Economic Analysis of Korea Green Building Certification System in the Capital Area Using House-Values Index

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Abstract

Since 1980, there have been widespread efforts by international organizations, governments, and research centers to achieve sustainable development. In Korea, green building certification has been developed and adopted for various types of buildings. However, although research has been conducted regarding the economic benefits of the Korean green building certification system, no research efforts have compared the average house-values between green building certified and non-certified buildings. In addition, there is a lack of research concerning the impact of public transit on the average house-values in certified green buildings. The objective of this study is to investigate the economic benefits of green certified buildings using the average house-values index and to identify how proximity to public transit affects building values. According to the findings, house-values are higher for green certified buildings than for non-certified buildings. Furthermore, house values increase with proximity to bus stops. These results reflect the potential economic gain from a utilization of the Korean green building certification system (K-GBCS). In addition, by illustrating the economic benefits of the system, this study could encourage major stakeholders to use the K-GBCS.

Keywords: Korea green building certification; house-values; public transits; analysis of variance; regression analysis

1. Introduction

Since the end of the 1980's, efforts to achieve sustainable building development have been conducted by international organizations, governments, research centers, etc. Among the countries promoting sustainable development, the Building Research Establishment Environmental Assessment Methodology (BREEAM) in the UK and the Leadership in Energy and Environmental Design of the U.S. Green Building Council (LEED) have been widely adopted. In Korea, green building certification has been developed and adopted for various building types since the Korea Green Building Council (KGBC) was formed in 2002.

However, according to Kibert (2007), the green building certification system increases construction time and costs compared to uncertified construction, due to the various demands of the certification process to satisfy LEED criteria Thus, the public's perception of green certified buildings is that they are more expensive than traditional buildings. In this respect, various studies have focused on the economic benefits of the green building certification system.

In Korea, although several studies have addressed the economic benefits of the Korean Green Building Certification System (K-GBCS), there is no research comparing the average house-values between green building certified and non-certified buildings. In addition, no research has examined the impact of public transit on average house-values for both green certified and non-certified buildings. Therefore, the objectives of this study are to investigate the economic benefits of green certified buildings using the average house-values index for three years and to identify the impact of public transit on both green certified and non-certified buildings. As the population of interest, the Seoul and Gyeonggi provinces were selected since both regions have well-organized transportation systems and sufficient sample sizes.

If the average house-values of green certified buildings are greater than those for non-certified buildings, adopting a green certification system could produce long term economic benefits, despite the higher initial construction costs. In addition,

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by analyzing the importance of access to public transportation, this study can highlight the importance of access to public transportation, as a criterion for the green certification system.

2. Literature Review

2.1 Green Building Certification Systems

The growth of environmentalism has led to the emergence of environmental certification systems for buildings such as Green Star (Australia), LEED (USA), Energy Star (USA), Green Globes (USA), and BREEAM (UK). To qualify for these rating systems, economic benefits as well as their environmental contributions to the societies and future generations should be recognized in order to promote its wider adoptions and applications for the sake of sustainability.

However, the current studies of these green building certification systems have only focused on the environmental impact (Choi and Cho, 2014; Lee and Yeom, 2009). In order to achieve sustainable development, social, environmental, and economic improvement should be conducted together. Even though some researchers have investigated the impact of the green certification systems, the benefits are limited to the social and environment impacts (Lee and Yeom, 2012; Lee, 2007).

In the case of LEED only, in recent years, a few studies have started to investigate the economic impact of LEED for New Construction (LEED-NC) on land value (Park, 2009; Joshi, 2010; and Son, 2012). The results of the studies confirmed that there is a significant relationship between LEED-NC and land value. In this respect, this study has focused on the impact of the Korea green building certification system on the house-values of apartment buildings for identifying its economic benefits.

2.2 Korea Green Building Certification System

To encourage sustainable development in Korea's construction industry, the K-GBCS was started in 2002. K-GBCS is defined as a system which authorizes green building certification for buildings that contribute to saving operating energy, as well as reducing environmental pollutants across the life cycle of the building. Therefore, the K-GBCS aims to create sustainable development, including social, economic, and environmental development, similar to LEED and BREEAM.

Currently, the K-GBCS is being widely adopted by the Korean construction industry, and approximately 950 buildings have been certified since 2002. However, because the performance evaluation of the K-GBCS has only focused on energy savings, the economic effectiveness has not yet been sufficiently considered. In addition, the public's perception of K-GBCS is that it is not economically beneficial, despite several government incentives.

2.3 Previous Studies

Many researchers have investigated various factors that may be related to house-values. Researchers have examined the impact of land use, such as parks and wetlands, and views of water-covered areas on house-values (Lutzenhiser and Netusil, 2001; Schultz and King, 2001; Baranzini and Schaerer, 2011). In addition, researchers have focused on how proximity to public transit affects house-values (Cevero and Duncan, 2004; Landis *et al.*, 1995; Gatzlaff and Smith, 1993). Furthermore, some researchers have examined the economic impact of K-GBCS (Kang, 2008).

However, although several studies have been conducted regarding the economic benefits of K-GBCS, there is no research comparing the average house-values between green certified and non-certified buildings. In addition, no research has focused on the impact of proximity to public transit on average house-values for both types of buildings. Therefore, this study focused on the economic benefits of green certified buildings and the impact of public transit proximity.

3. Data Collection Methods

The six building types classified by K-GBCS are: apartments, complexes, accommodations, offices, stores, and schools (Fig.1.). Among these, apartments account for 35.1% of the total certified buildings. Twenty apartments were awarded the first grade and 330 were certified as second grade. This study focused on the green certified apartment buildings.

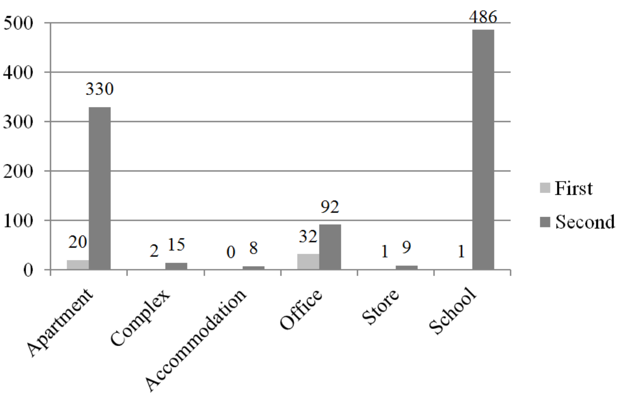
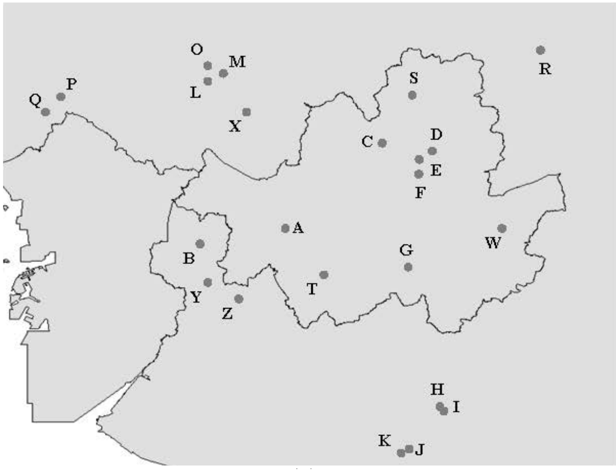


Fig.1. Green Certified Buildings in Korea

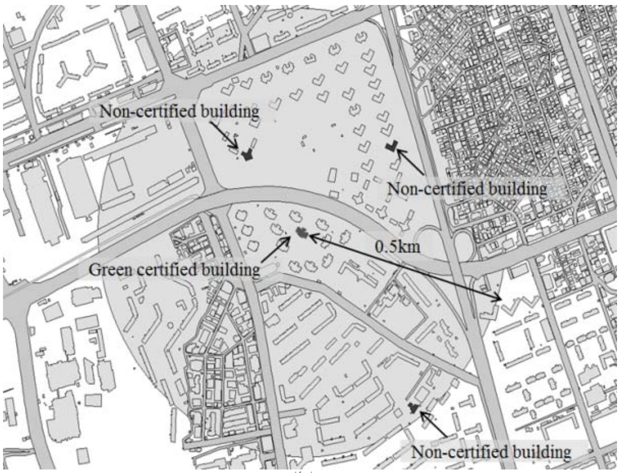
House-value is defined as a unit housing market price (₩/m^2) of the apartment buildings. By using the values, this study compared the average house-values between the green certified and non-certified buildings for three years.

The sampling process was as follows: first, out of all the green certified apartments, 238 apartments in Seoul and Gyeonggi province were selected. Second, to control for size and age, green certified apartments with an area of 85m^2 built in 2010 were selected. As shown in Fig.2.(a), 25 green certified apartments were selected in 25 regions and consisted of Green-Certified

Building Group (GCB) as a treatment group. Third, as shown in Fig.2.(b), three non-certified buildings with similar conditions and located within 0.5 km of each GCB were chosen. This Non-Certified Building Group (NCB) consisted of a control group. Fig.2.(a) represents the selected GCB and Fig.2.(b) shows the process for selecting the three NCB. Therefore, each region consisted of one GCB and three NCBs.



(a)



(b)

Fig.2. Selected 25 Regions (a) and NCB Sampling Process in Each Region (b)

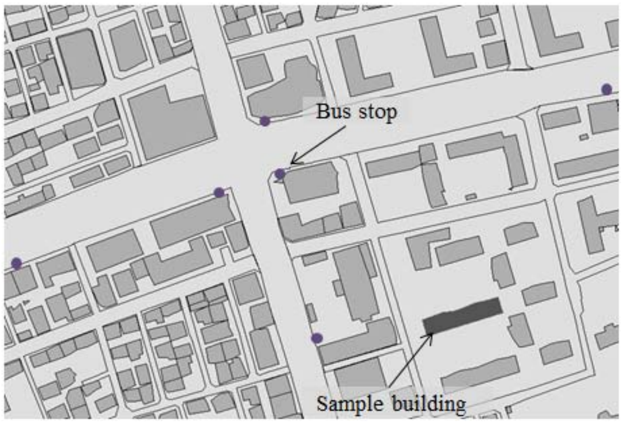
Since average house-values are affected by macroscopic variables, such as the population's level of education, the population density, and public transportation accessibility, the house-values for each region were analyzed separately. Therefore, after sampling, the Average House-values Index (AHI) was utilized in order to analyze the average house-values from 2010 to 2012.

$$\mathrm{AHI_{ij}} = \frac{\mathrm{HV_{ij}}}{\left\{\frac{1}{\mathrm{N}}\times\sum_{\mathrm{j=1}}^{4}\mathrm{HV_{ij}}\right\}} \qquad (1)$$

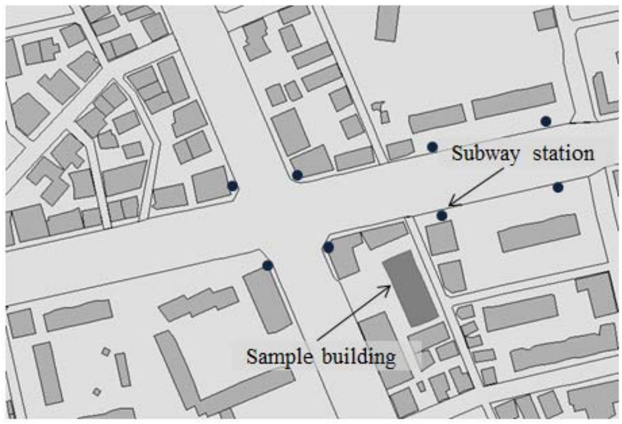
Where,
$i = i^{th}$ region, $j = j^{th}$ building,
AHI_{ij} = average house-values index of i^{th} region and j^{th} building
N = the number of samples in the i^{th} region,
HV_{ij}= house values of the i^{th} region and j^{th} building

The AHI is a relative index, taking into account the average of four samples in each region including GCB and NCB. Therefore, in the i^{th} region, the AHI of the j^{th} building can be estimated using Eq. (1). If the AHI of a building is higher than 1, it means that the value of the building is higher than the average of three nearby buildings. Otherwise, if the AHI is less than 1, it indicates that the value of the building is lower than the others.

In addition, to determine the accessibility of public transportation for GCB and NCB, the closest bus stop was mapped using GIS software, and this distance was recorded in the Fig.3.(a). The distance to the nearest subway station was recorded in the same way (Fig.3.(b)). Table 1. shows the physical characteristics and calculated house-values index for the sampled apartments. R, G, CY, AHI, B, and S mean a region, a group, construction year, average house-value index, the distance from sample centroid to closest bus (B) and subway (S), respectively.



(a)



(b)

Fig.3. The Estimation of the Distance from Sample Building to Bus Stop (a) and Subway Station (b)

Table 1. Collected Data: Construction Year, AHI, the Distance from Sample Centroid to Closest Bus and Subway

R	ID	G	CY	AHI	B (m)	A (m)	R	ID	G	CY	AHI	B (m)	S (m)
A	1	GCB	2010.01	1.113	206	913	M	51	NCB	2010.04	0.959	141	2,000
	2	NCB	2007.02	0.948	104	624		52	NCB	2010.06	0.988	165	2,010
	3	NCB	2008.04	0.953	119	246	N	53	GCB	2010.08	1.046	93	1,290
	4	NCB	2010.07	0.986	54	463		54	NCB	2009.09	0.870	202	577
B	5	GCB	2009.03	1.047	65	1,280		55	NCB	2010.06	1.066	244	2,190
	6	NCB	2009.01	0.970	122	500		56	NCB	2010.06	1.017	175	1,090
	7	NCB	2010.01	1.023	213	1,090	P	57	GCB	2010.08	1.058	145	1,475
	8	NCB	2008.06	0.959	84	1,090		58	NCB	2010.04	1.006	141	2,000
C	9	GCB	2010.04	1.376	91	104		59	NCB	2010.06	1.036	165	2,010
	10	NCB	2008.02	0.885	66	559		60	NCB	2009.09	0.900	202	577
	11	NCB	2010.03	0.821	176	450	Q	61	GCB	2010.07	1.031	189	1,191
	12	NCB	2009.11	0.918	206	204		62	NCB	2010.06	1.036	244	2,190
D	13	GCB	2010.08	1.199	213	324		63	NCB	2010.06	0.988	175	1,090
	14	NCB	2009.01	1.101	173	713		64	NCB	2010.04	0.945	141	2,000
	15	NCB	2008.04	0.850	53	710	R	65	GCB	2010.01	1.065	149	1,951
	16	NCB	2009.07	0.850	90	640		66	NCB	2010.06	1.001	165	2,010
E	17	GCB	2010.09	1.133	186	475		67	NCB	2009.09	0.869	202	577
	18	NCB	2010.06	1.073	196	652		68	NCB	2010.06	1.065	244	2,190
	19	NCB	2010.07	0.960	67	835	S	69	GCB	2010.08	1.047	175	3,392
	20	NCB	2008.01	0.834	50	561		70	NCB	2010.08	0.997	237	6,440
F	21	GCB	2010.06	1.073	46	305		71	NCB	2010.07	0.964	118	6,660
	22	NCB	2010.09	1.133	194	502		72	NCB	2009.11	0.992	207	6,220
	23	NCB	2010.07	0.960	67	835	T	73	GCB	2010.02	1.019	132	2,864
	24	NCB	2008.01	0.834	50	561		74	NCB	2010.08	0.982	237	6,440
G	25	GCB	2010.07	1.133	165	841		75	NCB	2010.07	0.985	118	6,660
	26	NCB	2010.09	0.960	194	502		76	NCB	2009.11	1.014	207	6,220
	27	NCB	2010.06	1.073	196	652	U	77	GCB	2010.08	1.011	76	3,075
	28	NCB	2008.01	0.834	50	561		78	NCB	2010.08	1.005	237	6,440
H	29	GCB	2010.01	1.150	137	141		79	NCB	2010.07	0.978	118	6,660
	30	NCB	2009.07	0.925	184	476		80	NCB	2009.11	1.006	207	6,220
	31	NCB	2009.03	1.066	165	173	V	81	GCB	2010.02	1.158	99	1,173
	32	NCB	2010.02	0.859	211	494		82	NCB	2009.07	0.975	96	1,560
I	33	GCB	2010.11	1.165	178	661		83	NCB	2010.05	0.988	73	931
	34	NCB	2008.02	0.819	84	964		84	NCB	2010.02	0.880	61	2,195
	35	NCB	2008.12	0.941	215	1,490	W	85	GCB	2010.02	1.127	211	1,184
	36	NCB	2010.08	1.075	108	290		86	NCB	2010.04	0.956	117	1,425
J	37	GCB	2010.02	1.135	123	221		87	NCB	2010.05	1.060	73	931
	38	NCB	2008.12	1.051	129	126		88	NCB	2010.02	0.857	61	2,195
	39	NCB	2009.03	1.037	106	225	X	89	GCB	2010.06	1.118	151	2,435
	40	NCB	2007.06	0.777	411	343		90	NCB	2010.05	0.863	98	945
K	41	GCB	2010.05	1.179	172	812		91	NCB	2009.11	1.003	188	642
	42	NCB	2007.09	0.877	88	615		92	NCB	2009.07	1.015	93	688
	43	NCB	2010.05	0.996	189	379	Y	93	GCB	2010.03	1.035	114	1,924
	44	NCB	2010.12	0.948	166	1,210		94	NCB	2010.02	1.036	84	6,912
L	45	GCB	2010.05	1.171	85	959		95	NCB	2009.07	1.025	238	7,521
	46	NCB	2010.12	0.941	166	1,210		96	NCB	2009.11	0.904	206	10,071
	47	NCB	2010.05	1.004	189	379	Z	97	GCB	2010.08	1.037	156	10,451
	48	NCB	2007.02	0.884	151	556		98	NCB	2010.12	0.934	104	6,923
M	49	GCB	2010.06	1.051	188	1,590		99	NCB	2009.05	0.996	144	8,075
	50	NCB	2010.06	1.003	175	1,090		100	NCB	2008.04	1.033	109	8,021

4. Data Analysis

4.1 ANOVA Test for GCB and NCB

Table 2. shows the descriptive statistics for both NCB and GCB. According to this descriptive analysis, the AHI for the GCB group was considerably higher than that for the NCB group. In addition, to analyze the data, the Cook's distance and the Leverage values must be determined. According to the standard residual, there were no outliers in either the NCB or the GCB group.

Table 2. Descriptive Statistics for the NCB and GCB Groups

	NCB	GCB
Mean	0.853	1.243
Standard Deviation	1.284	0.886
Min.	-2.62	-1.62
Max.	2.93	3.93

An analysis of variance (ANOVA) is used to test for differences among the means of two or more groups. In this study, an ANOVA test was used to determine if there were significant differences in the means of NCB and GCB. The following hypotheses were examined in this study.

$$H_0{:}\mu_{GCB} = \mu_{NCB}$$
$$H_1{:}\mu_{GCB} \neq \mu_{NCB}$$

Where

μ_{GCB}: AHI mean for Green certified building

μ_{NCB}: AHI mean for Non-certified building

The variance of the data to determine the statistical difference between two group means was analyzed using an F test to provide a p-value. With this p-value, the above hypotheses were tested for a decision. In the F test, if the between-group variability is larger than the within-group variability, H_0 could be rejected. In other words, the means of the two tested groups are statistically different. The F test results are as shown in Table 3. The p-value was 0.036. Therefore, the null hypothesis, that the means of the groups are the same, is rejected. Thus, there was a significant difference between the means of these groups.

Table 3. F-test Results

	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	6.512	1	6.512	4.529	0.036
Within Groups	140.927	98	1.438		
Total	147.439	99			

Even though the difference between the means of the groups was statistically significant, an F test was used to satisfy the following assumptions: Independence, Normality, and Equal Variance. In terms of independence, since the sample data were obtained from GIS sources, the data are not related to each other. Therefore, an observation does not provide any information associated with any other observations as shown in Table 3.

Table 4. Check for Standard Residual Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
Group	Statistics	DF	Sig.	Statistics	DF	Sig.
GCB	0.132	25	0.124	0.980	25	0.360
NGB	0.798	75	0.132	0.979	75	0.139

The check for normality of the residual is important since the ANOVA theory is based on this assumption. Therefore, if the residuals are not normally distributed, the results cannot be reasonably accepted. Table 4. represents the Kolmogorov-Smirnov and Shapiro-Wilk, which check the standard residual normality for GCB and NCB.

In general, the Kolmogorov-Smirnov is more valid than the Shapiro-Wilk when the samples number more than 50, while the Shapiro-Wilk is better than the Kolmogorov-Smirnov for a smaller number of samples. Since the sample size of NCB was 75, both methods are acceptable; however, for GCB, the Shapiro-Wilk should be used.

According to Table 4., the p-values were higher than 0.05, which means the null hypotheses (standard residuals are normally distributed) cannot be rejected. Furthermore, the Q-Q plot and histogram of the standardized residuals also showed that the residuals were normally distributed, as shown in Fig.4. (a) and (b). Therefore, the values and figures indicate that there was not a heteroscedasticity problem and confirmed the robustness of the data.

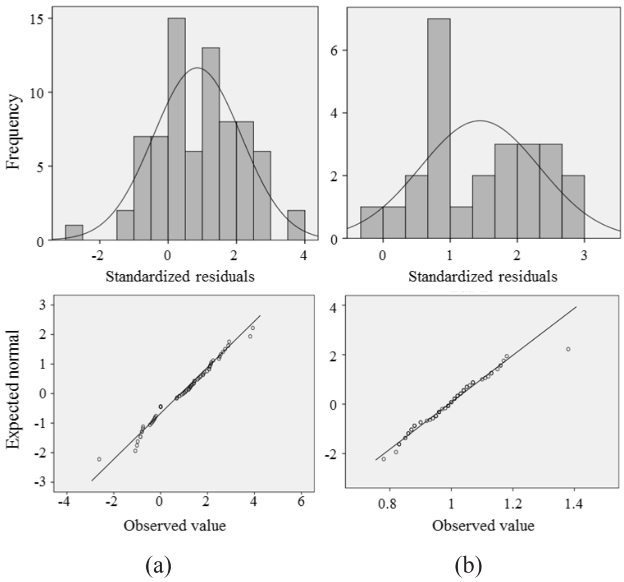


Fig.4. Histograms and Q-Q Plot of Standard Residuals for NCB (a) and GCB (b)

4.2 The Relationship between Public Transit and AHI

To investigate the economic impact of proximity to public transit, such as buses and subways on the AHI of GCB and NCB, the following hypotheses were tested.

1) There is a significant relationship between the distance to public transit and the average house-values index of both GCB and NCB.
2) The average house-values index increases as the distance to bus stops decreases.
3) The average house-values index increases as the distance to subway stations decreases.

In this study, a multiple linear regression analysis with one-way ANOVA was performed to determine the impact of proximity to public transit such as buses and subways on AHI. The following model was established.

$$\mathrm{AHI} = \beta_0 + \beta_1 \cdot G + \beta_2 \cdot B + \beta_3 \cdot S \quad (2)$$

Where,
AHI: average house-value index
G: 0, Green certified building, 1, Non-certified building
B: distance from sample centroid to the closest bus stop
S: distance from sample centroid to the closest subway station
β_0 = intercept, average house-value index when there are no bus stops and subway stations within 0.5km from sample centroid
β_1 = slope for G, β_2 = slope for B, β_3 = slope for S

Before proceeding to an interpretation of the regression model, it is necessary to determine if the residuals are normally distributed. Table 6. represents the check for the normality of the model. Kolmogorov-Smirnov and Shapiro-Wilk values confirmed that the residuals of the model were normally distributed since the p-value was higher than 0.05, as shown in Table 5.

Table 5. Check for Standard Residual Normality of the Developed Regression Model

Kolmogorov-Smirnov			Sharpiro-Wilk		
Statistics	DF	Sig.	Statistics	DF	Sig.
0.094	99	0.057	0.983	99	0.322

Furthermore, the Q-Q plot and histogram of the standardized residuals also showed that the model was normally distributed, as shown in Fig.5. (a) and (b). Therefore, there were no heteroscedasticity problems, and the robustness of the data was confirmed. In addition, the regression model was significant in testing the hypothesis.

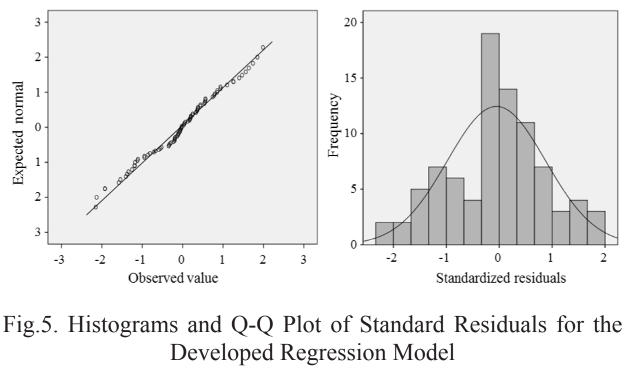


Fig.5. Histograms and Q-Q Plot of Standard Residuals for the Developed Regression Model

Table 6. shows the coefficients of the model. As a categorical variable, G represents the GCB and NCB buildings. When G is 0, it represents the GCB buildings, and when G is 1, it represents the NCB buildings. There are significant relationships between the intercept, G, the Bus variable, and the AHI (Table 6.). However, the Subway variable was not related to the AHI. In addition, there were no multi-collinearity problems for the model since the Variance Inflation Factor (VIF) ranged from 1.01 to 1.06 (Table 5.). The adjusted R-square of the model was 0.313, which suggests that the 31.3% variability in the AHI could be explained by these variables.

Table 6. Coefficient Results

Variable	B	Std. Error	t-value	p-value	VIF
(Constant)	0.894	0.026	34.572		
G	0.038	0.020	4.194	0.000	1.060
BUS	-0.071	0.035	-4.189	0.000	1.070
SUB	-0.038	0.020	1.889	0.371	1.010

*Dependent variable: AHI

Equations (3) and (4), based on the coefficients analyzed in this study were developed to investigate how the AHI is affected by proximity to public transit. Equation (3) represents the model for GCB, and Equation (4) shows the model for NCB. As shown in Equations (3) and (4), the following results were found.

β_1 = -0.071, slope for the distance to the nearest bus stop. This meant that as the distance to the nearest bus stop from the sample centroid increased, the AHI associated with that sample went down. This meant that if a parcel is located in close vicinity to a public transit bus stop, its AHI, (₩/m^2), will be more.

β_2 = -0.038, slope for the distance to the nearest subway station. This meant that as the distance to the nearest subway station from the sample centroid increased, the AHI associated with that sample went down. This meant that if a parcel is located in close vicinity to a public transit subway station, its AHI, (₩/m^2), will be more.

Therefore, for both GCB and NCB, there was a negative relationship between the AHI and proximity to a bus stop. This indicates that the AHI increases with proximity to a bus stop; however, there is not a significant relationship between the AHI and subway stations ($p>0.05$, Table 6.). In addition, according to Equations (3) and (4), the AHI_{GCB} value is higher than AHI_{NCB} due to the intercept. The ANOVA test results were verified in the model.

$$AHI_{GCB} = 0.932 - 0.071 \cdot B - 0.038 \cdot S \quad (3)$$

$$AHI_{NCB} = 0.894 - 0.071 \cdot B - 0.038 \cdot S \quad (4)$$

5. Conclusions

In this study, by investigating the average house-value difference from 2010 to 2012 between green certified buildings and non-certified buildings, it was confirmed that the house-values for green certified buildings were significantly higher than for non-certified buildings. In addition, there was a significant relationship between the average house-values of GCB and NCB and their proximity to bus stops, although distance to a subway stop did not significantly affect house values. Specifically, since the R-square value was 0.313, this model can be reasonably accurate in terms of showing the relationships between variables. Using the authors' model, one can conclude that the average house values index increases as the distance to bus stops decreases.

This study investigated the economic benefits of green certified buildings using average house values. These results may reflect the potential economic effectiveness in the actual economic effect of the K-GBCS. In addition, since the regression model confirmed that public transit accessibility is a significant factor affecting the house-values of GCB, it would be economically beneficial for K-GBCS to integrate this public accessibility criterion into its system. In addition, by demonstrating the economic benefits of GCB, this study could encourage major stakeholders to use K-GBCS.

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References

1) Baranzini, A. and Schaerer C. (2011) A sight for sore eyes: assessing the value of view and land use in the housing market. Journal of Housing Economics, 20(2011), pp.191-199.
2) BREEAM [Internet]. (2012) London: What is BREEAM?, 2010 [Updated 2010 Mar 2; cited 2012 Jun 11]. BRE Group; [1 screen]. Available from: http://www.breeam.org/about.jsp?id=66.html
3) Cervero, R. and Duncan, M. (2004) Land value impact of rail transit services in Los Angeles County. Report, National Association of Realtors Urban Land Institute, pp.123-124.
4) Choi, J. and Cho, T. (2014) Comparing perception concerning the importance of apartment complex components between consumers and housing providers, Journal of Asian Architecture and Building Engineering. 13(1), pp.109-116.
5) Gatzlaff, D. and Smith, M. (1993) The impact of the Miami metrorail on the value of residences near station locations. Land Economics, 69(1), pp.54-66.
6) Joshi B. (2009) Prediction of unit value of unimproved parcels of Harris County, Master's thesis, Texas A&M University, College Station, TX, USA.
7) Kang, Y. (2008) Modelling spatial variation of house value determinants. Journal Articles of the Korean Geographical Society, pp.907-921.
8) Kibert, C. J. (2004) Sustainable construction – green building design and delivery. 3rd edition. John Wiley & Sons, New York, USA.
9) Landis, J., Guhathakurta, S. and Zhang M. (1994) Capitalization of transit investments into single-family home prices. Working paper, University of California Transportation Center, p.38.
10) Lee, K. (2007) Sustainability Assessment and Development Direction of Super High-rise Residential Complexes from the Viewpoints of Residents, Journal of Asian Architecture and Building Engineering, 6(1), pp.127-134.
11) Lee, K. and Yeom, D. (2009) Comparative Research of Residents' Satisfaction Level between Green Building-Certified Apartment Complexes and General Apartment Complexes in Korea, Journal of Asian Architecture and Building Engineering, 8(2), pp.423-430.
12) Lee, K. and Yeom, D. (2012) Comparative research of residents' satisfaction level in KGBCC-Certified apartments in Korea, Journal of Asian Architecture and Building Engineering, 11(1), pp.55-62.
13) Lutzenhiser, M. and Netusil, N. (2001) The effect of open spaces on a home's sale price. Contemporary Economic Policy, 19(3), pp.291-298.
14) Park Y. (2009) Predicting the unit appraisal value of the unimproved and private land in the City of Houston by LEED sustainable site criteria. Dissertation, Texas A&M University, College Station, TX, USA.
15) Son K. (2012) Regression model predicting appraised unit value of land in San Francisco County from number of and distance to public transit stops using GIS, Dissertation, Texas A&M University, College Station, TX, USA.
16) Schultz, S. and King, D. (2001) The use of census data for hedonic price estimates of open-space amenities and land use. Journal of Real Estate Finance and Economics, 22(3), pp.239-252.
17) U.S. Green Building Council (USGBC). (2009) LEED-NC for new construction reference guide version 3.0. 1st edition. U.S Green Building Council, New York, USA.