HOUSING PRICE MODEL USING GIS 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 condominium price between the north and south of the Han river. Because the housing price is deciede by the immanent value of a house and neighborhood effects of the regional where the house is situated, the housing price is occurred difference.

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

The purpose of study is 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.

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

1.   Introduction

1.1   Research Backgrounds and Purpose

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 condominium 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 is 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

1.2   Research Methodology and Scope

This study set the scope of time by including apartments which have been constructed since 2003 and the scope of space by including 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, I 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).
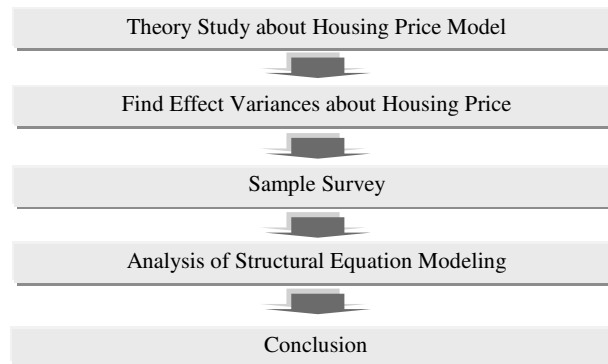

| Theory Study about Housing Price Model |
| Find Effect Variances about Housing Price |
| Sample Survey |
| Analysis of Structural Equation Modeling |
| Conclusion |

Figure 1. Research Procedure

2.   Theory Study

2.1.   The factors of deciding 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. As you know, a variety of factors have a 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.

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 not formulas.

The purpose of structural equation is to reveal the relationship among the variables through the model which shows 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.

3. Sample Survey

3.1. Scope of Sample Survey

The average price of apartments and price rising rate for 3 years in Seoul are surveyed to select the sample about similar areas..

Table 1. The average price of apartments for each district

(Symbols: 10,000 won)

The southern district of the Han river	The average price of apartment	The northern district of the Han river	The average price of apartemnt
Gangseo-Gu	1054	Eunpyeong-Gu	780
Yangcheon-Gu	1851	Seodaemun-Gu	849
Guro-Gu	842	Mapo-Gu	1195
Yeongdeungpo-Gu	1274	Jongno-Gu	1163
Geumcheon-Gu	722	Jung-Gu	1327
Dongjak-Gu	1203	Yongsan-Gu	1961
Gwanak-Gu	935	Seongbuk-Gu	886
Gangdong-Gu	1769	Jungnang-Gu	687
Seocho-Gu	2440	Dongdaemun-Gu	855
Gangnam-Gu	3038	Seongdong-Gu	886
Songpa-Gu	2268	Gwangjin-Gu	1418
		Dobong-Gu	659
		Nowon-Gu	674
		Gangbuk-Gu	706

Housing price rising ratio in Seoul	Selecting of sample districts
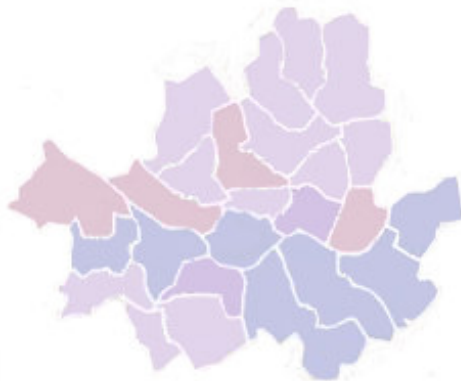
Housing Price Rising Ratio(%)

Figure 2. Housing price rising ratio in Seoul and 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
- The northern district sample of the Han river: Gangbuk-Gu, Dobong-Gu, Nowon-Gu

3.2. Decision of Sample Survey

Apartments which have not passed 3 years since construction are selected as a sample and information about the sample are 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.
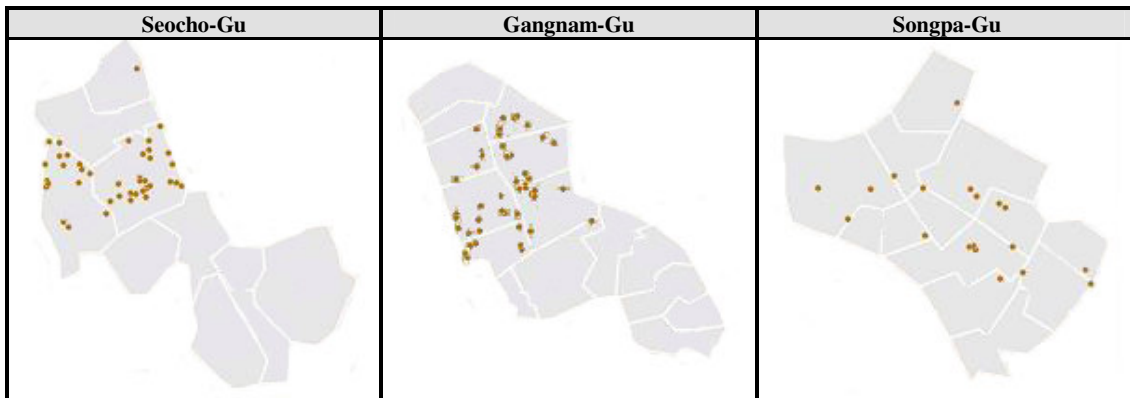The method to select index value of variable will be explained for the next.

Seocho-Gu	Gangnam-Gu	Songpa-Gu

Figure 3. Sample of Gang Nam district

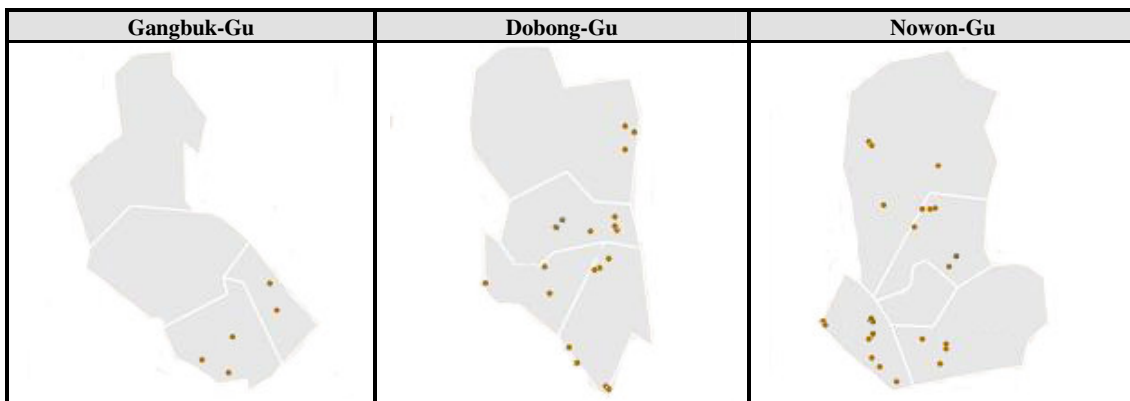| Gangbuk-Gu	Dobong-Gu	Nowon-Gu

Figure 4. Sample of Gang Buk district

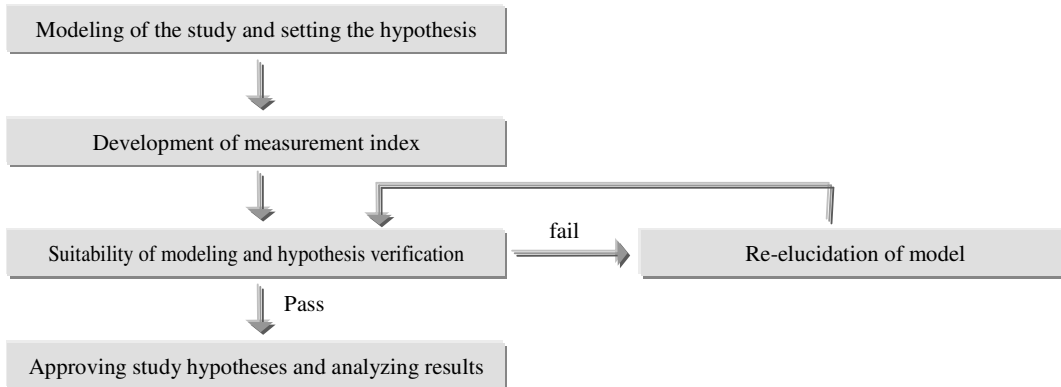# 4. Structural Equation Modeling of Housing Price

Figure 5. Research Procedure of Structural Equation Modeling

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.

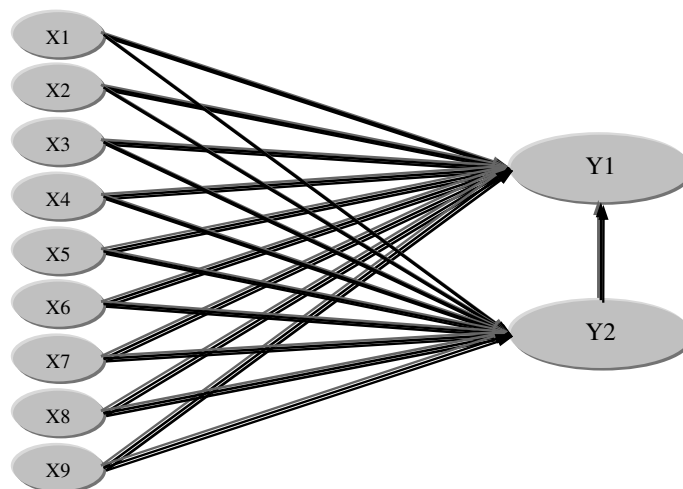## 4.1. Modeling of the study and setting the hypothesis

Figure 6. 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.

Table 2. 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

Selecting measurement indexes is shown at the table 3.
- x1, x2, x3 related with features of housing are 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 devided 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 3. 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	Real estate web-site

| | | | | | the apartment) | | |

4.3. Suitability of modeling and hypothesis verification

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.

Table 4. Hypothesis verification of the first model

Hypothesis	Model of Gang Nam district				Model of Gang Buk district			
	Estimate	C.R.	P	Judgement	Estimate	C.R.	P	Judgement
x1-->y2	0.217	4.826	0.000	***	-0.101	-1.345	0.179	Reject
x2-->y2	0.365	8.304	0.000	***	-0.023	-0.274	0.784	Reject
x3-->y2	0.163	3.502	0.000	***	0.155	1.822	0.068	*
x4-->y2	0.095	2.054	0.040	**	0.146	1.562	0.118	Reject
x5-->y2	-0.092	-2.014	0.044	**	0.170	2.001	0.045	**
x6-->y2	0.047	1.028	0.304	Reject	0.046	0.448	0.654	Reject
x7-->y2	-0.087	-1.355	0.175	Reject	-0.200	-2.194	0.028	**
x8-->y2	0.031	0.609	0.543	Reject	0.046	0.503	0.615	Reject
x9-->y2	0.022	0.409	0.683	Reject	0.349	3.564	0.000	***
x1-->y1	0.445	12.838	0.000	***	0.194	2.987	0.003	***
x2-->y1	-0.365	-10.213	0.000	***	-0.151	-2.322	0.020	**
x3-->y1	0.180	5.085	0.000	***	0.061	0.921	0.357	Reject
x4-->y1	0.084	2.408	0.016	**	0.458	6.268	0.000	***
x5-->y1	0.062	1.811	0.070	*	-0.187	-2.800	0.005	***
x6-->y1	0.097	2.112	0.035	**	-0.048	-0.608	0.543	Reject
x7-->y1	-0.307	-6.338	0.000	***	-0.120	-1.672	0.095	*
x8-->y1	0.007	0.183	0.855	Reject	0.198	2.820	0.005	***
x9-->y1	0.091	2.218	0.027	**	-0.016	-0.199	0.842	Reject
y2-->y1	0.321	8.460	0.000	***	0.106	1.494	0.135	Reject

※ $P<0.1 \sim |t| > 1.645$: *, $P<0.05 \sim |t| > 1.960$: **, $P<0.01 \sim |t| > 2.576$: ***

4.4. Approving study hypotheses and analyzing results

Table 5. Approving study hypotheses of the first model

Suitability Index	Criterion	Gang Nam district	Judgement	Gang buk district	Judgement
	-	17.620	-	27.598	-
	-	24	-	26	-
P	More than 0.05	0.821	○	0.379	○
	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	○

At the suitability analysis of the final modeling, it can be said that even though   ,
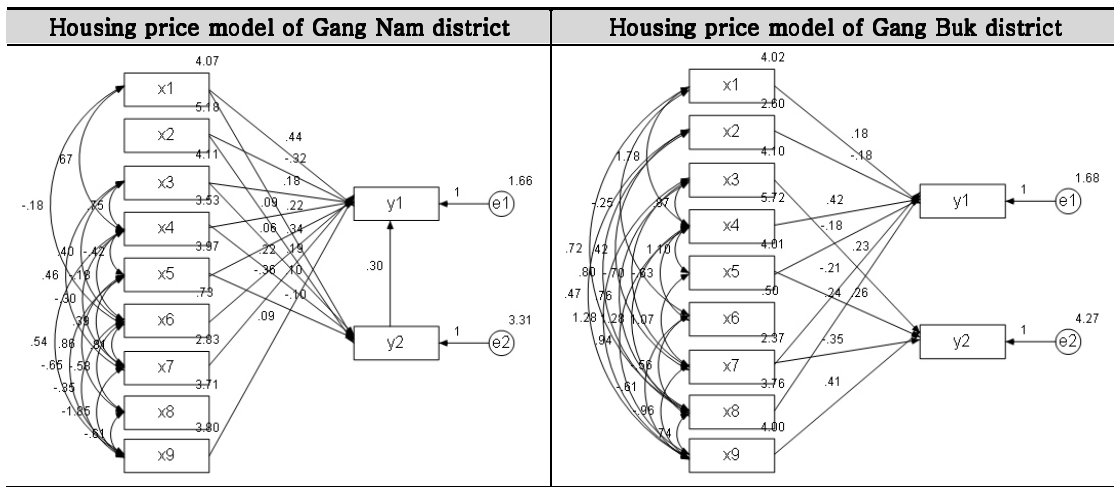RMR, PGFI are not good enough, it is suitable overall.

Figure 7. The final housing price model

At the first hypothesis modeling, rejected parts are corrected by verifying hypothesis and suitability analysis is performed to maintain the level of suitability. Through this process, the final model is proposed.

4.7.   Discussion about analysis result

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>

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 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>

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.   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. Suggestion

There can be a suggestion of this study 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 any visiting and understand conditions of locations which surround the searched location.
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 to decide the price of apartment 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.

5.2. limitation and hereafter direction of study

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

References

[1] **W.David Salisury. (2001).** "Perceived security and World Wide Web purchase intention". Industrial management & data Systems. 165-176

[2] **PRATIBHA A. DABHOLKAR. (2000).** "A Comprehensive Framework for Service Quality: An Investigation of Critical Conceptual and Measurement Issues Through a Longitudinal Study". *Int. J. of Solids and Struct.*, 24(3), 231-250.

[3] **Statistics Web-site: http://www.nso.go.kr**

[4] **Real Estate Web-site: http://www.r114.co.kr**

[5] **Joung, You Jin.** (2002)."An Empirical Analysis of Housing Price Determinants between Old and New Residential Area in Seoul". Hanyang University

[6] **Kim, Sang Kyun.** (2001)."Estimation of Residential location Demand Based on the Modified Potential Model Incorporating both Employment and Open-Space Accessibility". Hanyang University

[7] **Mike Fletcher.** (2004). "Comparing Hedonic Models for estimating and Forecasting house prices". Property Management Vol.22 No. 3. 189-200

[8] **Aurelia Bengochea Morancho.** (2003). "A hedonic valuation of urban green areas". Landscape and Urban Planning 66. 35-41

[9] **Min Hwang.** (2006). "The Dividend Pricing Model: New Evidence From the Korean Housing Market". J Real Estate Finan Econ 32. 205-228

[10] **Young-nam Jin.** (2005) "Education and Housing Prices: Evidence from Seoul Apartment Market". Housing Studies Rewiew Vol. 13. 125-148

[11] **Shin, Woo-Jin.** (2001). "A Study on the Changing Patterns of the Commercial Power based on Retail Trade Area Analysis". Real Estate Research Vol. 8. 1-11

[12] **Hwang, Eui-Jin.** (2006). "Analysis the Land Cover Class using Satellite Images". Journal of the Institute of Construction Technology Vol. 25. 131-141

[13] **Myung-Hee Jo.** (1999). "A Spatial Change Analysis of Water Quality Pollutant using GIS and Satellite Image". The Korean Association of Geographic Information Studies Vol.2. 60-70