	Underground	85,156 m ²
	Total	227,658 m ²
Story	41Stories	
Use	residential and commercial complex	

The project expected and real cost is showed as Table5. This table is not showing all project costs. But Construction cost and marketing cost up to 50% or more part of total cost so especially costs are selected. Following the table, 4.93% of differences are generated between expected and real costs.

Table5 . Expected and Real Cost of Chosen Project

Part	Item	Expectation	Real Cost
		(1000won)	(1000won)
Construction Cost(AC)	Direct cost	273,444,960	287,937,543
	Indirect cost	1,273,445	1,352,399
	Lead-in Cost	1,367,224	1,376,795
	Total	276,085,629	290,666,737
	Total Differences	-14,581,108 (5.01%)	-
Marketing Cost(MC)	Model House	1,768,000	1,812,200
	Marketing fee	18,808,071	19,579,202
	Total	20,576,071	21,391,402
	Total differences	-815,331 (3.8%)	-
(AC+MC)	Total	296,661,700	312,058,139
	Total differences	-4.93%	-

These tables show methodology of expected cost of the business and real cost. Typically, the expectation cost can be calculated AC plus SC. Such as, Formula (1) can be expresses as:

$$EC = AC + SC \dots \dots \dots (1)$$

(EC–Expectation Cost, AC–Actual Cost, SC–Sales Cost)

Formula (1) was calculated without Consideration of the risk factor. So factors were used in Fuzzy logics (Mamdani logic)-MATLAB process. Method of cost determinism - apply weight of risk, Formula (2) can be expressed as:

$$EC = \{AC+ (RC1 \times AC)\} + \{SC+ (RC2 \times SC)\} \dots \dots \dots (2)$$

(RC: Related with weight of risk cost)

Risk elements are consisted of positive risks and negative risks. So RC is Result of fuzzy logic; it can be expressed for RC form -1 to 1. [8]

7.3 Weight of risk Analysis with Matlab Tool

This Table6, 7 shows construction and marketing risk factor. Every risk factor is related each other.

Table 6. Construction Risk Factors

Factors		Part
c-1	Know-how	Material/ labor/ Money
c-2	Arrival Material (Network/manpower supply)	
c-3	Defect Conservation	
c-4	Project of period	Cost
c-5	Project Management	Maintenance
c-6	Claim	

Table 7. Marketing Risk Factors

Factors		Part
m-1	Unsold Apartment	Permission / Normal management
m-2	Lake of Marketing AD	
m-3	Permission delay	Permission
m-4	Economic slump	Normal management
m-5	Mismatch of Consumer Demand	

Fuzzy logic (Mamdani logic) was adapted in these dates. That process can be followed as Figure3.

Figure 3. Risk Factors of Matlab Process

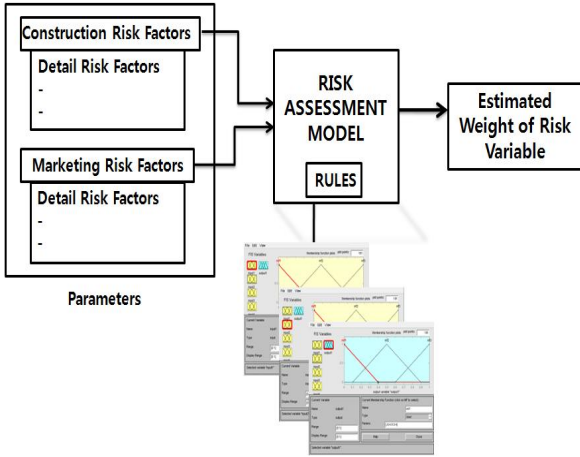
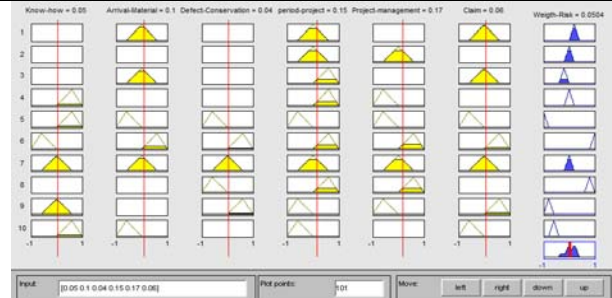


Table 8. MATLAB Analysis of Risk Factors

	<p><input type="checkbox"/> <u>Fuzzy set (Input)</u></p> <p>Input membership function</p> <p>Membership function of construction – 6</p> <p>Membership function of marketing – 5</p>
	<p><input type="checkbox"/> <u>Fuzzy set (output)</u></p> <p>Input membership function</p> <p>positive risks : 5 (PR1, PR2, PR3, PR4, PR5: 0~1)</p> <p>neutralization : 1(Normal : 0)</p> <p>negative risks : 5(NR1, NR2, NR3, NR4, NR5:0~-1)</p>
	<p><input type="checkbox"/> <u>Rule of construction risk factors</u></p> <p>Construction risk factors has 10 rules</p> <p>The rules are followed to AND&THAN RULE</p>
	<p><input type="checkbox"/> <u>Rule of marketing risk factors</u></p> <p>Marketing risk factors has 10 rules</p> <p>The rules are followed to AND&THAN RULE</p>

Part	Item	Expectation Cost	Weight of Risk Cost
		(1000won)	(1000won)
Construction Cost(AC) [0.0504]	Direct cost	273,444,960	287,226,586
	Indirect cost	1,273,445	1,337,626
	Lead-in Cost	1,367,224	1,436,132
	Total	276,085,629	290,000,344
	Increased		13,914,715
Marketing Cost(MC) [0.0488]	Model House	1,768,000	1,854,278
	Marketing fee	18,808,071	19,725,904
	Total	20,576,071	21,580,182
	Increased		1,004,111
(AC+MC)	Total	296,661,700	311,580,526
	Increased		14,918,826 (+5.03%)



Result of risk weight construction

Risk weight : **0.0504**



Result of risk weight marketing

Risk weight : **0.0488**

Each risk factor is calculated based on effect degree in detail parts. These results are showed by Table8. Fuzzy logic-MATLAB is calculated to construction weight of risk variable **0.0504** and marketing weight of risk variable **0.0488**.

It is compared to expectation and weight of risk cost. This result is showed as Table 9.

Table 9. Compare Expectation and Weight of Risk Cost

Result of this table is increased ₩ 14,918,826,000. And then weight of risk cost compare to real cost Table 10.

Table 10. Compare Real and Weight of Risk Cost

Part	Item	Real Cost	Weight of Risk Cost
		(1000won)	(1000won)
Construction	Direct cost	287,937,543	287,226,586

Cost(AC)	Indirect cost	1,352,399	1,337,626
	Lead-in Cost	1,376,795	1,436,132
	Total	290,666,737	290,000,344
	Total Differences	-	-666,393 (-0.23%)
Marketing Cost(MC)	Model House	1,812,200	1,854,278
	Marketing fee	19,579,202	19,725,904
	Total	21,391,402	21,580,182
	Total differences	-	188,780 (+0.88%)
(AC+MC)	Total	312,058,139	311,580,526
	Total differences	-	-477,613 (-0.16%)

Resulting of this table differs real cost to weight of risk cost at ₩ -477,613,000(-0.016%). But marketing cost has more ₩ +188,780,000(+0.088%); marketing cost tends to uncertainty higher than construction cost. Moreover, it hasn't a lot of data base.

8. CONCLUSIONS

When starting projects, early stage is very important in projects. And this stage is very effective to decision start or not. In feasibility study stage, project feasibility and profitability are analyzed. In this step, feasibility study is the most important factor and it is usually analyzed by risk parts.

Usually used method of determinism, this way is just consider financial parts. It can't consider total factor in project. So this paper survey risk parts and propose probability method by considering weight of risk. Especially land cost, construction cost and Marketing cost are divided and surveyed that bring importance and sensitivity of factors. This way is used to fuzzy logic-MATLAB which reveals rate of importance and effect.

This paper was considered real case. Same parts and factors were chosen to make feasibility study. Feasibility studies are affected by fixed form and atypical factors in real estate project. Therefore these two factors should be analyzed scientifically.

So this paper shows way to make exact and scientifically method, weight of risk analysis by fuzzy logic atypical factors in early stage of real estate project.

REFERENCES

- [1] Cho, sung., "A Study on Waste Management Method of Construction Project in Planning Stage", *Korea Institute of Construction Engineering and Management Academic Conference Memoir*, Vol 8, p.158, 2008.
- [2] Cobb, B. R., "Real options volatility estimation with correlated inputs", *Eng. Econ.*, 492 2004.

[3] Minhyung Kim., "A Study on the Method of the Risk Management in the Real Estate Development Project", *Construction & Economy Research Institute of Korea*, 2005.

[4] Mun. J., "*Real options analysis: Tools and techniques for valuing*", 2002.

[5] Breyfogle., F., "Implementing six sigma: Smarter solutions using statistical methods", *Wiley, New York*. 1999.

[6] De Neufville, R., "Real options: Dealing with uncertainty in systems planning and design", *Integrated Assessment*, pp. 41, 2003.

[7] Hyun-Ho Choi., "Risk Assessment Methodology for Underground Construction Projects", *Journal of Construction Engineering and Management*, ASCE, Vol. 130(2), pp. 258-272, 2004.

[8] James H. Paek., "Pricing Construction Risk: Fuzzy Set Application", *Journal of Construction Engineering and Management*, ASCE, Vol. 130(2), pp. 258-272, 2004.