Available online at 2019.creative-construction-conference.com/proceedings/

CCC 2019

Proceedings of the Creative Construction Conference (2019) 041

Edited by: Miroslaw J. Skibniewski & Miklos Hajdu

https://doi.org/10.3311/CCC2019-041

Creative Construction Conference 2019, CCC 2019, 29 June - 2 July 2019, Budapest, Hungary

Development of planning-stage feasibility-assessment model for extension remodeling projects of old apartment buildings

Koh Won-kyung[a], Yu Il-han[b]*, Jeong Dae-woon[b]

[a]*Ajou University, 206, World cup-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16499, Republic of Korea*
[b]*Korea Research Institute for Construction Policy, 13F Specialty Con. Bldg., 15Boramae-ro 5-gil, Dongjak-gu, Seoul, 07071, Republic of Korea*

Abstract

The government has continuously amended and developed laws for the vitalization of remodeling apartment buildings against the backdrop aging buildings. Despite such efforts, however, extension remodeling has not yet been used. Even though there are various issues causing this shortcoming, the present study focused on the fact that there is no instrument for reliable feasibility analysis and decision-making in the early stage of remodeling projects, thus proposing a remodeling project feasibility-assessment model. Generally, a feasibility (profitability) judgement is made after a design proposal is derived, and because decision-making for the implementation of remodeling projects is determined at the initial stage of implementation committee, a feasibility analysis model for projects at the planning stage is necessary. In this work, construction cost, project cost, financial expenses, and general sales revenues are calculated using remodeling project variables derived through existing apartment complex information, consultation, and research, and an algorithm was developed that can calculate approximate return on investment and the share of expenses of resident union members using the calculation results. In addition, the applicability of the model was tested by applying the developed early stage project feasibility analysis model to three cases already implemented. When the model was applied to three cases, the errors between the values predicted by the model and the actual values of the cases were 5% or less, indicating high reliability of the model. The model is expected to become a useful tool in practice if the applicability of the model is further proven by increasing the number of cases in the future. The project feasibility-assessment model developed in the present study will enable smooth implementation of projects by supporting residents' rapid decision-making. Moreover, if the model is variously applied by region, it is also expected to contribute to the policy establishment of local governments that identify the scale of apartment complexes in which extension remodeling projects are possible and support the remodeling.

Peer-review under responsibility of the scientific committee of the Creative Construction Conference 2019.

Keywords: Remodeling of old Apartment, Extension remodeling project, Feasibility-assessment Model

1. Introduction

The ratio of people living in apartment buildings in South Korea is significantly higher than in other countries, and apartment buildings account for almost 60% of all housing[1]. The massive supply of apartment buildings to provide housing since the 1980s and apartments built due to the construction of new cities in the metropolitan area has given rise to problems from aging. These problems include not only the physical aging of structures and facilities but also reduced convenience of existing buildings due to technological and economic growth. It is clear that the aging problem

*Corresponding author: Yu, Il-han, email: ihyu71@ricon.re.kr

is not only a problem for residents but is also an issue at the national level, because the number of aged apartments has grown to over four million units and will continue to grow.

1.1. Background

So far, the solution for the aging problems of apartment buildings has been reconstruction, but the number of complexes that can improve the residential environment through reconstruction is greatly reduced due to government policies such as reconstruction control, though remodeling projects are expected to increase.

Remodeling projects can be classified into general maintenance remodeling, customized remodeling, and extension remodeling, depending on the scope of remodeling. Extension remodeling, which is the target of the present study, focuses on the overall performance improvement of existing housing by extending household size or increasing the number of households through vertical or horizontal extension of building, building annexes, or partial reconstruction[2].

As extension remodeling is allowed under the 2012 revision of the housing act, project feasibility is greatly improved[3]. In particular, the amendment made possible the extension of three floors in the case of apartment buildings for more than 15 stories (up to 15% of the number of existing households). Despite the revision of the act, however, extension remodeling projects are making slow progress due to various problems in implementation. Accordingly, among various problems, the present study paid attention to the fact that there is no instrument for reasonable project feasibility analysis and decision-making in the early stage (before the design phase) of vertical extension remodeling projects.

The goal of this study was to provide union members with an efficient decision-support model at the planning stage of remodeling projects by calculating the contract area after remodeling based on only the basic information of the complex and calculating the share of the expenses by type (apartment size) of complex and return on investment (ROI). If it is possible for residents to make a rough decision on remodeling feasibility at the planning stage, it will have a considerable positive influence on saving project cost and initial bonding among residents through rapid decision-making and the implementation of the project. In addition, such an approximate feasibility model is expected to make it possible for the government and local governments to predict the overall demand for old local apartment buildings, establish local policies and master plans for the increasing problems of old apartment buildings, and provide basic data for policy decision-making.

1.2. Methodology

The research procedure was conducted in the following order: (1) review of domestic and foreign literature and previous research related to feasibility judgment methods, (2) selection and derivation of variables to be considered in predicting the feasibility of extension remodeling projects, (3) establishment of the overall feasibility assessment model process considering the influence of selected variables on feasibility, (4) presentation of assessment indices and decision-making methods of feasibility analysis to be presented as the resulting value, and (5) the verification of the effectiveness of the model. The procedures and methods are presented in Fig. 1.

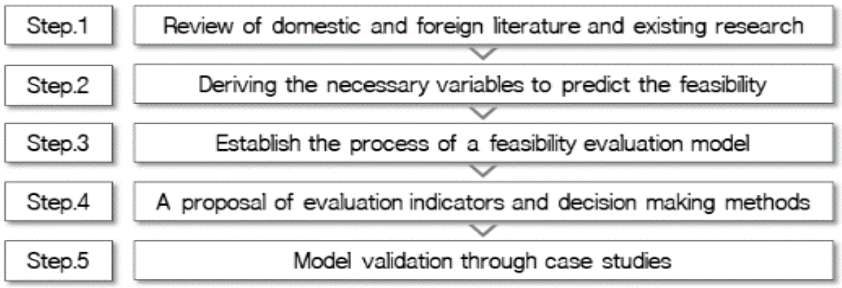

Fig. 1. Research procedures and methods.

2. Literature review

The feasibility assessment model of remodeling projects has been tried in various ways, as shown in Table 1.

Table. 1. Studies of remodeling feasibility assessment model

Author	Characteristic
Yoon and Park (2001)[4]	Survey on the factors affecting residents' consciousness to remodeling and affecting profitability of remodeling in Seoul and Gyeonggi-do
Lee, Cha and Lee (2003)[5]	Analysis of importance of assessment factors for economical assessment of remodeling business
Hwang and Song (2004)[6]	Analysis of the importance of economic value added through the survey of experts in construction and remodeling
Yoo, Kim, Yoon and Yang (2006)[7]	Analysis of profitability factors, assessment criteria, and profitability prediction model of remodeling business
Kim, Cha, Shin and Kim (2013)[8]	Proposal of a business-oriented decision-making process by using the proposed model based on a model that can predict revenue and expenses
Yoon, Shin and Kim (2016)[9]	Estimation of the construction cost of the area to estimate the value of the end-of-life, after-tax asset, development cost, and estimated contribution

When these studies are analyzed and summarized, the majority of previous studies conducted to develop feasibility models are classified roughly into two types: (1) calculation of construction cost according to the correlations among project variables based on the results of previous project cases and (2) research on feasibility assessment methods and setting variable values to develop a model. There is no research on extension remodeling, which is the target of the present study; however, because these two types of previous studies were conducted on customized remodeling projects.

In addition, the project expenditure costs, such as planning cost and construction cost, cost of extension remodeling projects are very sensitive to area changes because such projects can involve bearing wall demolition, structural reinforcement, and horizontal and vertical extension. Consequently, approximate estimation method based on the prediction of the contract area of the project and cost per unit area is essential for initial feasibility analysis.

Therefore, a feasibility assessment method based on ROI by the calculation of contract area and share of expenses by apartment size after remodeling appears to be more rational than feasibility analysis derived from correlations among feasibility variables based on previous project cases.

3. Feasibility assessment model

Feasibility assessment model can more accurately assess feasibility when construction cost is calculated by considering factors such as the size and type (corridor access type, flat-type, and tower-type) of existing apartments, location of the elevator(s), demolition of the bearing walls, structural type, foundation type, and the cost of structural reinforcement according to ground condition.

The present study cannot determine factors such as the removal of bearing walls or structural reinforcement cost according to ground conditions until detailed design proposals is available. This is because this study assesses feasibility before the design (proposal) is available in the initial stage of remodeling project, and it is very difficult to individually calculate construction cost according to the size and type of existing apartments, because there have been few cases of vertical extension of buildings until now.

Accordingly, the present study applied the recent average bid price (construction cost) per unit area of vertical extension remodeling work of constructors[10]. This construction cost per unit area is the actual bid price of constructors, which includes the size, type, and structural reinforcement cost of apartment houses, and expert consultations: KRW 5.3–5.7 million / pyeong (about 3.3 m^2) was applied depending on the floor-area ratio.

Based on the feasibility concept of an extension remodeling project, the development of the feasibility model presented in Fig 2 is possible.

ROI and feasibility are calculated by previous value (A), future value (A'), and the union share of the expenses (Y). The union share of the expenses is determined by project cost (W) and total revenue from general sales (X), and these two are calculated in relation to the area of the space that is changed by the remodeling project—i.e., the (future) contract area. Accordingly, the most important factor in the feasibility assessment in the initial stage of the project, which is before the finalization of remodeling design (proposal), is accurately predicting (future) the contract area.

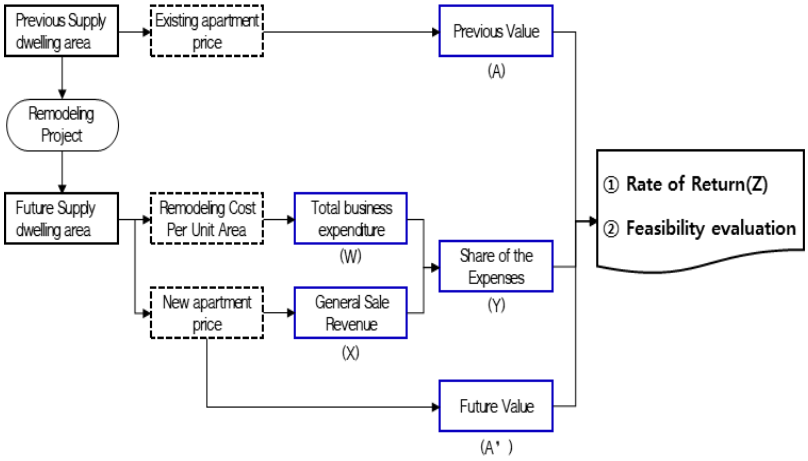

Fig. 2. Feasibility evaluation model process

4. Program Development

4.1. Program operation procedure

The presented feasibility assessment model is built on Excel, and the model can be divided into three modules: input, analysis, and decision-making. The operation procedure of the model is shown in Fig 3.

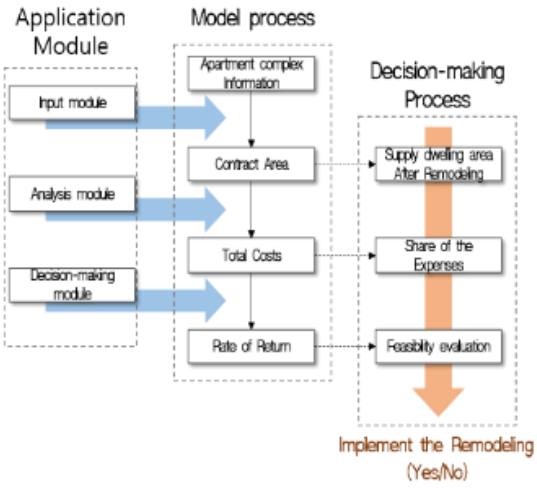

Fig. 3. Operation procedure of feasibility assessment model

In the input module, variable factors that have significant influence on feasibility are directly entered, or default values are chosen after entering (previous) apartment complex information, and go through a stage in which fixed factor values are confirmed.

The goal of the analysis module is calculating the total project cost by calculating contract area using the information of the input module. The total project cost is the total share of the expense of the union calculated by adding construction cost, other project cost, and difference between purchase and sales revenues.

The decision-making model helps to make decisions on the implementation of remodeling through three steps. The first step determines whether the feasibility analysis exceeds 100% (i.e., creates profit); the second step determines whether the allowed share of expenses of union households satisfies the expected share of expenses of the model; the third step assesses whether the proposed project is superior / good / average / poor depending on the level of ROI.

If there is an unsatisfactory item among the three steps above, a satisfactory value should be obtained by modifying the value of a variable factor of the input module. The roles of the three modules of the feasibility assessment model discussed above are presented in Table 2.

Table. 2. Detailed classification of feasibility assessment models

Division	Input module	Analysis module	Decision-making module
Step. 1	Input Actual Data	Calculate contract area	Feasibility evaluation
Step. 2	Variable Data Setting	Calculate future value	Rate of return
Step. 3	Identify Fixed Factor Data	Calculate total cost	Share of the Expenses

4.2. Program verification

Extension remodeling generates profits from the sales of the added apartments, unlike customized remodeling or reconstruction. Therefore, the physical verification of feasibility assessment is possible through comparison to the constructed complex after signing the contract between the constructor and the union. The physical verification of the union's share of the expenses and feasibility assessment is impossible, because currently there has been no case of extension remodeling.

Accordingly, attempts were made to increase the completeness of feasibility assessment through the verification of the contract area. As mentioned above, the contract area is judged appropriate to determine the accuracy of the model, because construction cost and project cost, and financial expenses for them are calculated by contract area. Accordingly, three complexes with different characteristics in terms of number of households, floor-area ratio, and apartment size among the remodeling complexes in the architectural design review stage were selected and used in the simulation.

The overview of verified complexes is presented in Table 3.

Table. 3. Overview of the verification case-study

Division	(Existing) Floor Area Ratio	Number of Households	Type	Characteristics
Seocho-gu 'A'	268.50%	239	89, 92 (m^2)	High Floor area ratio, Small scale complex, Medium type
Gangnam-gu 'B'	248.85%	138	92 (m^2)	Medium Floor area ratio, Medium scale complex Medium type
Gangnam-gu 'C'	182.81%	2,015	43, 53, 63 (m^2)	Low Floor area ratio, Large scale complex

Small type

The feasibility assessment model was developed by applying the existing value, actual value after remodeling, and predicted value of the model to three cases of complexes in architectural design review. The variable factor value of simulation was calculated as a default value, and the results are shown in Table 4.

Table. 4 Overview of the verification case study

Division		Seocho-gu 'A'	Gangnam-gu 'B'	Gangnam-gu 'C'
Floor area ratio	Existing data	268.50%	248.85%	182.81%
	Actual data	399.68%	387.76%	289.13%
	Prediction data	402.75%	373.28%	274.22%
Number of Households	Existing data	208	120	1,753
	Actual data	237	138	1,988
	Prediction data	239	138	2,015
Number of parking spaces	Existing data	134	55	489
	Actual data	286	152	2,450
	Prediction data	287	166	2,418
Exclusive Dwelling Area	Existing data	16,921.24 m²	10,121.70 m²	71,852.90 m²
	Actual data	23,501.78 m²	14,117.34 m²	100,512.08 m²
	Prediction data	23,685.80 m²	14,170.38 m²	100,594.06 m²
Dwelling Public Area	Existing data	1,921.24 m²	1,257.15m²	21,893.34 m²
	Actual data	4,799.73 m²	3,552.32 m²	47,084.24 m²
	Prediction data	4,835.42 m²	3,235.64 m²	42,572.76 m²
Service Facilities Area	Existing data	437.81 m²	1,206.75 m²	5,250.57 m²
	Actual data	1,537.17 m²	1,711.39 m²	9,264.97 m²
	Prediction data	984.22 m²	1,439.55 m²	5,502.48 m²
Underground Parking Lot Area	Existing data	3,702.17 m²	-	1,960.40 m²
	Actual data	9,221.97 m²	5,691.98 m²	86,156.02 m²
	Prediction data	10,906.00 m²	6,308.00 m²	91,884.00 m²
Contract Area	Existing data	22,979.65 m²	12,585.60 m²	100,957.21 m²
	Actual data	39,060.05 m²	25,073.03 m²	243,017.31 m²
	Prediction data	40,411.44 m²	25,153.57 m²	240,553.30 m²
Error in contract area(%)		**3.46 %**	**0.32 %**	**-1.11%**

The results showed that exclusive dwelling area and dwelling public area are highly accurate because they are obtained by limiting to floor-area ratio, but other common-use areas and parking lot areas showed some difference from the actual contract areas.

The accuracy of contract area is, however, the key point in this model, since the construction cost is calculated per contract area when a constructor is actually making a contract with a union. Simulation results showed high accuracy of the contract area, with an error rate of less than 5% (the contract areas of the three complexes were assessed to be 103.46%, 100.32%, and 98.99%). The reasons for the errors were that (future) floor-area ratio and the (future) number

of parked cars per household were predicted values, and the corrected values of (future) other common-use areas and (future) underground parking lot area do not perfectly reflect the areas after remodeling. The accuracy of contract area will increase as more cases are accumulated in the future.

5. Case Application

The developed feasibility assessment model was applied to Gumi-dong, Bundang-gu, Seongnam-si, Gyeonggi-do. The average feasibility of remodeling of this dong with 18 apartment complexes is "insufficient," with 103.1%. Even among them, areas with better location requirements showed "average" feasibility, which indicates the necessity of remodeling strategies and policies for each region in small units based on regional differences, as seen in the feasibility map below.

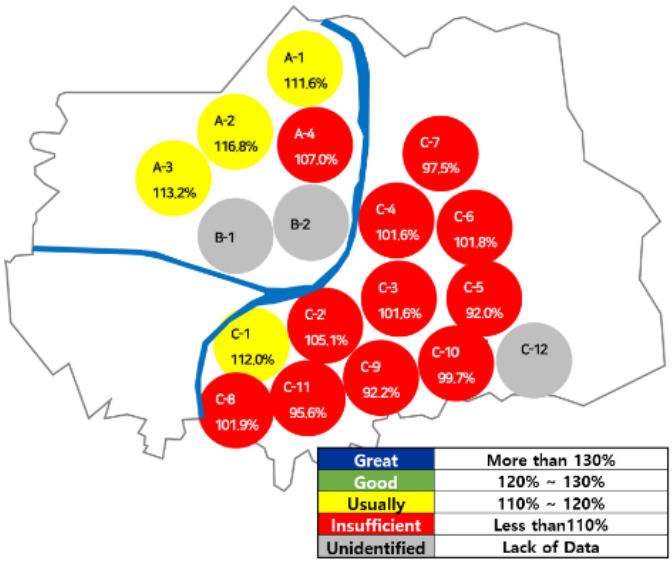

Figure. 4. Feasibility map applied to Gumi-dong

6. Conclusion

This study was motivated by the necessity of the overall feasibility analysis of extension remodeling projects of old apartment buildings. Accordingly, it presents a model with which overall feasib ility and ROI analyses are possible so that sound judgments can be made on whether to implement extension remodeling projects before the design phase, and the model was implemented using the Excel program.

The model was applied to three cases of complexes that actually implemented projects, and the analysis results were compared to actual outcomes. The results showed that the model was working as originally intended, and because the errors of the results were within 5%, the possibility of its practical use is high if the model is consistently complemented with new data.

In addition, feasibility was examined by applying the model to one dong (town) in Bundang-gu. As such, the model is judged to significantly contribute to the decision making of union households if it is widely applied to old apartment complexes. Moreover, if it is applied to local governments by region, the model is expected to contribute to the identification of the scale of apartment complexes for which extension remodeling projects are possible and the policy establishment of local governments that support the remodeling.

Acknowledgements

This research was supported by a grant (19RERP-B099826-05) from the Residential Environment Research Program funded by the Ministry of Land, Infrastructure and Transport of the Korean government.

References

[1] Statistics Korea (2017). "2017 Population and Housing Census." <http://kosis.kr> (Nov. 20, 2018)
[2] CART. (2017). Apartment remodeling business that we want to know and need to know. Munundang, Seoul.
[3] Lee, G. W. (2016). "Calculation Method of each household's payment of the Remodeling with an Increase the Number of Households" Remodeling, v62, 48-53.
[4] Yoon, Y. S., and Park, Y. S. (2001). Awareness of Remodeling of Apartment Residents in the Metropolitan Area, CERIK Construction Trend Briefing.
[5] Lee, J. B., Cha, J. S., and Lee, K. H. (2003). "A Study on the Priority Order of Elements for Economic Efficiency in Building Remodeling." Journal of the Architectural Institute of Korea Structure & Construction, 19(5), pp. 55-62.
[6] Hwang, K. S., and Song, S. Y. (2004). "The Priority Analysis of Remodeling Programs for Improving the Financial Value of Apartment." Journal of the Architectural Institute of Korea Structure & Construction, 20(3), pp. 211-218.
[7] Yoo, I. G., Kim, C. H., Yoon, Y. W., and Yang, K. Y. (2006). "A Study on the Building of Remodeling Evaluation Model" Journal of the Korea Institute of Building Construction, 6(3), pp. 67-73.
[8] Kim, W. H., Cha, H. S., Shin, D. W., and Kim, K. R. (2013). "Profit/Cost Prediction Model for Economic Feasibility Assessment on Aged-Housing Remodeling Projects"Journal of the Architectural Institute of Korea Structure & Construction, 29(4), pp. 85-92.
[9] Yoon, J. S., Shin, D. W., and Kim, K. R. (2016), "A Preliminary Study on Development of the Analysis Model at the initial Remodeling Project Phase", Proceedings of KICEM Annual Conference 2016, pp.115-116.
[10] Lee, G. W. (2016). "Calculation Method of each household's payment of the Remodeling with an Increase the Number of Households" Remodeling, v62, 48-53.
[11] Cho, J. Y., Lee, K. W., Yoo, H. S., and Kim, Y. S. (2012). "A Study on Vitalizing Plans of Extension Remodeling for Apartment Housings" Korean Journal of Construction Engineering and Management, KICEM, 13(4), pp. 33-47.
[12] Kim, K. R., Yoon, Y. H., and Kim, C. H. (2017). "A Study on the Component and Type of Old Multi- Family Residential Improvement Projects" Journal of Land, Housing, and Urban Affairs, LHI, 25(3), pp. 25-45.
[13] Lee, G. W. (2015). "[Remodeling vs reconstruction] Do we need to remodel our apartment? do we need to rebuild our apartment?" Remodeling, v56, 44-48.
[14] Lee, G. W. (2016). "Remodeling and Construction Cost" Remodeling, v59, 49-50.
[15] Lee, J. S. (2013). "A Study on the Rational Estimation Method of Share of Expenses in Remodeling Projects entailing with an increase of the number of household" Journal of the Korean Urban Management Association, 26(3), pp. 71-96.
[16] Lee, K. W. (2013). "A Study on the Profit Distribution and Sharing Cost Estimation in Apartment Remodeling Projects Increasing the Numbers of Hoseholds." MS thesis, Inha Univ.
[17] Seongnam (2015), "Seongnam City Apartment Housing Remodeling Master Plan.", Research report.
[18] Seoul (2016), "2025 Seoul Metropolitan Government Apartment Housing Remodeling Master Plan.", Research report.
[19] Shin, D. W., and Yoon, J. S. (2016). "The Necessity of Feasibility Analysis Tool (consumer-oriented) in the Early Stage of Remodeling Project" Construction Engineering and Management, 17(2), 34-37.