



전문가와 거주자 인식 관점에서 경량목구조주택 거주성 향상을 위한 발전방안 연구

Improvement Options to Promote Livability of Stick Wood Frame Houses from the Perspectives of Experts and Dwellers

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ABSTRACT

Purpose: According to prior research, Declining fertility rates and population aging have stirred up demand on the betterment of quality of long-term life style and qualitative livability, where dweller-perceived satisfaction with dwelling and type of eco-friendly high-quality houses are very important factor. **Method:** This study qualitatively analyzed the satisfaction and dissatisfaction factors rated by stick wood frame house dwellers about the livability of their dwellings in terms of interior and exterior physical aspects of stick wood frame houses, and proposed some feasible options to promote the improvement of the livability of stick wood frame houses based on expert opinions. **Result:** The findings of this study may be conducive to stick wood frame house dwellers' satisfaction with the quality of their dwellings and the advancement of localized technologies embodying the culture of Korean housing, and also provide some information applicable to stick wood frame housing, which will in turn serve as a significant variable in local housing market as an emerging type of dwelling.

KEYWORD

경량목구조주택
주택거주만족도
정성지표 분석
질적만족도

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Qualitative Study

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1. Introduction

1.1. Background and Purpose of Study

With the housing supply ratio exceeding 100% and reaching a saturation point in Korea, the needs of contemporary people enjoying the economic growth have varied to the extent that they now place a priority on eco-friendliness of and qualitative satisfaction with their dwellings. Subsequently, using eco-friendly materials whose affective, healthy and energy-efficient quality gives satisfaction, stick wood frame houses are increasingly supplied in Korean housing culture. Still, despite the growing interest in stick wood frame houses, whether the needs of dwellers are fully considered in stick wood frame house design has not been documented properly. Largely, previous studies were focused on technical development, e.g. the improvement of physical engineering and environmental performance of stick wood frame houses, with little attention paid to surveying stick wood frame house dwellers about their dwelling conditions and satisfaction based on the livability of stick wood frame houses[1].

Thus, using a qualitative method of analyzing the livability which goes beyond the existing quantitative statistic approaches,

this study cast light on the livability of stick wood frame houses based on diverse experiences of dwellers to identify relevant issues and problems and to propose some feasible options for promoting the improvement of the livability. Hence, by asking stick wood frame house dwellers to rate the livability of their dwellings, this study qualitatively analyzed the dweller-perceived dwelling conditions of stick wood frame houses to derive some issues and problems from the qualitative findings on the livability and gathered relevant opinions from experts for the purpose of gaining insight into promoting the improvement of the livability of stick wood frame houses.

1.2. Method and Scope of Study

This study analyzed the livability of stick wood frame houses by surveying the dweller-perceived architectural characteristics of stick wood frame houses and dwelling conditions thereof to illuminate some principal factors of dwelling satisfaction and quality issues and thereby gain insight into improvement options. Moreover, by refining the questions for the in-depth interviews based on the indicators derived from the literature review on multiple frames of reference, this inquiry case study conducted the qualitative and inductive analysis of the livability of stick wood frame houses.

Table 1. Data collection and analysis used in qualitative studies

Focus (finding)	Tradition	Data collection method
Society (description and analysis of groups)	Ethnography	Observation, interview, documents, recording
Sociological theory (development)	Grounded theory	Observation, interview, documents, recording
Experience (understanding of essence of empirical phenomena)	Phenomenology	Interview
Specific cases (Description of individual cases)	Case study	Observation, interview, documents, recording
Individuals (description of individual experience)	Life history research	Interview
Expert actions (Improvement of expertise)	Action research	Journal, interview documents, recording
Social interaction (explaining the meaning construction)	Conversational analysis	Recording

As for the sampling method used in this qualitative analysis of the livability rated by dwellers, the purposive sampling (Guba & Lincoln, 1985) was used to continuously extract the sample based on the gathered information until the information reported by each participant in the sample showed the repetitiveness comparable to given themes, unlike the statistical sampling. For the qualitative analysis of the interviews with the dwellers, the participant interviewees consented beforehand to have all the information they provided recorded. To identify any themes or patterns from the data, the constructs, findings, thoughts and feelings that formed certain patterns repeatedly found in the data were analyzed with the QSR Nivo 8.0 program, widely used for analyzing qualitative study data, prior to compiling. To find out any contradiction and gap in the records, and understand the participants' preconceptions or biases, expert opinions were sought repeatedly via the preliminary study[2].

The participants in this study were the stick wood frame house dwellers who had lived in their dwellings for one year or longer. Given the lack of experts and the scale of stick wood frame housing constructors in Korea, the target area was limited to the capital area. This study has limitations in that the small sample size hinders the generalization of its findings to the entire stick wood frame housing despite the facts in the field used to derive the livability ratings with the qualitative method.

2. Relevant Concepts

2.1. Previous Studies on Stick Wood Frame Houses

Until recent times, studies on wood frame houses mostly have

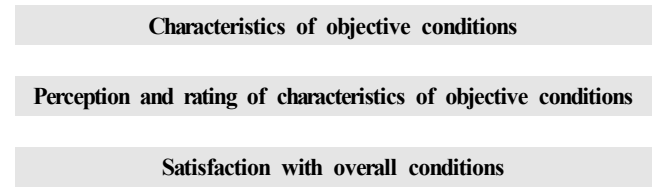


Fig. 1. A conceptual model of livability rating by dwellers

dealt with structural characteristics, construction work and physical environmental performance, e.g. experiments on construction work and design of traditional wooden houses versus stick wood frame houses. For 20 years since the early 1990s, case studies have compared Japanese versus Korean wood frame houses, investigated hanok as the traditional timber frame housing and also comparatively analyzed the types of wood frame house structures in Korea and overseas countries focusing on the early stages of stick wood frame housing. More recently, studies have delved into stick wood frame house production technology and improvement of construction work performance including new structures and materials of stick wood frame houses, construction methods, and improvement of indoor air quality and insulation performance[3]. Yet, no socio-cultural case study has been conducted concerning the lifestyle values, housing needs and dwelling conditions based on the life and experience of dwellers living in stick wood frame houses.

2.2. Analyzing the Livability of Stick Wood Frame Houses

Christian Noberg-Schulz defines the concept of dwelling as setting a meaningful relationship between humans and given environment (Schulz, 1995). To analyze the man-perceived livability, physical attributes should primarily be analyzed, for which quantitative and qualitative study methods were derived. As the definition of livability went beyond the physical housing characteristics and embraced the perception of dwellers, it became necessary to use the indicators focused on the ratings by actual dwellers rather than the physical factors (Choi, 2005). Previous studies relevant to the analysis of livability were continuously published until the mid-1980s, laying the foundation for further studies on new indicators proposed in the late 1980s. Additionally, to address the challenges resulting from the limitations of quantitative methods of including people as dwellers in the analysis of livability, qualitative methods have become inevitable

In Korea since the early 2000s comprehensive analysis methods dealing with the qualitative methods applicable to the analysis of dwelling conditions and the livability rating were first proposed. To develop the framework for the qualitative indicators for the analysis of livability, existing livability ratings and relevant

Table 2. Overview of previous works[3]

Author (Year)	Content	Comparative study	Experimental study	Design study
Moon Jihun (2022)	In-situ Measurement and Analysis of Thermal Resistance and Thermal Transmittance of Light Weight Wooden Exterior Wall		■	
Jang Hwa (2020)	A Study on Small Weekend Housing Design System for Small Families			■
Lee Jeonghun (2017)	Hygrothermal Behavior of Envelope of Stick Wood Frame Passive Houses		■	
Park Yongho (2016)	A Study on the Efficiency of BIM in Small Wooden Project		■	
Uh Sooil (2016)	Frame System and Structural Performance of Hybrid-type Composite Timber Structural Members		■	
Miyaz Yuji (2010)	Experimental Study on Seismic Response Control of Wooden House with Knee-Brace Oil Damper		■	
Byeon Jaeyoung (2010)	A Study on the Suburban Housing Complexes from an Ecological Point of View			■
Jo Gwanhaeng (2010)	Airtightness and Insulation Performance for Test House with Wood Frame		■	
Kang Youngseok (2009)	VOCs Emission Characteristics of Various Wood Coatings and their Effects on Indoor Air Quality		■	
Kim Younghun (2009)	Another Redesigning Proposal for the Densely Built Area by Using of Transferable Floor Area Ratio	■		
Lee Inchan (2008)	Racking Property of Light-framed Shear Wall with Hold-down Connector		■	
Ahn Gukjin (2007)	Wooden Housing Production and Technology for Sekisui Houses		■	
Ahn Jaeyun (2007)	Loess (Yellow Soil) Finishing Materials Using Water-based Adhesive for Wooden Construction Indoor Wall		■	
Kim Jaedeok (2007)	A Study on Plan Module Setting for Prefabricated Wooden Houses			■
Kang Manho (2007)	A Study on the Plan Modular Establishment for the Development of Wooden Dwelling Model			■
Kang Manho (2007)	A Study on Factors Influencing Demand for Wooden Houses	■		
Hirai Kenzi (2007)	A Study on Local Differences of Wooden Home Buildings by the Conventional Method of Construction	■		
Kim Jaedeok (2006)	A Study on Plan Module Setting for Prefabricated Wooden Houses			■
Ahn Gukjin (2006)	Wooden House Production System and Technology in Australia and New Zealand	■		
Kim Hwa (2002)	A Study on Roof-construction Method of Traditional Wooden Architecture : Comparison with Construction Method of Light Framing Architecture	■		
Seo Myeonglim (2000)	A Study on Stick Wood Frame House Design via Ecological Approach			■
Yu Younghee (2000)	A Typological Study on the Floor Plan of Wooden House in the Suburbs of Korean Cities	■		

indicators and checklists were adapted for the participants and then specified based on the review by stick wood frame house experts. The analysis of the livability of stick wood frame houses parallels the post occupancy evaluation(P.O.E), in that systematic and objective methods are used to analyze multiple factors of satisfaction and dissatisfaction with stick wood frame houses from the aspects of quality based on the responses gathered from the dwellers who have been living in their stick wood frame

houses since the completion of construction. Therefore, the analysis of livability is applicable to the P.O.E of the dweller-perceived livability but not to the pre-occupancy evaluation[5]. The important components in the analysis of livability should be constructed in light of multiple environmental contexts involving the empirical methods by components, functions, technologies, design stages and construction work process. The performance and technology items included in each

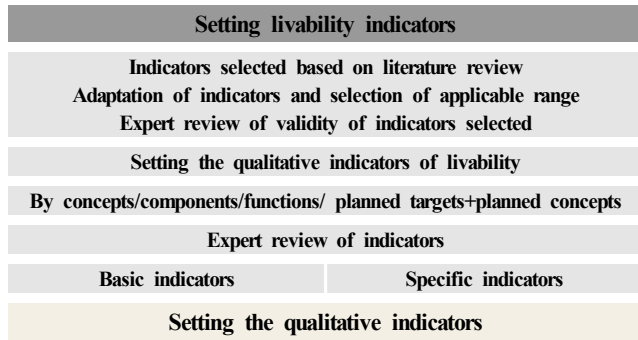


Fig. 2. Step-wise selection of indicators for livability rated by dwellers

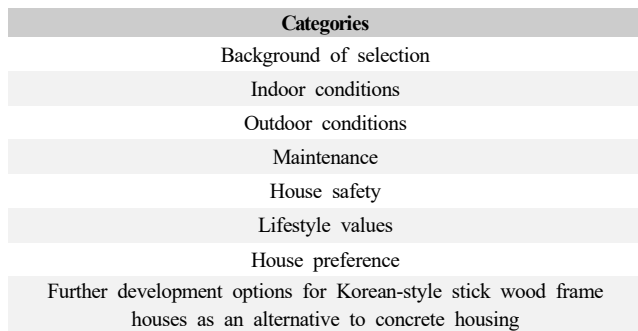


Fig. 3. Items relevant to the livability of stick wood frame houses

range of livability correspond to the physical characteristics items. Hence, the qualitative method of analyzing the livability was deemed a highly applicable and feasible analysis tool (Choi, 2005).

Based on the literature on qualitative indicators for livability rating, experts reviewed the validity of the items relevant to the livability of stick wood frame houses prior to setting the final indicators[3].

3. Livability of Stick Wood Frame Houses Rated by Dwellers

3.1. Livability Rating

To analyze the livability of stick wood frame houses, this study gathered some inductive cases of particular conditions based on architectural characteristics and dwelling conditions by means of observation, interviews, documents and recording, prior to conducting the qualitative case analysis and collecting the expert opinions. The participants in this study were the owner-dwellers of stick wood frame houses, who had gone through every aspect from stick wood frame house construction to dwelling. A total of 17 households were interviewed. Each participant had 1~3 interviews. Each interview lasted for 50~80 minutes. The interviews were open-ended regardless of the sequence of prepared questions on the interview sheets, followed the conversational flow and were recorded. After the interviews, the field study was conducted in reference to the descriptions of the

Table 3. Concepts and categories extracted

Categories	Subcategories
Background of selection	Personal preference
	Preference for surrounding environment
	Preference for wood frame houses
	Preference for detached houses
Indoor conditions	Interior design
	Indoor humidity
	Indoor insulation
	Indoor noise
	Air circulation
Outdoor conditions	Exterior design
	Easy exterior alteration
	Exterior finishing
	Nature-friendly environment
	Yard and deck
Maintenance	Exterior maintenance
	Interior maintenance
	Maintenance cost
House safety	Waterproofing
	Fire safety
	Response to natural disasters
	Security & public order
Lifestyle values	Contribution to health
	Emotional well-being & atmosphere
House preference	Economic value
	Preferred space
	Frequency of use per space
	Preferred members
	Intention to re-select
Further development options for Korean-style stick wood frame houses as an alternative to concrete housing	Intention to recommend
	High-rise construction
	Adaptability to climate
	Low availability of land
	Housing culture
	Stick frame construction technologies

facilities, interior and exterior, floor plans and photographs of stick wood frame houses. Also, post-interview expert opinions were gathered before asking additional questions of the participants and experts by email and phone. To preclude any case and opinion from manipulation or distortion and to analyze and verify the cases and opinions in natural contexts to the maximum extent possible, the qualitative multiple case study method was used. First of all, stick wood frame house dwellers were interviewed about their dwelling conditions to derive relevant problems and issues, which in turn underwent continuous questions and comparative analysis to name the concepts and then categorize comparable concepts. The attributes and dimensions of those categories were developed

further to determine the final factors. The recorded interview audio files were transcribed into texts, which were in turn analyzed with QSR Nvivo 8.0 to extract a total of 168 concepts, 35 subcategories and 8 categories. Following the assessment of the extracted final content by the panel of experts based on the foregoing categories via phone calls and email attachments, the advised design, construction work and structural improvement options were proposed[3]. The extracted 8 final categories and 35 subcategories were further developed to comprise the following specific items.

3.2. Assuring the Validity and Reliability

To add to the reliability prior to selecting the items used for the livability rating, this study reviewed the questionnaire surveys and interviews used in a range of previous studies. Also, to preclude participants' subjectivity to the maximum extent possible, the response options were sub-classified for raters, while simultaneously overlapping questions dealing with similar content were set to increase the reliability. Moreover, to help the participants understand the purpose of the interview and to increase the accuracy of their responses, they were fully informed of the survey beforehand. As a way of increasing the validity of this study, the inclusion criteria required of prospective participants the experience of dwelling in concrete housing for at least one year in addition to their dwelling in stick wood frame

Table 4. Step-wise survey on dwelling conditions of stick wood frame houses

Step	Approaches	Purposes & meanings
Planning	• Defining goals & plans	• Establishing the purpose of the survey on dwelling conditions of stick wood frame houses
Preliminary survey	• Literature review • In-depth interviews with target housing dwellers • In-depth interviews with experts • Writing up question items	• Based on literature review & survey with experts in accordance with qualitative study process, objective issues are derived to prepare the interview sheets. • Reconstructing the content of the interview sheets via preliminary survey and expert opinions
Survey & rating	• In-depth interview with participants • Field study & analysis and experts' opinion	• Qualitative analysis of interview texts • Establishing the content through field analysis and expert opinions
Gathering results	• Gathering in-depth interview results • Gathering field study results	• Comprehensive analysis of qualitative study and results

houses, and set the lower limit of the period of their dwelling in their current stick wood frame houses to comparatively analyze the dwelling conditions of the concrete versus stick wood frame houses. Then, the analysis findings on the participants' responses and experts' opinions were reviewed by stick wood frame house associations, architects, construction workers and owner builders. In selecting the specific question items, instead of simple Yes or No questions about the factors of dwelling conditions as used in previous studies, the questions were constructed in connection with the characteristics of dwelling in stick wood frame houses to elicit more specific responses. To preclude the bias of the interviewer, the interviewer kept neutrality and described the data collection and analysis process in detail[4].

4. Results

4.1. Analysis Results of Livability Rated by Dwellers in Stick Wood Frame Houses

Based on the analysis of the content gathered from the interviews with 17 participants, positive and negative words were derived and ranked in order of frequency.

The primary positive responses (or words) were relevant to humidity control, insulation performance, yard and deck and emotional well-being and atmosphere, whereas the primary negative responses were relevant to construction work and soundproofing. Based on the comparative priorities of improvement options depending on the characteristics of dwelling in stick wood frame houses, the following specific factors relevant to dwellers' dissatisfaction with stick wood frame houses need to be improved.

Based on the analysis findings on dwelling conditions of stick wood frame houses, the dweller-perceived satisfaction factors were optimal indoor humidity, optimal indoor temperature, indoor air circulation, easily alterable interior structure, yard and deck, easily alterable exterior environment, nature-friendly environment, contribution to dwellers' health improvement, contribution to dwellers' emotional well-being, agreeable aesthetic individuality and short construction period.

The present analysis of dwelling conditions of stick wood frame houses highlighted the dweller-perceived dissatisfaction factors, viz. the lack of soundproofing, unprofessional construction work resulting in defect repair, difficulties in purchasing simple building materials, endless exterior maintenance, and security concerns. Notably, the analysis findings underscored the needs for improvement such as noise-proofing reinforcement, harmony of construction work and design considering earthquake and fire resistance,

Table 5. Priorities of dweller-perceived improvement factors of stick wood frame houses

Item	Indoor conditions		Outdoor conditions	Lifestyle values		Indoor conditions	Outdoor conditions	Indoor conditions	House safety	Maintenance	Indoor conditions
	Humidity control	Insulation performance	Yard & deck	Emotional well-being & atmosphere	Health	Indoor ventilation	Exterior design	Interior design	Fire safety	Construction technology	Sound-proofing
Rank	1	2	3	4	5	6	7	8	9	10	11
Positive	17	16	16	16	15	14	13	13	11	10	10
Negative	0	1	1	1	1	3	4	4	6	7	7

Table 6. Dweller-perceived satisfaction factors of stick wood frame houses

Item	Factor	Dependent variables
Factor 1	Humidity control	Less frequent use of humidifiers, getting better from respiratory and skin problems, cool and pleasant air quality due to good humidity control and ventilation, indirect experience of efficacy of natural materials
Factor 2	Insulation performance	Coolness of indoor air in summer, warmth of indoor air in winter, insulation effects are kept while the house is left empty.
Factor 3	Outdoor yard & deck	Small patches in the yard, decks used in replacement of small yards, duration of staying in the yard and deck, the place where dwellers are close to nature while feeling four seasons
Factor 4	Emotional well-being & atmosphere	A house surrounded by nature and inseparable from nature, interactions with neighbors at each other's eye levels, a house where they lie and see constellations, a house where they fall and roll over without getting hurt, a warm house without coldness, a house distinguishable from a distance
Factor 5	Health	Recovery from atopic diseases after long-term dwelling, recovery from respiratory diseases, sound sleep, recovery from heart diseases, healthy and long-term dwelling

specialization of construction technologies fit for Korea, development of more durable eco-friendly exterior materials for stick wood frame houses, affordable energy-saving options applicable to small houses, development of structures optimal for earthquake resistance and high-rise buildings, and improvement of integrated guidelines free from popular misconceptions and prejudices[5].

4.2. Improvement Options for Stick Wood Frame Houses Proposed by Experts based on Findings on Livability

Wood frame house experts proposed the improvement options based on the problems reported by the participants. Defects and problems were classified into three aspects, i.e. design, construction work and structural aspects, to derive relevant improvement options. The defects and problems found in indoor, outdoor and indoor/outdoor spaces and relevant improvement options are outlined in Tables 1, 2 and 3 below.

As analyzed in Table 8, ~10., based on the analysis findings on livability of stick wood frame houses, the expert opinions suggested the improvement options for the physical components of indoor space, i.e. windows, boilers and basements, and for those of outdoor space, i.e. the structural design of outdoor space, exterior building materials, roof joints, lighting and

decking. Also, in terms of the indoor and outdoor spaces, the structure, design and construction work of front doors, ventilation, drainage and water supply, indoor and outdoor security were proposed to be improved as outlined in the tables above based on the expert opinions.¹⁾

5. Conclusion and Implications

The qualitative survey was conducted by way of in-depth interviews about 8 categories and 31 specific items with 17 households dwelling in stick wood frame houses in the capital area to analyze the livability of stick wood frame houses in Korea. The 8 categories were the background of selecting stick wood frame houses, indoor conditions, outdoor conditions, maintenance, safety, lifestyle values, preference for stick wood frame houses, and satisfaction with stick wood frame houses as an alternative to concrete housing. In particular, the pleasant indoor air, humidity control and positive effects on dwellers' emotional well-being and health were found to be differentiated advantages of stick wood frame houses versus concrete housing. Yet, the maintenance and security were found to be the dissatisfaction factors in comparison to concrete housing[6]. That said, all participants wanted to continue to dwell in stick wood frame houses and rated high the physical advantages and

Table 7. Dweller-perceived dissatisfaction factors of stick wood frame houses

Item	Response	Dweller-perceived needs for improvement
Insulation performance	<ul style="list-style-type: none"> All participants gave positive responses about the superiority of materials providing coolness in summer and warmth in winter. Negative responses about the failure to deal with heating costs in contrast to their experience of dwelling in apartments. Long-term dwellers responded the heating cost less by 20% or so owing to the superior insulation effects of framing lumbers and the materials in walls and roofs. 	<ul style="list-style-type: none"> Extra attention needs to be paid by construction workers to dealing with the insulation materials inbetween framing lumbers of roofs and walls. Insulation performance is more about design than wood materials. Using window awnings and curtains, multifaceted energy-saving options need to be sought.
Yard & deck	<ul style="list-style-type: none"> Respondents were satisfied with yards and decks in connection with the pros of detached housing but negative about the hassle of endless yard maintenance. Respondents raised concerns about wood materials for their susceptibility to uv rays, moisture, temperature change and mold, resulting in discoloration and rot. 	<ul style="list-style-type: none"> Less deformable, easy-to-care and eco-friendly treated timbers(ACQ) need to be used. Regular oil stain coating is needed to add colors to breathable wood surfaces as desired. Only rotten or denatured lumbers need to be replaced. As in the US and Canada, materials need to be available to dwellers in large hardware stores so that they can easily replace/care denatured timber.
Emotional well-being & atmosphere	<ul style="list-style-type: none"> Respondents were overall satisfied with Korean-style villages, roofs, housing and yard atmosphere rather than the ambience inside the house per se. Easily available natural timber forms a harmony between nature and people. 	<ul style="list-style-type: none"> Wood frame houses are better for emotional well-being than other types of housing. Stick wood frame houses need to be harmonized with traditional Korean housing style. Yards and houses need to be built considering the overall atmosphere of the village.
Health	<ul style="list-style-type: none"> Convenience-oriented altered construction work compromises the public perception of wood frame houses. Few respondents hardly felt the health benefits of eco-friendly materials. Respondents preferred the warm lumber texture to the touch of cold concrete structures. 	<ul style="list-style-type: none"> Responses contrast with negative health experience in concrete housing, e.g. respiratory and atopic diseases. Positive responses and recommendation for natural humidity control leading to sound sleep and recovery from diseases. Extra attention need to be paid to interior and exterior finishing for wood frame houses to breathe.
Indoor ventilation	<ul style="list-style-type: none"> Cyclic natural ventilation and spontaneous humidity control of natural timber materials keep indoor conditions pleasant. Positive responses include recovery from atopic diseases and dry skin conditions. 	<ul style="list-style-type: none"> In that indoor ventilation is affected by not only stick frame construction materials but also the design and construction work of window shapes and placement, design is important as the participants responded.
Exterior design	<ul style="list-style-type: none"> Exterior design carrying the individuality reflecting dwellers' demand and easily alterable structure and design. Some respondents complained about dodgy adhesive work ignoring the properties of wood frames. 	<ul style="list-style-type: none"> Various non-standardized materials force dwellers to have trouble looking for materials for each repair and reinforcement work. More exterior wall finishing materials are needed.
Interior design	<ul style="list-style-type: none"> Despite little difference from concrete apartments in terms of floor plans, wood frame houses have thinner walls, which allow the better use of space. Wood materials need to be finished to visually deliver their warmth. Wood materials allow owners and designers to create various interiors at their discretion. 	<ul style="list-style-type: none"> Primarily relying on the plaster boards used as interior materials, the fire resistance of wooden structures need to be reinforced. Participants gave a negative response that they had insured against fire due to their concerns about the flammable stick frame construction materials and mentioned the need to reinforce the fire resistance of insulation materials and other materials including paints.
Fire safety	<ul style="list-style-type: none"> Most participants gave negative responses about fire attributable to their anxiety and concerns. Some gave positive responses about the relative openness of stick wood frame houses ensuring a safe evacuation. Some gave positive responses that stick frame construction materials produce less toxic gas, giving more leeway for evacuation. 	<ul style="list-style-type: none"> Exchange of diverse stick wood frame house technologies with advanced countries, and specialization of stick frame house construction suitable for Korean climate and sentiment are necessary to increase owners' trust in and preference for and the supply of stick wood frame houses.
Sound-proofing	<ul style="list-style-type: none"> Most participants agreed that stick frame construction materials are prone to noise and responded that Korean stick wood frame houses are fitted with the ondol floor system, which functions as a secondary filter for noise between floors in contrast to existing overseas stick wood frame houses and serves as a good soundproofing option. 	<ul style="list-style-type: none"> Since it is perceived that materials used for stick frame construction are more prone to noise transfer than other materials, accurate design and standard soundproofing materials need to be applied. Challenges caused by the noise of high-rise stick frame construction need to be addressed technically without fail.

Table 8. Problems and improvement options for indoor space of stick wood frame houses

Defects		Problems	Improvement options	
Indoor space	Windows	<ul style="list-style-type: none"> • Due to Korea’s distinct temperature change across four seasons, waterproofing, insulation, security, natural lighting, ventilation and views need be considered without fail. • Hot summer and cold winter air need be blocked from entering inside. Frame warping and gaps between windows and frames cause windows to malfunction, which needs attention but frequently occurs. • Ordinary windows, not the frames and windows for wood frame houses, cause problems. 	Design	<ul style="list-style-type: none"> • Without window standards, indiscreet design of large windows to meet owners’ need may cause issues related to fireproofing and earthquake-proofing. • Widespread apartment housing culture inhibits the potential diversification of sizes and styles of wood frame houses.
			Structure	<ul style="list-style-type: none"> • Windows whose openings are too wide for wall areas and that are too expansive and splendid against the law are prone to defects and earthquake-proofing issues.
			Construction work	<ul style="list-style-type: none"> • For airtightness of wood frame houses, specialized wood system doors and windows need to be used. • National standards for lightweight wood frame windows and doors should be established, displacing manufacturers’ arbitrary standards. • Plastic U-PVC windows need to be installed for airtightness. • Insulation bars need to be reinforced to prevent the thermal bridge between the inside and outside of the building envelope. • Aluminum or vinyl resin needs to be used for exterior window frames. • Waterproofing the inside and outside of windows and doors in compliance with installation methods is important.
	Boiler	<ul style="list-style-type: none"> • Cleaning the boiler increases thermal efficiency but maintenance is a hassle. • Normally, boilers are replaced after 8~10 years of use including partial repairs and costly breakdowns. 	Construction work	<ul style="list-style-type: none"> • Geothermal system is used instead of solar system prone to summertime overloads and restrictions on installation areas. • For long-term cost savings, solar energy is used for heating and warm water in addition to fireplaces. • Specialized management system is needed. • Heating system is very important in Korean stick wood frame houses, and the installation of a slightly higher capacity than standard is recommended.
	Basement	<ul style="list-style-type: none"> • Dodgy construction work leads to rainwater leakage, damp patches and molds. • Steep narrow stairways cause ventilation issues. • Musty smells build up and natural lighting is hard to bring. 	Construction work	<ul style="list-style-type: none"> • It is better not to have a basement. • Basements cause the construction cost to double. • In basements, extra attention should be paid to leakage, ventilation and flammables. • Basements require forced mechanical ventilation and artificial lighting. • When a homeowner insists on a basement, waterproofing and ventilation systems need be installed outside with a sunken for natural ventilation. • Double walls need to be installed.
	Structural design	<ul style="list-style-type: none"> • Any failure to fully review and reflect owners’ needs in design plans causes inconvenience in everyday life and dissatisfaction with the house across the board, compromising the quality of life. • Additional modifications and alterations cause hassles, financial losses and waste of time. • Adjustment issues are serious. 	Structure	<ul style="list-style-type: none"> • Structural construction work per se is favorable. Construction cost and financial aspects are challenging. • Fundamental structure and design can be reinforced. Technical reinforcement is needed.
			Construction work	<ul style="list-style-type: none"> • Detached houses are hardly bothered by noise unlike apartments. • Spaces are possibly designed to be placed separately to block noise. • Despite an increasing number of constructors, substandard skills of small businesses have caused negative images of wood frame houses. • Large businesses now focus on construction work, lacking in development of materials.
	Structural finishing & ventilation	<ul style="list-style-type: none"> • Dodgy construction work and finishing cause substantial ventilation issues. • Stagnant indoor air causes stuffy atmosphere and moisture. • Among other indoor spaces, kitchen and bathroom ventilation problems are serious. 	Design	<ul style="list-style-type: none"> • Initial lot design needs to consider natural ventilation, with large/small and high/low windows properly designed. • Not only framing lumbers but also design needs to be used for better indoor air flows through natural ventilation around the house.
			Construction work	<ul style="list-style-type: none"> • Ventilation system for the lot and the area for ventilation need to be secured. • Effects of materials are maximized and both natural and forced ventilation systems need to be installed. • Hybrid ventilation systems are used.

Table 9. Problems and improvement options for outdoor space of stick wood frame houses

Defects		Problems	Improvement options	
Outdoor space	Outdoor alteration	<ul style="list-style-type: none"> Any failure to fully review and reflect owners' needs in design plans causes inconvenience in everyday life and dissatisfaction with the house across the board, compromising the quality of life. Additional modifications and alterations cause hassles, financial losses and waste of time. Heavy wintry precipitation and ice on steep outdoor slopes cause trouble to snowplowing and driving. 	Design	<ul style="list-style-type: none"> Home owners' opinions must be maximally considered in design, which is why communication with owners is important. Design should be done within a reasonable budget and pursue universality with essential requirements being considered without fail. Hot wires are installed for black ice to melt.
			Structure & construction work	<ul style="list-style-type: none"> In budget planning, work out costs properly. Finishing materials are consumable and replaceable, which need to be considered in budget planning. Sand and potassium chloride boxes need to be kept at hand for heavy snow.
	Exterior building materials	<ul style="list-style-type: none"> Wood surfaces need to be painted every 3-5 years, which troubles homeowners Imported exterior building materials are expensive. 	Construction work	<ul style="list-style-type: none"> Diverse materials need to be used. Artificial wood products, points of wood plastic composites and dry exterior building materials are developed for preservation. Localized exterior building materials need to be developed and supplied to reduce the reliance on costly imported exterior building materials. In replacement of the existing cement boards, it is essential to locally manufacture cost-effective fire-proof coated panels which allow the diversification of design (e.g. timber and exposed concrete looks). Oil staining and coating reduce shrinking. The frequency of re-coating need to be reduced by using exterior finishing materials which ensure the longevity of paintwork.
	Roof joints	<ul style="list-style-type: none"> Heavy rain storms cause flooding of eaves troughs and gutters. Roof joint boards are lifted, causing leakage, attracting dead leaves contracting rot and decay, and shortening the roof life. Prolonged stay of rainwater causes materials to contract rot and then holes, leading to leakage. 	Construction work	<ul style="list-style-type: none"> Reinforcement in construction work is important. Manual skills of construction workers and design are also important (workmanship, attentiveness and mind-set). Copper used for eaves trough and gutter systems discolors over time. A range of products need to be developed, e.g. steel-coated plastic materials. Roof materials need to be installed to be exposed by 5cm or so for water to fall. Spots affected by trees and water need to be minimized. Corrosion-resistant long-life copperplate eaves trough and gutter system need to be used. The size of eaves troughs should be considered for heavy rain-storms. Anti-rust coated steel- and copper-plates need to be used to prevent defects, instead of thin metal plates prone to rainwater leaks.
	Lighting	<ul style="list-style-type: none"> It looks darker in the yard at night. Seasonally, trees block sight. Lighting needs to be installed to highlight different parts in different ways. Automatic lighting systems fitted with smart brightness control features need to be installed. 	Construction work	<ul style="list-style-type: none"> Eco-friendly solar lights need to be installed. Intelligent energy-efficient light control system with hassle-free automatic time settings.
	Deck	<ul style="list-style-type: none"> Decks are widely installed in small yards. Prolonged exposure of deck boards to outdoor environment lead to rot and decay. Decks become slippery due to dew or rain. 	Design	<ul style="list-style-type: none"> Decks are designed to be separate from the main body of the house. Each decking board needs to be installed and separately removed for repairing.
			Construction work	<ul style="list-style-type: none"> Wood plastic composites are costly but prevent decks from rotting. Continual maintenance Composite wood, not treated wood, is used. Decking is potentially developed into a free-standing prefab structure. Non-skid deck coating or carpets are applied.

Table 10. Problems and improvement options for further development

Defects		Problems	Improvement options	
Indoor & outdoor space	Doors	<ul style="list-style-type: none"> Changing seasonal temperature and humidity cause wood materials to shrink and swell, leading door frames to deformation, cracks and joint defects until the wood is seasoned. 	Construction work	<ul style="list-style-type: none"> ABS doors made of wood plastic composites are used to prevent deformation. Construction worker training and supply is important. Even a 1-cm hole causes substantial heat loss. Gaps at the top and bottom of insulation materials placed 40cm apart cause waterproofing and insulation defects. Manufacturers have set internal standards. No national standards exist. Precision construction work complies with widely used standards. Extra attention needs to be paid to patio door water-proofing, wind-proofing and insulation. Door materials need to be chosen considering locations of houses, e.g. mountain and sea, and seasons. Front door insulation performance must be reinforced. Chinks in doors must be finished with waterproofing. Well-dried materials must be used for interior wooden doors (moisture content; 13~15%).
	Drainage & water supply	<ul style="list-style-type: none"> Blocked sewerage pipes are usually repaired by strata managers. Yet, for a lot owner to repair blocked pipes is a real hassle. Backflow causes sewage stench. Everyday oil waste poured down the drain is rapidly cooled and clotted into solid, causing a massive problem. 	Design	<ul style="list-style-type: none"> Underground cesspit must be designed to be easily replaced and cleaned.
			Construction work	<ul style="list-style-type: none"> Pipes wider than standards are better. Wide drainage must be designed initially. Separate pipes need to be installed depending on water usage to disperse wastewater. Drain traps must be installed to prevent any domestic wastewater overflow and stench. Pipes need to be sloped to facilitate draining.
	Vent	<ul style="list-style-type: none"> Improper construction work and finishing causes ventilation issues. Indoor air quality gets worse in winter unlike in summer when it is easy to keep houses well ventilated. Stagnant indoor air flow causes stuffiness and moisture. Kitchen and bathroom ventilation issues 	Construction work	<ul style="list-style-type: none"> Interior finishing materials, e.g. silk wallpaper, block the air flow, causing humidity control and ventilation issues. 24h ventilation system (hybrid ventilation system) is used. To meet increasing demand, large businesses have rushed to invest in the market for preemption rather than profits. Diverse materials need to be localized.
Construction work			<ul style="list-style-type: none"> Aluminum shutters for upstairs windows are developed. Outdoor shutters add insulating effects. People inside the house sleep with shutters rolled down. Shutters deter trespassers. Shutters are effective for natural surveillance. Still, the same direction the windows face compromise the neighborhood watch, which challenge need be addressed. 	
Security	<ul style="list-style-type: none"> Security concerns Hiring private security services Neighborhood watch 	Construction work	<ul style="list-style-type: none"> Aluminum shutters for upstairs windows are developed. Outdoor shutters add insulating effects. People inside the house sleep with shutters rolled down. Shutters deter trespassers. Shutters are effective for natural surveillance. Still, the same direction the windows face compromise the neighborhood watch, which challenge need be addressed. 	

lifestyle values of stick wood frame houses[7]. The present findings imply that technical reinforcement and product development will contribute to increasing the satisfaction with the quality of dwelling in stick wood frame houses, and also that Korean housing market has the potential to supply the stick wood frame houses utilizing localized technologies and to develop the industry through the betterment of livability.

In Korea faced with declining fertility rates and super-aging population, policy makers should reduce apartments in future new-town projects and instead develop some national projects

ensuring a balanced supply of detached and fusion housing to enable a systematic supply of stick wood frame houses and to increase the efficiency of home buying with small-scale housing complexes and small-size homes assuming the characteristics of stick wood frame houses. Furthermore, the advancement of stick wood frame house construction methods and research on construction technologies suitable for future domestic housing market will be conducive to establishing a systematic stick wood frame house construction system, diversifying the types of housing in Korea, increasing the satisfaction with the quality of

dwelling, and quantifying the stick wood frame house construction system, which will in turn add to the supply and development of stick wood frame houses as an economically feasible, stable, energy-efficient and eco-friendly housing option.

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