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A Study on Pricing Model of High-Rise Residential Buildings From the viewpoint of Landmark Factor

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ABSTRACT : Previous research on super high rise buildings focused mostly on the use of public space from building plan perspective, survey of residents' satisfaction evaluation, construction technology and structural technology. But little research is done on the economic analysis of landmark factors. The purpose of this study is to find landmark factors that can be quantitatively measured, collect data on super high rise residential buildings in Seoul. Find the intrinsic values of the landmarks, and analyze how these values differ in areas with different densities, i.e. in 3 Gangnam-gus & Yeongdeungpo-gu and in other areas. It is expected that the results of this study can be used to set an appropriate price of super high rise building in consideration of its landmark value in different area

Keywords : Hedonic Pricing Model ; Super high rise building ; Landmark Factor ; Seoul

1. INTRODUCTION

1.1 Background & purpose of research

These days, the number of super high-rise residential building is increasing more than we expect. Land price hike due to the expansion of city and population concentration in cities caused high dense housing development. To improve the efficiency of land use, solve the problem of doughnut phenomenon, and cope with new types of urban residence, super high rise residential buildings have been built. Such buildings originated in New York and Chicago in the 1930s but they became a type of urban residence in Hong Kong and other Asian cities in the 1970s through 1990s due to the development of urban areas. The construction of high rise residential buildings is not limited to certain countries. It has been happening in major cities around the world especially in the Middle East and Asia since late 1990s including Korea(4th), China(1st), UAE(3rd) and Japan(5th).

In Seoul, super high rise residential buildings are considered more attractive than high rise residential buildings in terms of buying value.(Han, Yongtae, 2005) They are considered more luxurious residences than high rise apartments because they provide more comfortable environment, various amenities, and maintenance services using high tech systems. Super high rise apartment buildings have turned into luxury apartments using information technology and the concept of apartments and stores in one building. They have become a new type of urban residence and it is expected that the number will continue to grow.

Such super high rise apartments affect urban landscape and urban culture. They are important especially because of their symbolic importance as landmarks in the region. (Lee, Eun-jung, 2006) Helsley(2008) indicated that height and size, the landmark factors, play an important role in the formation of the price of super high rise building. In other words, the price of a super high rise building is affected by its landmark function.

Previous research on super high rise buildings focused mostly on the use of public space from building plan perspective, survey of residents' satisfaction evaluation, construction technology and structural technology. But little research is done on the economic analysis of landmark factors.

Therefore, this research based on economic analysis of landmark factors. First, Review the items in the super high rise buildings and look at the definition. Also we evaluate the factor of super high rise buildings. The

results from that review are used for looking for landmark influence of super high rise buildings. And we can search the pricing model from that result.

1.2 Scope and Procedure of Study

The definition of super high rise building differs from country to country according to the size and technology level of the country. In the case of Korea, literature review revealed that a building with more than 30 or 40 floors is considered a super high rise building. Chi-joo Lee et. al(2004) analyzed the status of super high rise residential buildings in Korea using a facility information management system. They found that buildings with more than 30 floors are seldom found outside of Seoul and major cities. But there are more than 8,000 residential buildings with 21-30 floors.

Base on this, about 30 residential buildings with 30 or more floors in Seoul are selected as research subjects for this study. Through literature review of previous studies, this study finds the factors determining the price of super high rise housing and its landmark factors. And a quantification method is explored using real estate GIS internet sites and actual surveys. Then quantitative data on the landmark factors and housing price determinants are collected, a Hedonic Pricing Model is set and a multiple regression analysis is carried out to select the factors within the significance level and estimate their values. Lastly, a multiple regression analysis is carried out to find the impact of the relativity of landmark factors on the price value by comparing the super high rise residential buildings in 3 Gangnam-gus and Yeongdeungpo-gu and those in other areas.

2. THEORETICAL EXAMINATION

2.1 Previous Studies

As can be seen in table 1, research on super high rise residential buildings has been carried out actively since late 2000, when the number of these buildings started to increase. Diverse studies have been conducted but most of them focused on the problems of newly built buildings and solutions such as performance evaluation and satisfaction level of residents, functions of apartment, such as floor impact sound, handling of interior traffic flow, external environment issue such as environmentally friendliness, and the use of public space. But, there is not enough research on the impact of landmark factors, an important attribute of super high rise building, influencing the price of the building. Therefore, it will be meaningful to find the impact of landmark factors on the formation of price in an area with higher density of super high rise buildings and an area with lower density.

Table 1. Previous studies of super high rise buildings

Researcher	Title	Research content
Cho, Yoon-suk (1996)	A study of construction plans for apartments with stores in city center - Focusing on the case of Hanyoung Apartments in Sinsa-dong, Gangnam-gu-	Found problems of these buildings from urban planning perspective through an analysis of the sites. Suggests low to mid height apartments with stores to vitalize city function
Lim, Soo-hyun (1997)	A comparison of residential environment of super high rise apartments with stores and super high rise apartments	Suggests ways to improve the problems of super high rise apartments with stores by comparing them with super high rise apartments
Son, yoon-rak (1999)	A study of environmentally friendly space planning for super high rise apartments with stores	Presents environmentally friendly space planning methods and designs based on theoretical examination after analyzing cases
Shin, Jung-jin (2004)	A study of planning for super high rise buildings to promote their public role	Analysis indices are drawn from the publicness concept of super high rise buildings. Problems are analyzed in various ways using these indices and methods to promote the publicness of super high rise building are presented
Park, Young-ki (2005)	A study of the evaluation model of super high rise residential buildings	Developed an evaluation model for residents and managers to find the status of use

Lee, Sang-moo (2006)	A study of factors affecting the floor impact sound of super high rise apartments	Measured, and evaluated noise levels in super high rise apartments and analyzed the factors affecting them
Park, Chi-ho (2007)	An analysis of economic and social effects of super high rise buildings	Economic and social roles and effects of super high rise buildings are drawn and their importance is analyzed

2.2 Definition of super high rise building

In Korea, there is no clear definition of super high rise building. But in general, a building with 21 floors is used as a criterion because these buildings are required to use earthquake resistant design for structural safety. In the case of Europe, however, a building with 12 or more floors is considered a high rise building. In Chicago, a building with 70-100 floors is considered a super high rise building. As the criterion for super high rise building differs according to the region or the level of technology development, it is difficult to define the super high rise building according to the number of floors(Song, Doo-hyun, 2002). Council on Tall Building and Urban Habitat(CTBUH) defined a super high rise building as a building that requires special conditions that are different from the general conditions required for its design, construction, and maintenance of a building in a certain region and period due to its height.

In Korea, most of apartment buildings have 20 or more floors due to technology development, high land price and consumer demands since 2000. Therefore, it is difficult to define a building with 25 or more floors as a super high rise residential building. As discussed above, super high rise is a relative concept and different researchers will use different definitions. In this study, a super high rise building is defined as a building with 30 or more floors.

2.3 Hedonic Pricing Model

In economics, Hedonic Pricing Model theory is a method of estimating demand or value. It decomposes the item being researched into its constituent characteristics, and obtains estimates of the contributory value of each characteristic. This requires that the composite good being valued can be reduced to its constituent parts and that the market values those constituent parts.

In real estate economics, it is used to adjust for the problems associated with researching a good that is as heterogeneous as buildings. Because buildings are so different, it is difficult to estimate the demand for buildings generically. Instead, it is assumed that a house can be decomposed into characteristics such as number of bedrooms, size of plot, or distance to the city center. A hedonic regression equation treats these attributes (or bundles of attributes) separately, and estimates prices (in the case of an additive model) or elasticity (in the case of a log model) for each of them. This information can be used to construct a price index that can be used to compare the price of housing in different cities, or to do time series analysis. As with CPI calculations, hedonic pricing can be used to correct for quality changes in constructing a housing price index. It can also be used to assess the value of a property, in the absence of specific market transaction data. It can also be used to analyze the demand for various housing characteristics, and housing demand in general. It has also been used to test assumptions in spatial economics.

In Hedonic price modeling, regression analysis is performed as a multi-regression model by setting the price as the dependent variable and the various characteristics of a building as independent variables in order to calculate regression coefficients of independent variables through multiple regression analysis.

$$Y = \alpha + \sum_{i=1}^{n} \beta_i X_i + \varepsilon$$

Y=Price calculated by the model, α= Constant term, β=Coefficient representing building characteristics, X=Attribute of property, ε=Error term

2.4 Selection of the Variables

Previous studies on landmark factors focused on the identification of landmark factors based on surveys. Appleyard(1969) classified landmark factors into form, visibility, and significance. The variables for the form include movement, contour, size, shape, surface, quality, and signs. The variables for the visibility include viewpoint intensity, viewpoint significance, and immediacy. The variables for the significance include use intensity, use singularity, and symbolism. Based on this, he analyzed the correlation between the landmark and each variable through various surveys.

Jong-ho Kim et. al.(2001) classified the landmark recognition factors into history & culture, size, visual form, location, and uniqueness parametric factors based on a survey and defined the details. The landmarks in city center are classified into four types as shown in table 2 according to those five factors.

Table 2. Four types of landmarks (Kim, Jong-ho, 2001)

Item Type	Prominent landmark recognition	Landmark examples

	factor(Details)	
Type 1	History and culture(Historical significance and event)	Namdaemun, Seoul Train Station, Deoksugung palace, Myeongdong Cathedral, and Seoul City Hall
Type 2	Size (Volume, height, and scale)	63 Building, Namsan Tower, and KOEX
Type 3	Uniqueness (Uniqueness and name)	National Assembly Hall, Sejong Center for the Performing Arts, and Seoul Arts Center
Type 4	Visual form(Visual uniqueness and uniqueness of figure)	LG Building, COEX, and SK Building

To measure the values of landmark factors contained in super high rise residential buildings, this study has set the first hypothesis as the landmark factors influence the price of super high rise residential building. If the landmark factors of each sample are found to be statistically significant using the pricing model, the hypothesis that the landmark factors influence the price will be accepted. Second, if the landmark factors influence the price, the impact of a single landmark and that of a landmark among other high rise buildings are compared. Because the coefficient of each explanatory variable estimated using the hedonic pricing model is an index that explains the landmark's impact on the price.

Table 3. Price explanatory variables for super high rise residential buildings

Attribute Category	Variable	Unit	Definition
Building Attributes	Period	year	Years since building completion
Location Attribute	Price_D	₩ 10,000/㎡	Average price per m2 for residential buildings in the district
Landmark Attributes	R_Height	m	Difference between the height of the building being analyzed and average height of buildings within 200m in radius
	R_Area	m2	Difference between the area acreage of the building being analyzed and average area of buildings within 200m in radius.
	Form	Dummy	Uniqueness of the form

This study used the price per ㎡ as a dependent variable and building, location, and landmark attributes as independent variables. For the building attributes, the number of years after completion is used. To find out depreciation due to aging of the building, the number of years after completion is used.

For the location attribute, the average price per ㎡ of residential buildings in the same administrative district is used. In general, the location attribute is represented by access to transportation, convenience facilities, and green facilities. As these attributes are already incorporated in the market price of residential buildings in the neighboring area, this study used the average unit price of the buildings in the vicinity as the location attribute.

For the landmark attributes, this study used the landmark factors defined above such as relative height and area, and visual form. First, for the relative height, the difference between the average height of the buildings within 200m radius of the building being analyzed and that of the building being analyzed is used.

Hr = Ha – E(Hc)
Hr = relative height
Ha= Height of the target building
Hc = Average height of the buildings within 200m radius of the target building

For the relative area, the difference between the average area of the buildings within 200 m radius of the building being analyzed and that of the building being analyzed is used just like the relative height.

Ar = Aa – E(Ac)
Ar = relative area
Aa= Area of the target building
Ac = Average area of the buildings within 200m radius of the target building

For the visual form, the value was measured by using the existence or non-existence of traditional box type RC structure curtain wall as a dummy variable.

Detailed data for each variable have been collected using a field survey, Seoul Geographic Information System(GIS), real estate portal sites, and building registries.

3. ANALYSIS OF VALUES OF LANDMARK FACTOR

3.1 Selection of the Variables and verification of analysis model

To estimate using the hedonic pricing model, it is necessary to select variables and the form of regression function. Before doing this, variables that have high correlation with other variables were excluded using multicollinearity verification indicated above. And the linear functional formula for the factors affecting the unit price can be expressed as follows.

$$Price\_B = \alpha + \beta 1 Period + \beta 2 Price\_D + \beta 3 R\_Height + \beta 4 R\_Area + \beta 5 Form$$

α is a constant and $\beta 1 \sim \beta 5$ are regression coefficients representing the intrinsic values of attributes.

3.2 A comparative analysis of the impact of landmark factors - the density of super high rise residential buildings

Independent variables such as the number of years after completion, unit price of the buildings in the vicinity, relative height, relative area, and visual uniqueness identified using the regression equation played significant roles in determining the unit price of super high rise buildings. A regression analysis is conducted by area to find the impact of these factors on super high rise buildings in the higher density area and those in lower density area.

Table 4. Results of regression analysis of areas other than 3 Gangnam-gus and Yeongdeungpo-gu

Model		Nonstandardized coefficient		Standardized coefficient	Significance level	Multicollinearity	
		B	Standard error	Beta		Tolerance	VIF
1	(Constant)	110.942	318.712		.735		
	No. of years after completion(Years)	-7.008	13.629	-.078	.610	.780	1.283
	Unit price in the vicinity(10,000/㎡)	.740	.402	.296	.075	.700	1.429
	Ratio against average building floors within 200m radius(Floors)	10.039	3.332	.488	.013	.688	1.453
	Ratio against average building area within 200m radius	.039	.013	.482	.013	.764	1.309
	Uniqueness of the form	-.007	.006	-.189	.211	.902	1.109

Table 5. Results of regression analysis of 3 Gangnam-gus and Yeongdeungpo-gu

Model		Nonstandardized coefficient		Standardized coefficient	Significance level	Multicollinearity	
		B	Standard error	Beta		Tolerance	VIF
2	(Constant)	-171.366	338.124		.628		
	No of years after completion(Years)	-14.918	9.995	-.296	.154	.521	1.921
	Unit price in the vicinity(10,000 won/㎡)	1.198	.378	.760	.016	.269	3.713
	Ratio against average building floors within 200m radius(Floors)	9.096	2.796	.190	.080	.519	1.926
	Ratio against building area within 200m radius	.008	.020	.060	.051	.716	1.397
	Uniqueness of the form	18.061	16.723	.046	.062	.442	2.263

(1) One sample test(Kolmogorov-Smirnov)
If a sample has normal distribution, the hedonic price function is valid. But, the sample for the regression analysis by area might not have normal distribution because it is too small. Therefore, whether the sample has normal distribution or not was checked using one sample test(Kolmogorov-Smirnov). In all areas, the significance level(p-value) of the Z value of K-S was over 0.05. This does not reject the null hypothesis, which means the sample has normal distribution.

(2) A comparative analysis of landmark factors by area
An analysis using the hedonic price function for the higher density area and the lower density area showed that the impacts of price determinants in the higher density area and lower density area were different. The standardized coefficients of landmark factors were different, which means the impact of landmark factors differ according to the relative height and area. In the case of lower density area, the standardized coefficient for the unit price of the buildings in the vicinity was 0.296 and the coefficients for relative height and area were 0.488, and 0.462 respectively. This means that the super high rise buildings in the lower density area have become definite landmarks due to their scarcity in the area and it influenced the price greatly.
Even though the impact of landmark factors on the unit price in higher density area was statistically significant, the standardized coefficient for the unit price of buildings in the vicinity, a location attribute, was 0.790, which is much higher than that for other factors. This means that due to higher density, its importance as a landmark is not as strong as its investment benefit, or the feeling of psychological and social superiority of living in luxury housing.

4. CONCLUSIONS

This study identified and quantified the landmark factors that affect the price of super high rise residential buildings in Seoul and found their impacts in the higher density area of 3 Gangnam-gus and Yeongdeungpo-gu and in lower density area of other districts in Seoul.

Through literature review, the number of years after completion is set as the building attribute, the unit price of buildings in the vicinity as the location attribute, relative height and area and visual uniqueness as the landmark attributes.

These attributes were set as independent variables and a multiple regression analysis was conducted to find the impact of landmark factors according to the density. 3 Gangnam- gus and Yeongdeungpo-gu were set as higher density area and other areas were set as lower density area. One sample test was used to verify normal distribution of the sample.

The regression analysis showed that in the lower density area, the standardized coefficient for the unit price was 0.296 while those for relative height and area were 0.488, and 0.462 respectively. In the higher density area, even though the impact of landmark factors on the unit price was statistically significant, its standardized coefficient for the unit price was 0.790, which is much higher than those for other factors.

As discussed above, this study found that landmark factors affected the price of super high rise residential building. This study also found that the impact was different when the building was a sole landmark and when the building was among other high rise buildings. The study results can be used to set an appropriate price for a super high rise residential building in consideration of its landmark value.

This study has several limitations. Among the landmark factors, it simplified the size and visual uniqueness and used dummy variables for them. In addition, there are important factors such as historical background, social issues, recognition level, and the construction company's advertisement but these are difficult to quantify. Therefore, more comprehensive research on the quantification of landmark factors is needed by carrying out research on these factors.

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