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FEASIBILITY ANALYSIS MODEL FOR DEVELOPER-PROPOSED HOUSING PROJECTS IN THE REPUBLIC OF KOREA

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Abstract. The current construction industry recession in the republic of Korea has caused many construction companies to promote their own housing development projects. However, developers are still proposing many housing projects. While many studies on feasibility analysis for housing projects have been released, the focus was on economic feasibility, and factors related to developers have not been identified clearly enough to be used in practice. A feasibility analysis model is developed for apartment development projects in Korea to help main contractors make sound decisions on projects proposed by developers. To establish the model, 31 driving factors behind projects' success, in seven categories, were identified through several meetings with experts and surveys. Factors such as 'developer', 'method of raising funds' and 'method of contract', which were considered less important in previous studies, were included in the model. Criteria for each factor were also developed to assess the factors quantitatively. Then, each factor was assigned a weight by applying the Analytic Hierarchy Process. 'Salability', 'economic feasibility', 'site location' and 'method of raising funds' have relatively high weights. Finally, based on a Monte Carlo simulation, a feasibility analysis model was established, providing a probability distribution of each project's grade. The model was applied to 12 housing projects constructed in Busan (seven successful projects and five abandoned projects) to verify its reliability. The application results showed that the model properly filtered projects that are unlikely to be profitable, indicating that it is reasonably reliable. Our model could thus be a useful tool for contractors, especially those with limited experience in analyzing project development feasibility.

Keywords: housing development project, feasibility analysis, analysis factor, analysis model, Monte Carlo simulation.

1. Introduction

The current construction industry recession in Korea has caused many construction companies to promote their own housing development projects. However, developers still propose many housing projects. When construction companies and developers undertake housing projects, feasibility analysis is crucial for project success. Although some large construction companies use their own analysis models to control project-related risks, most companies do not have the capacity to analyze feasibility and so rely heavily on information from developers as well as decision makers' experience and intuition (Kwon 2004). Therefore, a feasibility analysis model that helps construction companies to examine whether to accept a building contract should be developed.

This study identified factors affecting the success of housing development projects and established quantitative criteria for each factor. After that, a feasibility analysis model was developed in order to help main contractors make correct decisions on projects requested by developers. The main components of this study are to:

1) review previous studies related to feasibility analysis;
2) identify driving factors in developer-requested housing development projects and establish quantitative criteria for each factor;
3) calculate weights for each factor using the analytic hierarchy process (AHP) and develop a feasibility analysis model based on Monte Carlo simulations;
4) apply the model to completed developer-proposed housing development projects to verify the model's reliability.

2. Literature review

2.1. Feasibility analysis

Feasibility analysis assesses the possibility of a project's completion, including technical possibility, financial feasibility and various social factors. Because the outcomes of construction developments are massive in terms of both scale and investment, it is impossible for them to be revised and redeveloped. In other words, problems occurring in early phases could be resolved easily, but those occurring in later phases are hard to resolve and require large effort and funds. This is why feasibility analysis in the planning phase is crucial in construction development.

2.2. Previous studies

Kang (1997) suggested a feasibility analysis model based on the concept of overall benefit, including social value and financial profit. Jeong (2001) identified factors in a feasibility analysis and examined the correlations between them to establish an analysis process model based on IDEF0 modeling. Joo (2002) identified the main factors affecting urban redevelopment projects and suggested an objective decision-making method by analyzing project processes. Yun (2003) identified major categories that influence the cost of construction development projects and analyzed the change of earning rate using a time-based technique. Shin (2005) divided analysis factors into qualitative and quantitative ones and used a survey to calculate weights for quantitative factors. His study also established criteria for quantitative factors to develop the feasibility analysis model for housing development projects. Table 1 shows the factors identified in previous studies.

In overseas, Enshassi *et al*. (2010) identified and ranked factors affecting a construction firm's 'bid/no bid decision' from the perspective of the contracting parties operating in Palestine. He used a postal questionnaire and found that the financial capability of the contractors, the financial capability of the clients, the financial values of the project, the due date of the payments, the availability of construction raw materials in local markets, and the stability of the construction industry were the most critical factors affecting the decision. Zavadskas *et al*. (2010) also assessed construction projects in a perspective of various risk factors that have influence on the construction process efficiency and real estate value.

Table 1. Feasibility analysis factors identified in previous studies

Kang (1997)	Jeong (2001)	Joo (2002)	Yun (2003)	Shin (2005)
Project site Preliminary design Marketability Financial feasibility Development scenario	Site analysis Market analysis Financial feasibility Feasibility decision	Regulation Technology Market analysis Economics Conflict relations	Site analysis Financial feasibility Feasibility decision	Development plan Market analysis Project budget Income analysis Feasibility decision

Tan *et al*. (2010) studied Hong Kong contractors' competition strategies in bidding and found thirteen typical bidding strategies. He addressed that better green practice, and better risk management, using joint venture were effective strategies besides lower tender price. Chan and Au (2009) investigated factors that contractors perceive to be important when they were pricing 'time-related' contract risks. His study revealed that employer's financial capability and their reputation to honor payment on time were critical.

2.3. Analytic Hierarchy Process (AHP)

The AHP is a structured technique to help people deal with complex decisions. Decision makers systematically evaluate various elements, comparing them with each other in pairs. In making the comparisons, the decision makers can use concrete data about the elements, or they can use their judgment about each element's relative meaning and importance. The AHP converts these evaluations to numerical values that can be processed and compared over the entire range of problems.

2.4. Monte Carlo simulation

Monte Carlo methods are a class of computational algorithms that rely on repeated random sampling to compute their results (Clemen 1996). Because of their reliance on repeated computation and random or pseudorandom numbers, they are most suited to calculation by a computer. Monte Carlo simulation methods are especially useful in studying systems with a large number of coupled degrees of freedom, such as fluids, disordered materials, strongly coupled solids, and cellular structures. More broadly, the Monte Carlo methods are useful for modeling phenomena with significant uncertainty in inputs, such as the calculation of risk in business.

3. Feasibility analysis factors and criteria

To establish the factors and criteria for each factor that were to be used in a feasibility analysis model, several meetings were held with experts, in which factors from previous studies were discussed and assessed. The experts include one development company representative director and 10 construction company employees, each of whom has more than 15 years' experience in development-related work. Table 2 summarizes the five major meetings. In the first meeting, the process and major considerations of housing development projects were discussed. In following meetings, factors and criteria were selected and revised for improvements. In the final meeting, the final factors and criteria were established.

3.1. Analysis factors

In the meetings described in the previous section, the experts recognized that many factors used in previous studies have rarely been applied in practice, as they were overly

Table 2. Summary of experts' meetings

	Summary
Meeting A	The process of housing development projects (Fig. 1); major considerations in projects
Meeting B	Review of analysis factors from previous studies; establishment of preliminary factors; setting guidelines for criteria development
Meeting C	Review of previous meetings; improvement of analysis factors; establishment of criteria
Meeting D	Review of previous meetings; improvement of analysis factors and criteria
Meeting E	Establishment of final analysis factors and criteria

detailed and studied only as a theoretical process. In this study, therefore, the factors separated in the past studies were merged to allow a simple and easy evaluation.

Related studies also suggested the discounted cash flow method using NPV (Net Present Value) and IRR (Internal Rate of Return) and a recent study (Park *et al*. 2009), furthermore, proposed PPV (Project Present Value), PRR (Project Rate of Return) and FRR (Firm Rate of Return) for more reliable decision makings. However, because housing development projects are completed relatively quickly, consideration of discount rates is not practically necessary (Kim 2008). Hence, the non-discounted cash flow method was selected instead.

Previous studies also lacked analysis of financing methods, payment arrangements for construction costs, and developer-related factors. Therefore, this study includes these as new factors, called 'Financing method', 'Payment arrangement' and 'Developer', and the factors from previous studies were reclassified and combined with those factors according to the project process to establish the feasibility analysis factors (Table 3).

3.2. Establishment of the criteria

The criteria and the analysis factors were established in the expert meetings (Table 4). The differences in the scores between contiguous levels were set differently because it is better to assess factors that have negative effects on projects with much lower scores to filter out projects that are unprofitable (Shin 2005). The criteria allow each factor to be scored easily and the criterion for 'number of projects conducted' is given in Table 5 as an example. Full detailed criterions of the factors attached as an Appendix A.

4. Development of the feasibility analysis model

As each factor has a different impact on project feasibility, it is unreasonable to evaluate each factor the same way. Therefore, to calculate weights for the factors, experts' opinions were converged and converted into values of weights by using the AHP. Finally, based on a Monte Carlo simulation using 'Crystal Ball 7' software, the feasibility analysis model was developed.

Table 3. Feasibility analysis factors selected

Level 1	Level 2	Level 3
1. Project site	1.1. Land condition	1.1.1. Land shape
		1.1.2. View
		1.1.3. Daylight
		1.1.4. Ground condition
	1.2. Site utility	1.2.1. Residential environment
		1.2.2. Transportation
		1.2.3. Educational facilities
		1.2.4. Basic amenities
2. Basic plan	2.1. Architectural plan	2.1.1. Floor plan
		2.1.2. Site plan
		2.1.3. Exterior plan
		2.1.4. Floor area ratio
	2.2. Project financing period	
	2.3. Policy	2.3.1. Housing policy
		2.3.2. Land policy
		2.3.3. Finance policy
3. Economic feasibility	3.1. Cash flow	
	3.2. Gross profit margin (construction company)	
	3.3. Gross profit margin (developer)	
4. Salability	4.1. Area environment	
	4.2. Price	
	4.3. Brand value	
	4.4. Specialty	4.4.1. Interior
		4.4.2. Exterior
		4.4.3. Landscape
		4.4.4. Community facility
5. Financing method		
6. Payment arrangement		
7. Developer	7.1. Experience	
	7.2. Land acquisition	
	7.3. Permission	

Table 4. Criterion structure

Level	Score	Criterion
A	10	1. According to the criterion of each factor 2. Assume probability distribution of score based on the criterion of each factor
B	9	
C	7	
D	4	
E	0	

Table 5. Criterion for 'number of projects conducted'

Analysis factor	Condition	Level	Score
Experience (7.1.)	Three or more projects	A	10
	One or two projects	C	7
	None	E	0

Table 6. Criterion for importance comparison in pairs

Important <--------------				Equally important	--------------> Important			
5	4	3	2	1	2	3	4	5

4.1. Calculation of the weights using the AHP

To calculate the weight of the each factor, experts who participated in establishing the analysis factors and criteria converged their opinions and compared factors on the same level in pairs according to the criterion for importance comparison in pairs (Table 6). Contingency Index (CR) is a value that determines validity of the data used for the AHP analysis. If the CI is less than 0.1, the result can be considered 'Reliable'. In this study, every CI was less than 0.1, suggesting that all results provided by the AHP are reliable.

Table 7 shows the comparisons in pairs of level 1 factors by the experts, which were converted into values for weights of the level 1 factors (Table 8). Factors such as 'Salability' and 'Economic feasibility' were given higher weights than other factors.

The level 2 and level 3 factors were also compared in pairs and weights were calculated for each (Table 9).

Table 7. Comparisons in pairs of level 1 factors

	Project site	Basic plan	Economic feasibility	Salability	Financing method	Payment arrange-ment	Developer
Project site	1	2	1/2	1/2	1	3	3
Basic plan	1/2	1	1/2	1/3	1/2	2	2
Economic feasibility	2	2	1	1/2	2	3	3
Salability	2	3	2	1	2	5	5
Financing method	1	2	1/2	1/2	1	3	3
Payment arrangement	1/3	1/2	1/3	1/5	1/3	1	1/2
Developer	1/3	1/2	1/3	1/5	1/3	2	1

Table 8. Weights of level 1 factors

	Project site	Basic plan	Economic feasibility	Salability	Financing method	Payment arrangement	Developer
Weight	0.149	0.092	0.206	0.296	0.149	0.049	0.059

Table 9. Weights of level 1, 2 and 3 factors

Level 1	Weight	Level 2	Weight	Level 3	Weight
1. Project site	**0.149**	1.1. Land condition	**0.333**	1.1.1. Land shape	**0.163**
				1.1.2. View	**0.363**
				1.1.3. Daylight	**0.326**
				1.1.4. Ground condition	**0.148**
		1.2. Site utility	**0.667**	1.2.1. Residential environment	**0.397**
				1.2.2. Transportation	**0.232**
				1.2.3. Educational facilities	**0.232**
				1.2.4. Basic amenities	**0.139**
2. Basic plan	**0.092**	2.1. Architectural plan	**0.626**	2.1.1. Floor plan	**0.294**
				2.1.2. Site plan	**0.183**
				2.1.3. Exterior plan	**0.106**
				2.1.4. Floor area ratio	**0.417**
		2.2. Project financing period	**0.238**		
		2.3. Policy	**0.136**	2.3.1. Housing policy	**0.540**
				2.3.2. Land policy	**0.163**
				2.3.3. Finance policy	**0.297**
3. Economic feasibility	**0.206**	3.1. Cash flow	**0.194**		
		3.2. Gross profit margin (construction company)	**0.496**		
		3.3. Gross profit margin (developer)	**0.310**		

End of Table 9

Level 1	Weight	Level 2	Weight	Level 3	Weight
4. Salability	**0.296**	4.1. Area environment	**0.246**		
		4.2. Price	**0.299**		
		4.3. Brand value	**0.209**		
		4.4. Specialty	**0.246**	4.4.1. Interior	**0.456**
				4.4.2. Exterior	**0.141**
				4.4.3. Landscape	**0.141**
				4.4.4. Community facility	**0.263**
5. Financing method	**0.149**				
6. Payment arrangement	**0.049**				
7. Developer	**0.059**	7.1. Experience	**0.162**		
		7.2. Land acquisition	**0.491**		
		7.3. Permission	**0.347**		

Table 10. Feasibility analysis model

Level 1	Level 2	Level 3	Weight	Probability distribution					
				Distribution	Mean or score	Standard deviation	Min.	Likeliest	Max.
1. Project site	1.1. Land condition	1.1.1. Land shape	**0.081**						
		1.1.2. View	**0.180**						
		1.1.3. Daylight	**0.162**						
		1.1.4. Ground condition	**0.073**						
	1.2. Site utility	1.2.1. Residential environment	**0.395**						
		1.2.2. Transportation	**0.231**						
		1.2.3. Educational facilities	**0.231**						
		1.2.4. Basic amenities	**0.138**						
2. Basic plan	2.1. Architectural plan	2.1.1. Floor plan	**0.169**						
		2.1.2. Site plan	**0.105**						
		2.1.3. Exterior plan	**0.061**						
		2.1.4. Floor area ratio	**0.240**						
	2.2. Project financing period		**0.219**						
	2.3. Policy	2.3.1. Housing policy	**0.068**						
		2.3.2. Land policy	**0.020**						
		2.3.3. Finance policy	**0.037**						
3. Economic feasibility	3.1. Cash flow		**0.400**						
	3.2. Gross profit margin (construction company)		**1.022**						
	3.3. Gross profit margin (developer)		**0.639**						
4. Salability	4.1. Area environment		**0.728**						
	4.2. Price		**0.885**						
	4.3. Brand value		**0.619**						
	4.4 Specialty	4.4.1. Interior	**0.332**						
		4.4.2. Exterior	**0.103**						
		4.4.3. Landscape	**0.103**						
		4.4.4. Community facility	**0.192**						
5. Financing method			**1.490**						
6. Payment arrangement			**0.490**						
7. Developer	7.1. Experience		**0.096**						
	7.2. Land acquisition		**0.290**						
	7.3. Permission		**0.205**						

Table 11. Probability distributions

Distribution	Conditions	Applications
 normal	– Mean value is most likely. – Even distribution about the mean. – More likely to be close to the mean than far away.	Natural phenomena.
 triangle	– Minimum and maximum are fixed. – It has a most-likely value in this range, which forms a triangle with the minimum and maximum.	Useful with limited data when the minimum, maximum and most-likely values are known.
 uniform	– Minimum is fixed. – Maximum is fixed. – All values in range are equally likely to occur.	When the range is known and all possible values are equally likely.

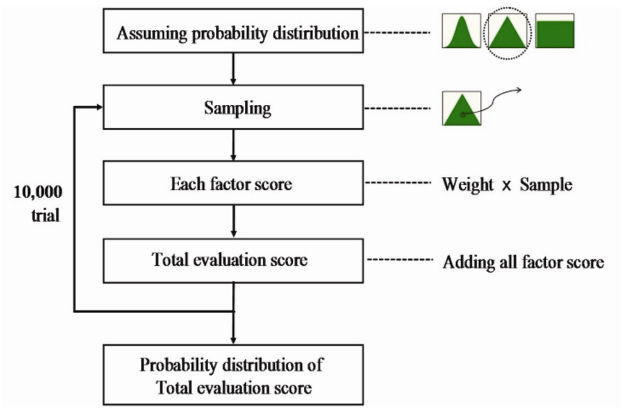

Fig. 1. Simulation process of the model

4.2. Development of the feasibility analysis model

The feasibility analysis model developed in this study draws not a single score but a score probability distribution through the Monte Carlo simulation. This provides decision makers with comprehensive information to help them make a reasonable judgment. The weights of the each factors at each level shown in Table 9 were substituted in the equation below (1), drawing the weight of the evaluating factors;

Weight of evaluation factor = weight of level 1 × weight of level 2 × weight of level 3 × 10. (1)

For example, the weight of the evaluation factor 'Land shape' was calculated by multiplying the weight of 'Project site' by 'Land condition' by 'Land shape' by 10. It is multiplied by 10 to make the perfect evaluation score 100 points.

Table 10 shows the feasibility analysis model suggested in this study. According to each criterion, each evaluation factor must be scored. The score of each evaluation factor can also be given as a probability distribution (Table 11) according to the project's condition. It has to be noted that the range of probability distribution of all the factors has to be limited to their minimum and maximum values, which cannot be infinities as the scoring system of the factors in the model is designed as it is. Based on the selected probability distribution data of each evaluation factor, the Monte Carlo simulation program conducts random sampling, and a sample of each evaluation factor is multiplied by the corresponding weight and the results are added together to present the total score. The feasibility analysis model repeats this process 10,000 times to obtain the probability distribution of the total score (Fig. 1).

5. Verification of the model

5.1. Verification process

To verify the reliability of the feasibility analysis model, 12 housing projects in the Young-nam region in Korea, seven successful (P1–P7) and five abandoned projects (P8–P12), were selected, applied to the model and assessed by means of the Monte Carlo simulation, drawing the probability distribution of the total score (Fig. 2).

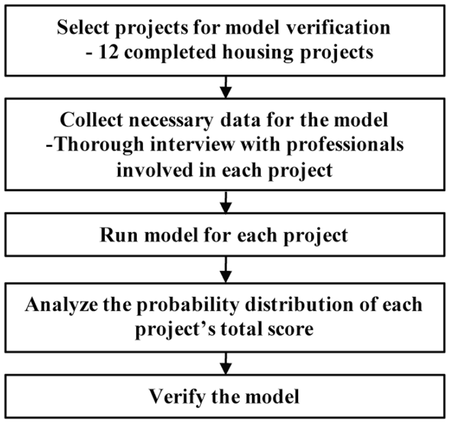

Fig. 2. Model verification process

5.2. Assessment of projects

Based on the criteria, the feasibility analysis model assessed 12 projects by Monte Carlo simulation. For more precise assessment, nine experts, each with more than 15 years' experience, converged their opinions to an input score or a probability distribution for each evaluation factor. Table 12 shows the data entered for Project 1. After the Monte Carlo simulations, the model gave each project's statistical values and the probability distribution of the total score. Table 13 shows the statistical values for the 12 projects, showing that P5 has the highest mean value with 85.91 points and P12 has the lowest mean value with 57.78 points (Table 13). Fig. 3 shows the P1's probability distributions of total score, presenting the probability and frequency of total scores.

5.3. Assessment results

All 12 projects assessed using the model had normal distributions for their total evaluation scores. Projects completed successfully had mean total evaluation scores from 67 to 83 and abandoned projects had mean scores about 20 points lower than successful projects, ranging from 54 to 57. Fig. 4 is an overlay chart of the 12 projects, showing that the distributions of completed projects are clearly separated from those of abandoned projects abandoned at approximately 62 points.

However, it should be clearly understood that the results of the simulation are only for providing decision makers with valuable information. The decision on whether or not a project should be executed or abandoned is solely left to users, due to following two reasons; 1) the number of projects used for the model is not sufficient enough to recommend a break point, 2) recommending a certain number or range in order to help making such decision may limit more practical application of the proposed model to practical cases. It is one of main reasons why the model is designed to provide its results in the form of probability distribution.

Experts from construction companies expressed very positive opinions on the model. In their feedback, they said that the analysis factors were well categorized and could be used easily and objectively in practice, and that the model would be a useful tool for construction companies, particularly those with limited experience in housing projects. Because the model gives not a single total evaluation value but probability distributions, it helps decision makters

Table 12. Raw data entered for project 1

∩: normal ∧: triangle ⊓: uniform

Factor	Weight	Probability distribution					
		Distribution	Mean or score	Standard deviation	Min.	Likeliest	Max.
1.1.1. Land shape	**0.081**	∧	–	–	4	7	9
1.1.2. View	**0.180**	∧	–	–	7	9	10
1.1.3. Daylight	**0.162**	∧	–	–	7	9	10
1.1.4. Ground condition	**0.073**	∧	–	–	0	4	4
1.2.1. Residential environment	**0.395**	–	4	–	–	–	–
1.2.2. Transportation	**0.231**	–	7	–	–	–	–
1.2.3. Educational facilities	**0.231**	–	7	–	–	–	–
1.2.4. Basic amenities	**0.138**	–	9	–	–	–	–
2.1.1. Floor plan	**0.169**	∩	9	2	0	–	10
2.1.2. Site plan	**0.105**	∩	7	2	0	–	10
2.1.3. Exterior plan	**0.061**	∩	7	2	0	–	10
2.1.4. Floor area ratio	**0.240**	–	9	–	–	–	–
2.2. Project financing period	**0.219**	∧	–	–	9	10	10
2.3.1. Housing policy	**0.068**	∧	–	–	5	7	9
2.3.2. Land policy	**0.020**	∧	–	–	5	7	9
2.3.3. Finance policy	**0.037**	∧	–	–	5	7	9
3.1. Cash flow	**0.400**	∩	10	1	0	–	10
3.2. Gross profit margin (construction company)	**1.022**	∩	7	2	0	–	10
3.3. Gross profit margin (developer)	**0.639**	∩	10	1	0	–	10
4.1. Area environment	**0.728**	∧	–	–	0	4	7
4.2. Price	**0.885**	∩	7	2	0	–	10
4.3. Brand value	**0.619**	–	9	–	–	–	–
4.4.1. Interior	**0.332**	∩	9	1	0	–	10
4.4.2. Exterior	**0.103**	∩	9	1	0	–	10
4.4.3. Landscape	**0.103**	∩	9	1	0	–	10
4.4.4. Community facility	**0.192**	∩	7	2	0	–	10
5. Financing method	**1.490**	–	10	–	–	–	–
6. Payment arrangement	**0.490**	–	10	–	–	–	–
7.1. Experience	**0.096**	–	10	–	–	–	–
7.2. Land acquisition	**0.290**	–	10	–	–	–	–
7.3. Permission	**0.205**	–	10	–	–	–	–

Table 13. Statistics

Project	Mean	Median	Minimum	Maximum	Standard deviation
P1	79.69	79.79	68.84	87.50	2.69
P2	75.39	75.38	64.14	84.13	2.77
P3	74.30	74.33	66.23	80.91	1.98
P4	72.77	72.72	64.20	81.63	2.38
P5	82.61	82.65	75.87	88.48	1.65
P6	73.59	73.64	64.32	82.29	2.53
P7	67.32	67.38	55.79	77.62	2.82
P8	55.69	55.73	44.93	66.00	2.93
P9	56.61	56.60	47.63	65.24	2.41
P10	56.72	56.70	47.70	64.76	2.38
P11	54.58	54.64	44.69	63.45	2.46
P12	55.20	55.21	47.54	63.16	2.05

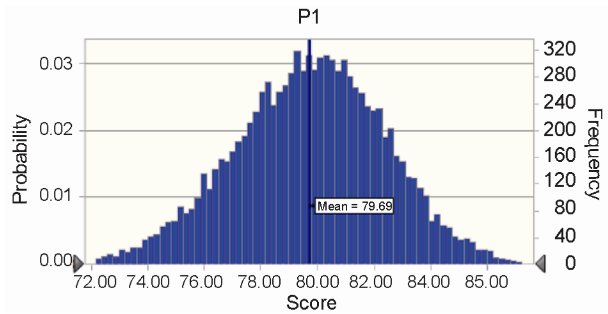

Fig. 3. Probability distribution of total score (Project 1)

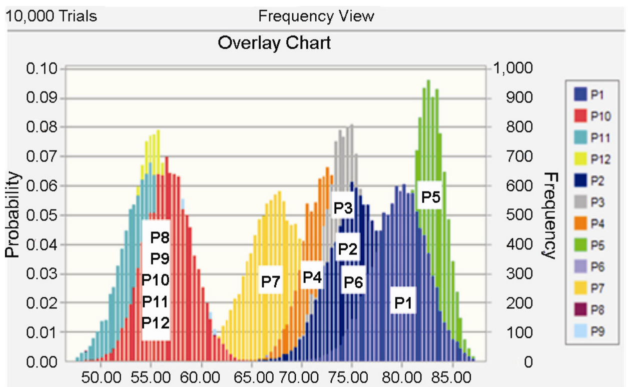

Fig. 4. Overlay chart

to consider risks. However, it was suggested that, to increase its practical use and improve its reliability, the model should be used to evaluate more projects by many other construction companies.

6. Conclusions

The factors behind the success of housing development projects were identified and quantitative criteria for each factor were established, to develop a feasibility analysis model to help main contractors make sound decisions on housing projects proposed by developers. The following are the main conclusions.

First, factors possibly driving project success were selected during a series of expert meetings and were categorized into three levels (levels 1, 2 and 3). Criteria for each analysis factor were established to evaluate projects objectively.

Second, among the weights of the factors calculated using the AHP, the weights of 'Salability', 'Economic feasibility', 'Site location' and 'Financing method' were relatively high, identifying them as important factors for project success.

Third, the model was applied to 12 housing projects in the Busan region, comprising seven successful projects and five abandoned projects, to verify its reliability. The application results showed that the model properly filtered projects that are unlikely to be profitable, indicating reasonable reliability of the model.

Expert feedback on the model developed in this study described it as a useful tool for contractors, especially those with limited experience in analyzing project development feasibility.

To increase the model's practical use and improve its reliability, the model should be used to evaluate more projects from other construction companies, and more quantitative criteria of some qualitative analysis factors should be established for easier and more objective assessment. Models that can evaluate other types of project should also be developed.

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Appendix A. Detailed criteria for the factors included in the model

Evaluation factor	Criteria	Grade	Score
Land shape (1.1.1.)	Building arrangement and space usage of site is very good.	A	10
	Building arrangement and space usage of site is good.	B	9
	Building arrangement and space usage of site is neutral.	C	7
	Building arrangement and space usage of site is not good.	D	4
	Building arrangement and space usage of site is very bad.	E	0
View (1.1.2.)	Very good	A	10
	Good	B	9
	Neutral	C	7
	Poor	D	4
	Very poor	E	0

Continue of Appendix A

Evaluation factor	Criteria	Grade	Score
Daylight (1.1.3.)	Very good	A	10
	Good	B	9
	Neutral	C	7
	Poor	D	4
	Very poor	E	0
Ground condition (1.1.4.)	Very good: will have no negative effect on time and cost	A	10
	Good: not likely to have negative effect on time and cost.	B	9
	Normal	C	7
	Poor: likely to have negative effect on time and cost.	D	4
	Very poor: will have negative effect on time and cost.	E	0
Residential environment (1.2.1.)	None of list below is applicable.	A	10
	One of list below is applicable.	B	9
	Two of list below are applicable.	C	7
	Three or more of list below are applicable.	E	0
	City water and sewage connection is difficult. Possible hazard facility (nuclear power station/ substation/ steel power pylon, etc.) is located near the site. Disposal facility (waste disposal plant or dump site/ recycle treatment plant, etc.) is located near the site. Obnoxious facility (crematorium, cemetery, jail, psychiatric hospital, slaughterhouse, etc.) is located near the site. Exposure to pollution from factories, heavy traffic, etc. Exposure to noise from factories, traffic, trains, airplanes, etc. Exposure to shaking such as from factories, trains, etc. Security near site is poor. There are other environmental issues that can affect residents.		
Transportation (1.2.2.)	Four or more of list below are applicable.	A	10
	Three of list below are applicable.	B	9
	Two of list below are applicable.	C	7
	One of list below is applicable.	D	4
	None of list below is applicable.	E	0
	Bus station is located near the site. Subway station is located near the site. Accessibility to train station, highway or airport is good. Width of access road is wider than requirement. Connection to main road is good.		
Educational facilities (1.2.3.)	Four or more of list below are applicable.	A	10
	Three of list below are applicable.	B	9
	Two of list below are applicable.	C	7
	One of list below is applicable.	D	4
	None of list below is applicable.	E	0
	Elementary school is located near the site. Middle school is located near the site. High school is located near the site. University is located near the site. Included in good school district. Other positive facility is located near the site such as library, gymnasium, etc. ※ If there are facilities harmful to education, such as a motel, bar or club, the grade can be lower than the criteria.		
Basic amenities (1.2.4.)	Four or more of list below are applicable.	A	10
	Three of list below are applicable.	B	9
	Two of list below are applicable.	C	7
	One of list below is applicable.	D	4
	None of list below is applicable.	E	0

Continue of Appendix A

Evaluation factor	Criteria	Grade	Score
	Public office is located near the site. Market or shopping center is located near the site. Hospital is located near the site. Cultural facility (theater, auditorium, community center, exhibition, etc.) is located near the site. Other amenity (bank, park, etc.) is located near the site.		
Floor plan (2.1.1.)	Very good	A	10
	Good	B	9
	Neutral	C	7
	Poor	D	4
	Very poor	E	0
Site plan (2.1.2.)	Very good	A	10
	Good	B	9
	Normal	C	7
	Poor	D	4
	Very poor	E	0
Exterior plan (2.1.3.)	Very good	A	10
	Good	B	9
	Normal	C	7
	Poor	D	4
	Very poor	E	0
Floor area ratio (2.1.4.)	More than 100% of regulation requirement	A	10
	95~100% of regulation requirement	B	9
	90~95% of regulation requirement	C	7
	85~90% 85% of regulation requirement	D	4
	Less than 85% of regulation requirement	E	0
Project financing period (2.2.)	Less than 6 months	A	10
	6~10 months	B	9
	11~14 months	C	7
	15~18 months	D	4
	More than 18 months	E	0
Housing policy (2.3.1.) Land policy (2.3.2.) Finance policy (2.3.3.)	Positive	A	10
	Neutral	C	7
	Negative	E	0
Cash flow at peak time (3.1.)	Less than 5% of project turnover	A	10
	5~10% of project turnover	B	9
	10~15% of project turnover	C	7
	15~20% of project turnover	D	4
	20~25% of project turnover	E	0
Construction company gross profit margin (3.2.)	More than 20% of project turnover	A	10
	15~20%of project turnover	B	9
	10~15% of project turnover	C	7
	5~10% of project turnover	D	4
	Less than 5% of project turnover	E	0
Developer gross profit margin (3.3.)	More than 10% of project turnover	A	10
	8~10%of project turnover	B	9
	5~10% of project turnover	C	7
	3~5% of project turnover	D	4
	Less than 3% of project turnover	E	0
Area environment (4.1.)	Area preference and growth potential are very high	A	10
	Area preference and growth potential are high	B	9

End of Appendix A

Evaluation factor	Criteria	Grade	Score
	Area preference and growth potential are average	C	7
	Area preference and growth potential are low	D	4
	Area preference and growth potential are very low	E	0
Price (4.2.)	10% lower than nearby apartments	A	10
	5% lower than nearby apartments	B	9
	Similar to nearby apartments	C	7
	5% higher than nearby apartments	D	4
	10% higher than nearby apartments	E	0
Brand value (4.3.)	Ranking of the brand recognition is 1~10	A	10
	Ranking of the brand recognition is 11~20	B	9
	Ranking of the brand recognition is 21~30	C	7
	Ranking of the brand recognition is 31~40	D	4
	Ranking of the brand recognition is above 41	E	0
Interior (4.4.1.) Exterior (4.4.2.) Landscape (4.4.3.) Community facility (4.4.4.)	Best among nearby apartments	A	10
	Better than most nearby apartments	B	9
	Similar to nearby apartments	C	7
	Worse than most nearby apartments	D	4
	Worst among nearby apartments	E	0
Financing method (5.)	Developer's own capital	A	10
	Developer's own capital + Project financing	B	9
	Developer's own capital + Bridge loan + Project financing	C	7
	Developer's own capital + Bridge loan	D	4
Payment arrangement (6.)	On work progress	A	10
	On milestone	B	9
	Development trust	C	7
	After sold out	D	4
Developer experience (7.1.)	Three or more projects	A	10
	One or two projects	C	7
	None	E	0
Land acquisition (7.2.)	100% Completed	A	10
	95~99% Completed	B	9
	90~95% Completed	C	7
	Less than 90% Completed	E	0
Permission (7.3.)	Completed	A	10
	Submitted	C	7
	Not yet submitted	E	0

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