World Academy of Science, Engineering and Technology
International Journal of Architectural and Environmental Engineering
Vol:12, No:4, 2018

# Development of a Standardization Methodology Assessing the Comfort Performance for Hanok

Mi-Hyang Lee, Seung-Hoon Han



***Abstract*—**Korean traditional residences have been built with deep design issues for various values such as social, cultural, and environmental influences to be started from a few thousand years ago, but its meaning is being vanished due to the different lifestyles these days. It is necessary, therefore, to grasp the meaning of the Korea traditional building called Hanok and to get Korean people understand its real advantages. The purpose of this study is to propose a standardization methodology for evaluating comfort features towards Korean traditional houses. This paper is also trying to build an official standard evaluation system and to integrate aesthetic and psychological values induced from Hanok. Its comfort performance values could be divided into two large categories that are physical and psychological, and fourteen methods have been defined as the Korean Standards (KS). For this research, field survey data from representative Hanok types were collected for each method. This study also contains a qualitative in-depth analysis of the Hanok comfort index by the professions using AHP (Analytical Hierarchy Process) and has examined the effect of the methods. As a result, this paper could define what methods can provide trustful outcomes and how to evaluate the own strengths in aspects of spatial comfort of Hanok using suggested procedures towards the spatial configuration of the traditional dwellings. This study has finally proposed an integrated development of a standardization methodology assessing the comfort performance for Korean traditional residences, and it is expected that they could evaluate inhabitants of the residents and interior environmental conditions especially structured by wood materials like Hanok.

***Keywords*—**Hanok, comfort performance, human condition, analytical hierarchy process.

## I. Introduction

THIS is a reality that Hanok, the Korean traditional residence, composed of wooden structure has not been promoted to activate as contemporary housing in Korea due to its weakness for mass-production [1], although it has multiple advantages in aspects of environmental performance which is good for human. Especially spatial comfort is one of the best strengths of Hanok, and its wooden structure makes spaces possible to provide healthy conditions for residents pretty easily.

Korean government is recently establishing a policy for promoting the construction of Hanok in order to revive the traditional asset [2], and this is why standard methods for assessing its own values including spatial comfort should be organized and a precise monitoring process is important to help residents operate their spaces more effectively for better life. The ultimate goal of this study is to propose integrative standard methods for building the assessment system for Hanok comfort performance.

Mi-Hyang Lee is a Ph.D. candidate with the Multi-Disciplinary Graduate Program of Cultural Properties, Chonnam National University, Gwangju, Korea (e-mail: dahyeon01@naver.com).

Seung-Hoon Han is a professor with the School of Architecture, Chonnam National University, Gwangju, Korea (corresponding author, phone: +82-62-530-1646; fax: +82-62-530-1639; e-mail: hshoon@jnu.ac.kr).

## II. Assessment for Hanok Spatial Comfort

### A. Specifications for Comfort Factors

This study has analyzed comfort factors from previous researches first, and as a result, it was confirmed that both physical and psychological comfort factors could be meaningful for building assessment methods. Because comfort performance is affected by integrative indoor environment [3], this study has utilized a comprehensive set by AHP that is a method based on the survey conducted by pair-wise comparison of the factors [4], [5].

The comprehensive comfort index for Hanok comprises with 14 major factors, and those can be classified into two categories for the effectiveness of evaluation. The first one is psychological factors induces from user experiences such as spatial convenience and building aesthetics. The second one is physical factors based on environmental monitoring for the space such as temperature, humidity, heat insulation, air tightness, Predicated Mean Vote (PMV) and so on.

### B. Standards Methods Assessing Comfort Factors

Standard methods for assessing Hanok comfort performance have a clear direction that is focused more on simplicity and universality rather than reliability and suitability, because Hanok industries are relatively small and poor in aspect of the economy and they cannot afford to pay for using expensive assessment methods [6]; this is a paradigm shift for developing a new standardization methodology and different from that of the contemporary buildings.

The standard methods for Hanok comfort performance in physical condition could be defines as the following:

1) Humidity Controllability: Measuring the capability to control interior humidity using traditional materials,
2) Air Tightness: Judging construction quality for openings with adding air pressure and counting the exposure, [7]
3) Air Cleanness: Collecting interior air and analyzing TVOC and HCHO for the allowance, [8]
4) Dew Controllability: Measuring the capability by official simulation to maintain normal conditions of interior walls and joints,
5) Insulation Capability: Capturing resistance rate of architectural elements from the outside heat gain,

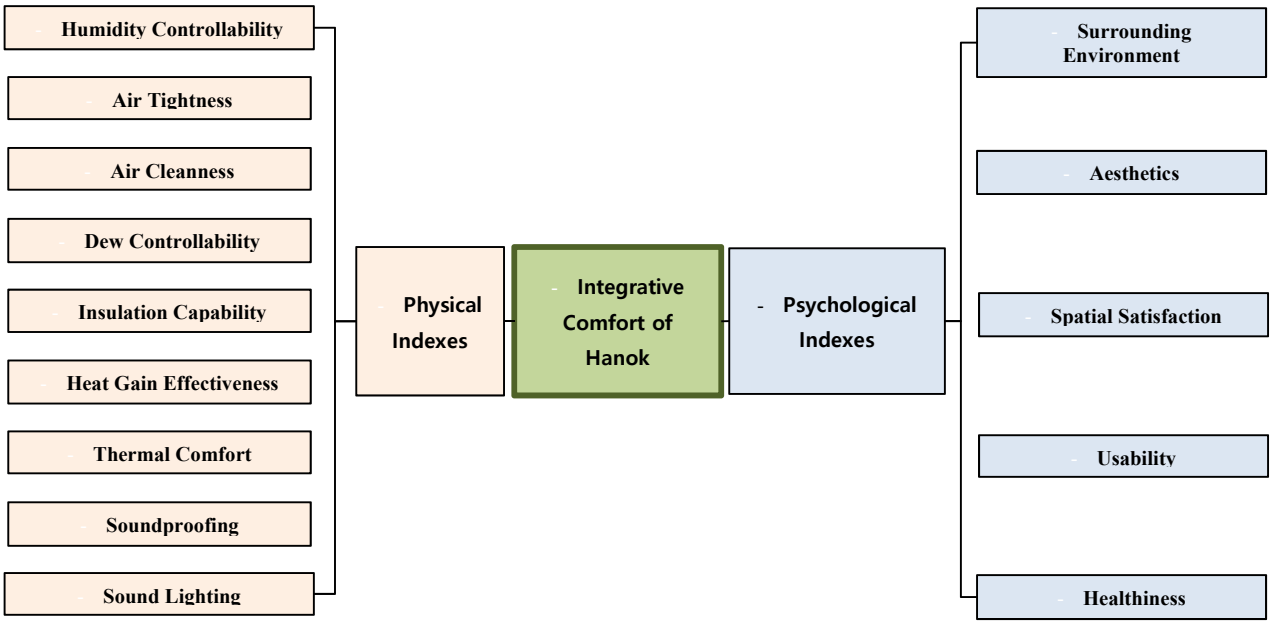


Fig. 1 Comprehensive assessment factors for Hanok

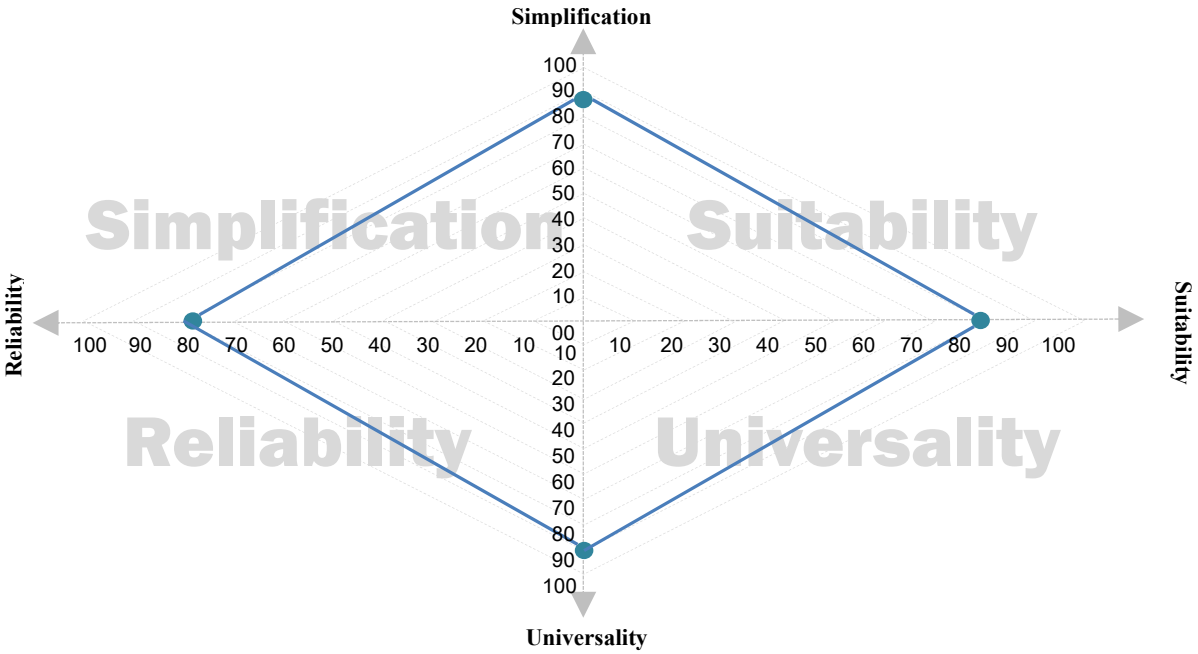


Fig. 2 Main scope of developing standard methodology

6) Heat Gain Effectiveness: Simulating energy efficiency gotten from the outside heat gain,
7) Thermal Comfort: Calculating PMV which is a traditional method to determine interior thermal comfort, [9]
8) Soundproofing: Measuring the capability to control audial comfort using traditional materials from any noise, and
9) Sound Lighting: Measuring the capability to control visual comfort using traditional openings with natural lights.

Otherwise, the standard methods for Hanok comfort performance in psychological condition could be performed with the drawings and the survey, and are defined as follows:

1) Surrounding Environment: Checking by residents to judge audial satisfaction from the Hanok atmosphere,
2) Aesthetics: Checking by residents for judging visual satisfaction for the beauty of the Hanok components,
3) Spatial Satisfaction: Checking by residents to measure sensory satisfaction for the interior environment,
4) Usability: Checking by residents to assessing spatial satisfaction for the planar layout of Hanok, and
5) Healthiness: Checking by residents to assessing their psychological satisfaction for design principles for Hanok such as Feng-Sui [10].

## III. Verification of the Methodology towards Practical Testbed of Hanok

### A. Standard Settings for Assessing Physical Indexes

As shown in Fig. 1, the comprehensive comfort index of Hanok is composed of 14 factors, and those can be divided into two main categories for providing a convenient way of the assessment. The first part is physical perception factors based on microscopic atmospheres of the building such as humidity, heat insulation property, air tightness and so on. The factors in this category can be analyzed before occupancy of building.

The other part is psychological cognitive factors based on residents' living experiences and spatial emotions such as usability for and beauty of Hanok. Assessment periods for these factors are during the pre-occupancy by residents. These two categorized factors can be assessed comprehensively, and Table I shows standard settings for measuring physical conditions of the Hanok comfort.

TABLE I
Standard Methods for Assessing Physical Properties of Hanok Comfort

| Factor | Definition | Measuring Method |
|---|---|---|
| Humidity Controllability | Humidity control performance of material and equipment | Sensor (Relative humidity) |
| Air Tightness | Resistance of air leakage | Tightness test (Leakage rate per unit area) |
| Air Cleanness | Dust , CO and $CO_2$'s ratio of indoor air | Sensor (the ratio of the air) |
| Dew Controllability | Natural ventilation performance of material and equipment | Ventilation test (Ventilation hour per unit) |
| Insulation Capability | Heat exchange performance of wall, slab and roof system | Plan analysis & Infrared camera |
| Heat Gain Effectiveness | Indoor solar energy gain or shielding | Sensor monitoring (wh) |
| Thermal Comfort | Measurement of residents' comfort conditions | Calculating PMV suggested by Dr. Fanger |
| Soundproofing | Sound absorption performance of interior material and sound insulation performance from outside sound | Sound absorption test (check the dB from both indoor and outside sound sources) |
| Sound Lighting | Natural and artificial lighting performance | Sensor monitoring (Lux) |

These suggested methods have been verified by applying for the practical testbed of Hanok properties. The regular measurements for physical conditions of Hanok comport have been performed for four different seasons in order to identify the adaptability to special weather conditions that can be appeared on Korean peninsula. Fig. 3 exemplifies a sort of normal environmental situation such as Spring and Autumn, and Fig 4 shows extraordinary conditions that requires special settings for the measurement system; they include a couple of abnormal conditions like Summer and Winter and/or any traditional features such as Ondol that is a heating system unlikely being used for the contemporary housing.

Fig. 3 Hanok testbeds using normal physical conditions and regular assessment settings

Fig. 4 Hanok testbeds with special comfort conditions

On the other hand, the assessment system for Hanok comfort in psychological conditions is a form of the questionnaire based on residents' responses derived from the field survey. Total of five items using a Likert scale are calculated for each element in priority and set. It occupies an important position in the higher value of those elements for Hanok comfort evaluation. Now, both physical and psychological assessment indexes are passed to be run with AHP to define each weight and differentiate the proportion of each value in order to induce the comprehensive comfort in one. A total of 50 people have participated in survey researches who are composed of 30 students in architectural major and 20 professionals including professors and workers in the field of Hanok as well.

## IV. Conclusion

The purpose of this study is to suggest an appropriate standardization methodology about comfort evaluation methods towards Hanok and to propose the new way of its assessment system. While collecting physical comfort data with the series of the respective equipment, psychological comfort factors could be analyzed through questionnaires in forms of the survey checklist. Then, comprehensive comfort scores have been derived from the weights and finally obtained.

The suggested assessment methodology includes both scientific, quantitative analyses and qualitative prediction that would show more accurate integrative results. It was turned that the result showed satisfactory records towards the establishment of KS for assessing Hanok comfort performance that can be emphasized as the most important strength of the Korean traditional residence. As ongoing research study, verifying performance grades should be processed to apply the suggested methodology for the practical field of Hanok.

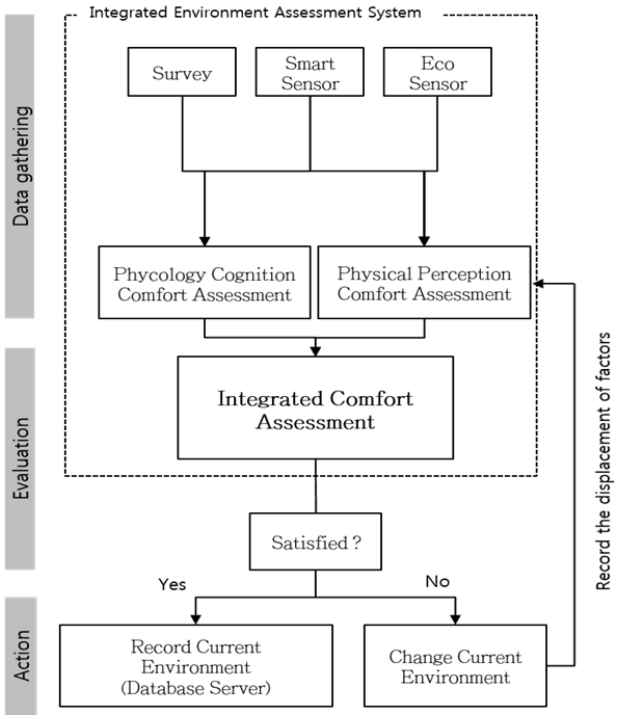


Fig. 5 Standard process for accessing the comprehensive Hanok comfort [11]

## ACKNOWLEDGMENT

This research was supported by a grant from Urban Architecture Research Program (Technology Development of Design and Construction for Large-Space Hanok over 10 Meters, Development of Hanok Technology, Phase III) funded by Ministry of Land and Transport Affairs of Korean Government. (Project No.: 17AUDP-B128638-01).

## REFERENCES

[1] T. Kim and S. Han, Integrated Evaluation for Environmental Comfort in Interior Space of Korean Traditional Residence, International Journal of Social Science and Human Behavior Study, Vol. 2 No. 2, 2015.
[2] S. Hong, "A study on the Users' Cognition of Symbolism in the University Architectures," The Architectural Institute of Korea Journal, Vol. 14 No. 3, 2012.
[3] Y. Choi, "Improvement measure based on the evaluation of the architectural color environment of downtown streets; focusing on the new and old urban centers of Daejeon city," Hongik University, 2011.
[4] J. Kim and S. Han, A Preliminary Evaluation System for the Facial Aesthetics of the Building Façade Using Colorful Materials, Proceedings of International Conference on Economics, Management and Social Study, Hungary, Budapest, Oct., 2017.
[5] S. Han, O. Im, M. Lee and D. Cheon, "A Study on the Establishment of an Evaluation System for Integrative Comfort," Journal of Korean Housing Association, Vol. 24, No. 6, Jun. 2013.
[6] T. Kim, K. Kim, S. Kim and S. Han, "A Composition of Monitoring System for Environmental Comfort Performance of Korean Traditional Residence," in Proceedings of the Second International Conference on Advances in Computing, Communication and Information Technology, Nov. 2014.
[7] Y. Kwon, "A Consumer Research for NEO-Hanok Maeul, Korean Traditional Style Village," Journal of Architectural Institute of Korea, vol. 26, no. 11, Nov. 2011.
[8] S. Min and T. Kim, "A Study on the Attractive Items of Hanok in Urban Area focused on Preceding Studies," Journal of Korean Institute of Rural Architecture, vol. 14, no. 3, Aug. 2012.
[9] S. Kim, K. Kim, J. Park and S. Han, "A Process of Value Assessment for Building Components of Hanok Residence," in Proceedings of the Second International Conference on Advances in Computing, Communication and Information Technology, Nov. 2014.
[10] S. Park, "A Study on the application of the Environmental Control Methods Expression in Korean Traditional Residence to Korean Modern Architecture," Master's Thesis, Korea University, 2011.
[11] T. Kim, K. Kim and S. Han, "Implementation of Intelligent Pre-Occupancy Evaluation for Hanok Performance," in Proceedings of 2015 International Conference on Advances in Agricultural, Biological & Environmental Sciences, July. 2015.