A Study on Recommendations for Improving Minimum Housing Standards

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Posted Date: 30 August 2023

doi: 10.20944/preprints202308.2054.v1

Keywords: minimum housing standard; housing rights; Korea housing survey; semi underground house

Article

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Abstract: Minimum housing standards aim to safeguard housing rights and enhance residential conditions. Governments develop housing policies, including provision, preservation, and support for welfare programs, guided by the status of households below these standards. Growing nations commonly utilize this approach to decrease the proportion of households not meeting these criteria. In South Korea, the ratio of households below these standards was 4.5% in 2021, down from 16.6% in 2006, as indicated by the initial Korea Housing Survey. However, this downward trend has stalled over the past decade. With the 2004 and 2011 revisions, the standards have been effective for 12 years, yet no longer mirror current housing realities due to ongoing improvements. This study aimed to propose enhancements to Korea's minimum housing standards. Through analyzing laws, prior research, present household statuses, international cases, and expert insights, recommendations emerged. Categorizing households by size, we developed precise standards covering area, facility, and location aspects. These new standards led to an 8.4% non-compliance rate in 2021. This research's findings anticipate aiding the revision of minimum housing standards, formulating pragmatic policies for enhancing residential conditions in line with present situations.

Keywords: minimum housing standard; housing rights; Korea Housing Survey; semi-underground house; accommodations for students studying for exams

1. Introduction

1.1. Research Background

In the past, South Korea maintained a supply-based housing policy to address the shortage of housing inventory. With the steady increase in the housing supply rate, however, people have become more interested in the quality of housing, as well as related demands. In particular, South Korea has shown a growing interest in solving unique problems in the country, such as providing accommodations for students studying for exams and developing compact buildings with small rooms. In this sense, the Korean government has broadened the spectrum of housing policies by including housing management and welfare, rather than adhering to supply-based policies.

As the housing policy has focused more on welfare, there has been a need to create comfortable residential environments, apart from the supply of sufficient housing. The necessity for housing that satisfies minimum housing standards has been the most important factor, because if the stability and comfort of housing are not guaranteed, people would have to continuously live with anxiety [1-6]. Under these circumstances, minimum housing standards were provided for people to live in comfortable and stable residential environments, resulting in the establishment of standards regarding room configuration, area, essential facilities, and structure/performance/environment for the first time. The minimum housing standards suggested by the Ministry of Construction & Transportation (Currently, the Ministry of Land, Infrastructure and Transport) in 2000 were enacted into law in 2004 as the "Housing Act" or "Enforcement Decree of Housing Act," and they have since been applied to housing policies along with the enhancement of area standards in 2011 [7,8].

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Despite the newly strengthened standards, the ratios of households below the minimum housing standards showed a general decreasing tendency, falling to 4.5% in 2021 (Table 1) [9]. A steady supply of new housing, a decrease in the average number of household members, a drastic increase in one- to two-person households, and a decline in substandard houses have been reported as contributors to the decline. As the ratios of households below the minimum housing standards have decreased, the minimum housing standards required by people have naturally improved. Additionally, the suitability and effectiveness of the revised 2011 minimum housing standards have been in question due to the current situation of housing inventory and supply.

Table 1. Households below the minimum housing standards in South Korea [9].

	2006	2008	2010	2012	2014	2016	2017	2018	2019	2020	2021
Ratios (%)	16.6	12.7	10.6	7.2	5.4	5.4	5.9	5.7	5.3	4.6	4.5

1.2. Research background and purpose

This study was conducted for the following reasons:

First, we investigated the areas of small houses of 60m² or smaller and determined the area standard of the minimum housing standard in 2011 while considering the area of the bottom 3% of them. However, we assumed that the current bottom 3% standard would be higher than that in 2011. Second, as the residential area per capita generally increased from 20.2m² in 2000 to 33.9m² in 2021, there should be considerations regarding this tendency (Table 2) [9]. Third, as the physical characteristics of Koreans have changed, there should be new standards considering the human scale. Fourth, facility standards should be reconsidered. Finally, it is necessary to prepare standards regarding the quality of housing and housing safety, which are not included in the current minimum housing standards. In Korea, safety accidents in semi-underground houses due to flood damage have become a recent social issue, and the government has implemented a policy to remove semi-underground houses [10].

Accordingly, this study aims to propose a new minimum housing standard and measures for utilizing policies.

Table 2. Average residential area per capita (m²) [9].

2000	…	2006	2008	2010	2012	2014	2016	2017	2018	2019	2020	2021
20.2	…	26.2	27.8	28.5	31.7	33.5	33.2	31.2	31.7	32.9	33.9	33.9

2. Materials and Methods

2.1. Definition of Terms

2.1.1. Minimum housing standards

As minimum housing standards are intended to guarantee people's housing rights, we categorized the standards into area, bedroom, facility, and location criteria. While standards can be subjective depending on the era and viewpoints, we aimed to establish them in as objective a manner as possible.

2.1.2. Area standard

This standard pertains to the minimum area required by a resident in a house. We established an "exclusive residential area," defined as an enclosed space usable exclusively by a resident upon opening the front door, as the area criterion. For multi-unit dwellings, we excluded communal areas like hallways, parking lots, elevators, and open spaces. Regarding detached houses, non-exclusive residential areas such as yards and detached parking lots were excluded.

The essential rooms included bedrooms, kitchens or dining rooms, bathrooms, and other spaces, which were aggregated to calculate the ultimate exclusive residential area.

2.1.3. Bedroom standard

This standard defines the quantity and types of specific rooms that must be provided for each household member. The variables of "per household member" encompass the number, age, and gender of household members.

2.1.4. Facility standard

This standard pertains to the facilities that residents must have while living in houses. We focused on the following facilities: (1) kitchen, (2) toilet, (3) bathing facility, (4) water supply facilities, (5) sewer system (septic tank), (6) heating systems, (7) fuel for cooking, (8) entrance (front door), and (9) fire-fighting appliances.

2.1.5. Location standard

This is the standard covered in this study for the first time, and it pertains to the location of a house. We aimed to establish a standard for the location of a house that may pose safety and health risks to residents [11]. In this study, we categorized houses into the following four types: underground, semi-underground, above-ground, and rooftop houses.

2.2. Scope and Methodology of the Study

We targeted households ranging from one-person households to six-person households. The sub-standards to be established were categorized into area, bedroom, facility, and location standards.

This research was conducted based on four steps: analysis of the current status, collection of expert opinions, derivation of improvements, and assumptions (Table 3).

Table 3. Research Methodology.

1. Current status analysis				
1.1. Analysis of the current status of households below the minimum housing standards in South Korea				
Data	Data from the Korea Housing Survey from 2006 to 2021			
Analysis targets	Households below the minimum housing standards Households below area, bedroom, and facility standards			
1.2. Overseas case studies				
United Kingdom and Japan				
2. Collection of expert opinions				
Date	March 10 – 31 2023			
Method	Visit in person or written questionnaire			
Field	Housing Policy	Housing Welfare	Facilities and Equipment	Housing Plan
Number	6	5	5	6
3. Improvements in minimum housing standards				
3.1. Prerequisite Settings				
Theoretical consideration of housing rights, and minimum housing standards in South Korea				
3.2. Direction for specific improvements				
Literature review	Analysis of the current status of households below the standards	Overseas case studies	Collection of expert opinions	
3.3. Design simulation				
Estimation of furniture sizes	Universal design	Human Scale		

 doi:10.20944/preprints202308.2054.v1

3.4. Improvements in minimum housing standards		
Area standard	Facility standard	Location standard
4. Estimation of households below the minimum housing standards based on new standards		
5. Suggestions for policy utilization of minimum housing standards		

First, we investigated households falling below the minimum housing standards to analyze the current status. Using data from the Korea Housing Survey spanning 2006 to 2021, we reviewed the situation of entire households below the minimum housing standards, as well as the status of households unable to meet sub-standards (e.g., areas, bedrooms, and facilities). In the section on overseas case studies, we focused on the United Kingdom and Japan, which employ similar housing standards to South Korea's and analyzed their housing standards. We selected these countries as target cases because their situations are akin to Korea's situation in terms of country size (e.g., area and population), population density, state earnings, and urbanization rates.

Second, we collected expert opinions. We interviewed 22 experts in four fields for approximately three weeks. The questions mainly consisted of topics that cannot be identified from the current status alone, and opinions regarding the outcomes of the current analysis.

Third, we derived improvements in minimum housing standards through three detailed methodologies. First, we derived a prerequisite based on theoretical studies. Next, we determined the direction for specific improvements, based on the outcomes from the literature review, analysis of the current status of households unable to meet the standards, overseas case studies, and expert opinion collection. We also conducted a design simulation considering estimates of furniture sizes, universal design, and human scale. Through these three methodologies, we suggested the final improvements based on the area, facility, and location standards.

Fourth, we estimated households not meeting the new standard for minimum housing standards. Finally, we suggested policy utilization measures for the minimum housing standards.

3. Theory and Literature Review

3.1. Theoretical considerations

3.1.1. Housing rights

According to the UN's Universal Declaration of Human Rights, housing rights pertain to economic, social, and cultural rights while safeguarding the right to live as a human being [12]. South Korea addresses housing rights in Article 35 of the "Constitution," which states: "All citizens have the right to live in a comfortable environment, and the state shall actively implement policies for this purpose" [13]. Article 2 (Housing rights) of the "Framework Act on Residence," enacted in 2015, asserts that "all citizens have the right to live in decent, comfortable, and stable residential environments free from physical and social dangers, as stipulated by related laws and ordinances" [14]. Article 3 of the same act outlines the responsibilities of the state and local governments in guaranteeing the housing rights of all citizens [14].

Several overseas studies define housing rights as follows. Pane et al. [15] provide the following definition: "The right to adequate housing is the right of all citizens without exception" [15]. Concerning housing rights, Kucharska-Stasiak et al. [16] indicated as follows: "Adequate housing conditions are an indicator of a decent life, whereas the lack is one of the main reasons behind so-called social exclusion. The importance of housing, in ensuring the social safety of citizens, as well as supporting social equity, has been emphasized for decades" [16]. Some studies also assert that basic residential conditions or conveniences are necessary to safeguard fundamental human rights and enhance human welfare [17].

3.1.2. Minimum housing standards in South Korea

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Article 17 of the "Framework Act on Residence" stipulates the establishment of minimum housing standards. Paragraph 1 of the Article states that the purpose of minimum housing standards is to set the necessary standards for people to maintain a pleasant and fulfilling life; the duties of the Minister of Land, Infrastructure, and Transport are to set and solidify the standards. In addition, Paragraph 3 of the Article specifies factors of minimum housing standards as follows: (1) residential area, (2) the number of rooms per use, (3) structure of a house, (4) facilities in a house, (5) performance of a house, and (6) environmental factors of a house [14].

Article 18 of the Act also stipulates the following priority supports for households below the minimum housing standards: (1) The State or a local government may give priority to supplying housing or subsidizing improvement funds for households below the minimum housing standards. (2) The State or a local government shall endeavor to reduce the number of households below the minimum housing standards. (3) The Minister of Land, Infrastructure, and Transport or the head of a local government shall take necessary measures for granting authorization and permission, such as issuing an order to supplement an application for approval for project plans in compliance with the minimum housing standard. (4) The Minister of Land, Infrastructure, and Transport or the head of a local government may take necessary measures to preferentially construct rental houses in an area densely packed with households below the minimum housing standards [14].

Although minimum housing standards play a crucial role as a policy indicator for the quality of housing, as mentioned in the Introduction, South Korea has not had a second revision since its enactment in 2004 and the first revision in 2011. Although the Ministry of Construction and Transportation (currently, the Ministry of Land, Infrastructure, and Transport) first proposed it in 2000, it was not eventually enacted into law, and then it was not discussed in this study. This study aims to suggest the second revision of the minimum housing standards, which have been applied in the last 12 years since 2011.

3.1.3. Minimum housing standards in South Korea (in 2004 and 2011)

Minimum housing standards were initially legislated based on the "Housing Act" in 2004. The number of household members was categorized into 1 – 6 persons, establishing a standard household composition and specifying the minimum residential area per standard household composition and the number of rooms per use (Table 4). Concerning facilities, households are obligated to have a private walk-in kitchen, a private flush toilet, and bathing facilities, along with water supply facilities or groundwater facilities with good water quality. Furthermore, for structure, performance, and environmental standards, four criteria are proposed to ensure housing safety and comfort as follows: (1) The permanent building must possess structural strength, and principal structural parts must be heat-resistant, fire-resistant, and moisture-proof. (2) Adequate soundproofing, ventilation, lighting, and heating facilities must be provided. (3) Environmental factors like noise, vibration, odor, and air pollution must adhere to legal standards. (4) Housing should not be situated in areas at significant risk of natural disasters like tsunamis, floods, landslides, and cliff collapse [7].

Table 4. Minimum residential areas per household composition, and number of rooms per use (2004, 2011) [7,8].

Number of household members	Standard household composition[1]	Space(room) Requirement[2]		Total living area (m^2)	
		2004	2011	2004	2011
1	One person household	1 K	1 K	12	14
2	Married couple	1 DK	1 DK	20	26
3	Parents + 1 Child	2 DK	2 DK	29	36
4	Parents + 2 Children	3 DK	3 DK	37	43
5	Parents + 3 Children	3 DK	3 DK	41	46
6	Grandparents + Parents +2 Children	4 DK	4 DK	49	55

 doi:10.20944/preprints202308.2054.v1

[1] Based on 1 child aged 6 years old and older in a 3-person household
Based on 2 children (1 male and 1 female) aged 8 years old and older in a 4-person household
Based on 3 children (2 males and 1 female, or 1 male and 2 females) aged 8 years old and older in a 5-person household
Based on 2 children (1 male and 1 female) aged 8 years old and older in a 6-person household
[2] K refers to the kitchen, and DK refers to a combined dining room and kitchen; the figure refers to the number of rooms that can be used as bedrooms (including areas for living rooms) or rooms that can be used as bedrooms.
[3] Note: The principle of bedroom separation for setting the number of rooms is based on the following criteria:
(1) Married couple shares one bedroom
(2) Children aged 6 years old and older, have a separate room from their parents' rooms
(3) Opposite-sex children aged 8 years old and older have individual rooms.
(4) Grandparents use separate bedrooms.

In 2011, the first amendment was introduced. In comparison to 2004, the total residential area per household

member slightly increased. The standard household composition and the number of rooms per use remain unchanged. The standard for essential facilities has been updated to include a private walk-in kitchen, a private flush toilet, and a private bathing facility, along with water supply facilities, groundwater facilities with good quality, and sewage facilities. Additionally, "safe electricity utilities and structures and facilities for safe evacuation in case of fire" were added to the previous four criteria within the structure, performance, and environmental standards [8].

3.2. Literature review

There are two types of studies on minimum housing standards: studies on how to utilize the standards and studies on how to improve and amend the standards.

First, there are studies on how to utilize the standards. Choi et al. [18] applied the 2011 revised standards to population and housing census data to analyze changes in households falling below the standards. They indicated how the minimum housing standards can enhance the residential environment for those with inadequate housing conditions, while also highlighting the limitations of applying the standards to vulnerable populations living in non-housing spaces [18]. Lim [19] discussed how to employ minimum housing standards in designing welfare policies, estimating households below the standards, emphasizing the need to enhance minimum housing standards, and assessing their effectiveness [19].

Regarding the study of improving and amending minimum housing standards, Yun [20] compared how the standards were used in South Korea with their utilization in other countries. He underscored the need to improve the current minimum housing standards in South Korea for efficient usage, citing their abstract and unclear nature [20]. Kim et al. [11] asserted that poor physical residential environments detrimentally affect residents' health, highlighting that the current minimum housing standards should consider such factors [11]. Lee [21] suggested that the existing standards are overly broad and lack specific criteria, leading to weak effectiveness. He proposed additional countermeasures, incorporating social and economic criteria [21]. Kim [22] reviewed the composition and utilization plans of the 2011 revised minimum housing standards and the Long-term Comprehensive Housing Planning of cities and provinces. The aim was to propose directions for improving minimum housing standards to utilize them as tools for housing welfare policies [22]. Lim [23] mentioned that South Korea's minimum housing standards lack effectiveness in enabling the state to take minimal protective measures. To enhance effectiveness, improving the 2011 revised minimum housing standards is necessary [23].

Thus, this study examined Korean research on minimum housing standards from 2011 to 2021 to understand relevant scholars' perspectives on the standards since their first revision. While most studies highlighted issues with the current minimum housing standards and the need for improvements, they did not offer precise criteria for enhancing the standards. Therefore, we endeavored to provide specific plans for improving and utilizing the standards at a policy level through a systematic research methodology.

 doi:10.20944/preprints202308.2054.v1

4. Results

4.1. Analysis of the current status of households below the minimum housing standards in South Korea

4.1.1. Overview of the analysis

To analyze the current situation of households below the minimum housing standards, we utilized data from the Korea Housing Survey (Table 5) [9,24]. By Article of the "Framework Act on Residence" and Article 13 of the Ordinance for Enforcement of the Act, South Korea has implemented the Korea Housing Survey since 2006. The survey was sponsored by the Ministry of Land, Infrastructure and Transport, and the Korea Research Institute for Human Settlements under the Ministry of Land, Infrastructure and Transport conducted the survey; considering that, these data are reliable.

Table 5. Outline of Korea Housing Survey [9,24].

	Details		
Rationale	Article 20 of the "Framework Act on Residence" and Article 13 of the Ordinance for Enforcement of the Act		
Survey sponsor	Ministry of Land, Infrastructure and Transport		
Survey implementer	Korea Research Institute for Human Settlements		
Survey period	2006 ~ 2016: Biennial survey in even years 2017 ~ 2021: Every year		
Survey targets and scope	General households residing nationwide		
Survey methods	Face-to-face interview		
Total number of households in South Korea	21,448,463 households (in 2021)		
Number of valid samples	Approximately 51,000 households		
Survey period	The period between July and December every year		
Weighting	The weighting applied in consideration of the sampling probability of the population		
Survey items used for this analysis	(1) Area standard	(2) Bedroom standard	(3) Facility standard
	Number of household members Exclusive residential area	Household composition Number of bedrooms (including areas for living rooms)	Private walk-in kitchen Private flush toilet Private bathroom Water supply and drainage facility

We utilized the minimum housing standards in Korea, which are currently published (Refer to Table 4). Additionally, we utilized information gathered from the following statements to confirm the status of households below the minimum housing standards.

(1) Exclusive residential areas per number of household members:

In general, as residents do not know the exclusive residential areas of their houses, we utilized data registered in the building register.

(2) Private walk-in kitchen:

We confirmed whether the kitchen was used exclusively and walk-in. If either of these two conditions were not satisfied, we treated the households as households below the standard.

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(3) Private flush toilet:

We confirmed the status of the toilet whether it is a toilet for private use or a flush toilet. If either of these two conditions was not satisfied, we treated the households as households below the standard. We did not consider whether a Western-style toilet was installed or not.

(4) Private bathrooms:

We only confirmed whether bathrooms were used exclusively. If not, we treated the household as the household below the standard. The presence and absence of hot water were not considered.

(5) Water supply and drainage facilities:

We confirmed whether the water supply and drainage facilities were installed or not. As for the water supply facility, we recognized the availability of a groundwater facility with good water quality.

(6) Number of bedrooms per household composition:

Since the minimum number of bedrooms varies depending on the household composition (e.g., a married couple), the presence or absence of children, the age of children, and the gender of children, such a factor was applied. The number of living rooms used as bedrooms was included in the number of bedrooms.

4.1.2. Analysis results

The current status analysis of households below the minimum housing standards from 2006 to 2021 is as follows (Figure 1). We excluded the 2022 data since the Korea Housing Survey result has not yet been released.

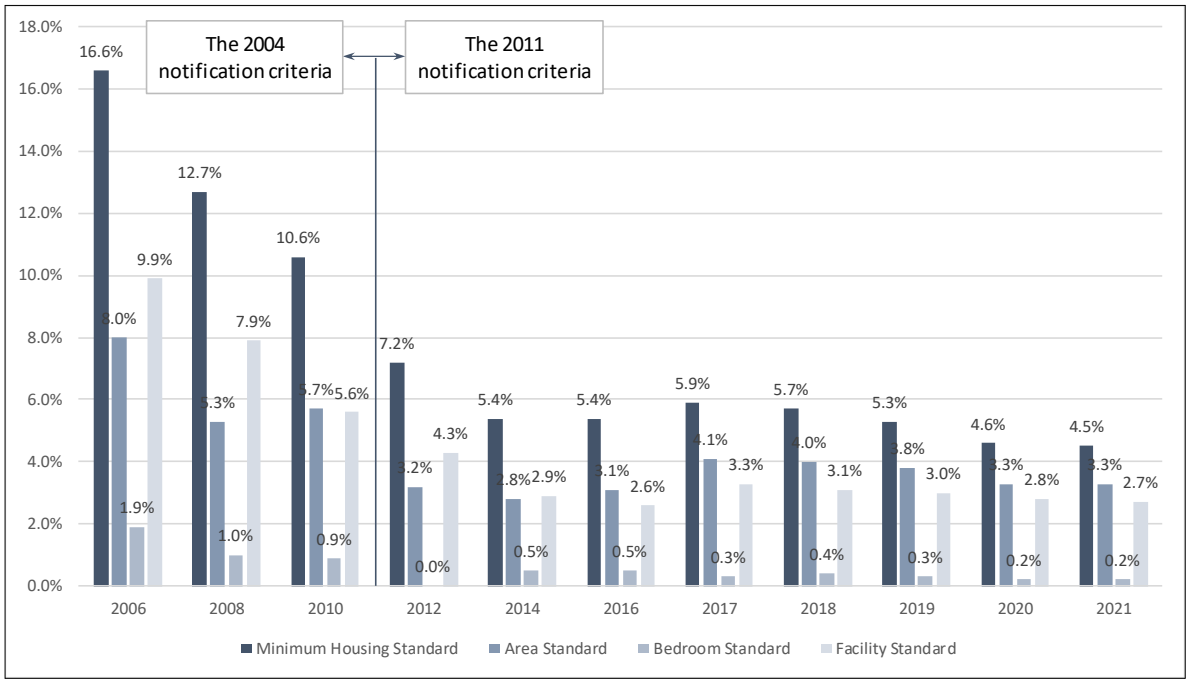

Figure 1. Status of households below the minimum housing standards.

(1) Households below the minimum housing standards:

The overall trend is downward, from 16.6% in 2006 to 4.5% in 2021. Since the trend was around 5% in 2014, it remained between 4-5% until 2021. Considering that the minimum housing standard was upgraded once in 2011, the rate of households below the standards since 2012 seems somewhat lower. This trend can be attributed to the following. First, the average number of household members

continuously decreased (2.7 persons in 2010 → 2.5 persons in 2015) [25]. Second, only the area standard increased when the 2011 standard was upgraded (Refer to Table 4). Third, the area standard of one-person households increased very limitedly, whereas the ratio of one-person households continuously increased (23.9% in 2010 → 27.2% in 2015) [26]. Fourth, there were effects of residential environment improvements in line with the higher number of housing losses. The number of housing losses rapidly increased from 62,485 in 2010 to 76,662 in 2011 and 77,234 in 2012 [27].

(2) Households below the area and facility standards:

The ratio of households below the area and facility standards generally showed a decreasing trend. The households below the area standard decreased from 8.0% in 2006 to 3.3% in 2021. The households below the facility standard dropped from 9.9% in 2006 to 2.7% in 2021. In 2021, the ratio of people residing in non-housing, including accommodations for students studying for exams, and compact buildings with compact rooms was approximately 1.7% [28]. Considering that, the ratio of households below the area and facility standards is likely to remain stuck in the range of 2-3% unless non-housing is fundamentally eliminated.

(3) Households below the bedroom standards:

The ratio of households that cannot reach bedroom standards was also downward in general. The rate decreased from 1.9% in 2006 to 0.2% in 2021, implying that most households satisfied the bedroom standard. This trend can be attributed to the following. First, since the minimum housing standards were first announced in 2004, the 2006 Korea Housing Survey, which was conducted for the first time, showed a low rate of households below the standard (1.9%), the standard was low from the beginning. Second, when the 2011 standards were upgraded, the bedroom standard was not changed. Third, living rooms that can be used as bedrooms were included as bedrooms. Compared to Western countries where bedrooms and living rooms are relatively separated, there are frequent cases where living rooms are used as bedrooms in Korea. Fourth, the average number of household members continuously decreased, and the number of required bedrooms dropped [25].

4.1.3. Direction for improving minimum housing standards based on the current status analysis of households below the standards

First, considering the fact that the rate of households below the minimum housing standards dropped from 16.6% in 2006 to 4.5% in 2021, it is necessary to upgrade minimum housing standards in general. There are two contributors to the lower rate. First, the residential environment has been improved by housing losses and the supply of new housing. The average number of household members continuously decreased as well. As standards can change in each era, it is necessary to upgrade standards in line with the current situation, since South Korea can contemplate more on the residential quality such as environment and safety, rather than the quantity of housing.

Second, it is also necessary to upgrade area and facility standards. As mentioned earlier, unless non-housing types such as accommodations for students studying for exams, and compact buildings with compact rooms are removed, the rates of households below area and facility standards cannot significantly decrease, which already dropped to those rates of 3.3% and 2.7%, respectively. As for the facility standards, there should be more new standards, such as the installation of western-style toilets, utilization of hot water in bathrooms, and security of parking lots.

Third, it is necessary to upgrade or abolish the bedroom standard. The rationale for upgrading the standard is as follows. The ratio of households below the bedroom standard was 0.2% in 2021, meaning that most households satisfied the standard. When setting the standard in 2004 and 2011, the focus was only on spaces for sleeping. Therefore, when there were a married couple and young children, sleeping together was the default. However, a bedroom is a space for sleeping, storage, and activities. One child requires some space for storage and activities, which is not smaller than a space for one adult. Therefore, it is necessary to redefine the criteria based on a bedroom per person.

The rationale for abolition is as follows: Korea had a traditional household composition in the past. Until the 1980s, Korea had a large family system with three generations living together, which

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could be categorized as "grandparents – parents-children." After the 1990s, as urbanization became in full swing, the households of "grandparents" who stayed in rural areas and "parents - children" who moved to cities gradually began to be divided. Here, the households of "children," who are independent of their parents due to marriage, employment, and study began to become common. In this regard, the minimum housing standards, which were established in 2004 and 2011, respectively, included three types of standard household compositions.

However, the current Korean household composition is very different from the past. First, the ratios of one- and two-person households have increased. In particular, as for the two-person households, diverse types of households have been found, including married couples, "siblings," "lovers," and "friends." The ratio of three-generation households in which grandparents, parents, and children live together has become so low that it is hard to find such cases. The traditional type of two-generation households has been more diverse: "Married couple – children," "grandparents – married couple," and "grandparents – children." Therefore, the standard household composition cannot become "standard." If it cannot have the feature of being "standard," it may be better to exclude it from new housing standards.

4.2. Overseas case studies

We analyzed the current status of housing standards in the United Kingdom and Japan, which have similar systems to Korea's housing standards. In particular, we analyzed the Japan case in more detail, as this country demonstrated a similar configuration of bedroom number and area, which are sub-standards of minimum housing standards.

4.2.1. Housing standards in the UK

The representative housing standard in the UK is the Decent Home Standard, which was established by ex-Prime Minister Tony Blair in 2000 [29]. The most recently revised standard was announced in 2016 and is still in use today. The UK government has applied this standard to council houses, encouraging council house providers to provide houses while meeting or exceeding the Decent Home Standard. The standards can be divided into one area standard and four performance standards, and the area standard is as follows (Table 6).

Table 6. Minimum residential area of the UK (unit: m^2).

Number of bedrooms	Persons	1 storey dwellings	2 storey dwellings	3 storey dwellings	Built-in storage
1	1	39(37)[1]	-	-	1.0
	2	50	58	-	1.5
2	3	61	70	-	2.0
	4	70	79	-	
3	4	74	84	90	2.5
	5	86	93	99	
	6	95	102	108	
4	5	90	97	103	3.0
	6	99	106	112	
	7	108	115	121	
	8	117	124	130	
5	6	103	110	116	3.5
	7	112	119	125	
	8	121	128	134	
6	7	116	123	129	4.0
	8	125	132	138	

[1] Where a 1b1p has a shower room instead of a bathroom, the floor area may be reduced from $39m^2$

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to 37m², as shown bracketed.

The Technical Housing Standards, released in May 2016, indicate the area standard [30]. This is an area standard for the interior of the house and is a standard for the supply of new housing.

Houses satisfying both area and performance standards are categorized as good housing, and if they do not meet the standards, owners or landlords must make immediate improvements. If they do not implement that, the government can take action against them, including compulsory eviction and the inability to rent houses out.

In November 2020, the UK government announced that it would completely revise the Decent Home Standard, which has been used for the last two decades [31]. A draft was completed in the fall of 2021, and stakeholder consultation was finished in the fall of 2022 [31]. It is expected that the new Decent Home Standard will be related soon.

4.2.2. Housing standards in Japan

Japan's minimum housing standards are highly similar in format to Korea's minimum housing standards, due to the composition and area of rooms according to the number of household members. Japan first introduced the concept of a minimum housing standard in 1976, while implementing the Third Five-Year Housing Construction Plan, aiming to provide housing services above the minimum standard along with a quantitative supply of housing. There is a difference between Japan's and the UK's housing standards: in the former, the minimum housing area for having a healthy and cultural residential life was set in relation to the number of household members.

(1) 1976 ~ 2005

The areas based on the minimum housing standards, which were applied from 1976 to 2005, are as follows (Table 7) [32]. The estimation of residential areas was based on architectural planning and design, targeting 1 to 7 households. Japan's standards had a significant difference from Korea's as it did not utilize a standard household composition; the former also had a distinction from the UK's as there was no compulsion on households below the standards, and the standards were used as a reference for the analysis of housing conditions and policies.

Table 7. Minimum housing standard of Japan (1976~2005) [32].

Number of household members	Space Requirement	Living area (room+living)	Residential area	Total area
1	1K	7.5m²	16m²	21m²
2	1DK	17.5m²	29m²	36m²
3	2DK	25.0m²	39m²	47m²
4	3DK	32.5m²	50m²	59m²
5	3DK	37.5m²	56m²	65m²
6	4DK	45.0m²	66m²	76m²
7	5DK	52.5m²	76m²	87m²

(2) 2006 – Current

During this period, a housing type where multiple households share a toilet and living room spread in Japan. To encompass diverse types of household members, the size of a household was displayed by the number of household members, and necessary areas per number of household members were calculated. The name of the "minimum housing standard" was changed to the "level of minimum living floor area."

The level of minimum living floor area enabled estimating necessary areas per functions such as sleeping and eating. First of all, the sleeping conditions of family members were set, and the combination of public and private spaces, sanitary spaces, and storage spaces was composed to calculate the size of the main spaces. After summing the areas up, the final residential areas were

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calculated through the composition of the flow of human traffic and empty room spaces. The improved level of minimum living floor area, along with the enactment of the Basic Law of Housing-Life in 2006, focuses more on the area standard than the physical conditions of housing (Table 8) [33]. Considering the population density in Japan, as it is difficult to adopt the 'one room per person' standard, the value of the number of household members is corrected in line with the age of household members.

Table 8. Minimum residential area standard of Japan (2006~current) [33].

Number of household members	Residential area	
1	25m²	(1) single: 25m² (2) more than 2: 10m² × person + 10m² (3) when calculating the number of household members Below 3 years old: 0.25 person 3 or more less than 6: 0.5 person 6 or more less than 10: 0.75 person If the calculated number of household members is less than two, it is counted as two.
2	30m²	
3	40m²	
4	50m²	

The Japanese Ministry of Land, Infrastructure, Transport and Tourism (corresponding to Korea's Ministry of Land, Infrastructure and Transport) analyzed households below the minimum residential standards through the 'Land and Housing Survey' which is implemented every five years, and the outcomes are reflected in housing policies, and utilized as the policy basis for setting the level of minimum living floor area.

4.2.3. Direction for improving minimum housing standards based on analysis results of overseas case studies

We examined the UK and Japan cases as these countries have similar or better conditions in terms of country size, population density, state earnings (the per capita gross national income), and urbanization rates (Table 9). As a result of examining the housing standards of the UK and Japan, we obtained the following implications.

Table 9. Comparison of minimum housing standards (area) of UK, Japan, and South Korea.

Country		UK		Japan		South Korea	
Country size (2021)	Area	243,610km²		377,970km²		100,410km²	
	Population	67,326,569		125,681,593		51,744,876	
Population density (2021)		276.4/km²		332.5/km²		515.3/km²	
The per capita gross national income (2021) [34]		45,380$		42,620$		34,980$	
Urbanization rates (2023)[1] [35]		84.6%		92.0%		81.5%	
Housing standard (Area standard)		Number of household members	Residential area (m²)	Number of household members	Residential area (m²)	Number of household members	Residential area (m²)
		1	40.0	1	25.0	1	14.0
		2	51.5	2	30.0	2	26.0
		3	63.0	3	40.0	3	36.0
		4	72.0	4	50.0	4	43.0
		5	88.5	5	60.0	5	46.0
		6	97.5	6	70.0	6	55.0

[1] Urbanization rates: Percentage of population dwelling in a city among a country's total population

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First, South Korea and Japan showed passive approaches, as they utilized the minimum housing standards as the design criteria for policy indicators or public housing supply. On the other hand, the UK employed the standards as an active guideline for imposing penalties on households below the standard.

Second, South Korea showed more detailed standards of housing structure, performance, and environments than the UK. The UK utilized the minimum housing standards in terms of housing management, rather than housing supply, by providing highly specific guidelines on the remodeling of houses.

Third, Japan was utilizing the most similar system to South Korea's, as it suggested residential areas per the number of household members. However, Japan's area standard is higher than South Korea's because it is assumed that the former implemented the minimum housing standard 28 years before Korea. Japan has used the 2006 revised minimum housing standard, and it seems that there would not be many changes in the area standard. Based on Japan's case, it is likely that South Korea would not change or delete the area standard after one or two revisions. Simultaneously, there would be more housing management than housing supply, that is, enhanced criteria in terms of quality.

Additionally, the area standard of South Korea is much lower than that of the UK. Although body size, gross national income, population density, and residential life culture should be considered, it is obvious that the standard is still low. In other words, South Korea's area standard should be upgraded after conducting a comparative study of overseas cases.

4.3. Collection of expert opinions

4.3.1. Summary of expert opinion collection

We set the direction for specific criteria per sector (area, bedroom, facility, and location standards) through theoretical consideration, literature review, the analysis of the current status of households below the minimum housing standards in South Korea, and overseas case studies.

In this section, we attempted to set the direction for the parts that could not be determined earlier, by collecting experts in each field (Table 10). We targeted 22 experts in four fields, visited them in person, and used a written questionnaire to collect opinions. This process proceeded from March 10 to March 31, 2023. Experts were selected if they satisfied one of the following specific criteria: (1) Participants in research projects related to housing standards (2) Authors of papers related to housing standards (3) Employees of housing-related policy organizations, research institutes, and execution organizations (4) Professors in housing and architecture-related departments.

Table 10. Outline of expert opinion collection.

Date		Mar. 10 – 31, 2023			
Method		Visit in person, or written questionnaire			
Expert	Field	Housing Policy	Housing Welfare	Facilities and Equipment	Housing Plan
	Number of experts	6	5	5	6

4.3.2. Result of expert opinion collection

We asked questions to those experts based on the direction for minimum housing standards, area standards, bedroom standards, and facility standards, and the findings are as follows:

(1) Direction for minimum housing standards

Regarding the question "Is it necessary to improve the current minimum housing standards?" the majority of experts answered as follows: "Active improvements should be followed." Experts indicated that the current standards are outdated and cannot reflect the current situations since the rate of households below the standards is low. Furthermore, compared to the past, household

composition, housing trends, and lifestyles have changed significantly, and many experts highlighted that corresponding improvements are urgently needed. On the other hand, they agreed on the idea of changing the current standards, but some experts were pessimistic about the minimum housing standards because they assumed that the standards would not be needed in the future where people's residential environments would reach a certain level in general. As for similar opinions, some experts indicated that area or bedroom standards should be removed, and related indicators of housing safety and performance should be strengthened.

Regarding the question "if standards need to be improved, to what extent should they be improved?" the majority of experts answered as follows: "The standards should be improved at a developed country's level while considering the residential life culture of South Korea." Although we reviewed the US cases, its standards were not reflected due to the reason. We reflected on experts' opinions that there are limitations to using the US cases since the residential life culture of the US is highly different from South Korea's. There was the minority opinion: "A standard in which the rate of household below the standard can be between 5 – 10%, is appropriate." Although it is inappropriate to set a standard based on the rate of households below the standard, there are several opinions that such an approach may be practical considering the role of the standard - "improvement of residential environments."

(2) Area standard

Regarding the question "A total exclusive residential area according to the number of household members is the current criteria. Do you think that it is an appropriate method?" the majority of experts said that "it is appropriate." There were two minority opinions. First, some experts expressed that considering that the rate of one- and two-person households rapidly increased, the exclusive residential area for those households should be set differently. Second, other experts indicated that as the common area for dwelling also affected the quality of life, the common area for dwelling should be considered.

Regarding the question "If you agree to increase the exclusive residential area, do you think that the UK and Japan cases, which were handled in this study, are appropriate for comparison?" the majority of experts indicated that "Those cases are appropriate for comparison." When setting the 2004 and 2011 standards, the UK and Japan cases were utilized as reference data, which became the rationale for this study. Japan has a similar residential life culture to South Korea; the residential life culture of the UK is different from South Korea's, but the UK case was appropriate considering it showed a target that South Korea should pursue. Regarding the upgraded level, there were many opinions that a level similar to Japan, but lower than the UK, was most appropriate. There was a minority opinion that universal design considering people with disabilities and the elderly living alone, who are relatively vulnerable, should be applied in the area estimation.

As for the question "We assume that five- or six-person households should have two toilets. Do you think it is appropriate?" most experts expressed that two toilets were appropriate. There was a minority opinion that the universal design does not have to be applied to the second toilet.

(3) Bedroom standard

Regarding the question "Do you think that the current standard for the number of bedrooms is appropriate?" most experts stated that "It is meaningless," or "The standard is low." In the past large family era, as there was a large number of household members, parents, and children, or children slept together, but in the current era of nuclear families, it is not common anymore. Since the household composition has become more diverse than in the past, several experts indicated that the concept of "standard" is not appropriate. The current status of households below the minimum housing standards objectively indicates that the current standard is low since almost all households satisfy the bedroom standard.

There was a minority opinion that "The distinction between bedroom and living room should be removed." There were two reasons. First, as many people sleep in a living room, the living room also serves as a bedroom. Second, several one- or two-person households reside in one-room houses

 doi:10.20944/preprints202308.2054.v1

or two-room houses without a clear distinction between the living room and bedroom, the living room sufficiently plays the role of the bedroom.

As for the question of "What do you think about the standard household composition? (Refer to Table 4)" a great number of experts stated that "The standard household composition, which is a specific criterion, should be removed." There were two reasons. First, as mentioned earlier, as there are more nuclear families than large families today, the previous standard household composition cannot be applied anymore. Second, the situation where young children sleep with their parents was set as the standard, this implies that a space for sleeping was only considered. In the current era where nurturing and education of young children are important, a space for young children is as necessary as a space for parents. There were minority opinions that it is better for opposite-sex children to have separate bedrooms regardless of their age and that a standard separating bedrooms in line with conditions is unnecessary.

(4) Facility standard

We explained the current facility standard in detail and asked experts about the facility standards that can be added. We also indicated the names of facilities, usage patterns, and types in specific to induce more objective responses. We utilized facility-related questions from the questions of the Korea Housing Survey, which is conducted by the government every year [9]. The names of facilities used in the questions are as follows: (1) kitchen (2) toilet (3) bathing facility (4) water supply facilities (5) drainage system (septic tank) (6) heating system (7) fuel for cooking (8) entrance (front door) (9) fire-fighting appliances.

The facility standards that experts would like to see added are as follows, in order of frequency of mention: (1) presence and absence and types of heating system (except for briquettes, firewood, electric heaters, etc.) (2) private bathing facilities, and absence or presence of hot water (3) private use of an entrance (front door) (4) a private flush toilet, and absence or presence of western-style toilets.

There were minority opinions regarding safety, evacuation, noise, and waterproofing. However, as there are practical limitations in preparing specific standards for corresponding criteria, these opinions were excluded from this study.

(5) Location standard

As for the question "As the current standards do not consider the location of housing, do you think underground or rooftop houses are appropriate?" most experts said, "They are inappropriate."

We asked more questions to experts who said the answer: "The locations of housing can be classified into above-ground house, semi-underground house, underground house, and rooftop house. Among them, which one does not reach the minimum housing standard? (Duplicate responses possible)" Eighteen experts thought underground houses are below the standard; 14 experts thought semi-underground houses are below the standard; 10 experts regarded rooftop houses are below the standard. Experts considered safety and health issues the most important regarding underground housing, while safety issues regarding illegal structures were most frequently mentioned in terms of rooftop houses.

The minority experts expressing an opinion of "no necessity" agreed with the need, but considering the reality that is difficult for some people to move to over-ground houses due to housing costs, a few experts emphasized that support policies for them should be prioritized over setting standards.

4.4. Direction for improving area and bedroom standards

4.4.1. Prerequisite

We contemplated the prerequisites for the area and bedroom standards, and the details are as follows (Refer to Section 3.1).

First, according to the "Constitution," "All citizens shall have the right to a healthy and pleasant environment. The State and all citizens shall endeavor to protect the environment." Second,

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according to the "Framework Act on Residence," "The people have the right to live a decent residential life in a pleasant and stable dwelling environment protected against any physical or social danger, as prescribed by relevant statutes and ordinances." Third, according to the "Framework Act on Residence," "The State has the duty of guaranteeing the people's housing rights." Fourth, according to the "Housing Act," the minimum housing standard aims to provide "a minimum standard required for the people to live a decent residential life in a pleasant dwelling environment."

4.4.2. Direction for specific improvements

We conducted the literature review, the analysis of the current status of households below the minimum housing standards, overseas case studies, and expert opinion collection to derive the direction for improving area and bedroom standards in line with the aforementioned prerequisites. As a result, we derived the following direction for specific improvements (Table 11).

Table 11. Direction for specific improvements in minimum housing standards.

		2011	2023	
			Improvement direction	Rationale
Area standard	1-person	14m²	▲	a, b, c, d
	2-person	26m²	△	a, b, c, d
	3-person	36m²	△	a, b, c, d
	4-person	43m²	△	a, b, c, d
	5-person	46m²	△	a, b, c, d
	6-person	55m²	△	a, b, c, d
	Universal design	Absence	▲	d
Bedroom standard[1]	1-person	1[2] K[3]	△	b, d
	2-person	1 DK[4]	▲	b, d
	3-person	2 DK	=	b
	4-person	3 DK	=	b
	5-person	3 DK	=	b
	6-person	4 DK	=	b
	Standard household composition	Presence	×	b, d
	Standard separating bedrooms	Presence	×	b, d

[1] Bedroom standard: The direct criteria for room configuration are deleted, but it is utilized as a sub-criterion for calculating the area standard.
[2] Figures in bedroom standard: Number of rooms that can be utilized as bedrooms (including spaces for living room)
[3] K: Kitchen
[4] DK: Dining room and kitchen

▲: Active improvement △: Passive improvement =: Maintenance

a: Literature review (Refer to Section 3.2)
b: Analysis of the current status of households below the standards (Refer to Section 4.1.3)
c: Overseas case studies (Refer to Section 4.2.3)
d: Expert opinion collection results (Refer to Section 4.3.2)

As for the area standard, opinions supporting an upgrade of the standard were found in almost all rationales. In particular, with the increase in the rate of one-person households, there was a rationale indicating the need for active improvements. Therefore, we decided to estimate the area

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standard by applying universal design principles that were not reflected in the 2011 minimum housing standards.

Regarding the bedroom standard, two main directions for improvements were identified. First, we opted to eliminate the standard itself. As household compositions have become more diverse, the concept of a "standard" has lost its relevance. Consequently, the "standard separating bedrooms" based on the "standard household composition" has also become less meaningful. However, the "room configuration (1K ~ 4DK)" was removed but retained as an auxiliary standard for calculating the area standard. Essentially, this implies that insufficient rooms based on the number of household members will not be considered as falling below the minimum housing standard. Since the number of rooms is already included in the area standard, and configurations (K, DK) are covered in the facility standard, duplications are unnecessary.

4.4.3. Design simulation

(1) Premise

This sector aims to calculate the size of each room that satisfies the minimum housing standards. After calculating the size of each room, it becomes possible to determine the exclusive residential area that meets the minimum housing standard per the number of household members. To achieve this, we conducted a design simulation in the following sequence. The methodology was partially based on the approach by Bae et al. [36].

(2) Estimation of Furniture Sizes

Initially, we selected the furniture that should be placed in each room to fulfill the minimum housing standards (Table 12). A bedding or bed, a wardrobe (blanket chest), and a desk are placed in the bedroom. A sink table, kitchen counter, gas table, and refrigerator are positioned in the kitchen and dining room. A toilet, washstand, and shower booth are located in the bathroom. The entrance, shoe rack, and boiler rooms were regarded as other spaces. However, for one-person households, where common heating systems are often used, boiler rooms were not taken into account. In Korea, standardized sizes known as the Korea Standard are commonly adopted in the industry [37]. Based on this standard, we computed the standard size. If checking the Korea Standard poses challenges, we considered the minimum unit size of commercially available products. The dimensions from the Korea Standard and commercially available items already take into account the body sizes of Koreans.

Table 12. Standard sizes per furniture item (width × length, unit: mm)).

Bedroom	Bedding	Bed (Bed frame)	Closet (Blanket chest)		Desk (Chair)
	Bedding for one person: 1000 × 2100 Bedding for two persons: 1400 × 2100	Single bed: 1000 × 2100 (1100 × 2300) Double bed: 1400 × 2100 (1500 × 2300)	900 × 700		800 × 600 (800 × 1200)
Kitchen and dining room	Sink table (free space)	Kitchen counter (free space)	Gas table	Refrigerator	Table
	840 × 550 (600)	Length: 550 (600)	2 burners: 700 × 600 4 burners: 750 × 600	1 person: 600 × 600 2 persons: 800 × 700 More than 3 persons: 1000 × 900	1~2 person: 800 × 800 More than 3 persons: 1200 × 825
Bathroom	Toilet (free space)		Washstand		Shower booth
	550 × 700 (650 × 800)		550 × 400		800 × 800
Others	Entrance		Shoe rack		Boiler room or Utility room

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1 person: more than 0.5m² 2 persons: more than 0.8m² More than 3 persons: more than 1.6m²	1 person: 600 × 300 2 persons: 900 × 300 More than 3 persons: 1200 × 300	1 person: more than 0.7m² 2 persons: more than 1.0m² More than 3 persons: more than 2.0m²

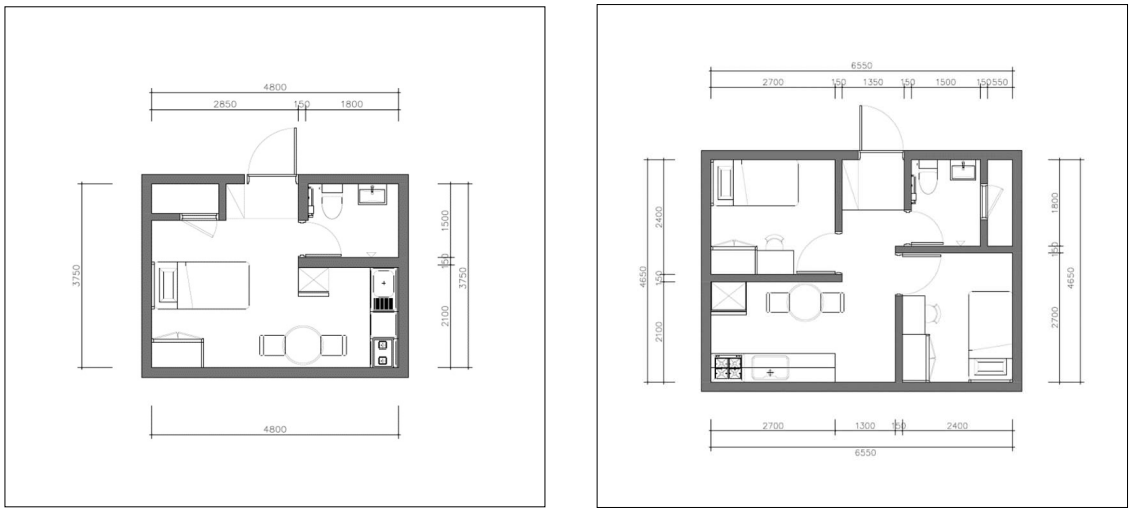
(3) Application of universal design

Among universal design considerations, we only took into account factors that could impact the calculation of exclusive residential areas, specifically focusing on the indoor use of wheelchairs by individuals with disabilities or the elderly living alone. In such instances, the entrance door's effective width should exceed 900 mm, and a space of over 1200 mm should be available in front of and behind the entrance door [38]. Furthermore, the minimum effective width of indoor pathways, considering wheelchair accessibility to bedrooms and kitchen, has been set at 800 mm or more. In the bathroom, handrails for individuals with disabilities have been planned to facilitate use without the need for a wheelchair.

(4) Design simulation results

We previously established criteria for furniture arrangement and sizes, as well as universal design. With these criteria in mind, we conducted a design simulation of a housing floor plan that meets the minimum housing standards using an Auto CAD program. The criteria are outlined as follows:

First, we arranged the essential furniture based on a standard for each household members. Second, we arranged openings while considering universal design principles. Third, we ensured the flow of human traffic, particularly accommodating those using wheelchairs. Fourth, we allocated free spaces to cater to the activities required for daily life, such as sleeping, cooking, washing dishes, resting, cleaning, and bathroom usage. Fifth, regarding bedrooms, the principle of one room per person was applied. However, if the number of bedrooms was fewer than the number of household members, the two people per room principle was also used. Sixth, all spaces were organized using 30 cm as the minimum unit of length, reflecting the common practice in Korean housing construction sites. Seventh, the simulation used interior dimensions, consistent with how the calculation of exclusive use area is based. Eighth, the bathroom area was assumed to be equipped with a combined shower and washbasin, adhering to minimum housing standards. Finally, the proposed residential area meeting all eight criteria was identified as the minimum housing standards' residential area (Figure 2).



(a) (b)

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Figure 2. Design simulation of minimum housing standard per household composition (unit: mm): (a) 1-person(18m²); (b) 2-person(30m²); (c) 3-person(40m²); (d) 4-person(48m²); (e) 5-person(56m²); (f) 6-person(63m²);.

4.5. Improvements in minimum housing standards

4.5.1. Area standard

The detailed criteria for calculating the area standard are as follows:

First, among the 2011 bedroom standard, the room configuration standard was utilized (1DK ~ 4DK). Considering the direction of improving details in the minimum housing standards, for a one-person household, the "kitchen" was upgraded to "dining room and kitchen." This change was made since a one-person household should have a basic and minimum space for dining. Furthermore, the number of rooms for two-person households was shifted from one to two. When setting the 2011 standard, as two-person households were standardized as "Married couple," and the number of rooms was set as one. However, as the composition of households became diverse, we considered other types of households rather than "Married couples" and then added another room (Refer to Table 11).

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Second, we also considered the design simulation of the housing floor plan in consideration of human scale. Based on these criteria, we suggest the following minimum housing standard improvements per household composition (Table 13).

Table 13. Improvements for minimum housing standards per household composition (area standard) (unit: m^2).

Number of household members	1	2	3	4	5	6
Spatial Composition	1DK	2DK	2DK	3DK	3DK	4DK
Bedroom 1	6.48 (2.4×2.7)	6.48 (2.4×2.7)	9.90 (3.0×3.3)	9.90 (3.0×3.3)	9.90 (3.0×3.3)	9.90 (3.0×3.3)
Bedroom 2	-	6.48 (2.4×2.7)	6.48 (2.4×2.7)	6.48 (2.4×2.7)	9.90 (3.0×3.3)	9.90 (3.0×3.3)
Bedroom 3	-	-	-	6.48 (2.4×2.7)	6.48 (2.4×2.7)	6.48 (2.4×2.7)
Bedroom 4	-	-	-	-	-	6.48 (2.4×2.7)
Kitchen & Dining	4.41 (2.1×2.1)	5.67 (2.1×2.7)	6.48 (2.4×2.7)	7.29 (2.7×2.7)	8.91 (2.7×3.3)	8.91 (2.7×3.3)
Bathroom 1	2.70 (1.5×1.8)	2.70 (1.5×1.8)	2.70 (1.5×1.8)	2.70 (1.5×1.8)	2.25 (1.5×1.5)	2.25 (1.5×1.5)
Bathroom 2	-	-	-	-	1.80 (1.2×1.5)	1.80 (1.2×1.5)
Others	4.41	9.13	14.34	15.09	16.64	16.86
Total Area	18	30	40	48	56	63

(1) As for the area of a room, the area is different by separating rooms into 1 bedroom and 2 bedrooms.
(2) Total Area is rounded to zero decimal places
(3) Others: Entrance + Shoe rack + Boiler room or Utility room + Hallway inside the household + Wall inside the household

4.5.2. Bedroom standard

The 2011 bedroom standard is as follows:

First, the basis for the number of rooms was established: one room for one- or two-person households, two rooms for three-person households, three rooms for four- and five-person households, and four rooms for six-person households. This also included living rooms that could serve as bedrooms. However, the concept of "standard" has become less meaningful due to the increasing diversity of households compared to the past (Refer to Sections 4.1.3 and 4.3.2). As a result, the criteria regarding the number of rooms were removed.

The second feature concerns room types. For one-person households, a kitchen was required, while other households needed a space that could serve as both a kitchen and a dining room. Since this criterion overlaps with the kitchen criterion in the facility standard, it was eliminated.

The third feature involves the standard for separating bedrooms. Implementing a standard for separating bedrooms presents challenges. The past standard household composition no longer fits the diverse household structures of today (Refer to Sections 4.1.3 and 4.3.2). Consequently, the standard for separating bedrooms was also removed.

After a detailed analysis of bedroom standards, we decided to eliminate them altogether. Despite their removal, we anticipate no issues since they indirectly and directly affect area and facility standards. The bedroom standard was incorporated when deriving the area standard (Refer to Table

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13). Additionally, the previous section on households failing to meet minimum housing standards indicated that only 0.2% of households were affected, which is insignificant (Refer to Section 4.1.3).

4.5.3. Facility standard

In terms of facility standards, the United Kingdom and the United States apply facility standards termed "performance standards." However, these standards are applied as benchmarks of adequacy rather than minimum requirements.

In Korea, based on the 2011 standard, only the kitchen, toilet, bathroom, water supply, and drainage facilities were subject to the standard (Refer to Section 3.1.3). We collected expert opinions to enhance this aspect (Refer to Section 4.3.2). Consequently, an overall upgrade to the standard was deemed necessary. We identified four facility standards for potential addition while retaining existing standards, based on frequency.

First, the presence and type of the heating system were considered. While this criterion was excluded assuming that few households wouldn't comply, an analysis of the 2011 Korea Housing Survey revealed only 0.1% of households lacked heating systems, primarily concentrated in one- to two-person households [24]. It is assumed that these households live in non-residential facilities. Nevertheless, given the essential nature of a heating system, we incorporated this criterion. Regarding heating system types, households using conventional fuels like briquettes, firewood, or large electric heaters were classified below the minimum housing standard. Large electric heaters, which might be debatable, differ from Western heating methods. Western cultures utilize electric heaters or radiators to heat spaces, whereas Korea traditionally employs floor heating. Since there are minimal space-heating facilities in Korean residences, this method is considered "temporary." Given that heating systems are essential, we included this criterion.

Second, we considered the presence or absence of hot water in the bathroom. Though this aspect is fundamental, it was omitted due to a presumed scarcity of non-compliant households. Even though the ratio of households failing to meet this standard is likely insignificant, we incorporated it, assuming these households primarily reside in non-residential facilities.

Third, the exclusive use of the entrance (front door) was added. Some housing types share a front entrance and hallway access to individual rooms, prevalent in accommodations for exam-studying students, mostly catering to one- or two-person households. This criterion pertains to family and personal privacy and safety, thus considered a fundamental right. Given its strong connection to basic human rights, we integrated it as a new standard.

Fourth, there were suggestions about Western-style toilets. Since few households lack Western-style toilets in Korea, we omitted this as a criterion, as the use of Eastern-style toilets doesn't pose significant inconvenience or hygiene issues.

Lastly, we deliberated on the presence or absence and type of cooking facilities. Given the reduced trend of home cooking compared to the past, we excluded this criterion.

We also considered other factors like fire-fighting appliances, structural safety, waterproofing, moisture-proofing, ventilation, lighting, noise, natural disasters, crime prevention, and sanitation. As safety and quality of life are paramount, we contemplated incorporating these criteria. However, due to the absence of objective confirmation via the current Korea Housing Survey and concerns about efficacy, we maintained the declarative essence of the 2011 minimum housing standard (Refer to Section 3.1.3).

Table 14. Minimum housing standard improvements per household composition (Facility standard).

Facility standard	Usage classification	Absence or presence of standard		Type classification	Absence or presence of standard	
		2011	2023		2011	2023
(1) Kitchen	Private	○	○	Walk-in	○	○

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(2) Toilet	Private	○	○	Flush toilet	○	○
(3) Bathroom	Private	○	○	Hot water	×	○
(4) Water supply and drainage facility	Installation	○	○	-	-	-
(5) Heating system	Installation	×	○	Fuel for heating[1]	×	○
(6) Entrance door	Private	×	○	-	-	-

[1] Heating fuels: Exclude conventional fuels such as briquettes firewood, and large electrical heaters.

4.5.4. Location standard

The location criterion did not exist in the past. As mentioned in the Research background and purpose, there is a recent issue in Korean society about the safety of underground or semi-underground houses due to flood damage (Refer to Section 1.2). In this study, we collected related opinions of experts through interviews (Refer to Section 4.3.2).

(1) Underground and semi-underground houses:

First of all, underground and semi-underground houses have safety issues. In the event of a flood, if people residing in those houses are not evacuated early, it is not easy to escape on their own due to water pressure. This issue is especially found in areas with low ground levels and high land prices. As the South Korean government has recognized that "underground and semi-underground houses" are inappropriate for housing, and has attempted to establish policies to provide countermeasures [10]. In addition, in the event of a fire, as there are often no emergency exits in such types of houses, people residing in such houses become more vulnerable than those living in above-ground houses.

There are also health issues. Basements are very humid and often are covered by mold. This can cause problems with respiratory diseases. Compared to above-ground houses, these types of houses are highly likely to have more cockroaches and rats, leading to a higher chance of transmitting germs to humans. As ventilation and lighting are also unfavorable, those conditions can harm the health of residents. Therefore, in this study, we set this criterion as a minimum housing standard.

(2) Rooftop houses:

Rooftop houses are also related to safety issues. "Rooftop" refers to the space at the top of a house or building. In many cases, the purpose of rooftops that were originally built for purposes other than residence are changed to residential facilities, or they are illegally expanded. This makes rooftops unsafe housing. Illegal buildings sometimes do not comply with safety-related standards, and there is no public management, which is the reason why such buildings are considered safety blind spots. Therefore, in this study, we set this criterion as a minimum housing standard.

4.5.5. New minimum housing standards with improvements (Synthesis)

We presented the minimum housing standards that combine area standards, bedroom standards (deleted), facility standards, and location standards (Table 15).

Table 15. Suggested minimum housing standards in 2023.

1. Area standard		2. Facility standard		3. Location standard	
(1) 1-person	18m^2	(1) Kitchen	Private & Walk-in	(1) Semi-underground house	Below the standard
(2) 2-persons	30m^2	(2) Toilet	Private and flush toilet	(2) Underground house	Below the standard

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(3) 3-persons	40m²	(3) Bathroom	Private and hot water	(3) Rooftop house Below the standard
(4) 4-persons	48m²	(4) Water supply and drainage facility	Installation	
(5) 5-persons	56m²	(5) Heating system	Installation & Fuel	
(6) 6-persons	63m²	(6) Entrance door	Private	
4. Structure, performance, and environment standards				
(1) As a permanent building, structural strength must be secured, and materials for principal structural parts shall be heat-resistant/proof, fire-resistant and moisture-proof. (2) Adequate soundproofing, ventilation, lighting, and heating facilities shall be provided. (3) Environmental factors such as noise, vibration, odor, and air pollution shall meet legal standards. (4) A house shall not be located in an area with significant risks of natural disasters such as tsunamis, floods, landslides, and cliff collapse. (5) It shall be equipped with safe electrical facilities, and structures and facilities for safe evacuation in case of fire.				

4.5.6. Estimation of households below the minimum housing standards based on new standards

We estimated new households below the minimum housing standards, based on the raw data from the 2011 Korea Housing Survey [24]. As a result, 8.4% of total households were found to fall below the minimum housing standards (Figure 3). This represents an increase of approximately 3.9% compared to the 4.5% under the previous standards. Notably, high rates were observed among six-person households (19.6%) and one-person households (15.8%). The elevated rate for six-person households could be attributed to economic challenges leading to extended family cohabitation. For one-person households, the high rate might stem from temporary situations involving work, study, or employment preparations, coupled with limited financial resources. In addition, households below the minimum housing standards were relatively low in the case of 2-5 person households, which can be attributed to the higher proportion of independently formed families.

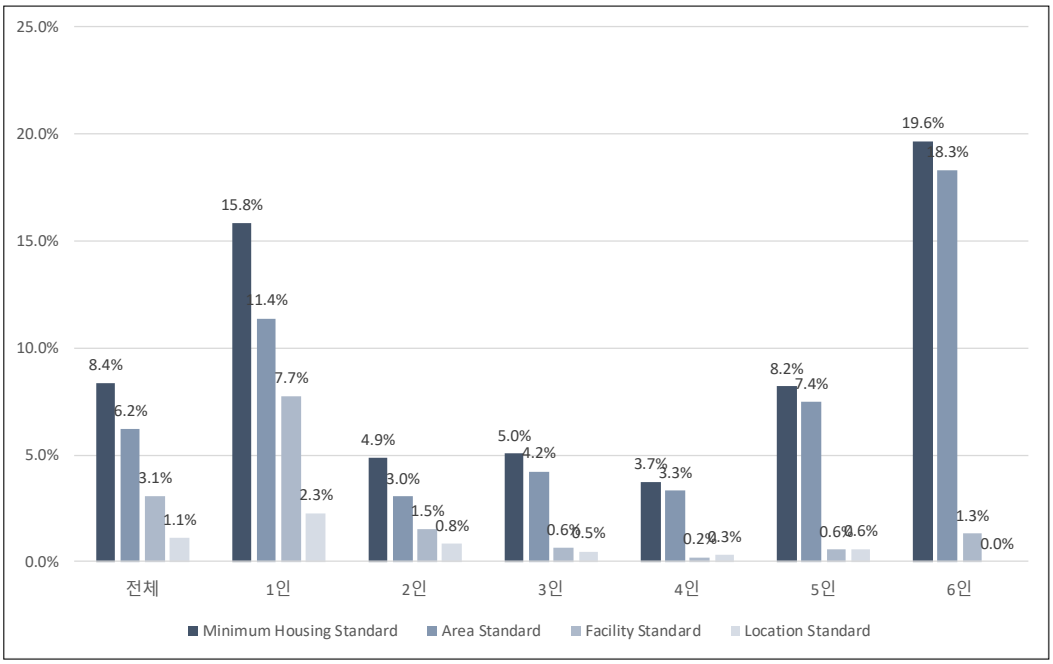

Figure 3. Households below the minimum housing standards based on new standards.

 doi:10.20944/preprints202308.2054.v1

Regarding the area standard, 6.2% of total households were identified as falling below the standard. This marks an increase from the previous standard's 3.3%, representing a rise of approximately 2.9% under the new standard. Among the sub-standards, the area standard demonstrated the most significant impact on the minimum housing standard. While the extent of this impact might vary based on the chosen standard, it can be assumed that it reflects Korea's high population density.

Regarding the facility standard, 3.1% of total households were found to be below the standard, an increase from the 2.7% under the previous standards. This difference is attributed to the inclusion of criteria such as the presence of hot water in the bathroom, the presence/absence of heating systems and relevant fuels, as well as private entrance doors. This outcome implies that most households are already equipped with these essential facilities. Notably, one-person households displayed a notably high rate of 7.7% below the standard, primarily due to their temporary residence in places like student accommodations or compact buildings with specialized compact rooms.

Regarding the newly proposed location standard, fewer than 1.1% of total households were found to be below the standard. This category encompasses households residing in underground, semi-underground, or rooftop houses. While constituting a small portion, such housing conditions are linked to safety and health concerns that require resolution.

Lastly, a total of 2,661 households (0.013%) did not meet all three standards. These households exclusively comprised single-person households, indicative of vulnerable households in urgent need of housing improvement. South Korea boasts a robust economy and a significant number of high-quality multi-unit dwellings, particularly apartments. However, the nation grapples with high population density and urbanization rates. Consequently, a relatively substantial number of households fall below the area standard, while the prevalence of households meeting facility and location standards is high.

5. Discussion

Since the enactment of the minimum housing standards in 2004, the ratio of households falling below these standards has been annually estimated through the Korea Housing Survey on a national scale. The rate of households below the minimum housing standards was 16.6% in 2006 but decreased to 4.5% in 2022, even with an update in the standards occurring in 2011.

Our study concentrated on this 4.5% rate. Even in developed countries with relatively favorable housing conditions, governments cannot fully cater to the residential needs of every individual. In this context, the 4.5% ratio could signify vulnerable segments within the population that require active government intervention to improve their housing circumstances. While this ratio may diminish assuming South Korea's continuous growth, it will eventually reach a threshold and not achieve 0%. Indeed, the percentages of households below the minimum housing standards between 2014 and 2021 have remained stagnant within the range of 4.5% and 5.9%.

Given the situation where most households, apart from those in vulnerable living conditions, meet the minimum housing standards, the standards should be elevated. In this perspective, we deliberated on the "meaning or definition of minimum housing standards" (Refer to Section 4.4.1), as well as the levels of these standards. Standards are context-dependent and subject to the times and the perspectives of those defining them. Recognizing these limitations, our study aimed to create standards as objectively as possible. We derived the direction for the minimum housing standards by examining pertinent regulations, conducting research encompassing literature reviews, analysing the current state of households not meeting the minimum housing standards, examining overseas case studies, gathering expert opinions, engaging in design simulations, and estimating households not meeting the standards under the new criteria.

Furthermore, we ensured the standards aligned with contemporary circumstances. First, we eliminated the standard household composition, rendered irrelevant by the diversification of household structures. For instance, the standard household composition classified a two-person household as a "Married couple," whereas in this study, "siblings," "partners," "friends," and "single-parent households" can all be classified as such. Consequently, we discarded the bedroom

standard predicated on the standard household composition and instead sought to supplement it with the area standard based on the number of household members.

Second, we incorporated evolving societal values. Over time, the significance of values such as human rights, safety, the environment, and quality of life has grown compared to the past. In light of this evolution, we integrated universal design principles for individuals with disabilities into the area standard. To address safety concerns, we introduced a "private entrance door" criterion within the facility standard, and included "above-ground housing" within the location standard. As we believed the location standard played a pivotal role in safety, environmental factors, and quality of life, we introduced this new criterion in our study. To address quality of life, we elevated the area standard and expanded living spaces, aspects intertwined with most of the other standards.

Third, we accounted for shifts in lifestyle. For one-person households, which were predominantly found in student accommodations and communal dining areas, the COVID-19 pandemic altered behavior, leading individuals to consume meals at home through delivery services. Consequently, we introduced a "dining room" criterion for one-person households. For two-person households, our previous assumption that married couples shared a bedroom was adjusted, as an increasing percentage now had separate rooms. In response, we assigned two bedrooms for two-person households. Notably, South Korea's advanced public bathing facilities like *jjimjilbang* (Korean dry sauna) experienced a shift during COVID-19, with more people opting to bathe at home due to infection concerns. Reflecting this change, we introduced "hot water in bathing facilities" as a new criterion. Additionally, as privacy concerns heightened, we introduced the new criterion of a "private entrance door."

6. Conclusions

In the previous section, "Discussion," we examined (1) the need to introduce new minimum housing standards, (2) the assurance of objectivity, and (3) the major changes to the minimum housing standards. In this section, we will discuss the implications of this study, focusing on the potential policy applications of the newly proposed minimum housing standards.

First, these standards can serve as criteria for government housing policies. By assessing households' housing conditions, effective policies can be formulated accordingly. The minimum housing standards can be considered a highly effective tool for making precise judgments. This accurate assessment of housing conditions empowers the government to devise housing supply strategies as well as housing policies regarding supply, loss, and housing welfare programs. Housing welfare programs can use these standards as pivotal criteria for identifying eligible beneficiary households.

Second, the standards can facilitate the establishment of housing management norms. Specifically, tailored management standards can be created for households falling below the minimum housing standards. In the public realm, this can lead to the formulation of policies concerning residential mobility and housing improvements through the allocation of public resources. In the private realm, these standards can serve as voluntary management indicators. Notably, since minimum housing standards relate to fundamental rights such as safety, environment, and human rights, proactive public interventions are warranted. Immediate measures should be implemented for the 2,661 households (0.013%) not meeting area, facility, and location standards, ultimately striving to improve the living conditions of 1,738,733 households (8.4%) below the minimum housing standards.

Third, the standards can be employed as criteria for the construction of public rental housing. Currently supplied public housing satisfies facility and location standards. As a result, minimum housing standards can serve as indicators for formulating area-specific design standards. Furthermore, when selecting prospective tenants for public rental housing, the number of household members intending to reside in the unit can be clearly established, with the area standard serving as a criterion.

Fourth, the standards can guide site selections for housing redevelopment projects, housing reconstruction projects, and urban regeneration initiatives. These projects entail large-scale

enhancements of residential environments in South Korea. Urban regeneration projects require public funding, and housing redevelopment and reconstruction projects are anticipated to yield real estate gains from developmental ventures, making site selection highly competitive. Utilizing minimum housing standards for site selection can help address the issue of households below the minimum housing standards and ultimately contribute to enhancing residential environments.

Finally, the ultimate role of minimum housing standards is to "enhance living conditions." The causal link between the decreased ratio of households falling below the minimum housing standards and the formulation of these standards cannot be fully explained. The exact correlation remains indeterminate based solely on the findings of this study. However, as the government has communicated minimum housing standards and is actively establishing and implementing policies to address this concern, the standards are assumed to play a part in enhancing living conditions.

The limitations of this study and the need for further research are as follows:

First, concerning the facility standard, we omitted standards that couldn't be objectively verified. The Korea Housing Survey targets around 50,000 households nationwide, with most questions answered directly by householders. While subjective responses can provide insights into safety and quality of life (e.g., structural safety, waterproofing, moisture-proofing, ventilation, lighting, noise, natural disasters, crime prevention, and hygiene), survey results based on these responses may lack the validity of practical verification. Hence, this study utilized the declarative meaning of the 2011 minimum housing standard. In the future, we plan to conduct follow-up studies on relevant aspects once a survey methodology capable of objective validation is developed.

Second, we excluded the independent role of the living room. In the design simulation, each room was arranged, and the remaining space resembled a living room (Refer to Figure 2). This aspect is a matter of choice rather than a limitation. The consideration of whether the living room's role is necessary in the minimum housing standards remains a topic for further research. In subsequent revisions, the living room could be categorized as an independent room.

Lastly, a study is needed to gauge the extent to which the minimum housing standards can contribute to enhancing housing conditions. To achieve this, an analysis of government policies employing these standards is essential, uncovering correlations with improvements in housing conditions.

Author Contributions: Conceptualization, D.K.; methodology, D.K. and S.K.; software, D.K.; validation, D.K. and S.K.; analysis, D.K. and S.K.; visualization, D.K.; supervision, S.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: When citing data in the text, we have provided the address in the references section with a link.

Acknowledgments: We would like to thank Editage (www.editage.co.kr) for English language editing.

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

References

1. Reyes, A.; Novoa, A.M.; Borrell, C.; Carrere, J.; Pérez, K.; Gamboa, C.; Daví, L.; Fernández, A. Living Together for a Better Life: The Impact of Cooperative Housing on Health and Quality of Life, *Buildings* **2022**, *12*, 2099.
2. Rolnik, R. Late Neoliberalism: The Financialization of Homeownership and Housing Rights, *Int J Urban Reg Res* **2013,** *37(3),* 1058-66.
3. Wilson, S. Litigating Housing Rights in Johannesburg's Inner City: 2004-2008, *SAfr J Hum Rights* **2017,** *27(1),* 127-151.
4. Troy, L.; Easthope, H.; Randolph, B.; Pinnegar, S. 'It depends what you mean by the term rights': strata termination and housing rights, *Housing Studies* **2017,** *32(1),* 1-16.
5. Jin, H.C.; Kang, D.W.; Lee, S.W. A Study on the Changing Factors of Minimum Housing Standard and Housing Density in Seoul Metropolitan Area, 1995-2005, *Hous Stud Rev* **2010,** *18(1),* 41-68.

6. Xu, K.; Chai, X.; Jiang, R.; Chen, Y. Quantitative Comparison of Space Syntax in Regional Characteristics of Rural Architecture: A Study of Traditional Rural Houses in Jinhua and Quzhou, China, *Buildings* **2023,** *13,* 1507.
7. Homepage of Korean Law Information Center. Available online: https://www.law.go.kr/admRulLsInfoP.do?chrClsCd=&admRulSeq=2000000055520 (accessed on 22 March 2022).
8. Homepage of Korean Law Information Center. Available online: https://www.law.go.kr/admRulLsInfoP.do?admRulSeq=2000000059613 (accessed on 22 March 2022).
9. Homepage of MOLIT Statistics System. Available online: https://stat.molit.go.kr/portal/cate/statFileView.do?hRsId=327&hFormId= (accessed on 11 July 2022).
10. Homepage of MOLIT. Available online: http://www.molit.go.kr/USR/NEWS/m_71/dtl.jsp?id=95087936 (accessed on 3 March 2023).
11. Kim, S.Y.; Kim, S.L.; Lee, J.S. The Effect on Housing on Health, *Health Soc Sci* **2013,** *34*, 109-133.
12. Homepage of the United Nations. Available online: https://www.un.org/en/about-us/universal-declaration-of-human-rights (accessed on 22 March 2022).
13. Homepage of Korean Law Information Center. Available online: https://www.law.go.kr/LSW/lsInfoP.do?efYd=19880225&lsiSeq=61603#0000 (accessed on 22 March 2022).
14. Homepage of Korean Law Information Center. Available online: https://www.law.go.kr/LSW/lsSc.do?section=&menuId=1&subMenuId=15&tabMenuId=81&eventGubun=060101&query=%EC%A3%BC%ED%83%9D%EB%B2%95#undefined (accessed on 22 March 2022).
15. Pane, A.; Gunawan, B.; Withaningsih, S. Development of Kampung Susun Akuarium Based on Sustainable Housing Principles. *Sustainability* **2023,** *15,* 8673.
16. Kucharska-Stasiak, E.; Źróbek, S.; Żelazowski, K. European Union Housing Policy. An Attempt to Synthesize the Actions Taken. *Sustainability* **2022,** *14,* 39.
17. Bacter, C.; Săveanu, S.; Buhaş, R.; Marc C. Housing for Sustainable Societies. Children's Perception and Satisfaction with Their House in Countries around the World. *Sustainability* **2021**, *13*, 8779.
18. Choi, E.; Kim, Y.; Kwon, S. Spatio-Temporal Changes of Households Failing to Meet the 2011 New Minimum Housing Standard(1995~2010), *J Korea Real Estate Analysts Assoc* **2012**, *18(4)*, 171-195.
19. Lim, S. The change of magnitude and characters in households below minimum housing standard(2005-2011), *Soc Sec Res* **2014**, *30(3),* 215-244.
20. Yun, H.J. Proposal of Minimum Housing Standard for Eup-Myun Area, *Journal of Rural Planning* **2011**, *17(2),* 13-21.
21. Lee, H.S. A Study on the Minimum Housing Standards and House Rental Supplement, *Pub Land Law Rev* **2011**, *54*, 95-117.
22. Kim, J.H. Minimum Standards for Residential Accommodation (MSRA) and the Housing Welfare Policy - Focusing on the 'Housing Comprehensive Plan', *J Korea Plan Assoc* **2015,** *50(4),* 185-207
23. Lim, S. A Study on the Minimum Residential Standard and Guaranteeing the Housing Rights from the Perspective of Administrative Law, *Admin Law J* **2021**, *66*, 175-204.
24. Homepage of Micro Data Integrated Service. Available online: https://mdis.kostat.go.kr/dwnlSvc/ofrSurvSearch.do?curMenuNo=UI_POR_P9240 (accessed on 9 January 2023).
25. Homepage of Korea Indicator. Available online: https://www.index.go.kr/unify/idx-info.do?idxCd=4229 (accessed on 2 February 2023).
26. Homepage of Korea Indicator. Available online: https://www.index.go.kr/unify/idx-info.do?idxCd=5065 (accessed on 2 February 2023).
27. Homepage of Korean Statistical Information Service. Available online: https://kosis.kr/statHtml/statHtml.do?orgId=116&tblId=DT_MLTM_5416&vw_cd=MT_ZTITLE&list_id=I1_11&scrId=&seqNo=&lang_mode=ko&obj_var_id=&itm_id=&conn_path=MT_ZTITLE&path=%252FstaticsList%252FstatisticsListIndex.do (accessed on 2 February 2023).
28. Homepage of Korean Statistical Information Service. Available online: https://kosis.kr/search/search.do?query=%EA%B0%80%EA%B5%AC%EC%88%98 (accessed on 2 February 2023).
29. Homepage of Government of U.K. Available online: https://www.gov.uk/guidance/decent-homes-standard-review (accessed on 15 April 2022).
30. Homepage of Department for Communities and Local Government. Available online: https://www.gov.uk/government/publications/technical-housing-standards-nationally-described-space-standard (accessed on 15 April 2022).
31. Homepage of Department for Communities and Local Government. Available online: https://www.gov.uk/guidance/decent-homes-standard-review#contents (accessed on 8 May 2023).

32. Homepage of Ministry of Land, Infrastructure, Transport and Tourism. Available online: https://www.mlit.go.jp/en/index.html (accessed on 2 May 2022).
33. Homepage of Ministry of Land, Infrastructure, Transport and Tourism. Available online: https://www.mlit.go.jp/common/001098415.pdf (accessed on 2 May 2022).
34. Homepage of Korean Statistical Information Service. Available online: https://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_2AS017&conn_path=I2 (accessed on 16 February 2023).
35. Homepage of Korean Statistical Information Service. Available online: https://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_2KAA204 (accessed on 16 February 2023).
36. Bae, S.S.; Chun, H.S.; Kim, M.C; Seo, J.A. Study on Improving Minimum Housing Standards. *Korea Research Institute for Human Settlements,* Sejong, Republic of Korea, **2010.**
37. Homepage of Korean Standards & Certification. Available online: https://standard.go.kr/KSCI/portalindex.do (accessed on 11 April 2023).
38. Homepage of Ministry of Government Legislation. Available online: https://www.law.go.kr/LSW/lsSc.do?dt=20201211&subMenuId=15&menuId=1&query=%EC%9E%A5%EC%95%A0%EC%9D%B8#undefined (accessed on 11 April 2023).