

Article

# A Technical Assessment of Comfort Performance of *Hanok* Using Comparative Field Surveys between Experts and Users

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Received: 19 September 2020; Accepted: 9 December 2020; Published: 10 December 2020



**Abstract:** The paper aims to evaluate the psychological factors of the comfort performance of the *hanok*. This is to guide restoration and improvement in consideration of the intangible variables that provide the quality of the *hanok*. Through this process, we ultimately intend to build an integrated residential performance evaluation system that includes factors related to the quality of residents' lives, such as the comfort of their surrounding and indoor environment, as well as the functionality and convenience of the *hanok*, a representative type of Korean traditional architecture. The test method to evaluate the comfort performance of *hanok* is largely divided into the physical perception element, which is a quantitative indicator, and the psychological cognitive element, which is a qualitative indicator. Physical perceptive factors are composed of nine quantifiable factors that can be measured by numerical values, namely humidity control, condensation, insulation, thermal comfort, air permeability, solar radiation, solar lighting, sound insulation, and air cleanness. This is a perceptual concept of viewing a building as it is, and a quantitative evaluation method of measuring data in the field using environmental sensors and equipment. Psychological cognitive factors that are evaluated based on the experiences of users (residents) living in *hanok*, are classified into five categories, of scenery, beauty, deodorization, usability, and health. This study was conducted through a questionnaire between experts and users (residents), limited to the psychological factors among methods of evaluating the comfort performance of *hanok*. As a result, it can be seen that environmental factors are the main variables that influence the degree of satisfaction with the psychological perception factor. This might be a merit factor of general *hanok*, and weight could be given when creating an integrated standard in the future.

**Keywords:** Korean traditional architecture; *hanok*; architectural locality; Korean rural house; architectural evaluation; comfort performance; environmental monitoring

## 1. Introduction

The concept of cultural identity commonly refers to a feeling of belonging to a group in which there are a number of shared attributes, which might include, among other things, knowledge, beliefs, artefacts, arts, morals, and law. Ultimately, all culture is about the ascription of values and meanings to both tangible and intangible elements of human experience [1]. As globalization accelerates, preserving and maintaining a country's cultural identity is one of the important values, even today.

*Hanok* is a unique architectural type in Korea that retains its cultural identity, and is characterized by its wooden structure and traditional curved roof structure. Up until the 1940s, it was a popular building type; but during the modernization period, it drastically decreased in numbers [2]. As of 2016, it is estimated that there are only 210,000 *hanok* left nationwide, which account for just 2.8% of the

total building stock. Moreover, *hanok* located in the capital or metropolitan cities with particularly high population densities only accounts for 13.8% of the total *hanok* stock [3]. Therefore, for inhabitants of large cities, *hanok* is a special type of building that can be experienced only in specific locations. In this situation, preserving and disseminating *hanok* as a traditional cultural type is important, not only in terms of the value of our ancestors' heritage, but also in terms of the reasons for existence of future generations [4]. In this sense, efforts to preserve and maintain cultural identity are a common concern worldwide beyond Korea.

*Hanok*, which is a traditional architectural type, has eco-friendly performance, but because of insufficient research and development (R&D), and the absence of a standardized definition, it is difficult to commercialize and globalize. Recently, the potential demand for *hanok* is increasing, due to expectations for the enhancement of the national brand value through traditional culture and its modernization, interest in its unique residential culture, and its possibility of an eco-friendly healthy home [5]. As the social demand for *hanok* is expanding, it has great potential for creating various cityscapes, and becoming an alternative to new residential environments. Social and policy interest in the modernization and revitalization of *hanok* has increased, and recently a technical development research project was initiated by the Korean government. Consequently, a modernized *hanok*, which includes various reinterpretations and recognition of changes to its layout and performance required for modern life, was constructed. The question is whether to accept and apply the characteristics of the traditional *hanok*. This is an important part of the modernization of *hanok*, and its application to the future [6].

For this study, representative target *hanoks* were selected and analyzed with evaluation using professional devices and monitoring know-hows for the period April 2019 to January 2020. They were all built as prototypical testbeds of *hanok* by the precedent R&D projects supported by the Ministry of Land and Transport Affairs of the Korean government. Through this study, evaluation methods for the performance of *hanok* have been utilized, with the evaluation analysis being mostly through environmental monitoring. The performance evaluation system, used widely through the monitoring of various categories in *hanok* and similar buildings, has been established to enhance the competitiveness of *hanok*, and to present solutions for the change of perception.

With this sense, this study aims to set an integrated residential performance evaluation system that includes factors related to the quality of residents' lives, such as the comfort of the surroundings and indoor environment as well as the functionality and convenience of *hanok* according to its unique applications. The main objective of this study is, therefore, to propose evaluation indexes for comfort of *hanok* buildings composed mainly of wooden structures based on classifications of psychological factors in aspects of residential performance, and to suggest the main strategies for sustainable habitability with monitoring recent facilities in the style of the modernized *hanok* structure according to territorial zoning and climate characteristics.

A number of evaluation systems, including 'Comprehensive Performance Evaluation Model for Existing Buildings' by the Korea Infrastructure Safety and Technology Corporation, were evaluated by classifying the indicators of performance evaluation as Environment, Function, and Comfort [7]. In particular, the Building and Environment Noise Consulting Research Institute, a joint research institute, is conducting a separate study on the environmental performance of *hanok* [8]. On the one hand, the functional performance of *hanok* was covered by another study by Lee, Cheon, and Han. The concept of residential performance of *hanok*, which is distinguished from modern architecture, was defined as Architectural Space, Village Complex, and Sustainability with spatial aspects of *hanok* experience based on human life, and a performance evaluation model reflecting the characteristics of *hanok* was presented from that point of view [9].

This study conducted a practical field survey based on KS (Korean Standard) A 6300-1 titled "Test Method for *hanok*: Part 1. Comfort Evaluation," a Korean Standard suggested by the National Institute of Technology and Standards. Jeong, Cheon, and Han raised another issue of maintenance and sustainability as a main factor of *hanok* habitability. They emphasized that architecture has a duty in societies to preserve the past, provide the possibility of retaining the present on the strength of

culture and tradition, and maintain the performance with sufficient monitoring to see whether *hanok* maintains its functions in regard of habitability [10].

While prior researches were limited to public facilities, this study additionally included a total of twenty-nine prototypical testbed *hanok* supported by the Ministry of Land and Transport Affairs of the Korean Government; two of them are located in Seoul, two in Gyeonggi-do, another two in Jeollanam-do, and twenty-three in Gangwon-do, all in South Korea. In addition, Hwasun Haetsal Village, where residents actually live, was considered for a comparative study. The level of completion of optimized evaluation methods and standards could be increased by accumulating data through on-site evaluation and analyzing trends of changes.

## 2. Literature Review

Traditional houses have a distinctive shape with features that depend on the climate, culture, environment, and the location of the country in which they are built. Strandberg-de Bruijn, Donarelli, and Balksten have conducted research for the preservation and development of traditional architecture in the region, through the case of historic Swedish timber buildings, the most historic single-family houses in Sweden [11]. Their concept is quite impressive, and the main issue suggests that it will be necessary to improve the architectural performance of historical buildings with materials suitable for the architectural framework, while preserving its characteristic elements.

Satish Kumar and Ardeshir Mahdavi emphasized the importance of comfort in indoor environment design, and reviewed supporting tools that effectively integrate it [12]. Shady Attia evaluated the role of a thermal adaptation design strategy for thermal comfort perception, occupant behavior, and building energy use in twelve high-performance Belgian households. Based on quantitative and qualitative fieldwork and in-depth interviews conducted in Brussels, the study provides insights into the impact of using mechanical systems [13]. Moreover, Luis Osterbeck and others observed that “integrated management” is recognized as fundamental to sustainable management of the world [14]. In fact, the model of sustainable development assumes a systemic relationship between society, environment, and economy, which were culturally oriented, essentially to one of these fields [15].

A prior study identified the representative strengths of *hanok* to include familiarity, friendliness, and eco-friendliness. Here, eco-friendliness means the use of natural materials obtained from nearby nature, good flow of air in the indoor space, and excellent ventilation of the members to control the temperature and humidity, which indicates comfort factors provided by the *hanok* [16]. The comforts of residence are in line with the residential performance, and should be discussed from various perspectives that include physical, psychological, emotional factors as well, focusing on the residents’ responses to the indoor environment.

Jo and Han mentioned limitations in which *hanok* buildings are evaluated solely for physical comfort factor. Their paper also emphasized the need for an integrated performance evaluation system on the aesthetic, traditional, and psychological values of the traditional Korean *hanok* [17]. Because of subjective factors, such as human factors and indoor environmental indices that may vary depending on the situation of the space, they have traditionally been evaluated as predicted mean vote (PMV) in the indoor environment, as shown in Figure 1. Thermal comfort, which is human satisfaction with the thermal environment, can be expressed as the PMV, based on Fanger’s model [18]. The PMV defines how people would be satisfied in a thermal environment, and it is standardized as ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) 55-2004, and used to evaluate thermal comfort. The values range (−3 to +3) (too cold, to too warm), while a range (−0.5 to 0.5) is normally recognized by ASHRAE as a comfort zone [19].

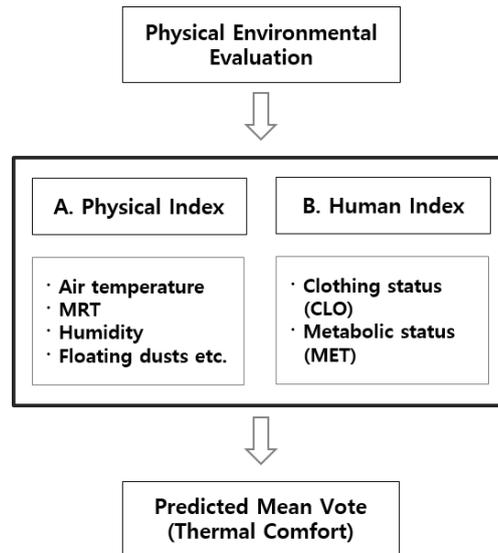


Figure 1. Evaluation for physical environmental comfort (source: Han et al., 2014).

While this is a quantifiable means of comfort performance, in a narrow sense, it was used as a criterion for evaluating the comfort of indoor environments in modern buildings. On the other hand, there may be differences in the hierarchy and the index of the evaluation system from the comfort performance standards that reflect the various values of *hanok*, as seen in Figure 2.

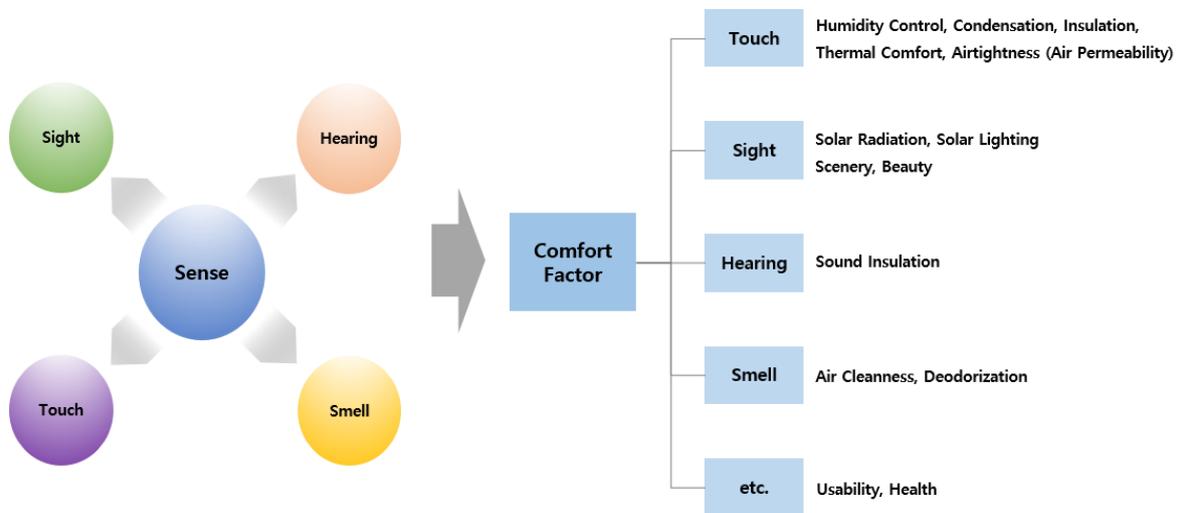


Figure 2. Comfort factors in the KS A 6300-1 evaluation method of spatial comfort for *hanok*.

When evaluating spatial comfort factors, a measurement method limited to the physical thermal environment omits the qualitative factors felt in space, considering the traditional value and merits of the *hanok*. In other words, the residents feel comfortable when staying in the space of the *hanok*; and the audiovisual pleasure of enjoying the seasonal changes in the natural environment, are major factors that when defining the value of the *hanok* cannot be ignored. However, it was excluded from the comfort assessment on the grounds that it could not be easily defined as quantitative. In this sense, the thermal comfort factor is normally considered to describe the psychological status of residents' minds, and is usually referred to whether someone is feeling too hot or too cold [20].

The KS A 6300-1 mentioned above divides comfort criteria into a physical perceptive element, which is a quantitative indicator, and a psychological cognitive element, which is a qualitative indicator. The physical perceptive element is composed of nine quantifiable factors that can be measured by

numerical values, of humidity control, condensation, insulation, thermal comfort, air permeability, solar radiation, solar lighting, sound insulation, and air cleanness. This is a perceptual concept of viewing a building as it is, and a quantitative evaluation method of measuring data in the field using environmental sensors and equipment. In contrast, psychological factors are qualitative items that include the experiences of residents living in *hanok*, and consist of five categories: scenery, beauty, deodorization, usability, and health [21].

This is a qualitative evaluation method using a subjective judgment scale based on the surveys of experts and residents, as previously suggested as a main research method. This research method has been frequently used in existing studies, and it collects subjective feedback from respondents using a questionnaire, and qualitatively analyzes the influencing factors. Liu, Wang, Wei et al. collected survey data from 207 families (553 residents) in three communities in Xi'an, the largest population in northwest China [22]. The researchers revised some questions and wordings in the questionnaire according to the comments and suggestions provided by participants. The study then employed a two-stage cluster sampling method, which is widely employed in the social science field. The colony extraction method, which extracts clusters, a set of observation units, under realistic constraints, such as survey cost and time, is commonly used in large-scale surveys. In particular, when observation units within a colony are very similar, a two-stage colony extraction method is preferred, in which a part is extracted and examined, instead of all observations in the colony [23,24]. Applying this existing objective research methodology in this paper, a survey was conducted by dividing into two categories: representative *hanok* design and construction experts, and users (residents) of houses & public facilities.

Among the two categories of comfort, the physical perceptible element was carried out through a separate study according to the difference in evaluation method [25], and this study was limited to the psychological cognitive element, which is qualitative evaluation.

### 3. Methodology

#### 3.1. Location of Target Hanok

Target testbed *hanok* for the research for monitoring and evaluation consist of a total of twenty-nine buildings across the country. Because the most serious limitation to the research was regarded as their lack of actual residents, additional evaluations for the practical *hanok* where present residents currently live was needed. Accordingly, the Haetsal Village located in Hwasun, Jeollanam-do was added as a target *hanok*.

Korea, located in the middle of the median at (33 to 43°) N latitude, has a temperate climate with four distinct seasons, and has unique climatic characteristics that depend on the four different orientations in the country. For example, the southern part of Korea is warm and rainy, while the eastern part has high mountains, causing a large difference in precipitation and temperature, depending on the region [26]. According to these differences, the target areas were divided into three different regions, namely Zone 1, Seoul–Gyeonggi in the western central regions; Zone 2, Gangwon in the eastside–central; and Zone 3, Jeonnam in the southern part of Korea, as summarized in Figure 3 and Table 1. Thus, it was planned to ensure continuous assessment by region.

Table 2 indicates representative testbed *hanok* by zone. Literature Center at Eunpyeong hanok Village located in Zone 1 uses many traditional elements, such as Daechung as the main hallway, Maru as corridors and yards defines the boundary between inside and outside fences. Moreover, Gangneung *hanok* Village is a sort of public building that requires a wide space with no pillars due to its spatial characteristics, because a neck structure alone normally has a difficulty in securing a necessary space without pillars. For this reason, most of them use the contemporary construction materials like RC (Reinforced Concrete) to form the base structure as the lower part. Geumwa Kindergarten located in Zone 3 shows the wooden structure for the upper part to demonstrate the traditional beauty of hanok, and this combined structure has been considered to satisfy the structural stability. [10]



Figure 3. Location of Target hanok.

Table 1. Target Testbed hanok for Evaluation.

Zone 1		Seoul–Gyeonggi		
Building Name	Literature Center	Community Center	Jishinjae	Hanok Technology Center
Program	Exhibition, Office	Community Service	Experimental Mock-up	Exhibition, Office
Location	Seoul	Seoul	Yongin	Suwon
Site Area (m <sup>2</sup> )	361.88	273.9	385	2661
Total Floor Area (m <sup>2</sup> )	142.2	249.16	126.18	946.32
Building Area (m <sup>2</sup> )	71.1	121.87	81.09	572.67
Structure	Korean-style Wooden Structure, RC (Reinforced Concrete) toward Foundation	Korean-style Wooden Structure, RC	Korean-style Wooden Structure, RC (Foundation)	Korean-style Wooden Structure, RC

Table 1. Cont.

Zone 2		Gangwon		
Building Name	Hotel Units	Energy-saving Unit		
Program	Commercial, Hotel	Commercial, Hotel		
Location	Gangneung	Gangneung		
Site Area (m <sup>2</sup> )	12,300	12,300		
Total Floor Area (m <sup>2</sup> )	1415.7 (unit: 104.4)	1415.7 (unit: 81)		
Building Area (m <sup>2</sup> )	1516.14	1516.14		
Structure	Korean-style Wooden Structure, Reinforced Concrete	Korean-style Wooden Structure, Reinforced Concrete		
Zone 3		Jeonnam		
Building Name	Geumwa Kindergarten	Agricultural Experience Center	<i>hanok</i> at Haetsal Village	Townhouse at Haetsal Village
Program	Education	Exhibition, Office	Residence	Residence
Location	Sunchang	Naju	Hwasun	Hwasun
Site Area (m <sup>2</sup> )	900	6615	540	179,540
Total Floor Area (m <sup>2</sup> )	446.17	263.25	99.586	871.958
Building Area (m <sup>2</sup> )	337.92	273.15	99.586	631.512
Structure	Korean-style Wooden Structure	Korean-style Wooden Structure, RC (Foundation)	Korean-style Wooden Structure	RC

Table 2. Detailed Specification of Representative Target *hanok* by Zone. (Source: Jeong, Cheon and Han, 2019).

Zone	1	2	3
Testbed <i>hanok</i>	Literature Center at Eunpyeong <i>hanok</i> Village	Hotel Units at Gangneung <i>hanok</i> Village	Geumwa Kindergarten
Climate	Cool, Humid	Warm, Dry-Humid	Warm, Humid
Year Built	2013	2016	2016
Composition			

### 3.2. Evaluation Periods

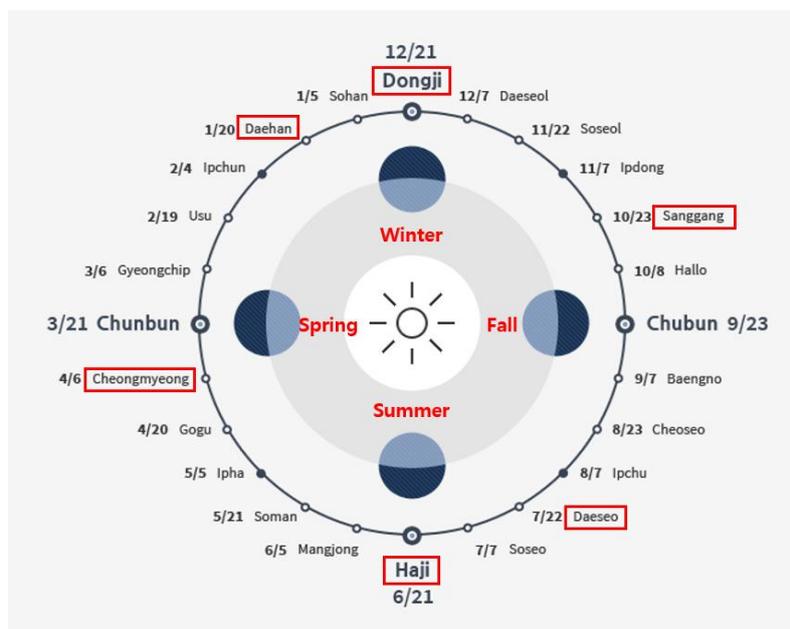
Assessment conditions are complicated by such considerations as seasonal variation, and regions with wide span of climatic characteristics. In particular, as a variable for environmental conditions, seasonal variation has to be thoroughly addressed. As Luiz Oosterbeek et al. observed, “The solution may reside in the integrated landscape management where all variables may be considered as equal both in the ecological, historical and geographical scopes, based on a shared social awareness filtered through the various cultural understandings”, so that integrated management from various perspectives is needed [14]. However, due to the nature of the on-site evaluation, there are many variables, such as weather changes and on-site conditions on the day of measurement, and there is a lack of means to control them. In addition, because the target sites are distributed by characteristics of regions in the

country, simultaneous progress cannot be made, and the assessment should be conducted on a certain cycle, rather than on a specific date.

The twenty-four solar terms traditionally used in Korea, designated as a UNESCO (United Nations Educational, Scientific and Cultural Organization) Intangible Cultural Heritage of Humanity, are divided into 24 parts per year based on the location of the Sun’s movement, and are closely related to climate and seasonal changes. Among the twenty-four solar terms, six periods were selected based on changes in actual weather data provided by the Korea Meteorological Administration [27]. Reflecting seasonal characteristics, Cheongmyeong in spring, Haji and Daeseo in summer, Sanggang in autumn, and Dongji and Daehan in winter were selected as main evaluation periods in detail. Table 3 and Figure 4 summarize the timing and climate characteristics of the measurements for the selected major seasons.

**Table 3.** Periods and climatic characteristics of the evaluation season.

Evaluation Season	Period	Climatic Characteristics
Cheongmyeong	4–13 April 2019	a clear and balmy spring day
Haji	23 June–2 July 2019	summer solstice, the longest day of the year
Daeseo	12–19 August 2019	the hottest day of the year
Sanggang	17 October–5 November 2019	the first day of frost
Dongji	18–25 December 2019	winter solstice, the longest night of the year
Daehan	15–30 January 2020	the coldest day of winter



**Figure 4.** Traditional seasonal divisions in the lunar calendar system.

In line with the objectives of this study, the frequency of assessment of residential facilities was set higher than that of public facilities. In addition, a measurement plan was developed in connection with the weather data provided by the Korea Meteorological Administration, taking into account the location, purpose, and operation of the target *hanok*. They can be largely classified as residential and public facilities according to their respective uses, as categorized and shown in Figure 5 in detail. The former includes Ojuk *hanok* Village in Gangneung and Haetsal Village in Hwasun, and six public facilities have been constructed in Yongin, Suwon, Eunpyeong, Naju, and Sunchang. Ojuk *hanok*

Village is currently operated as an accommodation facility. Therefore, it can be said that residential life depends on the guest experience of the facility.

Target Hanok	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Evaluation season	Period	
Jishinjae at Yongin			●								Cheongmyeong	2019.04.04. ~ 04.13.	●
Hanok Technology Center at Suwon			●										
Hotel units at Gangneung	●		●		●		●		●	●	Haji	2019.06.23. ~ 07.02.	●
Energy-saving unit at Gangneung	●		●		●		●		●	●	Daeseo	2019.08.12. ~ 08.19.	●
Literature Center at Eunpyeong	●		●				●		●				
Community Center at Eunpyeong	●		●				●		●		Sanggang	2019.10.17. ~ 11.05.	●
Agricultural Experience Center							●				Dongji	2019.12.18. ~ 12.25.	●
Geumwa Kindergarten			●				●		●				
Hanok at Hwasun			●		●		●		●	●	Daehan	2020.01.15 ~ 01.30.	●
Townhouse at Hwasun			●		●		●		●	●			

Figure 5. Evaluation Plans of the Target hanok.

It is also regarded as a place with advantages in terms of universality and securing a variety of parameters, because it can be used by an unspecified number of guests, and to obtain a large number of evaluation data from them. In the case of Eunpyeong hanok Village, two different buildings composed of the exhibition hall and the village hall as a public facility, were closely associated in an adjacent area, but the user evaluation was conducted separately, because of differences in the operation methods, and the buildings’ individual characteristics. In general, target hanok in this case are mainly public facilities, and even residential facilities so far have not actually been inhabited by changing their use.

To overcome these limitations, Hwasun Haetsal Village was added as a target site. This case is within a complex where hanok are actually occupied by residents, and this is considered to show great advantage in analyzing the trend of change, as it can secure cumulative data of the same user throughout the entire season. In the case of Naju Agricultural Experience Center, the evaluation was conducted during the ten-day local event of the Naju Agriculture Expo from October 17, in line with the intensive operation with practical visitors as respondents.

Gangneung and Hwasun hanok were evaluated six times for each season as the best places to meet research goals, as actual users lived there. On the other hand, Yongin hanok, manufactured for the use as experimental mock-up, was measured once in June, especially for the summer solstice called Haji in Korea, because its living space was not actually occupied, and was considered to have low importance in affecting the results. Hanok Technology Exhibition Hall in Suwon is also a public facility that is visited by a small number of users, normally through room rentals taking place irregularly on weekdays for the purpose of conference meetings. Most visitors come to watch exhibition pieces in the gallery, and take part in the experience program on weekends. Therefore, during the Haji period, visitors who participated in those events were selected for the evaluation once over the weekend. In the case of Naju Agricultural Experience Center, it was intensively operated during the biennial EXPO period, so one-time measurement at the Sanggang period in October was conducted. Geumgwa Kindergarten in Sunchang, a highly-utilized public facility for children and teachers that operates Monday through Friday, was measured three times, such as Haji, Daeseo in August, and winter solstice called Dongji in December, due to the high demand for seasonal evaluation.

### 3.3. Evaluation Process

The Focus Group Interview (FGI) approach, first of all, was utilized to set the assessment criteria for expert surveys. Since it is assumed that well-trained expert group recognizes about *hanok* characteristics professionally in advance, on-site evaluation process has been applied by using technical drawings and direct briefing reports by the field manager. In contrast to the expert survey with three-point Likert scale, general users have required more detailed information of *hanok* comfort and specified survey responses with the five-point scale as well; this situation caused to consider two different forms of data collection and the integrative process of those from each different group: expert and user. Then, survey results from both experts and users were to be joined to evaluate psychological cognitive factors in five categories: scenery, beauty, deodorization, usability, and health. These are qualitative elements that are physically impossible to measure, and are used to assess user satisfaction with the comfort performance, such as psychological, emotional, and empirical contents [28]. The overall scheme of the evaluation was properly organized as seen in Figure 6.

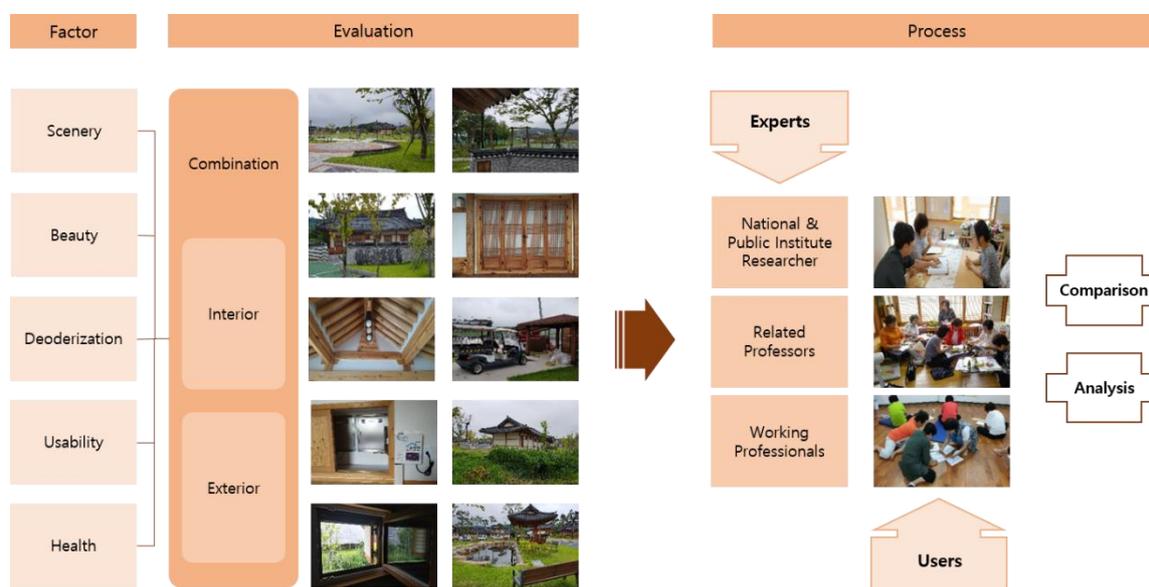


Figure 6. Evaluation process for psychological cognitive factors.

Scenery indicates satisfaction factor through comprehensive sentiment and scenery, taking into account the shape and appearance of *hanok*, the layout of space, the geographical location, and the surrounding situation, etc. Beauty, as a traditional aesthetic factor, shows the internal and external honorability, the sense of stability, and openness unique to *hanok*, and the psychological satisfaction achieved through patterns of traditional materials. Deodorization points out the comprehensive olfactory satisfaction factor that users can feel by scent in materials applied, etc., without unpleasant odors from indoor and outdoor environments. Usability emphasizes the user satisfaction factor with the convenience of operating various facilities that can control both indoor spaces and external environments. Finally, health indicates the psychological satisfaction that can be felt through the adoption of elements that affect the mental and physical health status of the user.

Expert evaluation consisted of relevant professionals in the research field of traditional architecture, including the design, construction, and repair of *hanok*, and repeated feedback using the Delphi technique was received [29]. The experts checked the surrounding environment, climate information, and other compositional elements of the target *hanok*, and prepared to fill out itemized checklists and build assessment reports through on-site verification using building drawings, test papers, annexes, and so on, as clues and evidence. In comparison, the user satisfaction survey was conducted with the assessment questionnaire using a three-point Likert scale for each factor, as suggested and shown in Figure 7 [30].

### On-site assessment of psychological recognition factors

Personal information				
Name		Site		
Belong to		Date		
Evaluation factor				
1-Scenery	Evaluation of satisfaction through comprehensive sentiment and scenery that residents can feel in <i>hanok</i> , such as geographical location and surrounding situation.			
Evaluation focus	The fore and rear views, the shape and appearance of a building, the layout of space, etc.			
Evaluation tool	Architectural drawings (Site plan, Floor plan, Elevation, etc.), on-site visits, visual observations, photographs.			
Questionnaire	As the seasons change, do the exterior panoramic views, including buildings, show a colorful atmosphere and scenery?	Dissatisfied	Normal	Satisfied
	Can the form and exterior of the building be harmonized with the surroundings, so that the emotions and scenery of the <i>hanok</i> can be felt?	Dissatisfied	Normal	Satisfied
	Is it easy to appreciate the views, landscapes, and sounds of buildings from inside to outside?	Dissatisfied	Normal	Satisfied

Evaluation

Figure 7. Example of the expert survey.

The Likert scale was developed by the American social psychologist Rensis Likert and colleagues in the early 1930s, and has been widely used as a methodology in the field of social science to evaluate respondents’ attitudes, feelings, beliefs, etc. for specific objects or concepts. It is comprised of various questions related to the subject to measure the level of likes or dislikes, agreements or disagreements expressed by the respondent. It can consist of a variety of methods, including three point, five point, and seven point scales, but the five-point scale is most frequently used. This measurement method is relatively easy to use for many people, and has the advantage of having high reliability by ensuring consistency. In addition, it is highly feasible, because it can minimize errors by directly utilizing the respondents’ response values, and because it utilizes a variety of questions [31]. However, there is a disadvantage, in that measurement is not possible for weights and relative importance by question. Moreover, it is difficult to fully reflect and interpret the meaning of the respondents’ response toward each question, because the total score of the question is used. Thus, for user evaluations in which the majority participated, the five-point scale was used to compensate for the shortcomings, while expert evaluation that fully reflected the representativeness was evaluated separately by three-point scale. After collecting all of the questionnaires, it was converted to the same criteria, and compared during the evaluation setting process.

For user evaluations, a form of questionnaire was used to actively reflect seasonal characteristics, taking into account their activities and hours of use according to the purpose of the building program. The questionnaire was collected in a way that expressed their opinions in a natural atmosphere, so beneficial information could be derived through interactions between respondents. Figure 8 shows an example of the user questionnaire, which was organized by separating the differences between family members, type of residence, type of facility, and general user information, such as gender and age.

The contents of the survey were designed based on a previously-used standard, such as the indoor environment comfort checklist by the Korean Society of Living and Environment Studies to construct user questions that could explain each factor, and to secure objectivity using the five-point Likert scale [32]. Three questions were asked according to the characteristics of the assessment factors, and the selection range was set from one to five, depending on the degree to which they were deemed comfortable, such as “very dissatisfied”, “dissatisfied”, “normal”, “satisfied”, and “very satisfied”.

This fundamental survey system is relatively easy to use for many people, and has the advantage of having high reliability by ensuring consistency.

**I. Personal Information**

1. Please select your gender.  
 Male     Female

2. Please select your age group.  
 Teenager     Twenty     Thirty     Forty     over Fifty

3. Please select a purpose for your visit.  
 (If you are currently living in a hanok, please choose a residence.)  
 Accommodation     Exhibition     Business     Education     Residence     etc.

4. Please select your current area of residence.  
 Seoul-Gyeonggi     Chungcheong     Gangwon     Gyeongsang     Jeolla     Jeju

5. Please select the type of residence you are currently living in.  
 Apartment     Modern Housing     Modern Hanok     Traditional Hanok     etc.

6. Please indicate the date of visit, the response time and number of visitors.  
 (If you currently live in Hanok, please select the response time and the number of residents.)  
 the date of visit & the response time ( )  
 1 person     2-3 persons     4-5 persons     6 or more persons

7. Please select your weight.  
 under 50kg     50-60kg     60-70kg     70-80kg     over 80kg

8. Please select your height.  
 under 150cm     150-160cm     160-170cm     170-180cm     over 180cm

**User's General Information**  
 (gender, age, region,  
 type of residence, number of  
 residents, etc.)

**User's Characteristics (Weight,  
 height)**

	Extremely No	Unlikely	Normal	Likely	Extremely Yes	
The view, the scenery, the atmosphere is not good.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	The view, the scenery, the atmosphere is good.
There is no atmosphere or style that goes well with <i>hanok</i> .	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	The yard, garden, fence, etc. are well suited to the <i>hanok</i> .
This <i>hanok</i> has a bad view, scenery, atmosphere, and etc.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	This <i>hanok</i> has a good view, scenery, atmosphere, and etc.

Figure 8. Example of the user questionnaire.

### 3.4. Data Analysis

Evaluations were completed by eight respected professionals according to the annual measurement plan. In the case of the user evaluation, 793 valid questionnaires were collected in total, composed of 448 answer sheets for Gangneung, 152 for Hwasun, 79 for Eunpyeong, 59 for Sunchang, 32 for Suwon, and 23 for Naju. During the Cheongmyeong period, as a preliminary evaluation, the current status of the target *hanok* was identified, its problems and improvement plans were reviewed, and overall outputs were reflected to the main evaluation performed later. Analyzed data for each evaluation factor was organized by constructing a database in the same configuration, according to the evaluation period and location.

Figure 9 summarizes the results of analyzing personal characteristics, such as gender and age. Some 67% of the respondents were female, while those in their 40s and older who prefer *hanok* accounted for 61% of the total. The proportion of respondents by season was generally constant, and height and weight information were collected to determine the comfort that individuals felt through their sensory organs. It can be said that the reliability of the sample was to some extent secured, given the fact that the average of Korea Adults came from 69 to 95% of respondents in height and weight, respectively [33]. Some 79% of the respondents said they were satisfied with the comfort of the interior space of the *hanok*. Some respondents cited noise, smell, and insects as the causes of discomfort, while others said it was hot and humid in summer, or cold and dry in winter, depending on seasonal characteristics. However, the majority of respondents said that the interior space of *hanok* was generally comfortable.

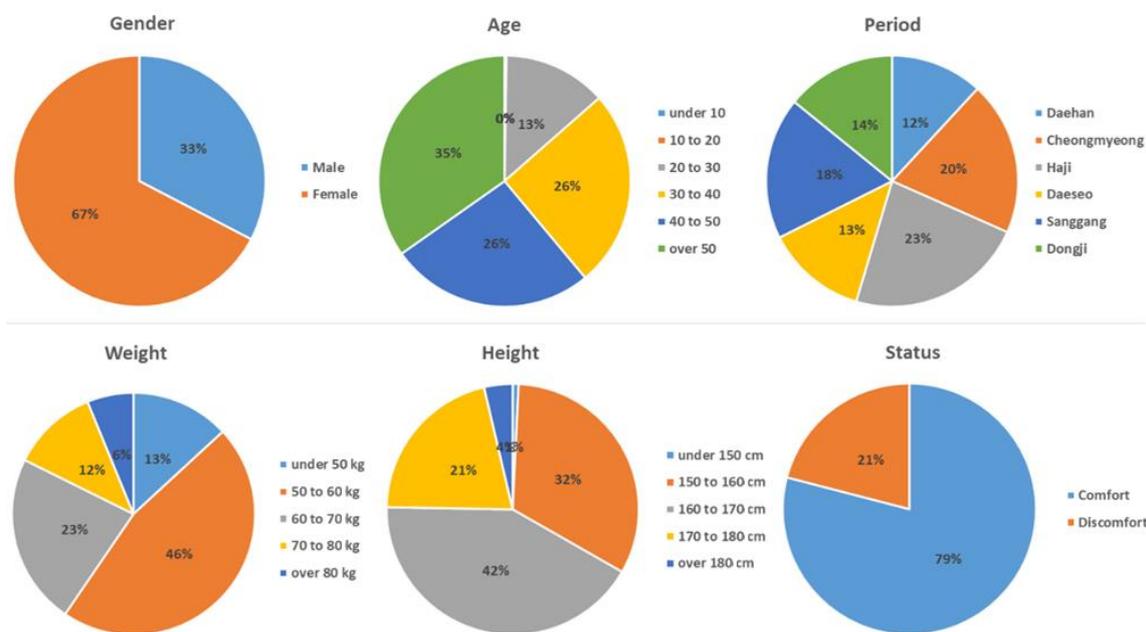


Figure 9. Personal characteristics of the survey respondents.

As shown in the case of composition of the data sheet in Figure 10, the results of the assessment were systematically organized, including the architectural outline of the target *hanok*, major mappings and drawings, user life cycle, and climate information on the measurement date.

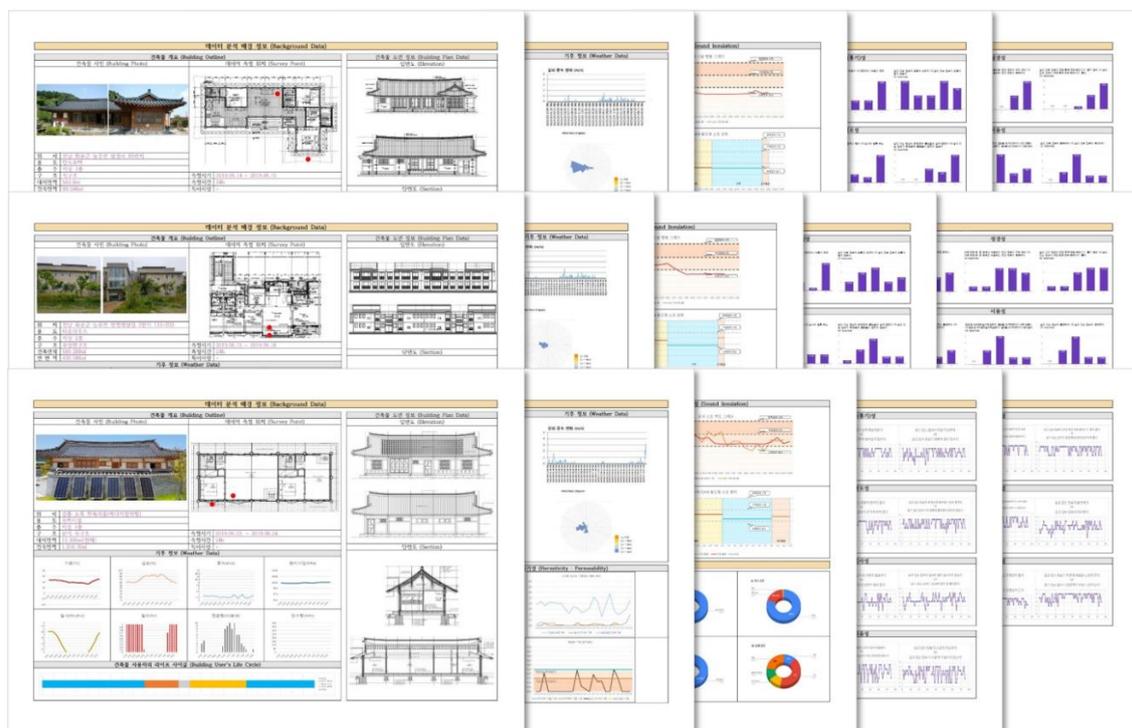


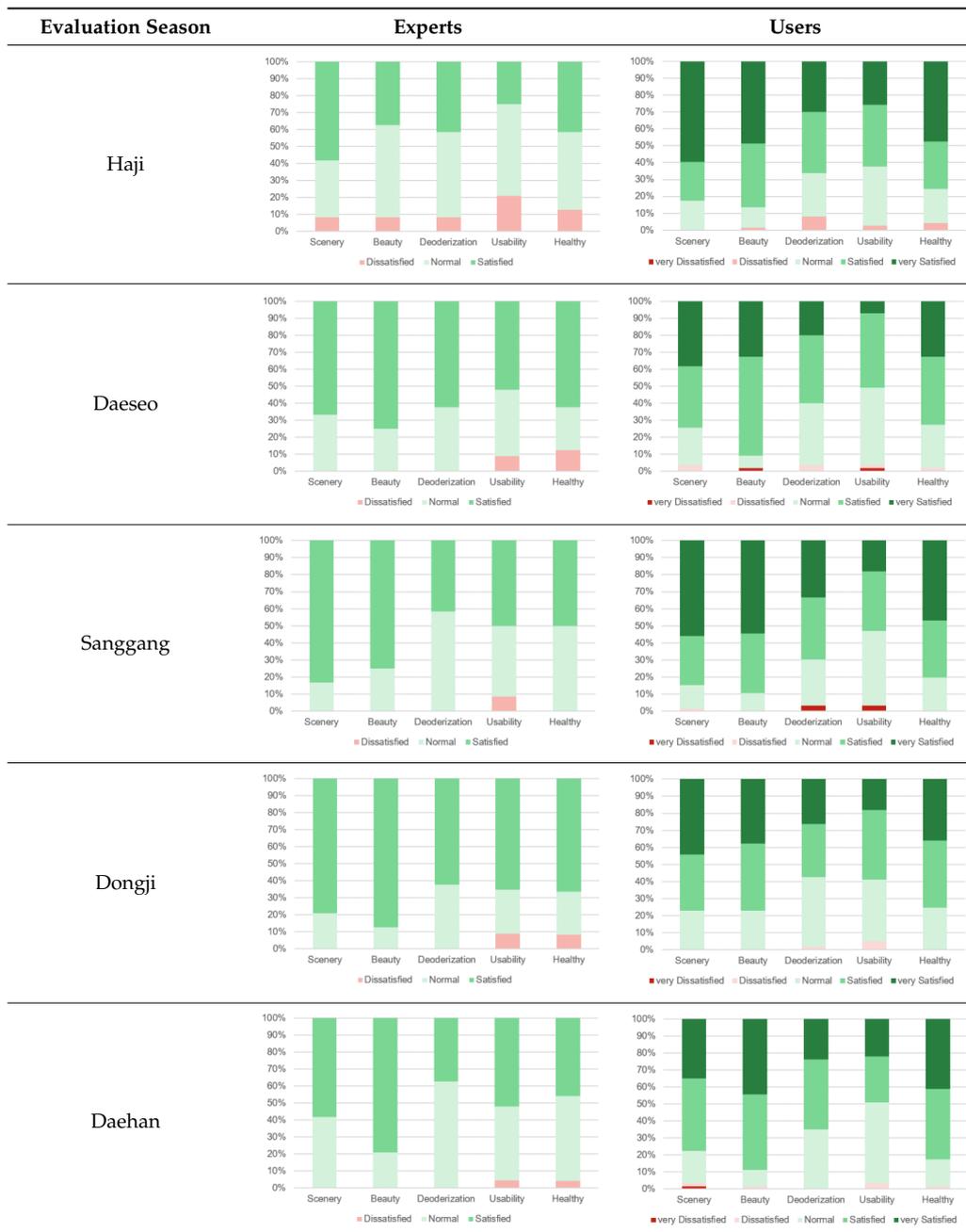
Figure 10. Exemplar database sheet of the *Hanok* evaluation for comfort performance.

#### 4. Results

In the case of expert evaluation, a preliminary evaluation was first conducted during the Cheongmyeong season. Then, after reviewing the architectural drawings for each target *hanok*, evaluation checklists were prepared according to the judgment scale for each factor, and decisions were

derived from repeated feedback based on the Delphi method. Each item was judged by a three-point Likert-type scale consisting of “dissatisfied”, “normal”, and “satisfied”. In sum, the evaluation results show that most professionals who submitted survey sheets responded on average to psychological cognitive factors as appropriate, and it was also found that there were few data for the factor of Usability that indicated ‘satisfied’. The evaluation period or type of target *hanok* did not show a significant difference among the evaluation results. Table 4 shows the differences between respondent groups for the comfort assessment, especially of the sample testbed *hanok* built in Ojuk Village in Gangeung.

**Table 4.** Comparative evaluation results in the case of the testbed *hanok* in Gangeung.



In the case of user evaluation, most of them evaluated as satisfactory or excellent, except for a very few. There was no difference in final results according to the evaluation period or type of target *hanok* too, and most users evaluated the overall comfort performance as excellent. In particular,

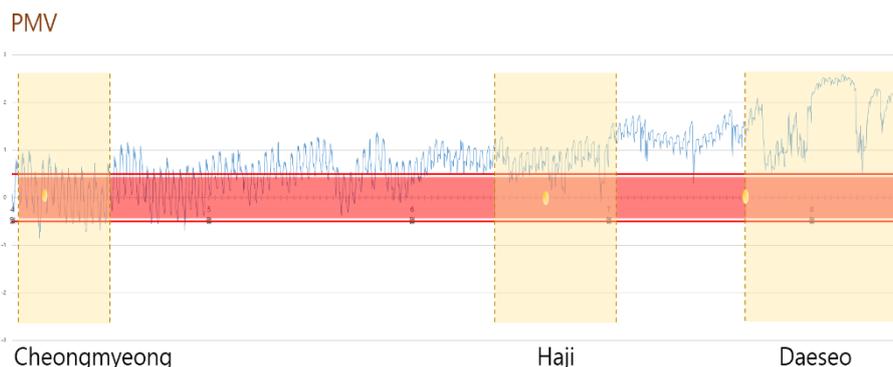
the level of satisfaction was reasonably high in terms of scenery, beauty, and deodorization among the psychological cognitive factors.

Table 5 indicates differences between respondent groups for the comfort assessment, especially for the exemplary practical *hanok* built in Haetsal Village in Hwasun. As a result, there were slight differences by season, but generally, both experts and users showed satisfactory responses. In particular, satisfaction was high in terms of scenery, beauty, and health. In terms of usability, there was some evaluation of dissatisfaction. In summary, it can be seen that environmental factors, such as natural environment and location, are the main variables that influence satisfaction with psychological cognitive factors. It can be seen that the formative beauty of *hanok* also has a major influence on satisfaction.

**Table 5.** Comparative evaluation results in the case of practical *hanok* in Hwasun.



Through this study, it can be seen that compared to modernized houses, *hanok* is superior in psychological terms, although in terms of physical performance, it is somewhat insufficient. Accordingly, this research could be amended by quantitative analyses with physical data collection in relation to human comfort such as clothing (CLO), metabolic rate (MET) and actual environmental clues monitored by sensing devices installed in *hanok*. Figure 11 shows an example for preliminary quantitative assessment performed during Cheonmyeong through Daeseo periods and predicated mean vote (PMV), a traditional scientific evaluation method of comfort, was utilized to indicate the integrative tendency; an ongoing research would be followed by this investigation.



**Figure 11.** Preliminary quantitative analysis of *hanok* comfort in the scope of predicated mean vote (PMV) (Gangeung, Korea).

## 5. Conclusions

This study was conducted to create a performance evaluation model of the target *hanok* constructed for research purposes for the dissemination and technology development of traditional *hanok* with national support. Monitoring evaluation was conducted in the six major seasons out of the twenty-four solar terms, according to the characteristics of seasonal changes during the year. Among the two factors that evaluated comfort performance, the result was analyzed by collecting questionnaires for experts and users, focusing on the psychological cognitive factor.

It is important to first grasp information related to the current performance, in order to present the performance evaluation criteria for *hanok*. However, until now, in previous researches, data required for analysis were insufficient, due to various problems, such as performance degradation and information loss over periods. Therefore, this study is meaningful, in that it secured data for collecting and analyzing information on psychological cognitive factors, which are qualitative evaluation items regarding the comfort performance of *hanok*. However, there are some limitations to this study. In this study, we mainly focused on the *hanok* built with the support of the state, but in order to actually spread *hanok*, it is necessary to meet the needs of individual clients. The researchers recommend further studies to obtain more samples and integrate them with physical perceptive factors. Moreover, additional research is needed to find weights to the general merits of *hanok* derived from these results, and apply them to a residential performance evaluation model.

*Hanok* is a unique architectural type in Korea that retains its cultural identity, and is a vernacular architecture using materials and structural methods suitable for the climate of the region. However, in the name of modernization, it drastically decreased in numbers. In this situation, preserving and disseminating *hanok* as a traditional cultural type is important, not only in terms of the value of our heritage, but also in terms of the reasons for our existence. In this sense, efforts to preserve and maintain cultural identity are a common concern worldwide beyond Korea. *Hanok* is sustainable and eco-friendly, but it is difficult to commercialize and globalize due to insufficient R&D, and the absence of clear standards.

This study secured and analyzed the satisfaction survey data of experts and users on psychological cognitive factors that affect the comfort performance of *hanok*. This study is meaningful in that we

collected basic data to develop an integrated performance evaluation tool for *hanok*. Nevertheless, more advanced research will be needed to address the weak points. In order to change and disseminate the perception of *hanok*, it is necessary to verify the evaluation method through regular monitoring, compare the results, and present appropriate standards. Through this, the evaluation method can be used as a tool for maintaining and improving the performance of *hanok*. This will not only contribute to improving the quality of *hanok* residence, but will also have the effect of preserving the national cultural identity.

In the future, central and local governments need to identify and support individuals wishing to live in *hanok* to promote regional identity and urban revitalization through the distribution of *hanok*. Furthermore, efforts should be continued at both, the individual building level and the local area to realize the effects of agglomeration. At the local area level, clusters of *hanok* could create synergy, and these areas should be well-maintained. However, *hanok* should be respected as a product of identity with great social and cultural value in itself, and these efforts have implications for other Asian cities and developing countries where the national identity has faded, and development is being promoted in the name of globalization.

**Author Contributions:** M.-H.L. and S.-H.H. designed the research settings; M.-H.L. performed the evaluations; M.-H.L. and S.-H.H. analyzed the data; D.-Y.C. verified the analysis results; M.-H.L., D.-Y.C., and S.-H.H. wrote the paper. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by the Ministry of Land and Transport Affairs of the Korean Government (Project No.: 20AUDP-B128638-04).

**Acknowledgments:** This research was supported by a grant from Urban Architecture Research Program (Technology Development of Design and Construction for Large-Space Hanok over 10 m, Development of Hanok Technology, Phase III).

**Conflicts of Interest:** The authors declare no conflict of interest.

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