



Research on Improvement of Outdoor Barrier-free Facilities for the Elderly With the Example of Kunming City Apartment

Hao Nong¹, Jae-cheol Kang²

¹ Master Student, Department of Industrial Design, Dong-Eui University, Busan, CO 47340, South Korea

² Professor, Department of Industrial Design & Fine Art, Dong-Eui University, Busan, CO 47340, South Korea

Abstract

Background/Objectives: Home-based care for the elderly is still a valued and accepted method for the elderly in China because of the ancient concept of loyalty and filial piety culture. The design of residential structures in current metropolitan communities, however, falls well short of addressing the behavioural and psychological requirements of the aged. In order to accommodate the growth of an elderly society, it has become crucial to construct barrier-free amenities in metropolitan neighbourhoods. **Methods/Statistical analysis:** The idea of barrier-free design suitable for older people is utilised to research outdoor barrier-free facilities in metropolitan areas. **Findings:** Examine and comprehend the requirements of the aged for an age-appropriate design through the initial investigation. Read and briefly describe the pertinent reports on the elderly and barrier-free research. Second, a field investigation and data collection were done on the outdoor barrier-free facilities in the following Kunming neighbourhoods: A Kangyuan Apartment, B Wancaicheng Apartment Phase 1, C Binjiang Junyuan Apartment, D Jinshouyuan Apartment, E golden times Apartment, F Jinyue Four Seasons Apartment, and G Jiangdong Fashion Home Apartment. **Improvements/Applications:** In order to address the issue of standard construction of outdoor barrier-free facilities in residential areas, the analysis and reconstruction suggestions for outdoor facilities in residential areas are presented.

Index Terms

An aging population, Old people, Apartment, Aging-suitable, Barrier-free facilities.

Corresponding author : Jae-cheol Kang

kang@deu.ac.kr

- Manuscript received September 28, 2022.
- Revised October 25, 2022 ; Accepted December 24, 2022.
- Date of publication December 31, 2022.

© The Academic Society of Convergence Science Inc.

2619-8150 © 2020 IJASC. Personal use is permitted, but republication/redistribution requires IJASC permission.

I. INTRODUCTION

A. Research background and purpose

Statistics from the sixth census show that the over-65 population in China makes up 8.87% of the overall population, whereas the over-65 population in the European Union makes up 7% of the entire population. This number indicates that it has surpassed the benchmark for an ageing civilization. In China, there are already 127 million individuals over the age of 65, and the population is getting older faster than before. The proportion of the elderly in China reached one third of the total population in 2015, making it the nation with the greatest percentage of the elderly[1].

The elderly's living environment differs from that of regular people because of the ageing process that affects their physical stamina, mental capacity, eyesight, and hearing. Elderly people experience significant inconveniences because of the nonstandard construction of residential facilities and the lack of attention paid to their needs. Paying attention to and advancing barrier-free design suitable for ageing is particularly crucial. It is crucial to adopt barrier-free design while creating senior housing in order to accommodate their demands and give them the ideal living environment. A apartment can really meet the barrier-free requirements of ageing, which should have the principle of justice, if barrier-free facilities are designed based on the psychology and physiology of the aged. The goal of perfectly designed barrier-free facilities is to assist the elderly in removing barriers from their thoughts and actions so that they can achieve their optimistic, self-assured, and practical life in a welcoming setting.

B. Research scope and methods

This study studies and analyses seven Kunming villages, as well as the outdoor barrier-free facilities in those communities, based on the idea of barrier-free design ideal for ageing. First, examine and comprehend the requirements of the aged for age-appropriate design through the initial investigation. Read and briefly describe the pertinent reports on the elderly and barrier-free research. The second was an on-the-spot investigation and data collection for the outdoor barrier-free facilities in the following Kunming communities: A Kangyuan Apartment, B Wancaicheng Apartment Phase 1, C Binjiang Junyuan Apartment, D Jinshouyuan Apartment, E golden times Apartment, F Jinyue Four Seasons Apartment, and G Jiangdong Fashion Home Apartment. In order to address the issue of standard construction of outdoor barrier-free facilities in residential areas, the analysis and reconstruction suggestions for outdoor facilities in residential areas are presented. These are based on the collection of barrier-free passages, blind sidewalk, barrier-free

handrails, barrier-free signs, and curb ramps in seven residential areas.

II. THEORETICAL BACKGROUND

A. The elderly's demand for suitable aging living environment

According to the findings of the seventh census, China now has 264 million senior citizens due to the country's rapidly ageing population. Currently, 90% of China's elderly opt to live in nursing homes, with the neighbourhood serving as the primary provider of the living environment. Because the physical, psychological, and behavioural demands of the elderly differ from those of younger people as they age, the majority of elderly people's living environments are ageing day by day. The elderly have a safe, healthy, and convenient living environment thanks to the design of the aging-friendly living environment. The aging-friendly living environment is designed to give as much convenience for everyday life and travel as feasible for the elderly with diseases and deteriorating functions.

Later, Li extensively explained the dynamic interaction between people and the environment in the process of ageing in his book "Ecological Theory of Adaptive Behavior and Aging," and he underlined the significance of the environment as a factor that impacts the quality of life of the elderly. In other words, the appropriateness idea between an individual and their environment is advanced along with recurrent emphasis on the environment's value for the elderly, whose physical activity will drop with ageing[2]. A decent living environment that is appropriate for ageing is what the elderly need, taking into account their needs.

The old people's demand for an aging living environment is due to the deterioration of their visual and physiological functions:

1. In the aged, sensory abilities including vision, hearing, touch, etc. are significantly diminished. It will be challenging for the elderly to distinguish between colours and textures because their vision does not have the same visual acuity as that of the young and requires more than twice as much light[3]. Because of the aging of human organs such as nerve endings, it takes longer for the human nervous system to transmit information, and it takes longer for the brain to receive and issue instructions. Therefore, the response of the elderly is slower than that of young people.

2. Naturally, muscular ageing will cause an elderly person's muscle strength, endurance, and flexibility to decline. In varied degrees, hyperosteo-geny, decreased lubrication between joints, decreased bone density, decreased bone toughness, and other skeletal system ageing issues will have a negative impact on

the lives of the elderly, including joint stiffness and discomfort. The specific symptom of spinal atrophy brought on by bone ageing is a reduction in height in the elderly[4]. (Figure 1- Change trend of human body height) Due to physiological changes, the elderly have very strict requirements on the living environment, and the non-standard aging living environment may lead to the psychological dissatisfaction and security of the elderly, so the aging -suitable living environment is the ideal home for the elderly.

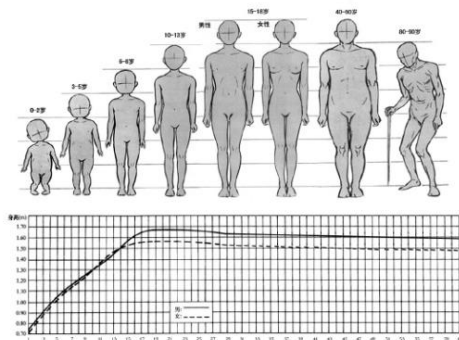


Fig. 1. Trend of Body Height Change.

B. Barrier-free design concept

Developed nations like the United States and Japan have been in the forefront of construction that is barrier-free. The world's first barrier-free building standard, known as American Standard Description of Buildings and Facilities for People with Physical Disabilities (ASA), was created by the American National Standards Institute in 1961. This standard gave disabled people the same access to public spaces, public transportation, and other services as others.

Legal assurance[5]. Early in the 20th century, barrier-free design became a notion in Europe. The phrase "barrier free" in English is a combination of the words "barrier" and "free," and its literal meaning is "to eliminate barriers." In their book *Barrier-free Design: A Handbook for Architects and Building Managers*, British authors James Holmes-Cidell and Cervin Goldsmith defined barrier-free design as "broadly speaking, the products designed by designers to meet the needs of the public, which can be conveniently used by all people." This definition is consistent with the United Nations' advocacy for barrier-free design and the humanistic care of "people-oriented"[6].

C. Configuration of outdoor barrier-free facilities

Outdoor barrier-free facilities are supporting service facilities in construction projects and are created to protect the comfort and safety of their

senior peers. Indoor and outdoor barrier-free facilities are the two categories into which barrier-free facilities can be classified in real life. The outdoor barrier-free facilities in ageing older communities are examined in this research. Road barrier-free amenities, such as blind sidewalk, parking spots, tunnels, curb ramps, etc., can be classified as outdoor barrier-free facilities in older communities. It is possible to categorise the service barrier-free facilities into signs, handrails, voice guidance, etc. the following (Table 1- Classification of outdoor barrier-free facilities).

Table 1. CLASSIFICATION OF OUTDOOR BARRIER-FREE FACILITIES (SELF-DRAWN)

Outdoor barrier-free facilities	
Differentiate	Type
Road facilities	Blind sidewalk, Parking spaces, Passages, Curb ramps
Service facility	Signs, Handrails, Voice prompts

D. Configuration of outdoor barrier-free facilities

1. handrail specification

(1) Concerning the railings' basic design concept. Continuous setting, left and right considerations, and firm installation are the three rules that need to be followed. The interruption of handrails in a continuous context should ensure that older people are not put in danger. When building handrails, it is important to take into account the elderly who move in the other direction in order to care for both the left and the right. As a result, it is important to install double-sided railings securely and ensure that they can handle pressure and stress. Using handrails can help the elderly stay safe when they are not as stable[7].

(2) When determining the handrail height. The barrier-free design tenet ought to be followed. The distance between the lower end of the handrail and the ground for a single-layer handrail is 850mm. It is preferable to install two handrails because some senior residents of nursing homes use wheelchairs. The upper railing is 850mm above the ground, while the lower handrail of the double-layer handrail is 650mm above it.

(3) The handle at the handrail's end needs to be bent more than 100mm downward or inward. Avoid putting clothes on hangers at the end of handrails for senior people[8]. (Table 2- Barrier-free Handrails)

Table 2. BARRIER-FREE HANDRAILS

Barrier-free passage	
Armrest	
Schematic diagram	
standard	Taking care of both the left and right means that the elderly who travel in the opposite direction should be considered when installing handrails. Therefore, double-sided handrails should be installed firmly, and the handrails should be able to withstand pressure and tension. When the elderly are not stable, using handrails can ensure the safety of the elderly.
Schematic diagram	
standard	-The height of single handrail is 850mm. -The height of the lower handrail from the ground is 650mm.
Schematic diagram	
standard	-The end of the handrail is bent downward or inward by more than 100mm.

2. Access to public buildings

Public entry and exit: Accessible entrances and exits in barrier-free buildings provide people with mobility impairments with a special pathway and are a prerequisite for their participation in social activities. The main entrance and exit of the barrier-free path are wider than 900mm, while the other entrances and exits are wider than 800mm. In Tokyo, it is required that general entrances and exits be at least 1000mm wide and at least 800mm wide. Adopting automatic doors or other doors that are practical for those with impairments. The ground at the entry must be paved with anti-slip materials, and there is no height difference between the entrance and the corridor.[9]such as (Table 3- Entrance Passage of Barrier-free Building)

Table 3. ENTRANCE AND EXIT PASSAGE OF BARRIER-FREE BUILDINGS

Barrier-free passage	
standard	The main entrance width is over 900mm. Other entrances and exits are 800mm wide. Tokyo standard: The entrance width is greater than 1000mm. Minimum 800mm

Barrier-free passage	
Height of slope: less than or equal to 750mm	
Specification diagram	

3. Barrier-free signs

The international sign for disabled people should be made in the ratio of 3:1, and a universal barrier-free sign should be made to meet the needs of "handicapped people," the location of facilities, and the warning. Barrier-free signs should adopt two contrasting colours: blue(R:0, G:0, B:255) and orange(R:225, G:124, B:3)[10]. such as (table 4- Barrier-free signs)

Table 4. BARRIER-FREE SIGNS

Barrier-free sign		
Schematic diagram		
standard	Blue (R:0, G:0, B:255)	Orange (R:225, G:124, B:3)

4. Blind sidewalk

(1) The location and direction of blind sidewalk can facilitate and guide people with visual disabilities to barrier-free facilities.

(2) Blind sidewalk must maintain their continuity, and obstructions like manhole covers, telephone poles, or tree pools cannot be placed in the midst of them[11].

(3) To make it easier for people who are visually impaired to distinguish the roads they are travelling and to serve as a reminder and a warning, dot-shaped warning blind sidewalk should be placed at the beginning and ending points of blind sidewalk as well as at turning points. Strip-shaped warning blind sidewalk should be designed for the blind sidewalk walking forward[12].

(4) The most ideal width for the blind sidewalk is 30 to 60 cm.

(5) If flower beds, green belts, or fences are placed outside of sidewalks, they should blend in with the surrounding landscape[13].

Keep a 25- to 50-cm-distance on the blind sidewalk.

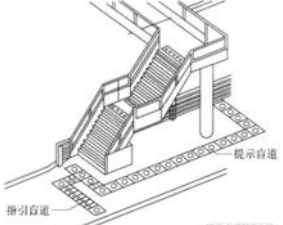
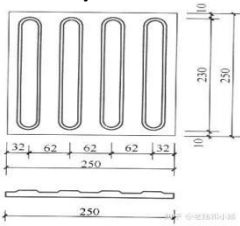
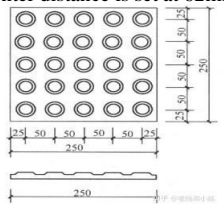

(6) The blind sidewalk's touch strip specs must adhere to the following criteria: a. The face's width (25mm b), the bottom's width (35mm c), the height (5mm d), and the centre distance (62mm/75mm) are all different sizes[14].

(7) The following recommendations are made about the criteria for tactile dots on blind sidewalk: a.

The dot height should be 5mm, the dot height should be 25mm, the bottom diameter should be 35mm, and the centre distance between the dots should be 50mm.

(8) Set prompt blind routes at least 25 to 50 cm away from ramps, stairs, and other obstructions[15]. Such as (Table 5- Blind sidewalk)

Table 5. BLIND SIDEWALK

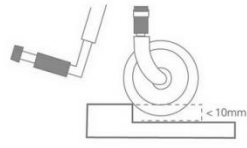
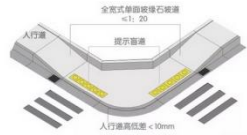
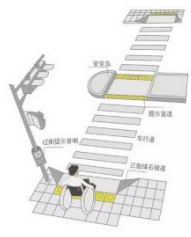
Blind sidewalk	
Schematic diagram	
standard	-It is suggested that the width of the blind sidewalk is generally 30 ~ 60cm. -25 cm ~ 50 cm away from the entrance and exit
Schematic diagram	
standard	-the surface diameter is set at 25mm. -The diameter of the bottom surface is set at 35mm. -The height of the bump is set at 5mm. The strip center distance is set at 62mm.
Schematic diagram	
standard	-the surface diameter is set at 25mm. -The diameter of the bottom surface is set at 35mm. -the dot height is set at 5mm. -the center distance of dots is set at 50mm.
Schematic diagram	
standard	The blind sidewalk should be set at 0.25m-0.5 m away from the fence, flower platform and green belt.

5. Kerb ramp

The curb ramp is a type of ramp that allows wheelchair users to enter the pavement while avoiding the traffic obstruction created by the curb on the sidewalk. Design guidelines for curb ramps: 1. Curb ramp should have a smooth, non-slip slope; 2. When

there is a height difference, the ground above the roadway shall not be higher than 10 mm. There should be no height difference between the kerb ramp groove and the roadway. It is preferable to use a full-width, single-side slope, edge stone ramp[16]. The curb ramp's slope must adhere to the following standards: 1. Full-width single-sided curb ramp's slope cannot be greater than 1: 20; 2. On three sides, the stone slope's front and side slopes shouldn't be steeper than 1:12. Other kerb ramps should not have slopes more than 1:12[17].The curb ramp's width should adhere to the following standards: 1. The walkway shall have the same width as the full-width single-sided curb ramp; 2. The front slope of the stone slope should not be narrower than 1 on three sides. 20m; 3. Other kerb ramps' groove width shouldn't be less than 1. 50m[18]. (Table 6- Curb ramp)

Table 6. CURB RAMP

Curb ramp	
Schematic diagram	
standard	-The slope of kerb ramp should be smooth and non-slip; -There should be no height difference between the groove of kerb ramp and roadway; When there is a height difference, the ground above the roadway should not be greater than 10mm;
Schematic diagram	
standard	-The slope of full-width single-side slope edge stone ramp should not be greater than 1: 20; -The slope of the front and side of the three-sided slope edge stone ramp should not be greater than 1: 12;
Schematic diagram	
standard	-The width of full-width single-sided slope edge stone ramp should be the same as the width of sidewalk; -The width of the front ramp of the three-sided slope edge stone ramp should not be less than 1. 20m; -The groove width of other kerb ramps should not be less than 1. 50m.

III. CASE STUDIES






This paper examines whether barrier-free facilities in seven older communities are standardised and makes reasonable improvement suggestions based on

the aforementioned theoretical knowledge and standards for barrier-free design, as well as on-the-spot investigation and data collection in A Kangyuan Apartment, B Wancaicheng Apartment Phase I, C Binjiang Junyuan Apartment, D Jinshouyuan Apartment, E golden times Apartment, F Jinyue Siji Apartment, and G Jiangdong Fashion Home Apartment.

A. Case Studies





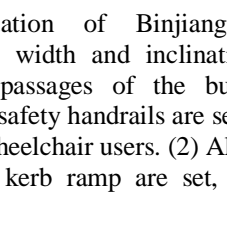
1. Kangyuan Apartment's current state is as follows: (1) Setting up barrier-free corridors in the building's entrance and exit ways is unnecessary. (2) blind sidewalk pose possible safety risks for those who are visually impaired and are worthless for avoiding manhole covers. (3) The absence of standard handrails on both sides of the barrier-free route and the fact that the left handrail is covered in vines will make it more difficult for wheelchair users to pass safely. (4) There aren't any barrier-free parking spaces or signs in place. (5) There are no suggestion bricks on the slope, and the kerb ramp is the regular size.

Table 7. INVESTIGATION STATUS OF KANGYUAN APARTMENT

Kangyuan apartment	
Name	Building entrance and exit passage
Picture	
Name	tactile paving (for the blind)
Picture	
Name	armrest
Picture	
Name	sign
Picture	
Name	curb ramp
Picture	

2. Current situation of Wancaicheng Apartment: (1) The width and inclination of the entrance and exit passage of the building are standardized, but there is no safety handrail to ensure the safe driving of wheelchair users. (2) The blind sidewalk and kerb ramp are standard, and the tip brick with dots at the inclined position. (3) Specification for handrail setting, width and height. (4) There are no barrier-free parking spaces and signs in this apartment.




Table 8. INVESTIGATION STATUS OF WANCAICHENG PHASE I APARTMENT

Wancaicheng	
Name	Building entrance and exit passage
Picture	
Name	tactile paving (for the blind)
Picture	
Name	armrest
Picture	
Name	sign
Picture	
Name	curb ramp
Picture	

3. Current situation of Binjiang Junyuan Apartment: (1) The width and inclination of the entrance and exit passages of the building are standardized, but no safety handrails are set to ensure the safe driving of wheelchair users. (2) Although the blind sidewalk and kerb ramp are set, the dotted



brick at the inclined position is not standardized.



Table 9. INVESTIGATION STATUS OF BINJIANG JUNYUAN APARTMENT

Hamarie Junsono	
Name	Building entrance and exit passage
Picture	
Name	tactile paving (for the blind)
Picture	
Name	armrest
Picture	
Name	sign
Picture	
Name	curb ramp
Picture	

4. Present situation of Jinshouyuan Apartment: (1) There is no barrier-free passage in the entrance and exit of the building, which will not cause great inconvenience to the elderly. (2) Code for setting blind sidewalk and kerb ramps. (3) Handrails are aged and not renovated.




Table 10. INVESTIGATION STATUS OF JINSHOUYUAN APARTMENT

Jinshouyuan	
Name	Building entrance and exit passage
Picture	
Name	tactile paving (for the blind)
Picture	

Jinshouyuan	
Name	armrest
Picture	
Name	sign
Picture	
Name	curb ramp
Picture	

5. Current situation of golden times apartment: (1) The width and inclination of the entrance and exit passage of the building are standardized, but no safety handrails are set to ensure the safe driving of wheelchair users. (2) Code for setting blind sidewalk and kerb ramps. (3) Handrails are not standardized and barrier-free handrails are not used.






Table 11. INVESTIGATION STATUS OF GOLDEN TIMES APARTMENT

Golden Years	
Name	Building entrance and exit passage
Picture	
Name	tactile paving (for the blind)
Picture	
Name	armrest
Picture	
Name	sign
Picture	
Name	curb ramp

Golden Years	
Picture	




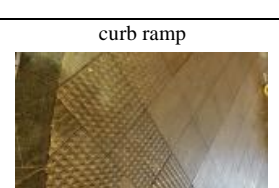
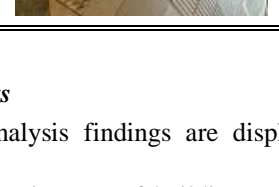
6. Current situation of Jinyue Four Seasons Apartment: (1) The entrance and exit passages of the building are set up in a standard way, with barrier-free signs, but the barrier-free signs are not blue or orange. (2) blind sidewalk and kerb ramps are set with specifications. (3) Handrails are not standardized and barrier-free handrails are not used.

Table 12. INVESTIGATION STATUS OF JINYUE FOUR SEASONS APARTMENT

Jinshouyuan	
Name	Building entrance and exit passage
Picture	
Name	tactile paving (for the blind)
Picture	
Name	armrest
Picture	
Name	sign
Picture	
Name	curb ramp
Picture	

7. The Jiangdong Fashion Home Apartment's current state is as follows: (1) Standardized entrance and exit ways provide for the safe movement of wheelchair users, and barrier-free railings are available. (2) Establish guidelines for kerb ramps and blind sidewalkways, and place dot cue bricks at angles and slopes.

Table 13. INVESTIGATION STATUS OF JIANGDONG FASHION HOME APARTMENT

Jiangdong Fashion Home	
Name	Building entrance and exit passage
Picture	
Name	tactile paving (for the blind)
Picture	
Name	armrest
Picture	
Name	sign
Picture	
Name	curb ramp
Picture	

B. Analysis Results

The survey's analysis findings are displayed in [Table 14]:

1. entrance and exit ways of buildings: 71.4% of residential areas have barrier-free entrance ways, but without safety handrails, there is no assurance that elderly people will be able to travel there safely; 28.6% of residential areas lack barrier-free entrance ways, but 28.5% of those areas were not built in accordance with barrier-free standards;

2. blind sidewalk: Although blind sidewalk have been installed in all communities, only 71.4% of

them are equipped to requirements that are barrier-free, and 28.6% of them are unreasonably constructed because there is no proper connection between the straight and polka-dot bricks at the corner or slope.

3. Handrails: Although handrails are present in 85.7% of residential areas, only 57.1% of residential areas have standardised installation.

4. A major issue for the elderly is that only 14.2% of residential areas have barrier-free signage in place, compared to the baseline rate of 0%.

5. Kerb ramps are present in all residential areas; however, only 28.5% of residential areas have implemented barrier-free curb ramps in a standard manner, and 28.6% of curb ramps are unreasonable due to the ramp form and the lack of a standard connection between the straight and dot bricks at the slope.(Table 14- Statistical Analysis Table)

Table 14. STATISTICAL ANALYSIS TABLE

Number	Name	Entrance channel	tactile paving (for the blind)	Armrest	sign	curb ramp
A	Kangyuan Apartment	x	x	x	-	x
B	Wancaicheng Apartment	x	o	o	-	o
C	Binjiang Junyuan Apartment	x	x	x	-	x
D	Jinshouyuan Apartment	x	o	x	-	o
E	Golden Times apartment	x	o	x	-	o
F	Yue Season Apartment	o	o	x	x	o
G	Jiangdong Fashion Home Apartment	o	o	o	-	o
	Standard rate%	28.5%	71.4%	28.5%	0%	71.4%
	Setting rate	71.4%	100%	85.7%	14.2%	100%

C. Advice For Improvement

The following recommendations for the transformation of barrier-free facilities suited for ageing in seven communities are based on the aforementioned barrier-free implementation specifications:

1. Improvement ideas for the Kangyuan Apartment:

(1). The building's entry and exit should be built on one side of the steps, with a width of 800mm to 1000mm; the highest point of the broken face should be no higher than 750mm, and barrier-free railings should be installed on both sides at a height of 1000mm. In order to give wheelchair users with easy

security, barrier-free handrails are installed at locations in the neighbourhood where driving is challenging (ramps, stairs).

(2). To ensure the safety of the continuous driving path for the blind, the manhole cover should be avoided on the blind sidewalk, and the cue brick should be placed at the corner.

(3). A global barrier-free sign, an international sign for the disabled in the ratio of 3:1, and two contrasting signs in blue (R:0, G:0, B:255) and orange (R:225, G:124, B:3) should all be placed in the neighbourhood.

(4). The kerb ramp shall have a minimum width of 1.50m and prompting bricks should be placed at the cracked surface of the blind sidewalk.

2. Improvement ideas for the Wancaicheng Apartment:

(1). For wheelchair users to be able to exit and enter the building safely, barrier-free railings should be installed at the entrance and exit points.

(2). A global barrier-free sign, an international sign for the disabled in the ratio of 3:1, and two contrasting signs in blue (R:0, G:0, B:255) and orange (R:225, G:124, B:3) should all be placed in the neighbourhood.

3. Improvement ideas for the Binjiang Junyuan Apartment:

(1). To enable the safe passage of wheelchair users, barrier-free handrails should be installed at the entrance and exit passageways of buildings, at a height of 800 mm to 1000 mm, as well as at locations where driving is difficult (ramps, stairs), in the apartment.

(2). It is advised that the brick be enlarged and longer at the blind sidewalk and curb ramp so that the visually impaired might be warned in advance that there is a slope ahead.

(3).A global barrier-free sign, an international sign for the disabled in the ratio of 3:1, and two contrasting signs in blue (R:0, G:0, B:255) and orange (R:225, G:124, B:3) should all be placed in the neighbourhood.

4. Improvement ideas for the Jinshouyuan Apartment:

(1). A barrier-free handrail with a height of 1000mm is installed on both sides, and the vines on the handrails are removed to provide smooth security for wheelchair users. The entrance and exit of the building should be constructed on one side of the stairs with a width of 800mm–1000mm; the height of the highest part of the broken face is less than or equal to 750mm.

(2). A global barrier-free sign, an international sign for the disabled in the ratio of 3:1, and two contrasting signs in blue (R:0, G:0, B:255) and orange (R:225, G:124, B:3) should all be placed in the neighbourhood.

(3).The handrail needs to be polished to remove the spikes from its mounting point because it is old and could potentially damage users.

5. proposals for enhancing the apartment of the Golden Ages:

(1). For wheelchair users to be able to exit and enter the building safely, barrier-free railings should be installed at the entrance and exit points.

(2). A global barrier-free sign, an international sign for the disabled in the ratio of 3:1, and two contrasting signs in blue (R:0, G:0, B:255) and orange (R:225, G:124, B:3) should all be placed in the neighbourhood.

(3). Even though there are handrails at the stairs in the residential area, they are not specified barrier-free handrails that take the needs of the elderly into account. In the residential area, barrier-free handrails should be installed at places where driving is challenging (ramps, stairs), removed, and used.

6. Improvements that could be made to Jinyue Four Seasons Apartment include:

(1). The apartment's outside barrier-free amenities are fully set up. The only issue is that the signs for accessible areas are milky white. They should be altered to the colours blue (R:0, G:0, B:255) and orange to create a stark contrast (R:225, G:124, B:3).

(2). Although handrails have been installed at the residential area's staircases, they are not specified barrier-free handrails that take older residents' needs into account. To maintain the daily safety of the elderly and regular traffic, barrier-free railings should be removed and replaced.

7. Improvement suggestions for the Jiangdong Fashion Home Apartment;

(1). Although this apartment's exterior barrier-free amenities are largely finished, there are no signs indicating their accessibility. According to the particular environmental requirements of the apartment, they should be put in the locations where barrier-free signs need to be displayed. Two contrasting hues, blue (R:0, G:0, B:255) and orange (R:225, G:124, B:3) should be used.

IV. CONCLUSION

90% of the elderly in China opt to remain in their homes for the elderly, and the majority of them reside in residential neighbourhoods, due to the country's antiquated notion, economic pressure, and many other factors. In order to establish a comfortable, secure, and convenient living place for the elderly that is ideal for ageing, this study proposes an improved design of the outdoor barrier-free facilities in the exterior space of the residential areas. The apartment environment has now been made more sensible and human. As one of the commonplace methods of caring for the elderly in

the future, home-based care should carefully examine the design pattern appropriate for ageing. Therefore, the disabled and vulnerable groups also require standardised and sensible barrier-free design to give protection in order to satisfy the psychological and physiological features of the aged while also taking into account their safety and convenience.

Therefore, this study examined and analysed the current state of barrier-free facilities in A Kangyuan Apartment, B Wancaicheng Apartment Phase I, C Binjiang Junyuan Apartment, D Jinshouyuan Apartment, E golden times Apartment, F Jinyue Siji Apartment, and G Jiangdong Fashion Home Apartment in Kunming, China, from the perspective of barrier-free design, referring to China's "Barrier-free Design Code." The findings reveal that there are numerous issues with the design of outdoor barrier-free facilities suited for seniors in the majority of these communities, including: 1. Barrier-free facilities have not been systematically provided in many localities. 2. No renovations were made because barrier-free facilities were already old. 3. The ergonomics of the elderly are not taken into account while designing barrier-free facilities, therefore factors like size and material that do not adhere to the criteria are not taken into account. 4. Elderly people's eyesight is deteriorating, so the issues with logo colour are not taken into account from the standpoint of their poor colour perception and poor colour vision. 5. One of the 5.7 communities is the only one without a sign, and even that one doesn't match the colour of the elderly's visual impairments.

Through this survey, we can see the drawbacks of barrier-free apartment amenities and then the value of barrier-free architecture for the elderly. Based on the results of this study, it will be beneficial for China in the era of ageing to thoroughly examine and analyse the implementation standards of barrier-free construction that are suitable for older people, combine them with the unique national circumstances of China and the unique circumstances of the implementation sites, etc.

Home-based senior care is provided in accordance with the conventional idea and is the best option to accommodate the demands of the majority of people. Additionally, a standard and ideal aging-friendly environment is in line with the preferences of the elderly and can lessen the burden of old age on the nation. The logical research on barrier-free design suitable for ageing offers benchmarks for the renovation of older residential areas, identifies issues, and proposes solutions so that residential areas become perfect senior housing. The only seven apartment situations I studied for this essay can't

possibly represent all the communities in Kunming, China, hence this paper has certain limits.

REFERENCES

- [1] Zhang, J., Kim, M.S. & Wang, X. (2016). A Study on the Barrier-Free Design of the Public Space in China - Focused on the Analysis on Historic-cultural Street, *Tianjin Five Great Avenues(Wu Da Dao)* -. *Archives of Design Research*, 29(3), 163-172.
DOI: 10.15187/adr.2016.08.29.3.163
- [2] Jang, E. & Hong, S. (2022). The Effects of Age-Friendly Environment on Health Promotion Behavior Among Elderly People Living Alone : Focusing on Gender Difference . *Korea Care Management Research*, 43, 171-201.
DOI: 10.22589/kaocm.2022.43.171
- [3] Pang, F. (2005). Outdoor Design for Old People. *Interior Design and Decoration*, 2005(12), 132-133.
DOI: 10.3969/j.issn.1005-7374.2005.12.036.
- [4] Gao. (2014). Research on barrier-free design of mobile assistive devices for the elderly. *Wuhan University of Technology*.
DOI: 10.7666/d.D617831
- [5] LIN, S.Y. & Xue, Y.X. (2020). Barrier-free urban design-taking Beijing as an example. *Construction Science and Technology*, 2020 (11), 36-49.
DOI: 10.16116/j.cnki.jskj.2020.11.007.
- [6] Zhong, Z.Y. & Shen,L.M. (2012). Design on obstacle-free Kitchen and Toilet in the Aged Sitting Room. *Shanxi Architecture.*, 38(5), 8-9.
DOI: 10.3969/j.issn.1009-6825.2012.05.006.
- [7] Zhang, Q. & Liu, Y.X. (2006). Long Life Social Housing Development in Japan. *Architectural Journal*, 2006(10), 13-15.
DOI: 10.3969/j.issn.0529-1399.2006.10.004.
- [8] Yue, X. (2013). Analysis on the General Design of Public Building Entrance and Entrance. *Journal of Yangtze University(Social Sciences)*, 36(3), 178-179.
DOI: 10.3969/j.issn.1673-1395.2013.03.077.
- [9] Zhou, Y.M. & Wang, X. (2014). Study on the Renovation of Barrie-freeAccessibility of Old Residential. *Architectural Skil*, 2014(3), 94-97.
DOI: 10.3969/j.issn.1674-6635.2014.03.016.
- [10] Jia, W.Y. (2018). Research on Quantitative Design of the Color and Scale of Architectural Accessible Signs. *Research on Design*, (1), 48-53.
DOI: 10.3969/j.issn.1000-0232.2018.01.048.
- [11] Wei, M. (2022). Research on the Urban Blind Road Facilities Problrm from the Standardization Perspective-Taking Guangzhou and Zhaoqing as Examples. *Standard Science*, 2022(4), 55-58, 73.
DOI: 10.3969/j.issn.1674-5698.2022.04.009.
- [12] Zhao, L., li, Y.X. &Wang, J.T.(2022). Brief Analysis on Key Technologies and Development trend of Tactile Ground Surface Indicator. *Disability Research*, (z1), 84-88.
DOI: 10.3969/j.issn.2095-0810.2022.z1.016.
- [13] Lv,J. & Yang, J.Y.(2005). Research for Blind Road Development and Usage Condition. *Journal of Jilin Architectural and Civil Engineering Institute*, 22(3), 21-24.
DOI: 10.3969/j.issn.1009-0185.2005.03.006.
- [14] Li, D.M. &Li, J.Y. (2019). Strengthening Blind Road Standards and Standardization: Take the Beijing Metro Station as an example. *Standardization in China*, (22), 226-227.
DOI: 10.3969/j.issn.1002-5944.2019.22.107.
- [15] Bian Xin. (2013). Research on barrier-free facilities design for the elderly in urban public space. *Qilu University of Technology*.
DOI: 10.7666/d.D775860
- [16] Lv, H.L. (2018), Who was the kerbstone ramp built for?. *Disabled persons in China*, 2018(12), 64-65.
DOI: 10.3969/j.issn.1003-1081.2018.12.021.
- [17] Wang, C.et al. (2021). Evaluation of Accessibility of Road Traffic Sidewalks Using the Codes for Accessibility Design in the Mega-city: a Case of Shanghai. *Chin J Rehabil Theory Pract*, 27(10), 1225-1232.
DOI: 10.3969/j.issn.1006-9771.2021.10.014.
- [18] Zhu, C.K. (2004). Design of barrier-free municipal facilities. *Municipal works in China*, 2004(1), 8-9.
DOI: 10.3969/j.issn.1004-4655.2004.01.004.