

A Positive Analysis of Housing Price Model in Seoul: Applications of Structural Equation Modeling

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Abstract

Our nation has a problem with discrimination of income distribution and inefficient of resources distribution caused by real estate price rising from a sudden economy growth and industrialization. Specially, in recent years, there is a great disparity of apartment price between the north and south of the Han river. Because the housing price is decided by the immanent value of a house and neighborhood effects of the regional where the house is situated, the housing price is occurred difference.

The purpose of study was to analyze the influence of various factors of housing price. Also, this study tried to predict real estate market and to establish previous effective real estate policy. In this study, we analyzed the differences of housing price determinants about apartment developments between the north and south of the Han river, and found the important factors that affect the housing price using Structural Equation Modeling(SEM). As a result of this study, the older the buildings are, the more the housing price and the housing price rising ratio have increased, in Gang Nam area. This reason is that these have large possibility to be reconstructed and many convenient facilities, in this area. In the case of Kang Buk area, the increase rate of housing price are so low that they couldn't take effect on the housing price and they were declined. So to speak, constructing the infrastructure which takes effect on the increase rate of housing price is very urgent.

Keywords : Housing Price Model, Geographic Information System(GIS), Structural Equation Modeling(SEM), Indicator, Path Diagram, Factor, Variable, Sample Survey

1. INTRODUCTION

1.1. Research Background and Purpose

The house is affected by not the housing character itself, but also neighborhood effects of the region where the house is situated. In case of Korea, specially apartment is affected by many external effects and shows the housing character well.

After the 1960's, our nation needed new residential space due to a sudden economy growth and industrialization. So, in the 1970's, construction boom of apartment occurred for population of the city and apartment become the prime object of speculation. Now, this has been a important issue about housing policy of the government. But housing price between Gang Nam and Gang Buk district is different, and the gap between the two district increases gradually because of simple housing policies of the government.

In fact, although housing price is formed by speculation, it is also formed by other variables. So, housing price model need to consider various variables.

The purpose of this study is to find factors of housing price and investigate the effects of factors in the case of Gang Nam and Gang Buk districts. I analyzed the housing price model between Gang Nam and Gang Buk through this study.

1.2. Research Methodology and Scope

This study set the scope of time by including apartments which have been constructed from 2003 to 2006, and the scope of space by confining to Seo-Cho, Gang Nam, Song Pa in the Gang Nam district and Gang Buk, Do Bong, No

Won in the Gang Buk district as a target of study through geographic conditions, housing average price, and housing price rising rate.

In this study, we analyzed the differences of housing price determinants about condominium developments in the old and new residential areas, and found the important factors the affect the condominium price using Structural Equation Modeling(SEM).

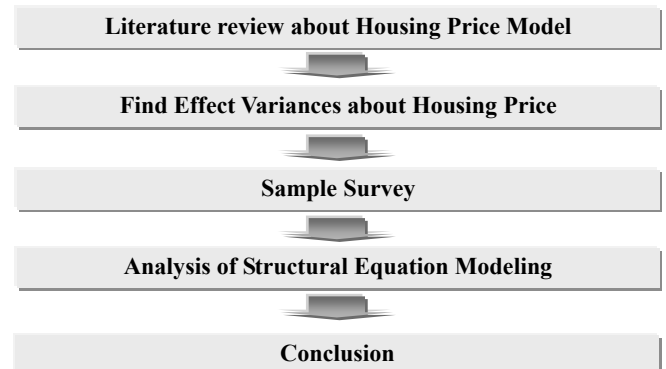


Figure 1. Research Procedure

- 1) Consider how to decide the price of apartment theoretically and deduce an effective variable of the apartment price.
- 2) Set the scope of sample of the apartment variable and decide sample.
- 3) Analyze the relationship between the apartment price and effective factors by input data of variable deciding price in the structural equation and deduce the factors of deciding price in the Gang Nam and Gang Buk district.

2. LITERATURE REVIEW

2.1. Determinant of housing price

There are various factors which decide the housing price. These factors can include physical features of housing such as a scale of housing, the number of rooms, the passed years after construction, a bathroom, the number of stories, the number of households and a type of heating etc. They also comprise the features of location such as distance between the house and many facilities which include subway station/school/shopping mall/city hall/parks and the features of household such as the level of inhabitant's education. In general, a variety of factors have an effect on housing price. Besides, recent studies show that the quality of living environment which comes from noticing the importance of educational environment and environment itself and the possibility of reconstruction issued lately affect the housing price.

Table 1. The housing price factors by literature review

Section	Researcher	Physical variable	Variable of location
Education environment	Ju-hyong Lee (1989)	Number of room, Years of construction, Area of land, Kitchen, Bathroom, Restroom, Water supply facilities, Waste, Heating facilities	The type of house, Market / Hospital / School approach
	Myong-Kyu Song (1990)	The type of house, Area of total house, Years of construction	Population density, Level of Education about residents, Distance by the subway, Occurrence of crime, Occurrence of fire, Distance by disgust facility and pollution area, Distance by a city hall, Park area
Quality of environment	Won-Yong Go (2001)	The number of p'yong, Years of construction, Direction of residence, Floor, the number of households, the number of parking	
	Kyu-Sik O (1997)	Director, Location of households, Noise	The right to a view, Type of a spectacle
Possibility of reconstruction	Sang-Kyong Lee (2001)	The type of p'yong, Scale of housing complex, Years of construction	
	Jong-Min Lee (2001)	Area of exclusive use, Years of construction,	
Factors to determine between sub-markets	Ong-Rae Joe (1990)	Area of land, Square measure of structure, The number of room, Water supply facility	Level of school, Fame of school
	Hyon-Ung Lee (1999)	The number of p'yong, Royal floor, Heating type, Years of construction	Factors of household (age of household, number of household, income of household, vehicle going to the office, etc)
	Won-Yong Go (2001)	Years of construction, Direction of residence, floors, The number of a household, The number of parking	



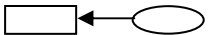
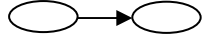


2.2. The concept of structural equation modeling

It is analyzing method to understand the relationship among the variables which are considered they are related by using cause-and-result model. By this method, it can be explained that there is a cause-and-effect relationship among the genetic features of a population. The best strong point of structural equation model is that it can show more visual results for analyzing cause-and-effect relationship by using pictures rather than formulas. Also, this can deal with measure error for variables.

The purpose of structural equation is to reveal the relationship among the variables through the model which shows the relationship between a cause variable and an effect variable. Once the direction and the strength of relation are decided, it is possible to decide precedence because it can be showed deductively whether which relation is more important relatively than others.

AMOS(Analysis of MOment Structure) of structural equation modeling program is developed by Arbuckle and Werner. This program is convenient to use because of its visual graphic. And the data of this program acts an interaction with SPSS, Excel, etc.

Table 2. The symbol used for AMOS

Symbol	Meaning
	Latent variable
	Observed variable
	Path coefficient between observed variable and latent variable
	Path coefficient between latent variable and latent variable
	Structural error
	Measurement error

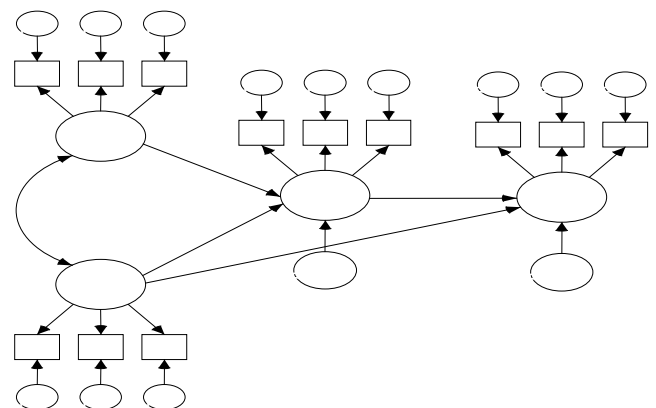


Figure 2. Structural equation modeling

2.3. The concept of GIS

GIS(Geographic Information System) is an information system to integrate the geography data which occupies the location at space with the attribute data which relates Attribute data. And it is the hardware, software, geography data and the whole system body of the human resource which is used to collect, store, renewal and control geographic information of the form which is various efficiently.

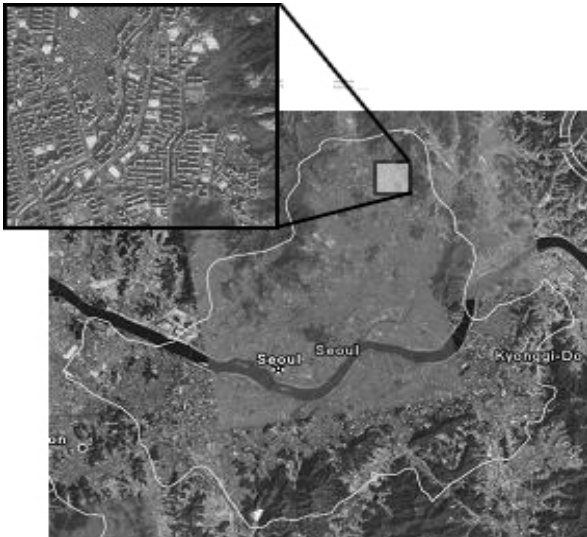


Figure 3. The satellite photo in Seoul



Figure 4. The map of land classification

3. SAMPLE SURVEY

3.1. Scope of Sample Survey

As showing in the Table 3, 4 and 5. we can see the large gap between the housing price of Kang Nam and that of Kang Buk. So analyzing formation model of housing price in Kang Nam and Kang Buk is necessary.

In this study, the average price(the standard of 2006 year 10 month) of apartments and price rising rate for 3 years in Seoul are surveyed to select the sample about similar areas.

Table 3. The average price of apartments for Gang Buk district

(Symbols: 10,000 won/pyeong)

The northern district of the Han river (Gang Buk district)	The average price of apartemnt
Eunpyeong-Gu	780
Seodaemun-Gu	849
Mapo-Gu	1195
Jongno-Gu	1163
Jung-Gu	1327
Yongsan-Gu	1961
Seongbuk-Gu	886
Jungnang-Gu	687
Dongdaemun-Gu	855
Seongdong-Gu	886
Gwangjin-Gu	1418
Dobong-Gu	659
Nowon-Gu	674
Gangbuk-Gu	706
Average	1003

Table 4. The average price of apartments for Gang Nam district

(Symbols: 10,000 won/pyeong)

The southern district of the Han river (Gang Nam district)	The average price of apartment
Gangseo-Gu	1054
Yangcheon-Gu	1851
Guro-Gu	842
Yeongdeungpo-Gu	1274
Geumcheon-Gu	722
Dongjak-Gu	1203
Gwanak-Gu	935
Gangdong-Gu	1769
Seocho-Gu	2440
Gangnam-Gu	3038
Songpa-Gu	2268
Average	1581

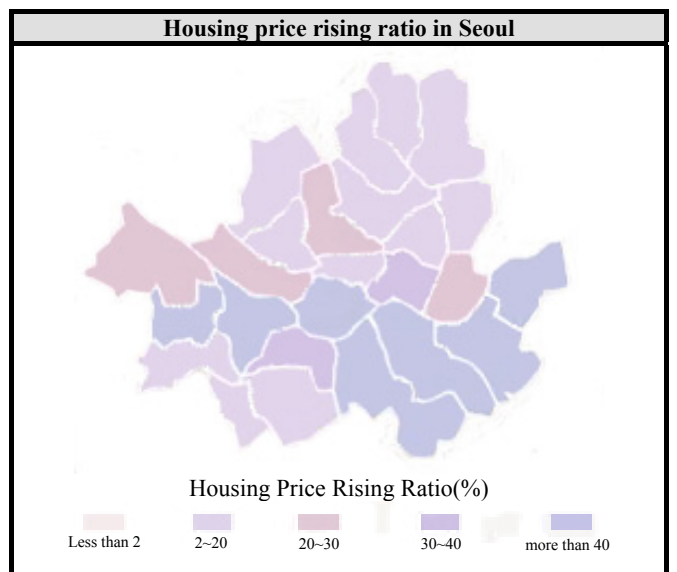


Figure 5. Housing price rising ratio in Seoul

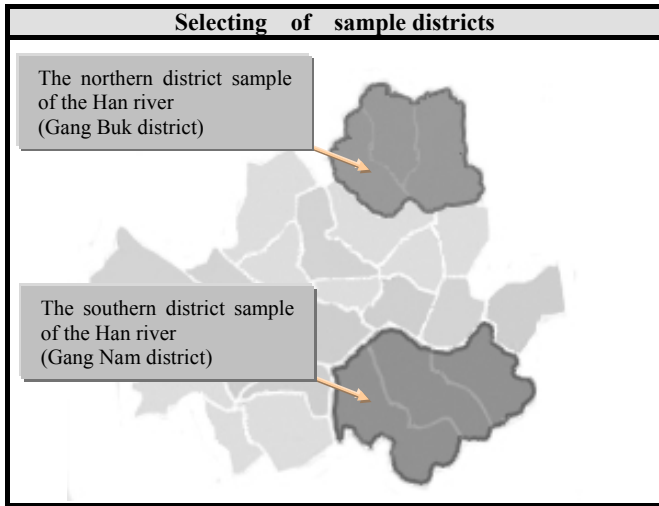


Figure 6. selecting of sample districts

As a result, Gang Nam and Gang Buk district each have its own bounded sample area which has similar average price of apartments and housing price rising rate in each district.

- The southern district sample of the Han river: Seocho-Gu, Gangnam-Gu, Songpa-Gu(most expensive housing price)
- The northern district sample of the Han river: Gangbuk-Gu, Dobong-Gu, Nowon-Gu(cheapest housing price)

3.2. Decision of Sample Survey

Apartments which is no longer than 3 years since its construction were selected as a sample and information about the sample were collected by GIS. The reason to select apartments passed less than 3 years is to limit the variable of housing price from housing price depreciation and possibility of reconstruction caused by deterioration of old apartments.

GIS and real estate portal site are used to collect data about variables.

The method to select index value of variable will be explained in the following chapter.

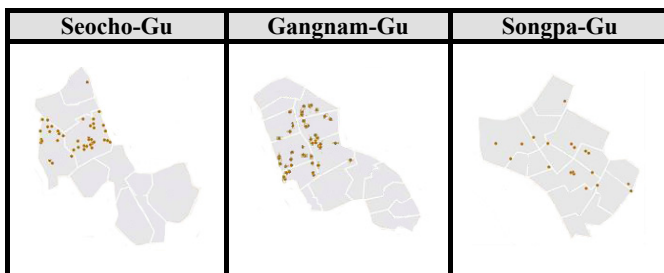


Figure 7. Sample of Gang Nam district

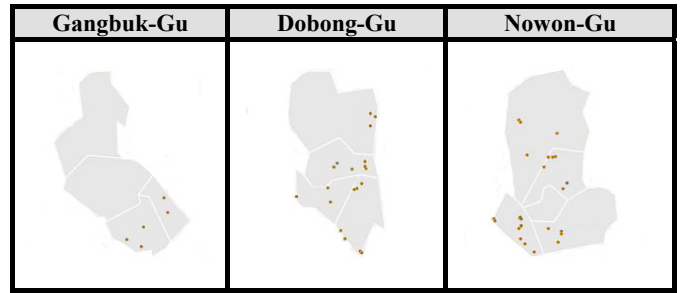


Figure 8. Sample of Gang Buk district

4. STRUCTURAL EQUATION MODELING OF HOUSING PRICE

In this study, structural equation modeling process of housing price sets right hypotheses corresponding with the purpose of this study and develops variables as a measurement index about each hypothesis, and modeling is built and data are applied to it by using AMOS 6.0 program. After evaluating suitability of the first modeling each hypothesis is verified. During this process unsuitable parts are modified through feed-back step to select the final modeling. Finally, the hypothesis verification and the suitability of final modeling are shown and then we consider analysis about the result and final modeling.

4.1. Modeling of the study and setting the hypothesis

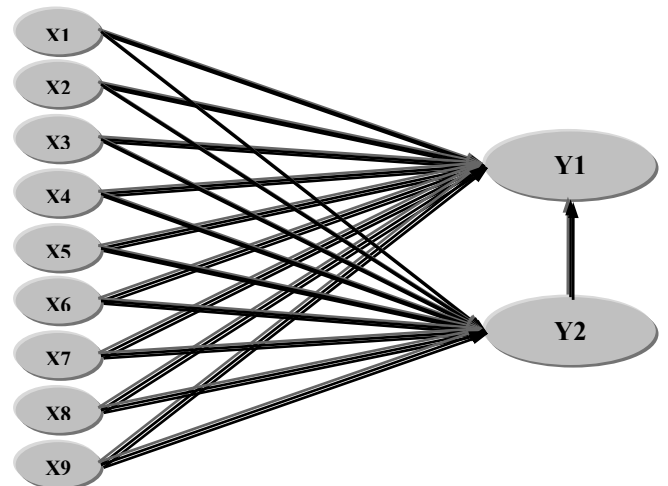


Figure 9. Research Procedure of Structural Equation Modeling

The features of housing and surrounding location are set as an independent variable and the housing price rising rate and housing price are set as a dependent variable. There are two hypotheses of this study. One is that the independent variable has an impact on the dependent variable, and the other is that housing price rising rate affect housing price.

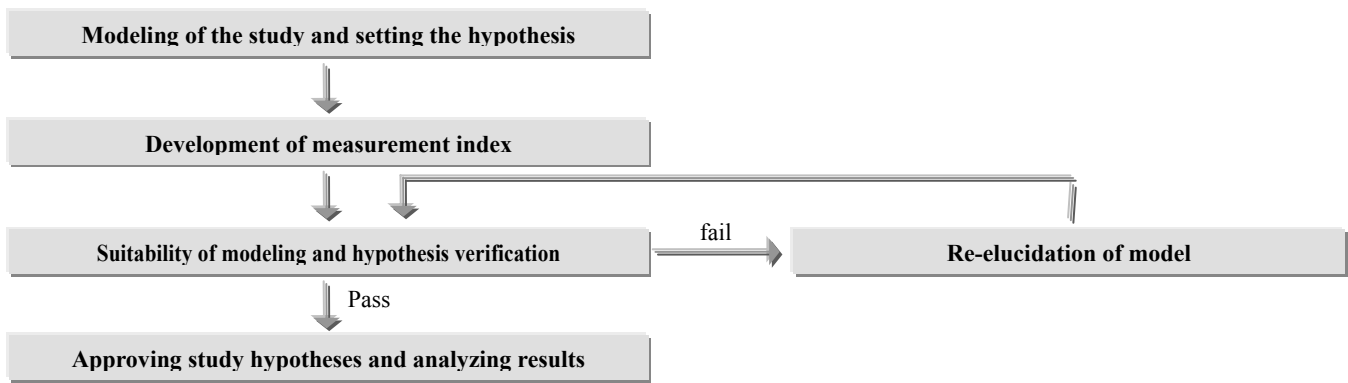


Figure 10. Research procedure of structural equation modeling

Table 5. Setting the hypothesis for housing price model

Hypothesis 1	Use area → Housing price rising ratio (+) (x1 → y2)
Hypothesis 2	Deterioration → Housing price ratio (-) (x2 → y2)
Hypothesis 3	Housing complex → Housing price ratio (+) (x3 → y2)
Hypothesis 4	Housing brand → Housing price ratio (+) (x4 → y2)
Hypothesis 5	Traffic → Housing price ratio (-) (x5 → y2)
Hypothesis 6	Nature → Housing price ratio (-) (x6 → y2)
Hypothesis 7	Shopping → Housing price ratio (-) (x7 → y2)
Hypothesis 8	Education → Housing price ratio (+) (x8 → y2)
Hypothesis 9	Housing price for each districts → Housing price ratio (+) (x9 → y2)
Hypothesis 10	Use area → Housing price (+) (x1 → y1)
Hypothesis 11	Deterioration → Housing price (-) (x2 → y1)
Hypothesis 12	Housing complex → Housing price (+) (x3 → y1)
Hypothesis 13	Housing brand → Housing price (+) (x4 → y1)
Hypothesis 14	Traffic environment → Housing price (-) (x5 → y1)
Hypothesis 15	Natural environment → Housing price (-) (x6 → y1)
Hypothesis 16	Shopping environment → Housing price (-) (x7 → y1)
Hypothesis 17	Educational environment → Housing price (+) (x8 → y1)
Hypothesis 18	Housing price for each districts → Housing price (+) (x9 → y1)
Hypothesis 19	Housing price rising ratio → Housing price (+) (y2 → y1)

4.2. Development of Measurement Index

We choose variables taking effects on housing by surveying existing references, values of each variable are developed for more accurate housing price,

Selecting measurement indexes is shown in table 3.

- x1, x2, x3 features are related with housing and built as data by using real estate web-site.
- x5, x6, x7 are related with conditions of location and distances among indexes are measured by using GIS.
- The brand recognition is divided by section scale and x4 is the value from each section.
- x8 is the ratio of students who go on to top 3 university by using data from the national statistical office.
- Housing price (y1) is the sale price per pyeong from real market price.
- Considered sensitive change rate of housing price, housing price rising rate (y2) is the rate of housing price rising for 1 year.

Table 6. Development of measurement index for each variables

Variables	Contents of Indicator	The source of data
Use area (x1)	Using square measure of apartment	Real estate web-site
Deterioration (x2)	Years after moving in a apartment	Real estate web-site
Housing complex (x3)	The number of all the family in housing complex	Real estate web-site
Housing brand (x4)	Acknowledgment of housing brand(score) (1~10 position: 7 score, 11~20 position: 6 score,)	Position by a question (www.worker.co.kr)
Traffic (x5)	Measurement of the distance to the subway station	Application of GIS
Nature (x6)	Measurement of the distance to the mountain / river / park	Application of GIS
Shopping (x7)	Measure of the distance to the department store	Application of GIS
Education (x8)	The ratio of student who go on in the internal third university	Statistics web-site
Housing price for each districts (x9)	The average housing price in the district	Real estate web-site
Housing price (y1)	The APT sale price per a unit of area	Real estate web-site
Housing price rising ratio (y2)	Housing price rising ratio for 1 year : (B-A)/A*100, B: housing price for the present, A: housing price before 1 year (if less than 1 year, calculate for the day moving in the apartment)	Real estate web-site

4.3. Suitability and Hypothesis Verification of the First Model

Table 7. Hypothesis verification of the first model at Gang Nam district

Hypothesis	Model of Gang Nam district			
	Estimate	C.R.	P	Judgement
x1-->y2	0.217	4.826	0.000	***
x2-->y2	0.365	8.304	0.000	***
x3-->y2	0.163	3.502	0.000	***
x4-->y2	0.095	2.054	0.040	**
x5-->y2	-0.092	-2.014	0.044	**
x6-->y2	0.047	1.028	0.304	Reject
x7-->y2	-0.087	-1.355	0.175	Reject
x8-->y2	0.031	0.609	0.543	Reject
x9-->y2	0.022	0.409	0.683	Reject
x1-->y1	0.445	12.838	0.000	***
x2-->y1	-0.365	-10.213	0.000	***
x3-->y1	0.180	5.085	0.000	***
x4-->y1	0.084	2.408	0.016	**
x5-->y1	0.062	1.811	0.070	*
x6-->y1	0.097	2.112	0.035	**
x7-->y1	-0.307	-6.338	0.000	***
x8-->y1	0.007	0.183	0.855	Reject
x9-->y1	0.091	2.218	0.027	**
y2-->y1	0.321	8.460	0.000	***

Table 8. Hypothesis verification of the first model at Gang Buk district

Hypothesis	Model of Gang Nam district			
	Estimate	C.R.	P	Judgement
x1-->y2	-0.101	-1.345	0.179	Reject
x2-->y2	-0.023	-0.274	0.784	Reject
x3-->y2	0.155	1.822	0.068	*
x4-->y2	0.146	1.562	0.118	Reject
x5-->y2	0.170	2.001	0.045	**
x6-->y2	0.046	0.448	0.654	Reject
x7-->y2	-0.200	-2.194	0.028	**
x8-->y2	0.046	0.503	0.615	Reject
x9-->y2	0.349	3.564	0.000	***
x1-->y1	0.194	2.987	0.003	***
x2-->y1	-0.151	-2.322	0.020	**
x3-->y1	0.061	0.921	0.357	Reject
x4-->y1	0.458	6.268	0.000	***
x5-->y1	-0.187	-2.800	0.005	***
x6-->y1	-0.048	-0.608	0.543	Reject
x7-->y1	-0.120	-1.672	0.095	*
x8-->y1	0.198	2.820	0.005	***
x9-->y1	-0.016	-0.199	0.842	Reject
y2-->y1	0.106	1.494	0.135	Reject

* P<0.1 ~ | t | > 1.645; * P<0.05 ~ | t | > 1.960; ** P<0.01 ~ | t | > 2.576; ***

In this study, structural equation modeling is applied to verify cause-effect relation among basic concepts of the study modeling and a standard synthesized package, AMOS (6.0), is used. The maximum likelihood method is used to verify modeling.

This phase is for checking the structural equation model in Kang Nam and Kang Buk, so acceptance and denial of hypothesis depends on the following standards.

At the first hypothesis modeling, rejected parts are corrected by verifying hypothesis (P<0.1 ~ | t | > 1.645: *, P<0.05 ~ | t | > 1.960: **, P<0.01 ~ | t | > 2.576: *** and P>=0.1 ~ | t | <= 1.645: reject)

As a result of analysis, “x6-->y2, x7-->y2, x8-->y2, x9-->y2, x8-->y1” have been rejected in Gang Nam, and in Gang Buk area “x1-->y2, x2-->y2, x4-->y2, x6-->y2, x8-->y2, x3-->y1, x6-->y1, x9-->y1, y2-->y1” have been rejected. This means there are significant difference of influencing power between these two areas.

Table 9. Suitability analysis of the first model

Suitability Index	Criterion	Gang Nam district	Judgement	Gang buk district	Judgement
χ^2	-	0	-	0	-
$d.f.$	-	0	-	0	-
P	More than 0.05	-	-	-	-
$\chi^2/d.f.$	Less than 5.0	-	-	-	-
RMR	Less than 0.1	0	o	0	o
GFI	More than 0.9	1	o	1	o
AGFI	More than 0.8	-	-	-	-
PGFI	More than 0.5	-	-	-	-
NFI	More than 0.9	1	o	1	o
TLI	More than 0.9	-	-	-	-
CFI	More than 0.9	1	o	1	o
RMSEA	Less than 0.1	0.207	x	0.217	X

As a result of the feasibility analysis on first model, the values correspond to the ten criterion are under the middle, so this means incredible.

Therefore, denied hypothesis through checking steps will be corrected and they can output final model. The results are the same as figure11.12

4.4. Suitability and Hypothesis Verification of the Final Model

Table 10. Suitability of the final model

Suitability Index	Criterion	Gang Nam district	Judgement	Gang buk district	Judgement
χ^2	-	17.620	-	27.598	-
$d.f.$	-	24	-	26	-
P	More than 0.05	0.821	○	0.379	○
$\chi^2/d.f.$	Less than 5.0	0.734	×	1.061	×
RMR	Less than 0.1	0.106	×	0.231	×
GFI	More than 0.9	0.992	○	0.961	○
AGFI	More than 0.8	0.978	○	0.901	○
PGFI	More than 0.5	0.361	×	0.379	×
NFI	More than 0.9	0.982	○	0.924	○
TLI	More than 0.9	0.959	○	0.989	○
CFI	More than 0.9	1.000	○	0.995	○
RMSEA	Less than 0.1	0.000	○	0.023	○

The level of suitability is low at the first hypothesis modeling and we may conclude feasibility seems to be low. So checking the suitability analysis of finally proposed model like figure11.12. compared with the first proposed model, the result are that seven criterions among ten criterions are suitable, it is estimated credible model. At the suitability analysis of the final modeling, it can be said that even though $\chi^2/d.f.$, RMR, PGFI are not good enough, it is suitable overall.

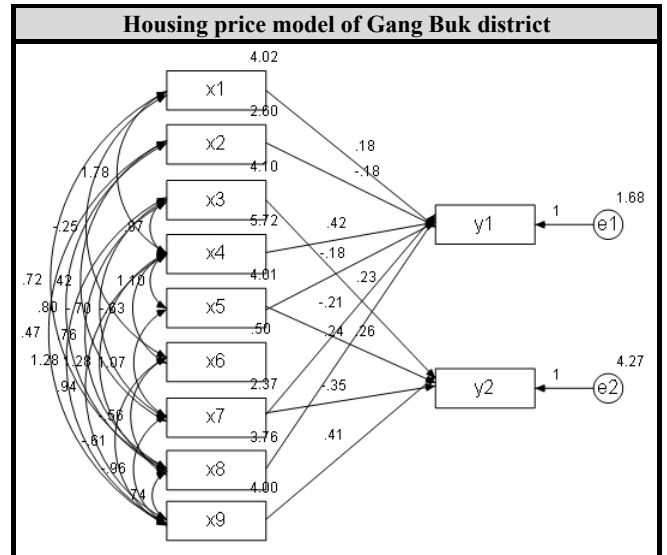


Figure 12. The final housing price model of Gan Buk district

5. CONCLUSION

In this study, measurement indexes were selected from various documents research and data were collected by GIS and real estate web portal site. Structural equation was built from housing price modeling in both Gang Nam and Gang Buk on the physical features of housing and neighborhood effect of surrounding area to compare and analyze.

5.1. Analysis of the results

At the first housing price modeling, variables are set by considering features of housing and conditions of surrounding location in Gang Nam and Gang Buk district theoretically and it is thought that all the selected variables would have impacts. However, there are a few variables which are rejected depending on two districts and contrary to the first hypothesis it is found that some variables have a negative effect not a positive effect.

<The southern district of the Han river(Gang Nam)>

Variables which have an effect on housing price are floor space of exclusive use, the passed years after construction, the number of households, brand recognition, traffic environment. Variables which influence housing price rising rate are exclusive use floor space of exclusive use, the passed years after construction, the size of complex, brand recognition, traffic environment, natural environment, shopping environment, average housing price. And, housing price rising rate have the most effect on housing price.

As a result of this study, it is particularly noticed that the hypothesis the passed years after construction have a

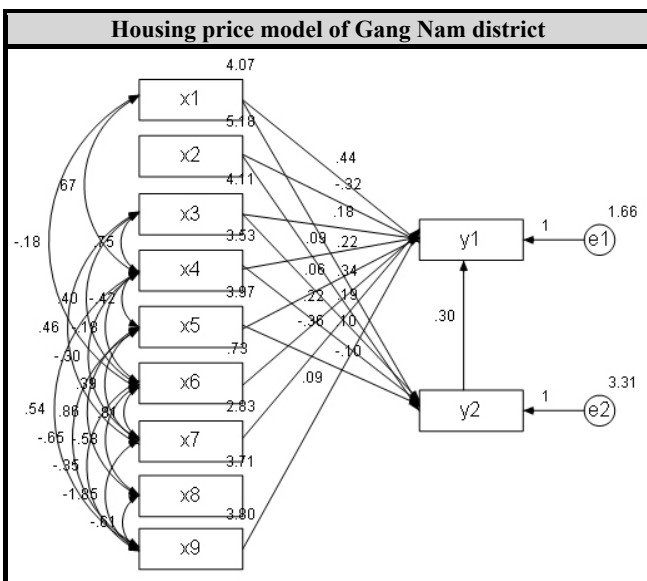


Figure 11. The final housing price model of Gang Nam district

positive effect on housing price and a negative effect on housing price rising rate, contrary to hypothesis that the passed years after construction have a negative effect on both housing price and housing price rising rate. As a result of this study, price rising rate of apartments is excessively high so present price of 3-year passed apartment risen by premium effect while present price of new apartment is relatively low because of less premium effect than 3-year passed apartment.

<In The northern district of the Han river(Gang Buk)>

Variables which have an effect on housing price are floor space of exclusive use, the passed years after construction, the number of households, brand recognition, traffic environment. Variables which influence housing price rising rate are exclusive use floor space of exclusive use, the passed years after construction, the size of complex, brand recognition, traffic environment, natural environment, shopping environment, average housing price. And, housing price rising rate have the most effect on housing price.

As a result of this study, particular fact that the housing price rising rate would influence housing price is rejected. The housing price rising rate has no effect on housing price in Gang Buk district while the housing price rising rate has the most effect on housing price in Gang Nam district. This fact say that the housing price rising rate in Gang Buk is too low to give impact on housing price.

5.2. Suggestion & limitation and further study

Some suggestions are made from these results.

- 1) On the process to grasp the number of apartments which have not passed 3 years since construction for data survey, it was found that brand-new apartments are much more insufficient in Gang Buk than Gang Nam.
- 2) GIS can make it possible to search locations we want to find without visiting and understand the surrounding conditions of locations.
- 3) It is noticed that the difference of housing price model is caused by the differences from features of housing and conditions of surrounding locations between Gang Nam and Gang Buk.
- 4) By showing that factors which affect the determinants of apartment price depend on district, it is suggested that the differential policies of housing and development are required according to features of housing demander and neighborhood attributes of housing market.

Factors which are referred in this study can not explain all the differences of apartment price between Gang Nam district and Gang Buk district. Therefore it is necessary to study more exactly about a variable which can explain the difference of housing price and reflect the feature of district.

6. ACKNOWLEDGMENT

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