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Evaluation and Optimization Strategies of Community Public Space Based on the Context of Aging in Place

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Abstract. Amid global aging acceleration, building aging-friendly community public spaces is critical. This paper uses literature review, field surveys and AHP to construct an evaluation system with four dimensions: pedestrian traffic, facilities, safety and spatial environment. Taking 3 Shanghai communities as cases and 300 questionnaires for empirical analysis, it finds common issues (poor sanitation, discontinuous roads, unclear signs): Chunjiang Community performs best, Jiangchuan Road Auto Community has risks like uneven ground, northern Shaanxi communities need most improvements. Based on low-score factors, it puts forward optimization strategies (health management, pedestrian networks, guidance systems) and a collaborative mechanism, aiming to shift aging-friendly construction from passive response to active optimization.

Keywords: ageing, community public space, evaluation system, optimization strategy

1. Introduction

With the acceleration of global population aging and the continuous growth of the elderly population in China, ageing-friendly construction has become an important issue for safeguarding the rights and interests of the elderly and promoting social equity. As the main place for the daily activities of the elderly, the level of ageing of community public space is directly related to the quality of life and sense of well-being of the elderly. The establishment of a scientific evaluation system is the key to promoting the construction of ageing-friendly facilities, which should take into account the hard indicators such as safety and convenience of facilities, and the soft needs such as experience of use and emotional recognition. This system helps clarify renovation directions, optimize resource allocation, shift aging-friendly facility construction from passive response to active optimization, and provide references for relevant practice and research.

2. Demand analysis of ageing-friendly community public space

With age, the physiological functions of the elderly decline, making them have special needs for community public space. Visually, elderly people's eyesight and light sensitivity decline, so the community needs to be equipped with reasonably spaced lighting facilities [1], and signage should use large fonts and contrasting colors such as black characters on a yellow background [2]. In terms of mobility, elderly people's muscle strength, joint flexibility and balance are weakened, so it is necessary to set up a barrier-free access route that meets the needs of wheelchair access, has a suitable

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slope, and is equipped with ergonomic handrails on both sides [3], and is equipped with resting chairs that have moderate heights, non-slip materials, and good backrest support [4]. Psychologically, security is a core need for the elderly; communities should install surveillance and emergency call systems, post safety signs, and upgrade greenery and cleaning frequency to boost residents' sense of belonging and well-being.

3. Evaluation and analysis of the current situation of community public space

3.1. Research process

3.1.1. Collecting information

This article relies on the comprehensive integration of various materials such as academic literature, policy documents, and industry reports at home and abroad to carefully analyze the current research status and key issues of public Spaces in elderly-friendly communities. This approach lays a solid foundation for subsequent research work.

3.1.2. Case analysis

This article will select representative domestic and foreign cases of public Spaces in aging communities, and conduct an analysis from aspects such as the changes before and after the renovation of these cases, specific implementation measures, and the resulting impacts. Then, by comparing the characteristics and all their advantages of these cases, successful experiences will be summarized. This is to verify whether the optimization strategy is feasible and provide reference content for actual operation.

3.1.3. Construct an evaluation system

Tailored to the elderly's actual needs and public space characteristics, this study develops a sound evaluation system with clear indicators, weights, evaluation criteria and methods, which comprehensively reflects aging-friendly performance and provides quantifiable tools for the construction, renovation and management of public spaces.

3.1.4. Field survey

Researchers conducted on-site investigations in selected communities via observation, questionnaires and interviews, documenting spatial layouts, facility types and distributions, and collecting elderly residents' usage experiences, needs and expectations for firsthand analysis data.

3.1.5. Write a report

The entire research process and findings were systematically summarized in a final report. The report details the study's objectives, procedures, results, and recommendations, offering theoretical and practical guidance for aging-adapted transformations of community public spaces.

3.2. Indicator system

Table 1. Evaluation indicator system

Objective layer A	Guideline layer B	Indicator layer C

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Table 1. (continued)

Evaluation Indicators of Ageing of Community Public Space	Pedestrian Transportation B1	Continuity of pathways C1
		Unreasonable Occupancy of Site C2
	Facilities B2	Configuration of ageing-friendly services in elderly service centers C3
		Number of leisure seats C4
		Number of fitness equipment C5
	Community safety and security B3	Clarity of signs C6
		Levelness of the ground C7
		Coverage of lighting facilities C8
		Coverage of monitoring and control C9
		Degree of completeness of emergency call system C10
	Spatial environment B4	Degree of maintenance of facilities C11
		Property Management C12
		Greening Diversity C13
		Frequency of sanitation C14
		Coverage of sun and rain shelters C15

3.3. Case presentation

3.3.1. Case selection

Based on factors such as the age of buildings, their scale, the proportion of elderly residents in the community, and geographical location, this paper selects representative communities as research cases. By adopting such a method, it can ensure the diversity of community types and also enhance the representativeness of the samples. In this way, people can have a relatively comprehensive understanding of the current situation and challenges faced by the community's public Spaces.

3.3.2. Shanbei community (Ruyi Li), Huangpu District, Shanghai

Located at 575 Middle Henan Road, Huangpu District, between Suzhou Creek and Nanjing Road Pedestrian Street, this 1980s-built old neighborhood has a high elderly population ratio. In recent years, the district has taken advantage of the construction of "beautiful homes" and other opportunities to implement a comprehensive aging transformation(see Figures 1 and 2), including the creation of a "cognitive impairment support center"(see Figure 3), upgrading the elderly service station, and coordinating the staggered parking through the Party Building Union to ensure the safety and integrity of outdoor activity space. The transformation experience is exemplary.



Figure 1. Pre-remodeli



Figure 2. After remodeling



Figure 3. Cognitive impairment support center

3.3.3. Chunjiang community, Huangpu District, Shanghai

The neighborhood is located on Wuliqiao Street in the Huangpu District, built in 1983 with over 1,000 residents. As a small-scale old district, it has implemented effective ageing measures such as transforming the utility room into "Spring River Alley"(see Figures 4 and 5) and installing elevators

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through social linkage, which provides valuable practical experience for the transformation of similar districts.



Figure 4. Gelixiang Service Station



Figure 5. Service Center Health Room

3.3.4. Jiangchuan Road motor community, Minhang District, Shanghai

Located on the Huangpu River and built in the 1980s, the community has outdated infrastructure and a large elderly population. The "Beautiful Homes" project created the "Hedong Scenic View" (see Figures 6 and 7),added party stations and fitness courts, and resolved chronic issues like water logging. This people-centered model offers a blueprint for renewing aging communities(see Figure 8).



Figure 6. Hedong Scenic View



Figure 7. Installation of safety handrails



Figure 8. Center for Geriatric Services

3.4. Data sources

3.4.1. Questionnaire survey

This study used questionnaires to collect first-hand data on the aging status of community public spaces and elderly's actual needs, focusing on four core dimensions: pedestrian traffic, facility configuration, safety assurance and spatial environment (see Table 1). Respondents were permanent residents aged 60+ from Huangpu's Shanbei, Chunjiang Communities and Minhang's Motor Community to ensure sample representativeness; the questionnaire had a reliability of 0.89 and validity of 0.91, confirming good credibility.

3.4.2. On-site research

Field research was conducted in three communities: Shanbei and Chunjiang (Huangpu District) and Jiangchuan Road Auto Community (Minhang District), with 30 residents aged 60+ randomly interviewed per community (90 total). Semi-structured interviews focused on four aspects—pedestrian transportation, facility configuration, safety guarantee and spatial environment—to gather qualitative feedback on residents' experiences and renovation needs, complementing prior quantitative survey data. On-site photography documented seniors' high-frequency areas (walking routes, facility usage, surrounding environments), providing clear visual records to support subsequent problem analysis and strategic planning.

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4. Data analysis

4.1. Description of basic data

A total of 300 valid questionnaires were collected in this research, and each case has thirty valid questionnaires' The following are the statistical results of the mean value of each question item (scale scoring rules: 1=very dissatisfied, 5=very satisfied) as in Table 2.

Table 2. Statistical table of means of question items

Name	Shanbei community	Chunjiang community	Jiangchuan Road motor community
C1 Continuity of path	3.68	4.06	4.12
C2 Unreasonable occupation of the site	3.04	3.79	3.78
C3 Elderly service center's elderly-friendly service configuration	3.57	3.97	4.1
C4 Number of leisure seats	3.62	3.92	3.94
C5 Number of fitness equipment	3.55	3.93	4.04
C6 Clarity of signage	3.6	3.93	3.94
C7 Levelness of flooring	3.89	4.21	1.85
C8 Coverage of lighting facilities	3.83	4.1	4.29
C9 Monitoring and control coverage	3.6	4.15	4.14
C10 Degree of completeness of emergency call system	3.05	3.57	3.94
C11 Degree of facility maintenance	3.69	3.94	4.12
C12 Property management	3.42	3.77	4.06
C13 Greening diversity	3.6	4.01	4.13
C14 Frequency of sanitary cleaning	3.2	2.7	2.83
C15 Coverage of sun and rain shelters	3.3	3.7	4.05

On the whole, the comprehensive score of Chunjiang community is the highest, followed by Jiangchuan Road motor community, and Shanbei District is the lowest, indicating that the overall level of community public space aging is relatively better in Chunjiang community, and Shanbei community has more room for improvement.

4.2. Weighting analysis

4.2.1. Shanbei community

Table 3. Linear combination coefficients and weighting results of Shanbei community

Linear combination coefficients and weighting results				
Name	Factor 1	Factor 2	Combined score coefficients	Weights
Eigenroot (after rotation)	4.087	3.814		
Explanation of variance	27.24%	25.43%		
3. What do you think about the continuity of walking routes in public spaces in your community?	0.0255	0.4019	0.2072	5.75%
4. have you experienced public space access routes being occupied by motorized vehicles or sites being unreasonably occupied?	0.2689	0.2413	0.2555	7.09%
5. what do you think of the service configuration of the senior center?	0.3102	0.0917	0.2047	5.68%
6. do you think the number of benches and sitting seats in the community is sufficient?	0.1490	0.3212	0.2322	6.44%
7. do you think the number of fitness equipment in the community meets the demand?	0.2994	0.2784	0.2893	8.03%
8. are you satisfied with the clarity of signage in your community?	0.2168	0.2463	0.2310	6.41%
9. Do you think the ground in the community is smooth?	0.1773	0.3578	0.2644	7.34%

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Table 3. (continued)

10. how satisfied are you with the coverage of lighting in your community?	0.2461	0.2415	0.2439	6.77%
11. Are you comfortable with the surveillance coverage in your community?	0.2788	0.2483	0.2641	7.33%
12. Do you think the emergency call center in the community is safe?	0.3216	0.1181	0.2234	6.20%
13. are you satisfied with the level of maintenance of public space facilities in the community?	0.2942	0.2403	0.2682	7.44%
14. Are you satisfied with the property management of the community?	0.2327	0.2679	0.2497	6.93%
15. Are you satisfied with the diversity of greenery in the community?	0.1183	0.3210	0.2161	6.00%
16. What is the frequency of sanitation and cleaning in the community?	0.3957	0.0067	0.2079	5.77%
17. How satisfied are you with the level of shade in the community?	0.2960	0.1898	0.2447	6.79%

For aging suitability, fitness equipment adequacy has the most significant impact, followed by ground levelness and surveillance coverage; unreasonable space occupation is also highly important. Shelter coverage, lighting and seating availability exert moderate influence, while service center configuration, hygiene frequency and greenery diversity have relatively weaker effects.

4.2.2. Chunjiang community

Table 4. Linear combination coefficients and weighting results of Chunjiang community

Linear combination coefficients and weighting results					
Name	Factor 1	Factor 2	Factor 3	Combined	
Eigenroot (after rotation)	4.101	2.483	2.024	score	Weights
Explanation of variance	27.34%	16.55%	13.49%	coefficients	
3. What do you think about the continuity of walking routes in public spaces in your community?	0.0018	0.5233	0.0145	0.1552	4.74%
4. have you experienced public space access routes being occupied by motorized vehicles or sites being unreasonably occupied?	0.3250	0.0714	0.2781	0.2408	7.35%
5. what do you think of the service configuration of the senior center?	0.1682	0.4245	0.0584	0.2163	6.60%
6. do you think the number of benches and sitting seats in the community is sufficient?	0.3479	0.1506	0.0541	0.2219	6.77%
7. do you think the number of fitness equipment in the community meets the demand?	0.3135	0.0570	0.0598	0.1799	5.49%
8. are you satisfied with the clarity of signage in your community?	0.0910	0.4472	0.0862	0.1926	5.88%
9. Do you think the ground in the community is smooth?	0.2272	0.1933	0.3487	0.2460	7.51%
10. how satisfied are you with the coverage of lighting in your community?	0.3330	0.2292	0.1629	0.2631	8.03%
11. Are you comfortable with the surveillance coverage in your community?	0.3298	0.1975	0.1162	0.2414	7.37%
12. Do you think the emergency call center in the community is safe?	0.2113	0.2161	0.4056	0.2584	7.89%
13. are you satisfied with the level of maintenance of public space facilities in the community?	0.3723	0.0866	0.0848	0.2223	6.78%
14. Are you satisfied with the property management of the community?	0.2993	0.0682	0.1308	0.1930	5.89%

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Table 4. (continued)

15. Are you satisfied with the diversity of greenery in the community?	0.2688	0.1775	0.2984	0.2494	7.61%
16. What is the frequency of sanitation and cleaning in the community?	0.0073	0.0504	0.5901	0.1568	4.78%
17. How satisfied are you with the level of shade in the community?	0.1484	0.3052	0.3425	0.2393	7.30%

Lighting coverage is the most influential factor for the aging suitability of community public spaces. The upgraded emergency call system and ground levelness are also critical. Surveillance coverage and sun/rain shelters have moderate effects, while sanitation frequency and path continuity exert relatively lower impacts.

4.2.3. Jiangchuan Road motor community

Table 5. Linear combination coefficients and weighting results of Jiangchuan Road motor community

Linear combination coefficients and weighting results				
Name	Factor 1	Factor 2	Combined	
Eigenroot (after rotation)	4.811	3.044	score	Weights
Explanation of variance	32.08%	20.29%	coefficients	
3. What do you think about the continuity of walking routes in public spaces in your community?	0.2933	0.0398	0.1951	5.35%
4. have you experienced public space access routes being occupied by motorized vehicles or sites being unreasonably occupied?	0.1704	0.3720	0.2485	6.81%
5. what do you think of the service configuration of the senior center?	0.3055	0.0588	0.2099	5.75%
6. do you think the number of benches and sitting seats in the community is sufficient?	0.2548	0.2026	0.2346	6.43%
7. do you think the number of fitness equipment in the community meets the demand?	0.1869	0.3081	0.2339	6.41%
8. are you satisfied with the clarity of signage in your community?	0.3464	0.0363	0.2262	6.20%
9. Do you think the ground in the community is smooth?	0.2490	0.2676	0.2563	7.02%
10. how satisfied are you with the coverage of lighting in your community?	0.2392	0.2851	0.2570	7.04%
11. Are you comfortable with the surveillance coverage in your community?	0.2583	0.2310	0.2477	6.79%
12. Do you think the emergency call center in the community is safe?	0.3015	0.2463	0.2801	7.68%
13. are you satisfied with the level of maintenance of public space facilities in the community?	0.3070	0.1625	0.2510	6.88%
14. Are you satisfied with the property management of the community?	0.2148	0.3006	0.2480	6.80%
15. Are you satisfied with the diversity of greenery in the community?	0.2476	0.2661	0.2548	6.98%
16. What is the frequency of sanitation and cleaning in the community?	0.1285	0.4818	0.2654	7.28%
17. How satisfied are you with the level of shade in the community?	0.2770	0.1808	0.2397	6.57%

In this community, the most influential factors for aging suitability are the perfection of the emergency call system and ground leveling. Lighting coverage and monitoring protection also show notable impact. Unreasonable occupation of public space has a moderate influence, while continuity of walking routes and diversity of greenery contribute relatively less to the overall assessment.

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4.3. Comprehensive score comparison

4.3.1. Data description

Table 6 presents the composite scores of Shanbei, Chunjiang, and Jiangchuan Road Motor communities across 15 factors (C1–C15). Overall, the neighborhoods vary in their performance on individual factors, providing a basis for analyzing their respective strengths and weaknesses.

Table 6. Statistics of factor composite scores

Name	Shanbei community	Chunjiang community	Jiangchuan Road motor community
C1 Continuity of path	0.2116	0.192444	0.22042
C2 Unreasonable occupation of the site	0.215536	0.278565	0.257418
C3Configuration of age-appropriate services at senior service centers	0.202776	0.26202	0.23575
C4 Number of leisure seats	0.233128	0.265384	0.253342
C5 Number of fitness equipment	0.285065	0.215757	0.258964
C6 Clarity of signs	0.23076	0.231084	0.24428
C7 Levelness of floor	0.285526	0.316171	0.12987
C8 Lighting coverage	0.259291	0.32923	0.302016
C9 Monitoring and control security	0.26388	0.305855	0.281106
C10 Degree of perfection of emergency call system	0.1891	0.281673	0.302592
C11 Degree of facility maintenance	0.274536	0.267132	0.283456
C12 Property management	0.237006	0.222053	0.27608
C13 Greening diversity	0.216	0.305161	0.288274
C14 Sanitary cleaning frequency	0.18464	0.12906	0.206024
C15 Coverage of sun and rain shelters	0.22407	0.2701	0.266085

From a comprehensive perspective, Spring River Community performs well in facility provision, safety, and spatial environment, showing a relatively high overall level of aging adaptation. The Jiangchuan Road Auto Community performs quite well in terms of whether pedestrians can easily reach it and property management. However, when it comes to safety-related factors such as the flatness of the ground, there are very prominent deficiencies. Compared with the Jiangchuan Road Auto Community, the Shaanbei Community is not bad except for the fitness equipment. The scores obtained in many different indicators are relatively low, which indicates that the communities in northern Shaanxi need to make all-round improvements in terms of the functions that are friendly to the elderly.

4.3.2. Analysis of high scoring factors

Analysis of 300 valid questionnaires shows all three communities score high in public space facility maintenance: Jiangchuan Road Auto Community leads (0.283456), followed by Shaanbei (0.274536) and Chunjiang (0.267132), with a mere 0.016336 score gap. This highlights their strong performance, sufficient funding and efforts in facility upkeep, with no obvious aging or disrepair. Scoring well on the 1–5 satisfaction scale, they gain positive elderly feedback, proving long-term effective management of fitness equipment, seats and other public facilities with timely repairs to support daily activities. Notably, despite lower scores for venue occupancy and emergency call systems, sound facility maintenance remains their shared strength.

4.3.3. Factor analysis of low scores

Analysis of 300 valid questionnaires reveals three key indicators—hygiene/cleaning frequency (C14), path continuity (C1), sign clarity (C6)—consistently score low across all three communities, showing

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aging-friendly renovations prioritize core facilities over basic services and overlook seniors' high-frequency demands for hygiene, accessibility and wayfinding. C14 ranks lowest for Chunjiang, Jiangchuan Road Auto Community and Northern Shaanxi, far underperforming other indicators; this ties to elderly dissatisfaction with delayed cleaning, garbage buildup and poor sanitization of public facilities, undermining basic environmental safety and comfort. C1 scores are also low with small inter-community gaps: Jiangchuan Road Community fares better, Shaanbei and Chunjiang lag. Field inspections show damaged roads, missing signs and blocked passages often disorient seniors or force detours, greatly inconveniencing those with mobility issues and necessitating a more comprehensive walking network.

5. Data analysis

5.1. Analysis of the current status of the low-scoring factor

5.1.1. Frequency of sanitary cleaning: lack of management mechanism leads to insufficient environmental protection

Among the three low-scoring indicators, the scores for hygiene and cleaning frequency are the lowest. For instance, Chunjiang has a score of 0.129, Northern Shaanxi has a score of 0.185, and Jiangchuan Road Auto Community has a score of 0.206. Their scores are all below 0.25. From this situation, it can be seen that the satisfaction of the elderly with hygiene and cleaning is relatively low. This article relies on on-site research and has identified three rather crucial issues. The first one is that the cleaning frequency does not quite match the daily activity patterns of the elderly. During the peak exercise hours in the morning and after their rest time in the evening, the cleaning work often lags behind. As a result, garbage accumulates near the seats and around the fitness area. The second issue is that the cleaning scope is not comprehensive enough. In the corners of the walls, the edges of the green belts and the corners of the stairs, dust and some debris are often left uncleaned. The third problem is that there are some deeper systemic problems. Most communities do not have a customized sanitation management system for their own conditions.The division of responsibilities for health work is not clear. After outsourcing the health work, there was no effective supervision [5]. In addition, the number of health workers was insufficient, and the training they received was also inadequate. A provincial-level related study showed that only 28% of all communities had full-time health workers, and among these workers, only 15% had received specialized professional training [6]. Due to insufficient funds, the community's sanitation facilities are relatively old and outdated, and the supply of disinfection products is also insufficient. This hinders the frequent and thorough cleaning work. Such an actual situation is contradictory to the role that sanitation facilities should play as a "basic guarantee for the quality of services for the elderly" [7] and it also brings health risks to the elderly. Studies have confirmed that in communities with poor sanitary conditions, the elderly are more likely to suffer from respiratory and digestive system diseases [8].

5.1.2. Path continuity: spatial planning deficiencies constrain access safety

This paper finds that the overall score of the path continuity factor is relatively low. Among them, the score of Chunjiang Community is 0.192, that of Shanbei Community is 0.212, and that of Jiangchuan Road Motor Vehicle Community is 0.220. The scores of the path continuity factor of these communities are all at a relatively low level, and this problem is more obvious in old residential areas. The old district has a situation of "double aging". When it was built in the early stage, the construction standards at that time did not fully take into account the passage needs of the elderly, and there was no systematic planning well in the design of pedestrian Spaces [9]. At the same time, during the renovation process, insufficient attention was paid to the pedestrian space. Many times,

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only the upgrading and transformation of core facilities were emphasized, while the basic requirement of path continuity was overlooked [10]. Walking continuity is directly related to the travel safety and fall risk of the elderly, and the frequent occurrence of breakpoints will reduce their participation in community activities, which is in contradiction with the statutory requirements of the Barrier-Free Environment Construction Law [11] and the planning principle of the "fifteen-minute community living circle" [12].

5.1.3. Clarity of signage: inadequate design adaptation affects access to information

The clarity factor score of signage is at a low to medium level, with a small difference between the scores of the three communities (0.230-0.244), and the problem is generalized. The problem is common. It is mainly manifested in signage with small fonts and thin strokes, and some of the signs are aged and blurred, not updated in time or even misdirected. The root cause lies in the fact that the signage design does not follow the principle of ageing: it follows the common signage system and does not incorporate the characteristics of cognitive decline of the elderly [13]; it lacks systematic planning and has a fragmented layout; and it does not adequately consult the elderly when designing it, and its adaptability is insufficient [14].

5.2. Optimization improvement measures for low scoring factors

5.2.1. Frequency of hygiene and cleaning: establish a long-term mechanism for ageing-friendly hygiene management

A "system guarantee-resource support-supervision & evaluation" tripartite optimization system is established: formulate dedicated management systems, clarify peak-hour (6-8 a.m.) enhanced cleaning mechanisms for high-frequency areas with a minimum 3 daily cleanings, deploy age-friendly sorted trash bins and standardize cleaning procedures; boost resource support via special funding, full-time staff allocation and training, and elderly volunteer supervision to build a synergy model; set up an evaluation-feedback mechanism with a hygiene star-rating system, link results to funding and performance, and open feedback channels [5].

5.2.2. Continuity of paths: building a safe and coherent ageing-friendly walking network

Based on the principle of "systematic planning, barrier-free connection and safety priority", build an adaptable walking space system: optimize the layout, improve the connection between the walking paths and functional areas, and coordinate the planning of the walking network to ensure that there are no breakpoints; strengthen the construction of barrier-free facilities, reconstruct the high-difference areas, set up ramps with slopes of no more than 1:12 and non-slip handrails, unify the height (12-15 cm) of steps and add non-slip strips, and set up rest seats at key nodes to build a "walking-resting" system. The height of steps is unified (12-15 cm) and anti-slip strips are added, and rest seats are installed at key nodes to build an integrated space of "walking and resting" [15].

5.2.3. Clarity of signage: building an age-appropriate visual guide system with strong adaptability

The signage system should be optimized for clarity, accessibility, and human-centered design through three key measures: adopting bold, high-contrast fonts (minimum size 24) in a "text + image" format to avoid abstract symbols and jargon [13]; implementing a three-tier guide system (overview map, regional guide, point signs) installed at key nodes, with regular inspection and maintenance [14]; and incorporating personalized elements such as auxiliary address/emergency signs, community-specific features, and participatory design with elderly residents to enhance recognition and satisfaction [16].

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5.3. Optimizing implementation safeguards

Addressing the three low-scoring factors requires a "government-led, community-driven, multi-party participation" synergy: government should increase funding, establish standards, and subsidize policies; communities should coordinate needs and resources; social capital should upgrade age-friendly facilities using smart technologies (e.g. automated cleaning, digital displays) to enhance service efficiency [17]; To create an environment where everyone works together, it is necessary to rely on enhancing public awareness. System optimization can transform the elderly-friendly measures that only focus on hardware into integrated solutions that take into account both software and hardware. This approach can improve the quality of life for elderly residents [9].

6. Conclusion and outlook

6.1. Main conclusions of the study

This study defines elderly's core needs for community public spaces: physiological (sufficient lighting, clear signs, barrier-free access, rest areas) and psychological (security, belonging in supportive spaces). Using AHP to integrate subjective judgments and objective data, it builds a scientific aging-friendly evaluation system with 4 criteria (pedestrian traffic, facilities, safety, spatial environment) and 15 indicators. Analysis of 3 case communities shows their strengths in high-scoring, well-managed facility maintenance, yet shared weaknesses: poor sanitation, discontinuous paths, unclear signs, reflecting priority of core facilities over basic services. Overall, Chunjiang performs best; Jiangchuan Road Auto Community is hampered by uneven ground; northern Shaanxi needs the most improvements. Targeted strategies are proposed for key deficiencies: long-term sanitation management, continuous safe walking networks, adaptive guidance systems, and a government-guided, community-led multi-stakeholder collaboration mechanism, to advance balanced hardware-software integration in aging-friendly development.

6.2. Research limitations

This study has several limitations.its three Shanghai community samples, despite differing ages and scales, have a narrow geographic scope that reduces representativeness and nationwide applicability across city tiers, towns and north-south regions; lacking long-term follow-up surveys and fieldwork, it fails to capture the dynamic impacts of aging-friendly renovations and evolving elderly needs over time; additionally, the evaluation system covers core dimensions but lacks indicators for smart aging facilities like intelligent monitoring and electronic guidance, limiting alignment with the smart aging trend.

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