Taylor & Francis
Taylor & Francis Group

Journal of Asian Architecture and Building Engineering

ISSN: 1346-7581 (Print) 1347-2852 (Online) Journal homepage: https://www.tandfonline.com/loi/tabe20

An Hedonic Valuation of Landmark Factors on Super High-Rise Residential Building Prices in Seoul (Republic of Korea)

Woncheol Choy, Sanghyo Lee, Yoonsun Lee & Jaejun Kim

To cite this article: Woncheol Choy, Sanghyo Lee, Yoonsun Lee & Jaejun Kim (2010) An Hedonic Valuation of Landmark Factors on Super High-Rise Residential Building Prices in Seoul (Republic of Korea), Journal of Asian Architecture and Building Engineering, 9:1, 71-78, DOI: 10.3130/jaabe.9.71

To link to this article: https://doi.org/10.3130/jaabe.9.71

Published online: 24 Oct 2018.

An Hedonic Valuation of Landmark Factors on Super High-Rise Residential Building Prices in Seoul (Republic of Korea)

Woncheol Choy[1], Sanghyo Lee*[2], Yoonsun Lee[3] and Jaejun Kim[4]

[1] Ph.D. Candidate, Department of Architectural Engineering, Hanyang University, Korea
[2] Ph.D. Candidate, Department of Sustainable Architectural Engineering, Hanyang University, Korea
[3] Assistant Professor, Department of Architectural Design, Hanyang University, Korea
[4] Professor, Department of Sustainable Architectural Engineering, Hanyang University, Korea

Abstract

The objective of this study is to analyze the influence of landmark factors on the price of super high-rise residential buildings. The level of influence is analyzed by means of an hedonic pricing model.

In this paper the height and area are identified as landmark factors in analyzing the landmark's influence quantitatively. Also, the concept of relative quantity is introduced regarding the height and area because the landmark factors involve comparisons with neighboring buildings rather than by the building's absolute characteristics alone. Relative height and relative area derived by such an approach were established as independent variables for the hedonic pricing model, along with conventional price-determining factors. Samples subjected to this analysis included thirty super high-rise residential buildings each containing at least thirty stories and all located in Seoul. Results from a linear regression model and a semi-log regression model revealed that p-values were less than 0.05, indicating that the regression coefficients of relative height and relative number of stories are significant.

Keywords: landmark factor; hedonic pricing model; super high-rise residential building

1. Introduction

1.1 Background and Goals of the Research

Super high-rise residential buildings are increasingly being constructed around the world. According to data of the Council on Tall Buildings and Urban Habitat (CTBUH), a review of such structures built since the late 1990's shows that this trend is not confined to only a few countries but appears all over the world.

As shown in Table 1., Korea is ranked 4th in the construction of super high-rise residential buildings. It is considered to be related to the trend in which high-rises are now considered to provide a desirable lifestyle rather than merely a solution to overpopulation.

Actually, the unit price per m^2 of super high-rise residential buildings is about 40% higher than other buildings. This is a result of the strategy of constructing more large-scale and quality residential buildings in close proximity to commercial areas, thereby having a landmark function of targeting the rich (Han *et. al*, 2005). Also, Helsley *et al.* (2008) pointed out that height as a landmark factor plays a key role in determining the price of super high-rise buildings. That is, landmark factors have an influence on the market price of super high-rise residential buildings. There have been numerous studies that used the hedonic pricing model regarding various characteristics that have an influence on the price of

Table 1. Construction of Super High-rise Residential Buildings Per Country

No	Country	Qty	No	Country	Qty
1	China	985	14	Israel	16
2	USA	392	15	Malaysia	15
3	UAE	134	16	Argentina	14
4	Korea	76	17	Panama	13
5	Japan	75	18	India	12
6	Australia	59	19	England	10
7	Thailand	42	20	Venezuela	6
8	Canada	37	21	Netherlands	5
9	Singapore	34	22	Spain	5
10	Brazil	26	23	Qatar	5
11	Philippines	22	24	Saudi Arabia	5
12	Indonesia	17	25	Egypt	4
13	Russia	16	26	Others	27
Total			2056		

Source: Jeong *et al.*, A Comparative Study on the Developing Trends and Characteristics of High-rise Housing of Cities World Wide, 2005

*Contact Author: Sanghyo Lee, Ph.D. Candidate, Department of Sustainable Architectural Engineering, Hanyang University, Haengdang-dong 17, Sungdong-gu, Seoul, 133-791 Korea
Tel: +82-2-2220-0307 Fax: +82-2-2296-1583
E-mail: siegfried_sun@hotmail.com
(Received April 8, 2009 ; accepted February 1, 2010)

residential buildings. However, there has been virtually no research analyzing the intrinsic value of the landmark characteristics of super high-rise residential buildings.

Accordingly, the objective of this study is to analyze the influence of landmark factors on the price of super high-rise residential buildings by using the hedonic pricing model. In this study, landmark factors that can be gauged quantitatively are derived and then applied to analyzing the intrinsic value of landmark characteristics for super high-rise residential buildings in Seoul. Also, this study might contribute to comprehending the high prices of super high-rise residential buildings, and suggest reasonable prices for constructing such buildings.

Table 2. Cumulative Number of Super High-rise Residential Buildings in Major Cities

No	City	Qty	No	City	Qty
1	Hong Kong	920	11	Honolulu	28
2	Dubai	112	12	Toronto	27
3	New York	107	13	Shanghai	18
4	Chicago	90	14	Shaza	17
5	Miami	61	15	Jakarta	17
6	Seoul	44	16	Melbourne	17
7	Tokyo	40	17	Moscow	16
8	Bangkok	36	18	Sunny Isle Beach	16
9	Singapore	34	19	Las Vegas	15
10	Busan	30	Others (122 cities)		411
Total			1645		

Source: Jeong *et al.*, A Comparative Study on the Developing Trends and Characteristics of High-rise Housing of Cities World Wide, 2005

1.2 Scope and Contents of the Study

Table 2. ranks the major cities around the world in terms of the number of super high-rise residential buildings constructed.

According to the table, because super high-rise residential buildings are constructed often enough in Seoul for it to be ranked 6th, it is considered to be easy to obtain enough cases to analyze.

A super high-rise building is defined differently in different countries, depending on the economy and architectural technology level of each country. In Korea it is defined as a building taller than thirty or forty stories. In particular, Lee e*t al.* (2004) discovered, through an analysis of super high-rise residential buildings based on facility information management systems, that buildings taller than thirty stories hardly exist outside Seoul and other major cities in Korea, but that there are more than 8,000 buildings that are between twenty-one and thirty stories high throughout the country. Based on this information, a super high-rise residential building is defined in this study as a building taller than thirty stories. In this study, landmark factors were extracted through a literature review. Additionally, the hedonic pricing model was applied and a multiple regression analysis was conducted after collecting quantitative data on the extracted landmark factors. Through a multiple regression analysis, which was performed by a linear regression model and a semi-log regression, the price variation upon fluctuation of the factors is estimated.

2. Hedonic Pricing Method

The hedonic pricing method breaks down the market price of a certain commodity according to the characteristics that define it, thus enabling the monetary value of each characteristic to be calculated by observing the differences in the market price among commodities sharing the same attributes (Morancho, 2003). This method is used for estimating the resource value of non-marketed goods, along with the travel cost method, contingent valuation method, multi-attribute utility theory, etc. Among these methods the hedonic pricing model has been studied substantially over the course of many years, thereby developing into a precise and elaborate method for gauging the values of characteristics comprising prices of residential property.

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

Y = Price
α = Constant term
β = Coefficient representing building characteristics
X = Attribute of property
ε = Error term

The fundamental proposition of the hedonic pricing method is that a residential property comprises a complex bundle of goods with multiple characteristics, each of which contributes to its selling price (Jim and Chen, 2006).

In the hedonic pricing model, multiple regression analysis is performed by setting the price as the dependent variable and the various characteristics of a building as independent variables.

3. Definition of the Landmark Factor

Prior studies have typically focused on examining landmark factors through surveys.

Appleyard (1969) classified landmark factors into form, visibility, and significance. Variables related to form are defined as movement, contour, size, shape, surface, quality, and sign; while variables related to visibility are defined as viewpoint intensity, viewpoint significance, and immediacy; and finally, variables connected to significance are defined as use intensity, use singularity, and symbolism. Appleyard (1969) analyzed the correlation between landmarks and these variables through a survey about these factors.

Lee *et al.* (1984) classified landmark factors into physical variables, non-physical variables, and individual characteristic variables.

The physical variables were defined as size, visible distance, locality, crowdedness, and historical aspect. The non-physical variables were defined as architectural form, advertisement function, and symbolism. The individual characteristic variables were defined as employment availability and visit experiences. Lee *et al.* (1984) analyzed the correlation between landmark recognition and landmark factors in Seoul by using these factors.

These studies are quite significant, as the construction market for super high-rise residential buildings intended to become landmarks of cities is rapidly expanding.

Referring to the abovementioned studies, landmark can be defined as "perceivable property" that results from relative differences between a target building and the surrounding buildings. For example, if several buildings of the same height and space were bunched together, it would be hard to single out one of them as a "landmark." In other words, landmark property can be acknowledged when a target building stands out among the surrounding buildings in terms of area and height so that people can easily recognize the building. This also applies to other landmark factors such as shape and sign that have been examined in previous studies. In this research, landmark is interpreted as a relative property, and the influence of landmark factors on value of super high-rise residential buildings is quantitatively analyzed.

This study defines factors related to size such as the height and area of buildings that may be represented quantitatively as landmark factors, considering the weaknesses of prior studies. This is because factors such as design and external form that were employed by Appleyard (1969) and Lee *et al.* (1984) cannot be represented quantitatively, and visit experiences and employment availability have to rely on surveys, making it difficult to quantify the data.

In this study, landmark variables are suggested concerning the aspect of size as follows. Results from a study by Appleyard (1969) show that relativity is important to landmark factors.

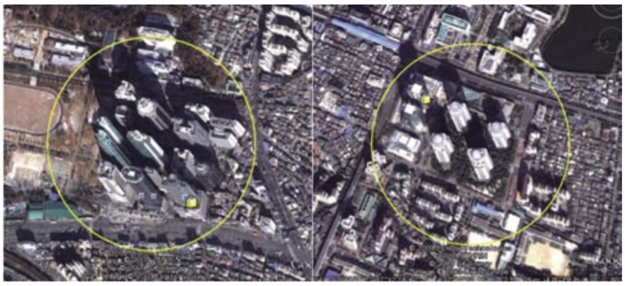
In other words, the landmark attribute is not determined by the absolute size of a building itself, such as height and area, but by its relative size to that of neighboring buildings.

(a) (b)

Fig.1. Concept of Relative Height

Fig.1. demonstrates that a high-rise building in picture (b) has greater perceptive capacity and higher "landmark level" compared to the building in picture (a) due to its height difference with surrounding buildings.

In Fig.2., buildings of the same area are bunched together in picture (c), while the target building has relatively greater area than surrounding buildings in picture (d), thus increasing its perceptive capacity and landmark level.



(a) (b)

Fig.2. Concept of Relative Area

Accordingly, in this study, relative height and area are defined as landmark variables for analyzing the influence of landmark factors on the price of super high-rise residential buildings.

Relative height and area share many common qualities with other elements that were examined in earlier studies. In particular, viewing ability is very similar to landmark factors that are specified in this study, as it is affected by the relative scale difference between a target building and its surrounding buildings. However, the existing literature on viewing ability reveals that in most cases, viewing ability was considered in a comprehensive manner in its relation to the surrounding landscape elements such as a park, river, or mountain (Jim and Chen, 2006; Morancho, 2003; Lange and Schaeffer, 2001). Thus, this study can be distinguished from others in the sense that the relative characteristics of landmark factors alone can influence the value of residential buildings, regardless of surrounding elements.

4. Empirical Models

4.1 Sample areas and data

In this study, research was conducted by targeting thirty super high-rise residential buildings containing a total of 3,600 units located within eleven administrative districts of Seoul.

Fig.3. shows the distribution of the selected buildings, revealing that they are quite concentrated in the areas south of the Han River. In Seoul, rapid urbanization has resulted in planar expansion and also in the relocations of various functions, causing the area to the south of the Han River to become more desirable than the area to the north of the river.

This has resulted in higher residential property values in the south, reflecting the fact that residents

Table 3. Sample Building List

No	Building	Height (m)	GFA (m^2)	No	Building	Height (m)	GFA (m^2)
1	Tower Palace III	262.82	223,538	16	Nasan Sweet	132.90	84,165
2	Hyundai Hyperion	250.73	387,632	17	The# Star River	128.10	76,449
3	Tower Palace I	211.50	457,999	18	Trump World II	127.20	68,423
4	The# Star City	192.40	418,415	19	Hyundai Parkvill	126.15	46,653
5	Tower Palace II	184.65	296,652	20	Lotte Castle Empire	126.00	129,489
6	Academy Sweet	169.70	102,379	21	Samsung Shervill	125.20	112,140
7	Daerim Acrovill	163.00	202,983	22	AcroRiver	123.32	64,879
8	Boramae Shervill	125.20	76,593	23	9th Avenue	122.38	80,254
9	Hyundai Supervill	150.60	226,180	24	AcroVista	119.63	258,338
10	Brown Stone Seoul	150.40	75,078	25	Lotte Gwanak Tower	118.44	60,188
11	Galleria Palace	149.40	265,698	26	Lotte Castle Ivy	112.25	140,423
12	Lotte Castle Gold	148.35	242,282	27	Hanwha Obelisk	109.85	120,054
13	Richensia	145.30	86,880	28	Twinvill	107.06	96,516
14	Academy Tower	141.90	81,848	29	Hyundai Tower	106.55	30,808
15	Trump World I	132.90	78,667	30	Trump World III	100.00	52,965

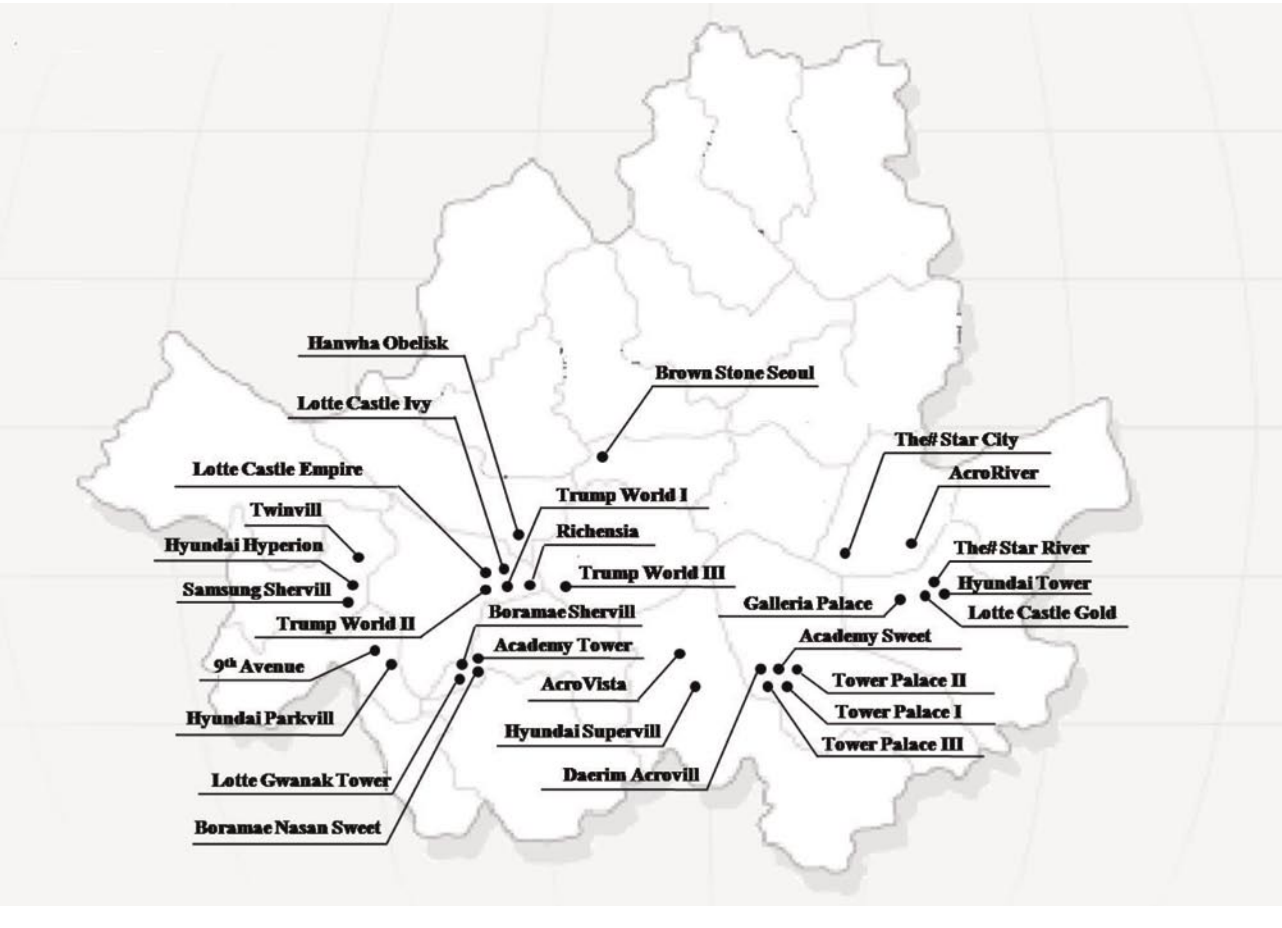


Fig.3. Location of Sample Buildings

in the south have higher average incomes than their northern counterparts. In the end, super high-rise residential buildings, which represent a high-end living environment, saw more demand in the south, resulting in the consequent concentration of super high-rise residential buildings there.

4.2 Selection of model variable

In this study, price per m^2 (P) was used as the dependent variable, and housing unit attributes, building attributes, location attributes and landmark attributes were used as independent variables.

First, housing unit story (H_1), housing unit space (H_2), the number of rooms (H_3), and the number of bathrooms (H_4) were defined as housing unit attributes. Additionally, the building height (B_1), the gross building space (B_2), years since building completion (B_3), the number of housing units (B_4), and the number of parking spaces (B_5) were defined as building attributes.

Building height (B_1) refers to the height of the tallest building in the complex; gross building space (B_2) and the number of housing units (B_4) were calculated by summing up all the space and housing units of each complex. By utilizing these, the physical volume of each complex was identified. Furthermore, to identify the depreciation expense, the years since building completion (B_3) were used, and to examine the convenience of parking as complex characteristic variables, the number of parking spaces (B_5) was used. To indentify the convenience of transportation as a location attribute, the distance to the nearest subway station (D_1) was used, while the distance to the nearest major shopping district (D_2), distance to the nearest green area (D_3), and distance to the central business district (D_4) were used to identify the spatial proximity to key areas.

The landmark factors of relative height (L_1) and relative space (L_2) were used as landmark attributes. First, the relative height was calculated as the difference in height between the analyzed building and the average height of neighboring buildings within a 200 m radius.

$$H_r = H_a - E(H_c)$$

H_r = Relative height
H_a = Height of analyzed building
H_c = Average height of comparative buildings within a 200 m radius

Relative area was defined as the difference between the building area of the analyzed building and the average building area of neighboring buildings within a 200 m radius.

$$A_r = A_a - E(A_c)$$

A_r = Relative area
A_a = Building area of analyzed building
A_c = Average building area of comparative buildings within a 200 m radius

Detailed data for each variable was collected through on-site investigation, GIS (Geographic Information System), real estate portal sites, and the building references.

4.3 Analyzing the hedonic pricing models

In this study, the hedonic model was used to determine, by analyzing the intrinsic value of the landmark attribute, that is, whether landmark factor is a statistically significant variable.

In this study, a linear regression model and a semi-log regression model were first set up.

The estimated equations are expressed as follows:

Linear regression model:

$$P = \alpha + \sum_{i=1}^{n} \beta_i X_i + \sum_{k=1}^{t} \tau_k \theta_k + \varepsilon$$

Semi-log regression model:

$$\ln P = \alpha + \sum_{i=1}^{n} \beta_i X_i + \sum_{k=1}^{t} \tau_k \theta_k + \varepsilon$$

P = Price per m^2
α = Constant term
β_i = Coefficient representing housing unit attributes, building attributes, location attributes
X_i = Housing unit attributes, building attributes, location attributes of property
τ_k = Coefficient representing landmark attributes
θ_k = Landmark attributes of property
ε = Error term

α is a constant, β_i is the coefficient representing housing unit attributes, building attributes, and location attributes, and τ_k is the coefficient representing landmark attributes.

To determine the correlation between the variables used for the hedonic pricing model, a correlation analysis was performed and the results are as shown in

Table 4. Definition of Variables Related to the Quality of Housing Units

Attributes category		Variable	Units	Description of variables
Dependent variable	Price	P	KRW (10,000 / m^2)	Transaction price of property
Independent variables	Housing unit attributes	H_1	story	Height of the housing unit
		H_2	m^2	Floor area of the housing unit
		H_3	Num	Number of rooms
		H_4	Num	Number of bathrooms
	Building attributes	B_1	m	Height of the tallest building in the complex
		B_2	m^2	Gross space of the tallest building in the complex
		B_3	year	Years since building completion
		B_4	units	Number of housing units in the complex
		B_5	Spaces/complex	Number of car spaces in garage
	Location attributes	D_1	m	Distance to the nearest subway station
		D_2	m	Distance to the nearest major shopping district
		D_3	m	Distance to the nearest green area
		D_4	m	Distance to the central business district
	Landmark attributes	L_1	m	Difference in height between the analyzed building and the average height of neighboring buildings within a 200 m radius
		L_2	m^2	Difference between the building area of the analyzed building and the average building area of neighboring buildings within a 200 m radius

Table 5.

As shown in Table 5., relative height (L_1) and relative area (L_2) had a positive correlation with price per m^2 (P). Relative height (L_1) was also shown to have a high correlation with height (B_1), and there were other cases of high correlations between variables as well.

This indicates that there is the potential for multicollinearity.

To precisely identify the multicollinearity, the tolerance and Variance Inflation Factor (VIF) are generally utilized, and in this paper, multicollinearity was checked by using tolerance. Generally, when the tolerance is less than 0.1, it is assumed that there is multicollinearity. However, as shown in Table 6. (the linear regression model), the tolerance was less than 0.1 with 0.096 of height (B_1), 0.044 of the gross building space (B_2), and 0.082 of the number of housing units. The semi-log regression model yielded the same results. Examining the variables that caused the multicollinearity from Table 5., it can be seen that there is a high correlation between those that caused multicollinearity. In other words, when excluding one variable among those that caused multicollinearity, it is possible that the remaining variables would not cause multicollinearity. Therefore, rather than simply excluding all the variables that caused multicollinearity, the model's capability of explaining the price of super high-rise residential buildings is raised by allowing as many variables as possible to remain in the model and then eliminating the variables one by one according to their degree of multicollinearity.

Accordingly, in this paper, the previous hedonic pricing model was adjusted by excluding the variables of height (B_1) and gross building space (B_2) which caused significant multicollinearity. As shown in Table 9., the adjusted R^2 of the adjusted linear regression

Table 6. Price Determinants (Linear Regression Model)

Variable	Coefficient	t-ratio	p-value	Tolerance
C	-482.423	-15.912	0.000	
H_1	1.398	7.023	0.000	0.680
H_2	1.392	14.145	0.000	0.202
H_3	20.184	4.406	0.000	0.218
H_4	15.276	2.092	0.036	0.388
B_1	3.239	25.170	0.000	0.096
B_2	0.001	7.129	0.000	0.044
B_3	1.987	1.142	0.254	0.571
B_4	-0.083	-3.847	0.000	0.082
B_5	129.014	24.729	0.000	0.451
D_1	0.082	6.890	0.000	0.549
D_2	0.053	8.777	0.000	0.213
D_3	0.041	14.166	0.000	0.294
D_4	-0.020	-7.406	0.000	0.300
L_1	-2.178	-15.500	0.000	0.121
L2	0.040	23.331	0.000	0.261

R^2 = 0.789 Adjusted R^2 = 0.789 F-ratio = 895.824 N=3600

Table 7. Price Determinants (Semi-log Regression Model)

Variable	Coefficient	t-ratio	p-value	Tolerance
C	5.135	138.544	0.000	
H_1	0.001	4.191	0.000	0.680
H_2	0.001	11.256	0.000	0.202
H_3	0.036	6.467	0.000	0.218
H_4	0.013	1.503	0.133	0.388
B_1	0.003	21.315	0.000	0.096
B_2	1.104E-06	12.027	0.000	0.044
B_3	-0.008	-3.741	0.000	0.571
B_4	2.500E-04	-9.451	0.000	0.082
B_5	0.202	31.611	0.000	0.451
D_1	1.811E-04	12.401	0.000	0.549
D_2	6.069E-05	8.200	0.000	0.213
D_3	3.859E-05	10.979	0.000	0.294
D_4	-3.723E-05	-11.512	0.000	0.300
L_1	-0.002	-13.965	0.000	0.121
L2	5.151E-05	24.463	0.000	0.261

R^2 = 0.815 Adjusted R^2 = 0.814 F-ratio = 1053.097 N=3600

Table 5. Correlation Coefficients between Building Attributes

	P	H_1	H_2	H_3	H_4	B_1	B_2	B_3	B_4	B_5	D_1	D_2	D_3	D_4	L_1	L2
P	1.000	0.355	0.551	0.486	0.410	0.557	0.666	0.174	0.461	0.698	-0.050	-0.409	-0.408	-0.038	0.248	0.399
H_1	0.355	1.000	0.273	0.269	0.250	0.497	0.337	0.143	0.129	0.216	-0.041	-0.243	-0.316	0.006	0.388	-0.042
H_2	0.551	0.273	1.000	0.811	0.727	0.249	0.236	0.078	-0.091	0.456	0.249	-0.374	-0.457	0.109	0.186	0.177
H_3	0.486	0.269	0.811	1.000	0.636	0.365	0.321	0.188	0.002	0.395	0.312	-0.432	-0.492	0.108	0.261	-0.005
H_4	0.410	0.250	0.727	0.636	1.000	0.138	0.142	-0.027	-0.061	0.287	0.238	-0.219	-0.437	-0.035	0.051	0.152
B_1	0.557	0.497	0.249	0.365	0.138	1.000	0.721	0.243	0.304	0.530	-0.142	-0.580	-0.594	0.081	0.783	-0.025
B_2	0.666	0.337	0.236	0.321	0.142	0.721	1.000	0.190	0.761	0.509	-0.262	-0.584	-0.382	0.161	0.515	0.441
B_3	0.174	0.143	0.078	0.188	-0.027	0.243	0.190	1.000	0.149	0.167	0.203	-0.031	-0.163	-0.190	-0.008	-0.320
B_4	0.461	0.129	-0.091	0.002	-0.061	0.304	0.761	0.149	1.000	0.258	-0.261	-0.136	0.038	-0.141	0.003	0.379
B_5	0.698	0.216	0.456	0.395	0.287	0.530	0.509	0.167	0.258	1.000	-0.128	-0.483	-0.514	0.041	0.239	0.245
D_1	-0.050	-0.041	0.249	0.312	0.238	-0.142	-0.262	0.203	-0.261	-0.128	1.000	0.295	-0.081	-0.315	-0.082	-0.373
D_2	-0.409	-0.243	-0.374	-0.432	-0.219	-0.580	-0.584	-0.031	-0.136	-0.483	0.295	1.000	0.461	-0.629	-0.547	-0.399
D_3	-0.408	-0.316	-0.457	-0.492	-0.437	-0.594	-0.382	-0.163	0.038	-0.514	-0.081	0.461	1.000	0.031	-0.349	0.037
D_4	-0.038	0.006	0.109	0.108	-0.035	0.081	0.161	-0.190	-0.141	0.041	-0.315	-0.629	0.031	1.000	0.357	0.415
L_1	0.248	0.388	0.186	0.261	0.051	0.783	0.515	-0.008	0.003	0.239	-0.082	-0.547	-0.349	0.357	1.000	0.003
L2	0.399	-0.042	0.177	-0.005	0.152	-0.025	0.441	-0.320	0.379	0.245	-0.373	-0.399	0.037	0.415	0.003	1.000

Table 8. Tolerance Fluctuation According to the Exclusion of Variables Causing Multicollinearity

	1st	2nd	3rd
Height (B_1)	0.096		
Gross building space (B_2)	0.044	0.097	
Number of housing units (B_4)	0.082	0.386	0.484

Table 9. Price Determinants after Eliminating Collinear Regressors (Linear Regression Model)

Variable	Coefficient	t-ratio	p-value	Tolerance
C	-270.460	-9.338	0.000	
H_1	2.471	11.614	0.000	0.717
H_2	1.290	12.001	0.000	0.203
H_3	30.580	6.171	0.000	0.225
H_4	3.429	0.430	0.668	0.391
B_3	15.499	8.955	0.000	0.696
B_4	0.171	17.491	0.000	0.484
B_5	173.207	31.952	0.000	0.503
D_1	0.008	0.643	0.520	0.580
D_2	0.010	1.632	0.103	0.229
D_3	0.004	1.405	0.160	0.450
D_4	-0.038	-13.831	0.000	0.327
L_1	0.870	11.890	0.000	0.540
L2	0.036	22.756	0.000	0.365

R^2 = 0.746 Adjusted R^2 = 0.745 F-ratio = 811.519 N=3600

model is 0.745.

Examining the p-value of each regressor, all the variables excluding the number of bathrooms (H_4), the distance to the nearest subway station (D_1), the distance to the nearest major shopping district (D_2), and the distance to the nearest green area (D_3) were shown to be statistically significant because their p-values were less than 0.05. The number of bathrooms variable (H_4) was shown to be statistically insignificant in the price determination of super high-rise residential buildings. In particular, the variables of distance to the nearest subway station (D_1), distance to the nearest major shopping district (D_2) distance to the nearest green area (D_3), which are generally assumed to greatly affect price determination, were shown to be statistically insignificant since the majority of super high-rise residential buildings are located in favorable areas. Examining the building price change according to the changes in the landmark attribute of relative height (L_1) yielded a positive regression coefficient, thus showing that the price per m^2 increased by ₩ 8,700 per each additional meter that the analyzed building's height is raised beyond the average height of neighboring buildings within a 200 m radius.

Additionally, the price was also shown to increase by ₩ 360 for each additional m^2 in the relative space (L_2) of the analyzed building over that of the average building space of neighboring buildings within a 200 m radius. As shown in Table 10., the adjusted R^2 of the adjusted semi-log regression model is 0.781. Examining the p-value of each regressor, the variables excluding number of bathrooms (H_4) and distance to the nearest major shopping district (D_2) were determined to be statistically significant since their p-values were less than 0.05. Examining the super high-rise residential building prices according to the change in landmark attribute of relative height (L_1) had a positive regression coefficient showing that the analyzed building's sale price per m^2 increased by 0.1% for each meter increase in the analyzed building's height above the comparison buildings within a 200 m radius. Additionally, the price was also shown to increase by 0.005% for each additional m^2 in relative space (L_2) of the analyzed building over that of the average building space of comparison buildings within a 200 m radius. In other words, it was discovered that the landmark attributes of relative height (L_1) and relative space (L_2) are statistically significant in the price determination of super high-rise residential buildings.

Table 10. Price determinants after Eliminating Collinear Regressors (Semi-log Regression Model)

Variable	Coefficient	t-ratio	p-value	Tolerance
C	-5.289	150.580	0.000	
H_1	0.002	8.102	0.000	0.717
H_2	0.001	9.955	0.000	0.203
H_3	0.053	8.747	0.000	0.225
H_4	-0.003	-0.318	0.750	0.391
B_3	0.011	5.282	0.000	0.696
B_4	0.000	13.282	0.000	0.484
B_5	0.249	37.897	0.000	0.503
D_1	9.550E-05	6.172	0.000	0.580
D_2	1.044E-05	1.344	0.179	0.229
D_3	-1.04E-05	-3.352	0.001	0.450
D_4	-5.65E-05	-16.762	0.000	0.327
L_1	0.001	15.955	0.000	0.540
L2	5.340E-05	27.545	0.000	0.365

R^2 = 0.781 Adjusted R^2 = 0.781 F-ratio =982.301 N=3600

5. Conclusion

The purpose of this study has been to analyze the influence of landmark factors on the price of super high-rise residential buildings. The level of influence has been analyzed by means of an hedonic pricing model. To do so, landmark factors were categorized based on prior studies, and relative height (L_1) and relative space (L_2) were defined in order to analyze the landmark factors in a quantitative manner. Based on this, by employing the hedonic pricing model, data was collected targeting thirty super high-rise buildings of over thirty stories tall, and containing over 3600 housing units, in eleven administrative districts of Seoul. Data was then analyzed according to a linear regression model and a semi-log regression model. As a result, the linear regression model showed that each additional meter of relative height (L_1) increased the sales price per m^2 by ₩ 8,700 and each additional 1

m^2 of relative space (L_2) increased the sales price per m^2 by ₩ 360. Additionally, the semi-log regression model showed that each additional meter of relative height (L_1) increased the sales price per m^2 by about 0.1%, and each additional 1 m^2 of relative space (L_2) increased the sales price per m^2 by about 0.005%. In other words, it was confirmed that landmark factors do indeed affect the super high-rise residential buildings' price determination. However, there were limitations, in that only the aspect of size was considered among various landmark factors. According to survey results of prior studies, even though the external design of a building can be a major landmark factor, it is relatively difficult to quantify this factor. In the future, more in-depth research should be performed in these regards in order to augment our understanding of quantifying landmark factors.

Acknowledgment

This research was supported by a grant (code No.06 Chumdan-eunghapE01) from Virtualmighty Program by the Ministry of Construction and Transportation of the Korean Government (MOEHRD) (R05-2004-000-10591-0) and the Sustainable Building Research Center of Hanyang University which was supported by the SRC/ERC program of MOST (R11-2005-056-03001)

References

1) Appleyard, D. (1969), Why Buildings are Known: A Predictive Tool for Architects and Planners, *Environment and Behavior*, 1 (2), pp.131-156.
2) Bae, J. I., An, B. G. and Kim, S. M. (2004), A Study on the Post Occupancy Evaluation of Super High-Rise Apartment, *Journal of Architectural Institute of Korea*, 20(9), pp.127-134.
3) Han, Y. T., Kang, B. S. and Kim, J. W. (2005), A Comparative Study on the Characteristics of Purchase between High-rise and Super-high-rise Apartments, *Journal of Architectural Institute of Korea*, 21(11), pp.155-162.
4) Helsley, R. W. and Strange W. C. (2008), A Game-theoretic Analysis of Skyscrapers, *Journal of Urban Economics*, 64, pp.49-64.
5) Jeong, C. Y., Kim, S. K., Kang, B. S. and Kim, J. W. (2005), A Comparative Study on the Developing Trends and Characteristics of High-rise Housing at World Wide Cities, *Journal of Architectural Institute of Korea*, 21(12), pp.193-200.
6) Jim, C. Y. and Chen, W. Y. (2006), Impacts of Urban Environmental Elements on Residential Housing Prices in Guangzhou (China), *Landscape and Urban Planning*, 78, 422-434.
7) Lange, E. and Schaeffer, P. V. (2001), A Comment on the Market Value of a Room with a View, *Landscape and Urban Planning*, 55, pp.113-120.
8) Lee, C. J., Kim, J. J. and Lee, Y. S. (2007), A Study on the Analysis of Planning and Management Factors of Finishing Works Using an Analytic Hierarchy Process, Korea *Journal of Construction Engineering and Management*, 8(1), pp.132-140.
9) Lee, G. Y. and Kim, Y. G. (1984), An Empirical Study on the Cognition of Landmarks and Associated Attributes in Seoul C.B.D., *Journal of Korea Planners Association*, 19 (2), pp.21-32.
10) Morancho, A. B. (2003), A Hedonic Valuation of Urban Green Areas, *Landscape and Urban Planning*, 66, pp.35-41.
11) Council on Tall Buildings and Urban Habitat (2008) Tall Buildings in Numbers., *CTBUH Journal*, 2, pp.40-41.