Comparative Research of Residents' Satisfaction Level in KGBCC-Certified Apartments in Korea

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Abstract
The aim of the research is to compare KGBCC-certified apartments, to verify the effect of the certification, and to suggest directions for improvements in terms of residents' satisfaction levels. For this study, two apartments with KGBCC certification were selected, and a questionnaire concerning the awareness of the KGBCC, satisfaction level, and cause of dissatisfaction on KGBCC assessment indicators were carried out on the residents in question. Finally, a comparative study and analysis of the survey with the certification scores were conducted. Based on the synthetic analysis result, assessment indicators were arranged into four groups based on the average of the total satisfaction level and scoring rate, and the effect and directions concerning improvement to the KGBCC were found.

Keywords: Green Building Certification System; residents' satisfaction level; assessment standard; KGBCC

1. Introduction
1.1 Background and Aim of the Research
At a time when recognition of the international environmental crisis is becoming more serious, and after many attempts by the world's architectural sector to rectify the situation, the KGBCC (Korean Green Building Certification Criteria) was launched in the same way and has operated in Korea since 2002. However, there have not been enough studies in the last 7 years about the overall satisfaction level of residents in certified apartments, so the necessity of studies regarding the effect of certification and the improved direction for the certification system based on residents' opinions is becoming stronger.

With this background, the aim of the research is to compare KGBCC-certified apartments, to verify the effect of the certification, and to suggest improvements in terms of residents' satisfaction levels. For this study, two apartments with KGBCC certification were selected, and a questionnaire concerning awareness of the KGBCC, satisfaction level, and cause of dissatisfaction regarding KGBCC assessment indicators were taken by the residents in question. Finally, a comparative study and analysis of the survey with the certification scores were carried out, and the effect and directions of improvement to the KGBCC were found.

1.2 Methodology
A satisfaction level questionnaire concerning the assessment indicators of the KGBCC was conducted with residents selected from two certified apartments. The questionnaire responses ranged from 'very dissatisfied' (-3 points) to 'very satisfied' (3 points) on a 7-point scale, and if the respondents checked 'dissatisfied' (-3~-1), the cause of dissatisfaction was also surveyed. The survey data was analyzed with the data analysis program, 'SPSS statistics 17.0'. Correlation analysis was carried out on the satisfaction level by certification indicators, dissatisfaction response rate, and certification scoring rate (percentage of the achieved points per allotted points), and based on it, the mean, percentage, and t-test results by indicators were analyzed. Moreover, the effect and improvement directions were also verified.

2. Research Trends
Recent studies concerning KGBCC include 'The Introduction of the KGBCC and Present Condition' (Kim, 2007), 'The Present Condition and Means of Improvement to the KGBCC' (Jo, 2007), and 'The Present Condition of National and International Green Building Certification Systems' (Jo et al., 2007)', which studied the present condition and improvement direction of the KGBCC focused on the system. After that, there were studies that focused on making improvements to the system by case studies such as 'A Study on the Post Occupancy Evaluation of the Environment-Friendly Certification Apartment Complex in Korea' (Kang, 2006), 'A Study of Case Analysis on Green Building Certification Criteria for Advanced Methods' (Mo et al., 2008), 'Comparative Research of Residents' Satisfaction Level between Green Building-Certified Apartment Complexes and general Apartment Complexes in Korea' (Lee et al., 2009), 'The Research on the Improvement Direction of KGBCC by Residents' satisfaction Level in the KGBCC Certified Apartment' (Lee et al., 2009), and 'Comparative Analysis of Evaluation Items in Green Building Certification
in the Case of Apartment Housing' Kim et al., 2010). Additionally, there were also studies which focused on the improvement of assessment items such as 'A Comparative Study on the Assessment Items of Korea’s Apartment Building Certification Systems' (Jung et al., 2010) and 'A Study on the Luminous Environment Evaluation Factors of Green House Building Certification Systems for Apartment Houses' (Jung et al., 2009). Finally, there were research projects conducted on the economic effect of KGBCC certification which include the 'Impact of the Green Building Rating System on Apartment Housing Price' (Song et al., 2010) and 'A Basic study on the Cost Impact of Environment-friendly Residential Buildings' (Kim et al., 2010).

In this research report, POE was conducted on the residents of two KGBCC certified apartments who have lived in their apartments for at least one or more years. Additionally, more than former studies such as satisfaction level analysis and improvement direction, this study compared and analyzed certification scores, satisfaction levels, and the cause of dissatisfaction. It also presented detailed directions for improvement, so this research is quite valuable.

3. The Present Condition of the KGBCC

The KGBCC was introduced in 2001, and updated in 2006 and 2010. The background of the first update was that there were applicability problems because the certification standards were higher than the construction technologies at that time, and the excessive amount of assessment papers were also changed and simplified. Also, a remodeling item was added, and exclusion of some qualitative standards and adjustment of various items according to legal changes were accomplished. In the second update, categories were removed from the former system which consisted of 4 categories and 9 items, and 6 mandatory indicators (7 for apartments) were added. Additionally, a minimum rating system was presented to intensify the certification standard. Also, the certification class was subdivided from 'Excellent' and 'Good' to 4 classes: 'Excellent' (Above 74 points), 'Very Good' (Above 66 points), 'Good' (Above 58 points), and 'General' (Above 50 points), and the certification process was strengthened through adjustment of the certification achievement period, reduction of the certification period, and an increase in the number of judges.

From 2002 to December 2009, based on counting one if a certain building achieved both pre-certification and certification, 1,047 buildings achieved KGBCC pre-certification, and of these 466 (44.5%) were apartments. Certification was not active in the early period; however, the number of certification instances increased from 2004 and appeared to rapidly increase as 138 pre-certifications in 2006. For 2006, 3% of the construction fee was added as an incentive to sales prices for KGBCC-certified apartments followed by the new incentive policy, which accelerated the certification process. After 2008, as new construction projects decreased because of a construction slowdown, the number of pre-certifications also decreased. However, the number of certification achievements by existing pre-certification apartments increased steadily (Fig.2.).

A total of 19 indicators out of 44 which are suitable for surveying both apartments were used to determine the residents' satisfaction level. Also, for the dissatisfaction cause analysis, when respondents answered 'dissatisfaction' (-1~3), the reasons were surveyed through additional questions. To improve the understanding of the respondents, the technical terms on the questionnaire were translated into general terms.
5. Summary of the Research Cases

For the selection of the research cases, certified apartments with a high score were surveyed and analyzed, and G apartment in the Dongtan district, Hwasung and M apartment in the Samsan district, Incheon were chosen because both apartments are in the capital region and the residents had lived there for more than one year. The basic information of the research cases is shown in Tables 2. and 3., and the KGBCC certification indicators and scores are shown in Table 4.

Table 2. Apartment G

| Address | Site Plan |
|---------|-----------|
| 406,Block, Dongtan-Dong, Hwasung, Kangwoon-do | |
| Units | 577 |
| Site area (m²) | 56,455.00 |
| Building coverage rate | 13.1% |
| Floor Space Index (%) | 179.9% |
| Structure | B1 ~ 25F |
| Number of Building | 11 |
| Unit type (m²) | 110,411,157.42 |
| Heating System | District Heating |
| Housing Resources | Conservation |
| Moving-in Date | 2009.12 |

Table 3. Apartment M

| Address | Site Plan |
|---------|-----------|
| 1 Block, Samsan-dong, Bupyoung-gu, Incheon, Korea | |
| Units | 1,050 |
| Site area (m²) | 68,247 |
| Building coverage rate | 13.1% |
| Floor Space Index (%) | 179.9% |
| Structure | B1 ~ 20-25F |
| Number of Building | 14 |
| Unit type (m²) | 127,49, 175, 177, 178, 180, 181, 183, 185, 201, 87 |
| Heating System | District Heating |
| Housing Resources | Conservation |
| Moving-in Date | 2009.05 |

6. Analysis of Survey Results

6.1 General Information of the Respondents

A residents survey was carried out from 25 April to 31 May 2008 for M (Preliminary on 12 April 2008) and from 11 to 30 August 2009 for G (Preliminary on 1 August 2009), and except for those that were disqualified, 70(G) and 111(M) the questionnaires were analyzed.

The reliability of questionnaires was verified with Cronbach Alpha coefficient, and the result showed 0.87 for G and 0.85 for M which are very reliable.

The number of respondents was 52 (male) and 129 (female) which showed that female respondents are twice as many as male. The majority of the respondents were in their 40s (38.7%), 30s (37%), while the others were in their 20s (12.7%), 50s (9%), and over 60 (2.7%). Seventy three point six percent of the respondents were educated with more than an undergraduate degree, and 57.5% answered more than $4,000 income per month, which are high standards. Regarding the number of family members, 4 was the majority (63%), and 81.8% of the respondents owned their own home. Ninety five point five percent of the respondents were living in their apartments for more than one year which is long enough for POE (Post Occupancy Evaluation).

6.2 Residents' Understanding of the KGBCC

The analysis results concerning the awareness of the KGBCC were: G Aware: 67.1% and Unaware: 32.9% and M (Aware: 47.7% and Unaware: 51.4%), which shows that residents of G were more aware of the KGBCC. Regarding the awareness of KGBCC certification concerning residents’ apartments, most of the residents of G were aware of certification (Certified: 80%, Not-Certified: 20%) while almost half of the residents of M did not know about it (Certified: 46.8%, Not-Certified: 5.4%, Don't know: 46.8%). Ninety point nine percent of the respondents answered that the certification system is necessary, and many residents thought that it had a positive effect on real estate value (G: 62.8%, M: 83.8%). To the question whether certification was considered when choosing apartments, many respondents in both apartments answered it was considered (G: 44.3%, M: 42.3%). However, for M apartment, 42.3% of the respondents did not know whether their apartment was certified or not, which showed a difference in awareness regarding the certification process. To the question whether they will consider certification when they choose to move, 85.6% answered that they will consider, so the certification affects the choice of apartment.
6.3 Analysis Results

6.3.1 Total Satisfaction Level and Satisfaction Level by Categories

The total satisfaction level concerning KGBCC assessment indicators appeared as 1.1 for G and 0.7 for M, which determined that G apartment showed a significantly higher satisfaction level ($t = -7.666, p = 0.000$).

Regarding the correlation analysis between satisfaction level by category and scoring rate (Table 5.), the satisfaction level and dissatisfaction answer rate showed a negative correlation. However, the satisfaction level and scoring rate appeared to be barely correlated so that the effect of the certification score on residents' satisfaction level appeared to be minor.

Table 5. Correlation Analysis Result

| Assessment Indicator | G | M | G | M |
|----------------------|---|---|---|---|
| Correlation Coefficient | 0.084 | -0.860 | 0.105 | -0.121 |
| Significance | 0.000 | 0.000 | 0.009 | 0.062 |

Fig. 3. Satisfaction Level by Category

For the satisfaction level by categories (Fig. 3.), the satisfaction level regarding 'Ecological Environment' category showed the highest point as 1.46 for both apartments, which means that residents are satisfied with it. However, the scoring rate compared to allotted points appeared relatively low (G: 70.67%, M: 53.8%), which showed the opposite result for satisfaction level. This category includes the planning elements which residents easily come in contact with during daily living so that the satisfaction level appeared to be relatively high. Regarding the difference between apartments, 'Land Use and Transportation' category showed the biggest difference and 'Additional Category' also showed a big difference in the satisfaction level. Also, the 'Energy Resources and Environmental Load' category appeared to have a relatively low satisfaction level compared to the high scoring rate. Most of the assessment indicators of this category evaluate the installation of the planning elements only so that it easily achieved a higher score than other categories, which also needs to be improved.

6.3.2 Satisfaction Level by Assessment Indicators and Analysis on Cause of Dissatisfaction

The analysis result of the residents' satisfaction level concerning KGBCC assessment indicators showed that the satisfaction level of G is slightly higher than that of M (Fig. 4.). Especially, the satisfaction level concerning the 'Land Use and Transportation' category, assessment indicators related with environmental pollution in 'Energy Resources and Environmental Load' category and noise related assessment indicators in the 'Additional Category' showed a big difference. For the G apartment, the 'Establishment of Pedestrian Pathway' of 'Land Use and Transportation' (2.23) and 'Green Space Area Ratio' (2.16) of the 'Ecological Environment' category showed the highest satisfaction level, and for the M apartment, 'Green Space Area Ratio' appeared to be 1.94 as the highest satisfaction level, which determined the satisfaction level concerning the plan by 'Green Space Area Ratio' in KGBCC, which appeared to be high. However, the 'Sound Absorption Level of Floor' showed the lowest rating as 0.23 of G and -0.68 of M in both apartments, which means this assessment indicator needs to be upgraded. The specific analysis results concerning assessment indicators by category are as follows.

1) Land Use and Transportation

The analysis results by assessment indicators of the 'Land Use and Transportation' category are shown in Fig. 5. and Table 6.

As an analysis result, except for 'Installation of Bicycle Path and bicycle Parking Lot' which found no difference by t-test ($t = -0.626, p = 0.532$), satisfaction level concerning other indicators appeared to be higher in the G apartment. However, indicators that showed the same scoring rate, 'Distance to the Public transportation', 'Distance to the Local Center and City Center', and 'Establishment of Pedestrian Pathway', also showed a big difference in satisfaction level. These indicators are evaluated by physical distance and the installation of facilities. However, regarding the analysis result of dissatisfaction, a major cause of dissatisfaction appeared to be opposite to the evaluation contents of KGBC, so these need to be reflected in the final assessment standard. Also if the scoring rates are the same, the satisfaction level can appear to be different by the basic condition of location so that the indicators need to be more precise and evaluate in detail the actual contents of the plan and conditions of the site. For the 'Installation of Bicycle Path and Bicycle
Table 6. Cause of Dissatisfaction concerning Land Use and Transportation

Table 7. Cause of Dissatisfaction concerning Energy Resources and Environmental Load

Table 8. Satisfaction Level in Land Use and Transportation

Table 9. Satisfaction Level in Energy Resources and Environmental Road

2) Energy Resources and Environmental Load

The analysis results by assessment indicators of 'Energy Resources and Environmental Load' category are shown in Fig.6 and Table 7.

In the 'Energy Resources and Environmental Load' category, except for 'Separate Living Waste Collection for Recycling' and 'Food Waste Reduction', the other four indicators showed no significant differences. 'Design Plan for Life-Cycle Change' appeared to be the same in terms of satisfaction level in spite of the difference in scoring rates (G: 60% and M: 100%) so that indicators need to be upgraded and more specific to improve the satisfaction level. The cause of dissatisfaction appeared as 'Original plan is not well-matched with real life' (G: 75%) and 'Not easy to change' (M: 67%), which needs to be changed.

The two indicators related with environmental load showed a big difference, although it achieved the same score, it showed a different satisfaction level ('Food Waste Reduction', G: 0.81, M: 0.07), and satisfaction level of G with a low certification score that appeared to be even stronger ('Separate Living Waste Collection for Recycling', G: 1.26, M: 0.47), so qualitative improvements are necessary in terms of residents' overall satisfaction level. The major cause of dissatisfaction for both indicators was 'Not well-managed, so it is unsanitary', and the assessment standard count is for the installation of related facilities only. As for improvements, the indicators for evaluating the quality and a new indicator for maintenance and management need to be developed.

Fig.5. Satisfaction Level in Land Use and Transportation

Parking Lot', the scoring rate of both apartments are 100% while the satisfaction level appeared as 0.77 for G and 0.63 for M, which determined that the plan needs to be much stronger.

For the 'Establishment of Community Center or Facility Planning', it was analyzed that the difference of the planning area is reflected in the difference of the satisfaction level, and most of the respondents answered 'Not enough facilities and spaces' (G: 75%, M: 83%) so that quantities appeared to be the first thing to consider in future updates.

For 'Reduction Plan of Daily Water Use' and 'Reduction Plan for Daily Water Use' which achieved full marks, the satisfaction level was found to be the same by the t-test. To improve these, for 'Reduction Plan for Daily Water Use', 'Weak water pressure' (G: 80%) and 'Other– Not efficient enough, No installation, etc' (50%) were the major considerations so that the installation performance needed to be upgraded, and for 'Reduction Plan of Rainwater Load', 'Water absorption capability' was the majority for both G (63%) and M (50%), so the assessment standard needs to be intensified.

The 'Providing User Manual' achieved a full mark for both apartments while the satisfaction level appeared to be relatively low (G: 0.70, M: 0.48), so the planning contents need to be upgraded by elevating standards regarding the simplicity of manual contents (G: 67%) and convenience concerning storing and reading (M: 64%).

3) Ecological Environment

The analysis results by assessment indicators of the 'Ecological Environment' category are shown in Fig.7 and Table 8.

The 'Ecological Environment' category showed the highest satisfaction level of all in both apartments, especially 'Green Space Ratio' showed 2.16 for G and 1.94 for M which is the highest of all indicators, however, the scoring rate appeared to produce the opposite results, which are relatively low.

The 'Application of Artificial Green Space Plan for Life-Cycle Change' appeared to be the same in terms of satisfaction level in spite of the difference in scoring rates (G: 60% and M: 100%), so that indicators need to be 0.63 for G and 0.63 for M, which determined that the plan needs to be much stronger.

For the 'Establishment of Community Center or Facility Planning', it was analyzed that the difference of the planning area is reflected in the difference of the satisfaction level, and most of the respondents answered 'Not enough facilities and spaces' (G: 75%, M: 83%) so that quantities appeared to be the first thing to consider in future updates.

For 'Reduction Plan of Daily Water Use' and 'Reduction Plan for Daily Water Use' which achieved full marks, the satisfaction level was found to be the same by the t-test. To improve these, for 'Reduction Plan for Daily Water Use', 'Weak water pressure' (G: 80%) and 'Other– Not efficient enough, No installation, etc' (50%) were the major considerations so that the installation performance needed to be upgraded, and for 'Reduction Plan of Rainwater Load', 'Water absorption capability' was the majority for both G (63%) and M (50%), so the assessment standard needs to be intensified.

The 'Providing User Manual' achieved a full mark for both apartments while the satisfaction level appeared to be relatively low (G: 0.70, M: 0.48), so the planning contents need to be upgraded by elevating standards regarding the simplicity of manual contents (G: 67%) and convenience concerning storing and reading (M: 64%).
Ecological Environment' and 'Green Space Area Ratio' was analyzed as the same by the t-test. Both indicators showed a relatively high satisfaction level, more than 1 point (a little satisfaction), but a low scoring rate. The major cause of dissatisfaction was 'Not well-managed, so it is not clean' (G: 75%) and 'Not good looking' (M: 56%) for 'Application of Artificial Green Space Plan for Ecological Environment', and for 'Green Space Area Ratio', 'Insufficient green space' (G: 100%) and 'Monotonous green space' (M: 63%) which were expressed by some of the respondents. While both indicators are evaluated by distance and area ratio, dissatisfaction of residents focused on the contents of the plan, so new indicators to evaluate the quality of the plan need to be developed and applied.

For 'Aquatic Biotope Planning', the satisfaction level appeared to be different (G: 0.73, M: 1.25) in spite of the similar scoring rate so that indicators need to be more classified. The improvement directions were analyzed as strengthening the management (G: 55%, M: 35%) and establishment of actual habitat space (G: 30%, M: 39%), so adding a new standard to the present indicators to evaluate area and technique and development of an actual standard to derive a realistic plan for the habitation of living things are needed.

5.2 Green Space Area Ratio

The cause of dissatisfaction for 'Level of natural ventilation' category are shown in Fig.7. and Table 8. and for 'Green Space Area Ratio', 'Insufficient green space' (G: 100%) and 'Monotonous green space' (M: 63%) which were expressed by some of the respondents. While both indicators are evaluated by distance and area ratio, dissatisfaction of residents focused on the contents of the plan, so new indicators to evaluate the quality of the plan need to be developed and applied.

4) Indoor Environment

The analysis results by assessment indicators of 'Indoor Environment' category are shown in Fig.8, and Table 9.

The major cause of dissatisfaction for 'Level of natural ventilation plan' appeared to be 'Performance of ventilation facilities' (G: 86%, M: 67%) for both apartments, which means there are improvement points in the actual performance of ventilation facilities. The present certification standard consists of a 5 grade ranking system to evaluate, 1-3 grade for the installation of facilities and 4-5 grade for window area ratio. Therefore, other than just installation or area, indicators to evaluate actual ventilation performance are also required.

In the case of 'Installation of Thermostatic System', there were no differences between G and M (t=0.549, p=0.445) and it showed the satisfaction level as more than 'a little satisfaction (1 point)'. The Dissatisfaction answers were analyzed as 'Maintenance and Management Fee' (G: 72%, M: 62%), so this needs to be improved for the performance upgrade of thermostatic systems.

The 'Sound Absorption Level of Walls' showed relatively low satisfaction level (G: 0.6, M: 0.15) in the 'Indoor Environment' category, and it needs to elevate the quality of the plan by increasing standards and allotting points and adding certification indicators for performance evaluation.

Table 9. Cause of Dissatisfaction Concerning Ecological Environment

| The Cause of Dissatisfaction | G | M |
|-----------------------------|---|---|
| Additional Category         |   |   |
| Sound Absorption Level of Floor | 0.48 | 0.60 |
| Daylight Ratio              | 0.67 | 1.00 |
| 5.3 Sound Absorption Level of Walls | 0.61 | 0.55 |
| Installation of Thermostatic System | 0.67 | 0.67 |

As a result of analysis, the 'Sound Absorption Level of Floor' showed the lowest satisfaction level (G: 0.23, M: -0.68) of all the indicators for both apartments, so it urgently needs to be upgraded. The M apartment especially showed lower satisfaction level in spite of having a higher score than G, which is not effective in terms of residents' satisfaction level. The present standard divides floor impact sound into 'light impact sound' and 'heavy impact sound', and evaluates it separately. However, the major cause of dissatisfaction was pointed out as 'Noise from Upstairs' G: 77%, M: 82%), so active derivation of high quality by an elevation of standards and weightings are necessary.

'Daylight Ratio' showed both high satisfaction levels (G: 1.61, M: 1.44) and a high scoring rate which analyzed...
it is as running well, and 'Short Daylight Time in Winter' (G: 50%, M: 60%) were the majority of the dissatisfaction answers, so the decreasing of dissatisfaction elements by adjusting incentives needs to be considered.

7. Synthetic Analysis Result

The synthetic analysis result of assessment indicators were arranged by the average of total satisfaction level (0.91) and scoring rate (83.5%) as shown in Table 11.

The Group A are indicators that both the satisfaction level and scoring rate appeared to be more than average, which includes 4 common indicators, 'Establishment of Community Center or Facility Planning' for G, and 'Design Plan for Life Cycle Change' for M. These were analyzed as running efficiently in general, and for the improvement direction, the derivative of the gradual upgrade of planning contents are needed by incentive adjustment, indicator classification, and development of new indicators for detailed evaluation.

The indicators belong to the Group B that showed a higher score rating and lower satisfaction than the average which included 5 common indicators, 'AquatichBiotope Planning' for G, and 'Separate Living Waste Collection for Recycling' for M. These indicators, except for the 'AquatichBiotope Planning' for G, achieved 100% allotted scores; however, satisfaction levels appeared to be low. Generally, improvements of planning contents by the elevation of standards are necessary to increase the overall satisfaction level.

Group C includes the 'Sound Absorption Level of Walls' and 'Sound Absorption Level of Floor' as common indicators and 3 indicators for the M apartment. These indicators showed a lower satisfaction level and scoring rate than the average, so these are the first indicators to be considered for improvement. For upgrading directions, active planning derivations are needed by standard adjustment, increasing allotted points, and weighting, and especially 'Sound Absorption Level of Floor' requires quality improvement.

The indicators belong to Group D which shows a lower scoring rate and higher satisfaction level than the average, which includes 'Application of Artificial Green Space Plan' and 'Green Space Ratio' as common indicators, 4 indicators for G, and 'AquatichBiotope Planning' for M. This group was analyzed to require gradual planning quality upgrades by incentive adjustment or new grants, the development of new indicators to evaluate actual planning contents and performance, and lowering the adjustment of allotted points of some indicators.

8. Conclusions

The aim of the research is to determine the overall improvement direction in terms of resident's satisfaction level. For this study, two apartments with KGBCC certification were selected, and a questionnaire concerning the awareness of the KGBCC, satisfaction level, and cause of dissatisfaction on KGBCC assessment indicators were taken by the residents. Finally, a comparative study and analysis about the survey with the certification scores were carried out, and the effect and the directions of improvement to the KGBCC were found. The final conclusions of the study are as follows,

1) Fifty five point two percent of residents were aware of the KGBCC, and 59.7% knew about the certification of their apartment. Most of the respondents answered that the KGBCC is necessary, and it appeared that certification affects the choice of an apartment. Seventy five point six percent of respondents answered that KGBCC certification positively affects real estate value, and 85.6% answered that they will consider certification when they move to another apartment. As a result, it appeared that residents' awareness concerning KGBCC and its effects are positive.

2) As an analysis result of the total satisfaction level on assessment indicators from KGBCC, G was 1.11 and M 0.7 which are close to the 'A little satisfaction'. In analysis by category, the 'Ecological Environment' category showed the highest satisfaction level at 1.46; however the scoring rate appeared to be relatively low so that there are various improvement points. 'Land Use and Transportation' and 'Additional Category' showed big differences
of satisfaction level, and the 'Energy Resources and Environmental Load' category showed a high scoring rate but relatively low satisfaction level, so the adjustment of the assessment standard is necessary.

3) In the analysis results of satisfaction level by assessment indicators, 9 (G) and 7 (M) out of 19 indicators appeared to be higher than 'a little satisfaction', however, 'Satisfied' (2.0) appeared only in the G apartment for 'Establishment of Pedestrian Pathway' and 'Green Space Ratio', and the indicators approaching 'very satisfied' (3.0) did not appear at all. This indicates that certification standards and satisfaction levels need to be elevated. Also, in certification evaluation, most of the assessment standards evaluate the quantity such as area or the number of installations, so the developments of new indicators to assess the quality of the plan are required.

Additionally, in spite of two updates of KGBCC, it focused on the system, not on detail standards, so the detailed contents of the plan were not evaluated by the KGBCC. As a result, the difference of score was not coupled with the actual satisfaction level, and even indicators with the same assessment score showed a different satisfaction level. Therefore, major complements with adjustment of the detailed standard and addition of new indicators are necessary.

4) Based on the synthetic analysis result, the assessment indicators were arranged by the average of total satisfaction level and scoring rate, and the improvement directions were indicated.

The indicators in group A showed higher satisfaction level and scores than the average which have a positive affect on residents' satisfaction level. For improvement, gradual quality elevations on general planning contents are needed through classification and the new development of key indicators.

Group B contains indicators with a high score and low satisfaction that requires strengthening of the assessment standard to improve planning contents and satisfaction level. Also, in spite of the qualified quantities, the qualities of the planning contents are still low, which decreased satisfaction level. As a result, the additions of new indicators for quality evaluation are necessary.

Group C showed low on both the satisfaction level and related scores, which are the first parts to improve. Aggressive derivations of planning are needed for this group by expansion of the standard, allot points, and weighting, and especially for 'Sound Absorption Level of Floors', improvement of planning quality with adjustment of evaluation standards are strongly required.

Group D includes indicators which are of a higher satisfaction level and lower scores than the average. The satisfaction level appeared to be relatively high but absolute values are low, so there is a lot of room for improvement. As a result, it requires gradual quality upgrades by incentive adjustment or new grants, development of new indicators for planning contents and performance, and lowering adjustment of allotted points for some indicators.

The significance of this study is the verification of residents' understanding of the KGBCC, analyzing overall satisfaction levels, cause of dissatisfaction, and scores, and indicating the improvement directions of the KGBCC based on residents' survey. The research results can be used as the basis for improving the assessment indicators of apartments in the KGBCC. The limitation of this research report is that the subjects of the study were limited to only two apartments. Thus, substantial follow-up research is needed with multiple data analysis, and with these additional research results, further research regarding an improved model of KGBCC standards for apartments in Korea can be drawn up in the future.

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