Journal of Infrastructure, Policy and Development 2024, 8(12), 7993.
https://doi.org/10.24294/jipd.v8i12.7993

Article

A Sustainable urban renovation assessment model (SURAM) for enhancing elderly-friendly environments

Mei Yang[1], Rostam Yaman[2,*], Farrah Zuhaira Ismail[3], Peiyun Cheng[4], Yong Jiang[5]

[1] College of Built Environment, Universiti Teknologi MARA, Shah Alam 40450, Malaysia
[2] Institute of Biodiversity & Sustainable Development, Universiti Teknologi MARA, Shah Alam 40450, Malaysia
[3] Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Shah Alam 40450, Malaysia
[4] School of Art, Chongqing Technology and Business University, Chongqing 400067, China
[5] Fine arts education, Chongqing Normal University, Chongqing 400000, China
*** Corresponding author:** Rostam Yaman, rosrose@uitm.edu.my

CITATION

Yang M, Yaman R, Ismail FZ, et al. (2024). A Sustainable urban renovation assessment model (SURAM) for enhancing elderly-friendly environments. Journal of Infrastructure, Policy and Development. 8(12): 7993. https://doi.org/10.24294/jipd.v8i12.7993

ARTICLE INFO

Received: 15 July 2024
Accepted: 30 August 2024
Available online: 5 November 2024

Abstract: The rapid increase in the aging population has raised significant concerns about the living conditions and well-being of elderly residents in old communities. This study addresses these concerns by proposing a Sustainable Urban Renovation Assessment Model (SURAM) specifically designed to enhance elderly-friendly environments in Chongqing City. The model encompasses multiple dimensions, including the comfort of public facilities, service safety and convenience, medical travel services, infrastructure security, life service convenience, neighbor relations, ambulance aid accessibility, commercial service facilities, privacy protection, elderly care facilities and service supply, and medical and health facilities. By employing factor analysis, the study reduces the dimensionality of the 49 indicator factors, allowing for a more focused and comprehensive evaluation of the effectiveness of aging-friendly renovation efforts. The main factors identified in the proposed model include community infrastructure security, elderly comfort of community public facilities, completeness and convenience of surrounding living services, and security and convenience of elderly care services. The results reveal that the age-appropriate comfort of public facilities plays a significant role in achieving successful aging-appropriate renovation outcomes. The findings demonstrate that by addressing specific needs such as safety, accessibility, and convenience, communities can significantly improve the quality of life for elderly residents. Moreover, the application of SURAM provides actionable insights for policymakers, urban planners, and community stakeholders, guiding them in implementing targeted initiatives for sustainable and inclusive urban development.

Keywords: sustainable urban; urban renovation; elderly-friendly; infrastructure security; assessment model

1. Introduction

The global phenomenon of population aging poses a significant and pressing challenge for urban communities worldwide. As demographics shift and the proportion of elderly individuals rises, it is crucial to address the specific needs and challenges faced by this growing population, especially those residing in old communities. The issue of population aging has emerged as a critical social problem in countries across the globe, including my own. In China, the problem of population aging is escalating, necessitating immediate attention and proactive measures (Wang et al., 2023). To effectively address the challenges associated with providing for the elderly, it has become imperative to undertake aging-appropriate transformations of old communities (Wu et al., 2022). By adapting existing urban areas to cater to the

unique needs of older adults, we can ensure their well-being, social integration, and enhanced quality of life (Mandi and Bansod, 2023).

In recent years, the renovation of old communities has been a research content that the academic circle has paid close attention (Luo et al., 2022; Wang and Chen, 2020). The progressive aging of the global population is particularly pronounced in China, where currently 18% of the population is over 65 years old, and this percentage is projected to increase to 33% (Lee et al., 2023). This demographic shift poses unique environmental challenges in residential areas, as the elderly tend to have a higher energy consumption due to spending more time at home and being more sensitive to temperature and comfort conditions (Jia et al., 2022). Successfully promoting aging in place relies not only on the physical characteristics of residential environments but also on the psycho-environmental factors that affect the well-being of the elderly residents (Yıldız et al., 2023). Residential satisfaction is a critical factor in achieving a high quality of life in residential areas (Sun et al., 2022). It encompasses various domains, including the physical building, the neighborhood, and the relationships with neighbors. Understanding social needs and designing effective architectural interventions for the elderly is crucial in promoting their well-being (Alam and Haque, 2022; Hasegawa and Lau, 2022). Another significant variable in urban regeneration for an aging population is place attachment, which refers to the positive emotional bond between individuals and their physical surroundings, contributing to the development of a territorial identity (Fu, 2022). This sense of attachment to the place plays a vital role in fostering a sense of belonging and well-being among the elderly population.

In response to the current situation, there is a growing focus on urban renovation research. This research calls for the development of new decision support systems that use multidisciplinary diagnoses to determine the most appropriate level of intervention in the built environment (Maslesa et al., 2018; Femenías et al., 2018). These assessment models should prioritize repair, adaptation, and renovation efforts based on specific regulations, social needs, and the socio-economic context of each area, aiming to create suitable housing environments (Ibarloza et al., 2018; Serrano et al., 2018). However, a research gap exists in the development of specific inspection tools and assessment procedures for the built environment, particularly in evaluating and quantifying accessibility conditions in social urban settings. As a result, there will be a growing need in the coming years to promote assessment tools and action strategies for urban renovation that enhance user autonomy. This can be accomplished by diagnosing and adapting the housing stock where the elderly population resides (Mercader-Moyano et al., 2021; Sheikh and Ameijde, 2022). Aligning with Sustainable Development Goal (SDG) 3, which promotes health and well-being for all ages, and SDG 11, which focuses on creating inclusive, safe, and sustainable cities, these strategies are essential for improving the quality of life for elderly residents in urban areas.

But how effective could these urban retrofit actions be towards enhancing the elderly-friendly Environments in Chongqing City? This study aims to develop a Sustainable Urban Renovation Assessment Model (SURAM) tailored specifically to the needs of the elderly population in old communities in Chongqing City. By utilizing a multidimensional approach, the SURAM encompasses various aspects crucial for enhancing the well-being and living conditions of elderly residents. These dimensions

include the comfort of public facilities, service safety and convenience, medical travel services, infrastructure security, life service convenience, neighbor relations, ambulance aid accessibility, commercial service facilities, privacy protection, elderly care facilities and service supply, as well as medical and health facilities. The development of the SURAM is based on a comprehensive review of existing literature pertaining to aging-friendly urban environments, sustainable urban renewal, and models for assessing the needs of the elderly population. The literature review serves as the foundation for understanding the key factors that contribute to successful aging-appropriate renovation in old communities. By drawing upon the existing body of knowledge, this study seeks to advance the understanding of the unique requirements and challenges faced by elderly individuals residing in Chongqing City's old communities.

2. Related background

2.1. Concept of urban design

Although there is broad agreement that urban design exists, no definitive definition of what urban design is or how to define it has been established. Urban design tries to develop a vision for a location before utilizing the abilities and resources necessary to make that vision a reality. It is viewed as a collaborative, multidisciplinary process that aims to shape the physical environment of an urban area while also providing specific physical design directions for urban growth, conservation, and transformation. Zhuang et al. (2019), noted that politicians, a wide range of stakeholders, and various professionals, including architects and planners, are all involved in the process of urban design, and that the success of this collaboration greatly affects the quality of the final product. Some people confuse the terms "urban design" and "urban planning" or "architecture" because they all deal with the physical setting of a region. They aren't the same, in actuality. Yazici and Ozturk (2023), urban design is the meeting point between urban planning and architecture while urban planning deals with the design of the built environment from a macro perspective at a less detailed level and incorporates zoning to manage land-use distribution and growth management to control pace of development, architecture focuses on the physical design of buildings and the areas nearby. Urban design involves both disciplines, but focuses on physical features of the built environment that goes beyond a single building or individual parcel of land. Urban design emphasizes on the relationships between urban spaces like interface between public and private realms, areas between buildings and streets, and spaces beneath buildings or within buildings (Coxon et al., 2019). Given this, urban design might be referred to as "large-scale architecture" or the "physical aspect of urban planning".

Urban design is a powerful instrument for obtaining a higher quality of life, greater economic vitality, and a more efficient use of resources. It is also essential for creating attractive, useable, durable, and adaptive environments. Liu et al. (2023) described Urban design aids in forming urban environments and transforming various facets of urban life into tangible, useable city forms. The promotion of sustainable lifestyles for the general public as well as the facilitation of future economic, environmental, and social growth are both achieved by taking into account the many

characteristics of the city and the concerns of the residents in the design of the physical environment (Abdul et al., 2023). According to earlier research, good urban planning can also increase property prices, the quality of the environment, and inhabitants' quality of life (Yang et al., 2022). Xie et al. (2022) asserts that urban design may address issues with resource misallocation, inefficient land use, and the needless demolition of buildings and other structures with distinctive architectural elements or historical significance (Yang et al., 2022). Previously, an economic model was used to assess the advantages of urban planning. A group of 102 commercial buildings in the US were subjected to a design analysis, and the researchers discovered that while good design did not always result in higher costs, the rental value grew with time. Since urban design has been shown to be a successful tool for achieving sustainability, many researchers and professionals are working to develop a high-quality and sustainable built environment for the public using this method (Yang et al., 2022).

2.2. Key urban design principles

The key considerations for creating livable, sustainable, and inclusive communities that meet the needs of all residents, including the elderly, have been identified through an extensive review of relevant literature and research (Tolfo and Doucet, 2022). By integrating these factors into urban design, planners and designers can develop communities that are safe, comfortable, and accessible for people of all ages, incomes, and abilities (Korkou et al., 2023). An essential aspect of urban design is community infrastructure security, as it ensures a safe and secure environment for all residents. This includes designing public facilities that are easily accessible, comfortable, and accommodating for elderly individuals. In addition, designing communities that provide easy access to a full range of services and amenities, including transportation options, healthcare facilities, recreational facilities, and retail establishments. Further, security and convenience of elderly care/elderly care services are also essential for ensuring that elderly individuals have access to necessary healthcare and other services that support their needs.

The Sustainable Development Goals (SDGs) most relevant to addressing the health and well-being of the elderly are SDG 3: Good Health and Well-being and SDG 11: Sustainable Cities and Communities. SDG 3 emphasizes the importance of ensuring healthy lives and promoting well-being for all at all ages, which is crucial for the aging population as it focuses on reducing health inequalities and improving access to healthcare services (United Nations, 2015). Meanwhile, SDG 11 advocates for creating inclusive, safe, and sustainable urban environments, which are particularly significant for the elderly population. This goal promotes the development of age-friendly cities that enhance accessibility, safety, and inclusivity in public spaces and services, thereby improving the overall quality of life for elderly residents (World Health Organization (WHO, 2017). These two SDGs work in tandem to address both the health and environmental needs of aging populations, supporting sustainable and equitable urban development.

Based on the theoretical framework and identified urban design considerations, the following key principles and considerations have been outlined for urban design:

Security and convenience of elderly care services: provide safe and convenient access to elderly care services, such as healthcare facilities and other services that support the elderly population.

Elderly comfort of community public facilities: take into account the needs and comfort of elderly individuals when designing community public facilities.

Health and well-being: consider the impact of the built environment on residents' health and active lifestyles, access to healthy food options, and safe and accessible public spaces.

Social equity: promote inclusive communities that meet the needs of all residents, regardless of age, income, or ability and considering access to services, transportation, and public facilities.

Aging in place: support aging in place by designing communities that allow elderly individuals to remain in their homes and communities as they age.

Table 1 outlines the urban design considerations that are connected to the broader theoretical framework for selecting urban design principles. Four major design principles are highlighted, supported by relevant literature. Some of these concepts have already been discussed and demonstrated earlier, while the remaining ones are drawn from previous studies. The urban design factors for this study are subsequently refined based on the design principles presented in **Table 1**.

Table 1. Identified urban design considerations.

Urban Design Considerations		Linked to Urban Design Principles	References
A	Community infrastructure security	Safety and security	(Strulak-Wójcikiewicz and Deja, 2022; Cheshmehzangi et al., 2021; Gaglione, et al., 2022)
B	Elderly comfort of community public facilities	Health and well-being; Aging in place	(Yung et al., 2016; Domisch et al., 2019)
C	Completeness and convenience of surrounding living services	Social equity; Health and well-being;	(Chen et al., 2019; Ma et al., 2021)
D	Security and convenience of elderly care/elderly care services	Social equity; Aging in place; Sustainability	(Poh-Chin et al., 2009; Ministry of Housing and Urban-Rural Development of the People's Republic of China, 2024)

3. Proposed model

3.1. Sustainable urban renovation assessment model (SURAM)

Within the academic community, there is currently no universally agreed-upon definition for "aging-friendly renovation." In this paper, we define aging-friendly renovation as the deliberate design of key activity areas within old communities, taking into consideration the physiological and psychological needs of the elderly population. The effectiveness of such renovations and the configuration of facilities can be measured by the satisfaction levels of the elderly with both hardware and software facilities.

To assess the impact of aging-friendly renovations in old residential areas, this study refers to the "Guiding Opinions on Promoting the Construction of a Livable Environment for the Elderly" issued by the National Office on Aging in China. This guidance document provides a framework for evaluating the effectiveness of aging-friendly renovations. The details of **Table 1** indicator system used in this study encompasses 49 evaluation indicators, categorized into two major groups: hardware facilities and software facilities (as shown in **Table 2**). These indicators are measured using a 7-point likert scale which participants rate their satisfaction levels on a scale of 1 to 5, with "Comparatively satisfied" and "Very satisfied" corresponding to the grades of 1, 2, 3, 4, 5, 6 and 7 respectively as shown in Appendix A. The SURAM model integrates these evaluation indicators to comprehensively assess the impact of aging-friendly renovations in old communities. By comprehensive assessment approach enables a holistic understanding of the effectiveness of aging-friendly renovations and provides valuable insights for policymakers, urban planners, and community stakeholders involved in urban renewal projects aimed at enhancing the well-being of the elderly population.

Table 2. Variables of evaluation index system.

Factory A—Community infrastructure security	
A1	Road safety
A2	Firefighting facilities
A3	Monitoring facilities
A4	Anti-theft facilities
A5	Electrical safety
A6	Completeness of public lighting facilities
A7	Provision of intelligent security system
Factor B—Elderly comfort of community public facilities	
B1	Safety of sports facilities
B2	Convenience of sports and entertainment facilities
B3	Provision of activity equipment
B4	Completeness of sports and entertainment facilities
B5	Facility Provision for Wheelchair Accessibility
B6	Personalization of community style
B7	Comfort of public facilities
B8	Comfort of leisure square
B9	Comfort of public green space
B10	Personalization of sports and entertainment facilities

Table 2. (*Continued*).

Factor B—Elderly comfort of community public facilities	
B11	Leisure square Personalization
B12	Community greening rate
B13	Configuration of plant varieties
Factor C—Completeness and convenience of surrounding living services	
C1	Public transport convenience
C2	Convenience of medical facilities
C3	Convenience of commercial facilities
C4	Completeness of Public transport
C5	Completeness of commercial facilities
C6	Completeness of service facilities
C7	Completeness of medical facilities
C8	Completeness of sanitary facilities
C9	Convenience of service facilities
C10	Convenience of sanitary facilities
Factor D—Security and convenience of elderly care/elderly care services	
D1	On-site medical delivery service
D2	On-site maintenance safety
D3	Housekeeping service security
D4	Safety of meal delivery service
D5	Convenience of Housekeeping service
D6	Convenience of meal delivery service
D7	Convenience of on-site maintenance
D8	Agent purchasing goods
D9	Accompanying to see doctor
D10	Assistance for travelling
D11	Convenience of elderly care facilities
D12	completeness of elderly care facilities
D13	Security Services
D14	Emergency treatment service
D15	Mental health counseling
D16	Address confidentiality
D17	Confidentiality of personal information
D18	Ambulance accessibility
D19	Accessibility of convenient services

3.2. Questionnaire design

In this research, the questionnaire survey was strategically designed to evaluate the significance of various urban design considerations in achieving four sustainable development objectives, using the analysis of stakeholders' perceptions. By examining and understanding their perceptions and preferences, we can derive valuable insights to make more informed and appropriate decisions for future

renovation projects in the territory. The survey serves as a crucial tool for aligning urban design strategies with specific Sustainable Development Goals (SDGs), such as SDG 11: Sustainable Cities and Communities, which aims to make cities inclusive, safe, resilient, and sustainable, thereby enhancing the overall effectiveness and impact of urban renewal endeavors. In Appendix A, samples of questionnaires for both the pilot study and the main study are provided. By employing a rating scale, respondents were able to express their feelings and opinions about the variables presented in the questionnaire. This attitudinal data was then used by the researcher to analyze preferences and characteristics related to the topic under investigation.

Furthermore, the questionnaires also gathered important demographic data concerning respondents' age, gender, education, occupation, and other house-relevant information. This demographic data is crucial for two purposes: first, it aids in assessing the representativeness of the sample for future reference, and second, it enables the examination of differences and similarities between groups' responses, offering valuable insights for the research analysis.

To ensure the questionnaire's user-friendliness and comprehensibility for various stakeholders, the following design approaches were implemented:

(i) Each questionnaire was accompanied by a covering letter, distributed via email or fax, outlining the survey's significance, objectives, and instructions for returning the completed questionnaire. The covering letter is provided in Appendix A.

(ii) To facilitate respondents in answering the questions, clear definitions of sustainability, urban renewal, and sustainable urban renewal were provided, along with relevant examples at the beginning of the questionnaire.

(iii) The questionnaire strategically incorporated checkboxes, enabling respondents to select from predefined response options.

(iv) To cater to the local citizens in the main study, a Chinese-language version of the questionnaire was thoughtfully prepared and used for data collection (Appendix B). This ensured that language barriers did not hinder effective participation and understanding among the targeted audience.

3.3. Analysis methods

This study employs Statistical Package Social Sciences (SPSS) software to carry out quantitative data analysis, a widely used tool for statistical analysis in social science research (Pallant, 2020). Reliability analysis is conducted to evaluate the internal consistency and reliability of a measurement scale or instrument, with Cronbach's alpha being one of the most commonly used measures for this purpose (Field, 2018). The process involves calculating statistical measures, such as Cronbach's alpha coefficient, to determine the degree of consistency across responses. The mathematical model for reliability analysis involves calculating measures such as Cronbach's alpha coefficient:

$$\alpha = (k/(k-1)) \times (1 - \sum si^2/st^2) \quad (1)$$

where, α represents Cronbach's alpha coefficient, k represents the number of items, si^2 represents the variance of each item, and st^2 represents the total variance of all items.

The Kaiser-Meyer-Olkin (KMO) test calculates a value between 0 and 1, with higher values indicating a better fit for factor analysis. A KMO value closer to 1

suggests that the variables share a substantial amount of common variance, indicating a strong interrelationship among them (Tabachnick, and Fidell, 2019).

Bartlett's Test of Sphericity is a statistical test used to assess the suitability of data for factor analysis. It examines the null hypothesis that the correlation matrix is an identity matrix, indicating no significant correlations among the variables (Kaiser, 1974). The test evaluates whether the variables in the dataset are interrelated, which is a prerequisite for conducting factor analysis. If the null hypothesis is rejected, it suggests that the variables have significant correlations and are suitable for further exploration using factor analysis. The significance of Bartlett's Test is determined by comparing the calculated chi-square value with the critical value at a given significance level. If the calculated chi-square value is greater than the critical value and the *p*-value is below the chosen significance level (typically $p < 0.05$), the null hypothesis is rejected, indicating that the variables are significantly correlated.

The exploratory factor analysis (EFA) method is used to perform dimension reduction analysis on the initial set of 49 indicators. Through this process, common factors are derived, and the significance of each common factor is determined based on its contribution to the overall variance. This can be mathematically represented as (Field, 2018):

$$X = LF + E \tag{2}$$

where, X represents the observed indicator data, L represents the factor loading matrix, F represents the factor scores matrix, and E represents the error matrix. Through EFA, the objective of the study to identify the common factors that explain the variance in the indicators related to aging-friendly renovations.

To address the potential influence of differing dimensions among the indicators, the indicator data is normalized, which is equivalent to the loadings in mathematical models. This normalization allows for the determination of the weight of each indicator on its corresponding common factor, facilitating an assessment of the degree of influence exerted by each indicator on the common factor.

By extracting these factors and determining their loadings, the study can categorize and understand the relationships between indicators, facilitating a thorough evaluation of the elements that influence these renovations.

4. Result and discussion

4.1. Data collection

Chongqing, one of the four direct-controlled municipalities in the People's Republic of China, boasts a substantial administrative division comprising 26 districts, 8 counties, and 4 autonomous counties, as depicted in **Figure 1**. By the close of 2022, the demographic landscape of Chongqing had witnessed a significant shift, with the proportion of the population aged over 60 years reaching 16.53%, as illustrated in **Figure 2**.

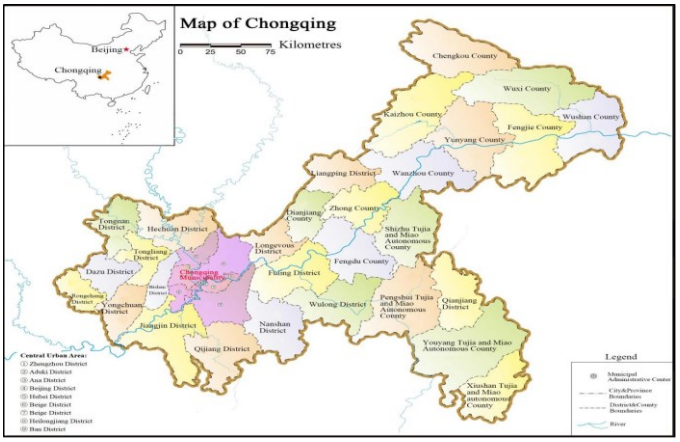

Figure 1. Chongqing city (author).

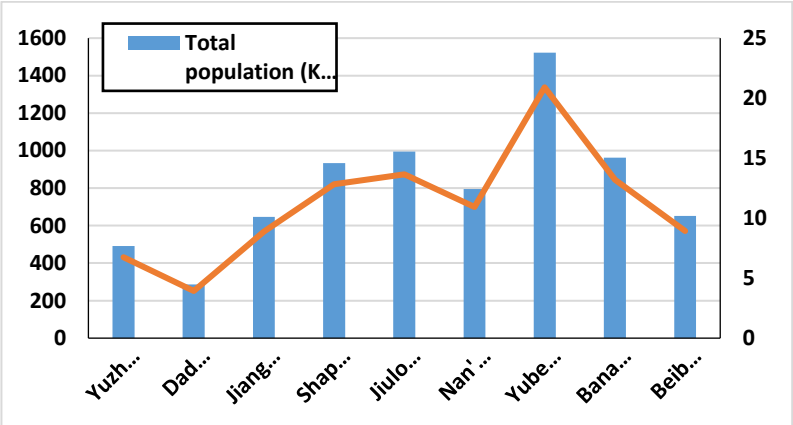

Figure 2. Population in each administrative district of Chongqing in 2022.

In the primary urban areas, specifically Yuzhong District, Dadukou District, Jiangbei District, Shapingba District, Jiulongpo District, and Nan'an District, the elderly population aged 60 and above numbered 7,010,400 individuals. This group accounted for 21.87% of the population, with a subset of 5,473,600 being 65 years or older, constituting 17.08% of the demographic composition in these areas.

It is worth noting that the overall aging rate in Chongqing, standing at 16.53%, is slightly below the national average of 18.13% and the provincial average of 18.12%. However, the rate of aging in Chongqing is on an upward trajectory, indicating a faster pace of growth. This trend is supported by data from the Chongqing Municipal Bureau of Statistics, which reveals that between 2010 and 2018, the population aged 60 and over experienced an average annual growth rate of 5.42%. Particularly noteworthy is the average annual growth rate of the population aged 80 and over, which reached an impressive 8.83% during the same period. These statistics reflect the dynamic demographic shifts within Chongqing and underscore the evolving challenges and opportunities associated with an aging population.

Currently Chongqing has 4135 communities built before 2012, and by the end of 2021, 279 old communities had been renovated. As of the end of 2021, 3682 renovations have been started, of which 786 renovations have been completed, involving 506,460 households. The number of renovations is around 89%, ranking among the top in the country. The old community renovation project in Chongqing

involves 35 sub-items in four categories: improving infrastructure and supporting facilities, improving housing quality and living functions, improving the landscape environment of the community, and improving public service facilities. Improve barrier-free facilities and facilities suitable for the elderly, and other items are inclusive projects. The main content of the aging-friendly renovation of old communities in Chongqing is that, in combination with the policy requirements of "Chongqing 15-minute retirement circle", the old communities with conditions are equipped with comprehensive day care and other elderly care service facilities (Chongqing Municipal Government, 2020). According to the survey results, each administrative district can ensure that each community is equipped with a day care service station for the elderly in accordance with the requirements of the municipal government. In order to meet the needs of the elderly, the renovation design of the old community includes the improvement of barrier-free facilities and facilities suitable for the elderly. However, judging from the results of the renovation, most of the aging-friendly renovations of old residential areas that have been completed or are under construction basically focus on repairing roads, installing stair handrails, providing entertainment and fitness facilities for the elderly, and adding barrier-free ramps and blind paths. There are few communities that have installed elevators and added elderly care facilities (such as dining tables for the elderly, day care centers, etc.).

The data used in this article comes from the survey and interview results conducted by the research team on the civil affairs departments of 12 districts/counties, the housing construction departments of 6 districts/counties, and 24 old residential areas in each administrative district from February to April 2023. The sample communities are mainly selected from 12 typical administrative districts in Chongqing. A total of 450 questionnaires were distributed in this survey, and 412 questionnaires were returned, of which 402 were valid questionnaires, with an effective rate of 97.57%. The questionnaire is mainly divided into three modules: one is the information survey of ordinary residents, including basic information, transportation and environment, economy, and safety; the other is the information survey of the elderly (mainly 55 years old and above), including health status, leisure Entertainment methods, hobbies, etc.; the third is the age-appropriate rating table, which involves 50 evaluation indicators such as hardware and software facilities and service conditions.

From **Table 3**, it can be seen that the majority of the samples are women (72.89%); the proportion of residents aged 55 and above is 9.70%, and most of them are the direct stakeholders who are directly interested in the aging renovation of old residential areas. The sample selection is more representative; education background the level is mainly concentrated in undergraduates and below (42.29%); most people have professional's jobs (19.15%); the type of housing they live in is mainly High-rise building district (60.95%), which is in line with historical conditions; the residential area is between 91–105m² accounted for the largest proportion (21.64%), reflecting the basic living conditions of old communities from the side.

Table 3. Basic characteristics of residents in the interviewed community.

Characteristics	Category	Percentage %	Characteristics	Category	Percentage %
Gender	Male	27.11%	Occupation	Farmer	4.48%
	Female	72.89%		Soldier	0.25%
Age	<18 year	0.25%		Student	15.92%
	18–30 Year	32.59%		Self-employed persons	12.69%
	31–40 Year	34.83%		Professionals	19.15%
	41–54 Year	22.64%		Ordinary workers	11.69%
	≥55	9.70%		Business service workers	9.20%
Education	Junior school and below	10.45%		Government staff	0.75%
	High School	18.41%		Freelancer	12.44%
	Specialty	16.42%		retired	5.97%
	Undergraduate	42.29%		currently unoccupied	4.23%
	Master and above	12.44%		Other professionals	3.23%
House Type	Commercial apartment	5.97%	Residential Area	<50 m^2	7.96%
	High-rise building district	60.95%		50–75 m^2	12.69%
	Bungalow community	18.41%		76–90 m^2	19.15%
	Villa community	2.24%		91–105 m^2	21.64%
	Mixed community	3.98%		106–120 m^2	17.16%
	Self built house	8.46%		≥120 m^2	21.39%

4.2. Model validation

(1) Feasibility test

After subjecting the 49 variables to a thorough correlation analysis, it became evident that there existed a notable degree of correlation among these variables. This observation aligns well with the prerequisites for conducting factor analysis. To delve deeper into this, we used SPSS software to perform both factor analysis and a reliability test on the original dataset.

The reliability test, measured by Cronbach's alpha, yielded an exceptionally high value of 0.99, indicating that the scale used in the study is highly reliable. This suggests that the survey questions consistently and accurately assess the underlying constructs of interest. Additionally, the Kaiser-Meyer-Olkin (KMO) test produced a value of 0.978, which falls within the range of 0.90 to 1.0, demonstrating that the data collected is highly suitable for factor analysis. This result highlights the strong interconnections among the variables, allowing for meaningful interpretation. The Bartlett's Test of Sphericity, with a *p* value of 0.000, further supports this, showing a significance level below 0.05. This confirms that the data conforms to normal distribution and is well-suited for factor analysis. Both the high KMO value and the significant Bartlett's test indicate that the data is ideal for conducting a reliable factor analysis.

(2) Extraction and naming of common factors

The study employed the principal component analysis method to identify common factors among the various variables. Specifically, factors with eigenvalues

greater than 1 were selected as common factors. This rigorous selection process ultimately resulted in the extraction of four common factors. Notably, this approach offers a consolidated and structured way to understand the underlying patterns and relationships among the 49 variables considered.

Furthermore, it's essential to highlight that the cumulative variance contribution rate achieved a substantial 79%, as indicated in **Table 4**. This percentage represents the proportion of the total variance explained by the extracted common factors. In essence, it provides a comprehensive overview of the fundamental characteristics and dynamics captured by the 49 variables under consideration. This statistical analysis method plays a pivotal role in revealing the key dimensions that significantly influence the success of aging-friendly renovation efforts.

Table 4. Total variance explained.

		Total	% of Variance	Cumulative %
F1	Initial Eigenvalues	33.033	67.414	67.414
	Extraction Sums of Squared Loadings	33.033	67.414	67.414
	Rotation Sums of Squared Loadings	11.618	23.711	23.711
F2	Initial Eigenvalues	2.880	5.878	73.291
	Extraction Sums of Squared Loadings	2.880	5.878	73.291
	Rotation Sums of Squared Loadings	11.193	22.844	46.554
F3	Initial Eigenvalues	1.523	3.109	76.400
	Extraction Sums of Squared Loadings	1.523	3.109	76.400
	Rotation Sums of Squared Loadings	8.373	17.087	63.641
F4	Initial Eigenvalues	1.240	2.531	78.931
	Extraction Sums of Squared Loadings	1.240	2.531	78.931
	Rotation Sums of Squared Loadings	7.492	15.290	78.931

The result of factor analysis as shown in **Table 5**. The common factor F1 includes B1–B13, which reflects the "elderly comfort of community public facilities", covering safety of sports facilities (B1), convenience of sports and entertainment (B2), provision of activity equipment (B3), completeness of sports and entertainment facilities (B4), facility provision for wheelchair accessibility (B5), personalization of community style (B6), comfort of public facilities (B7), comfort of leisure square (B8), comfort of public green space (B9), personalization of sports and entertainment facilities (B10),leisure square personalization (B11), community greening rate (B12) and configuration of plant varieties (B13).

The common factor F2 includes C1–D2, D4, D6, D18, and D19, reflecting "completeness and convenience of surrounding living services", covering public transport convenience (C1), convenience of medical facilities (C2), Convenience of commercial facilities(C3), Completeness of Public transport (C4),Completeness of commercial facilities (C5), Completeness of service facilities (C6), Completeness of medical facilities (C7), Completeness of sanitary facilities (C8), Convenience of service facilities (C9), Convenience of sanitary facilities (C10), On-site medical delivery service (D1), On-site maintenance safety (D2), Safety of meal delivery

service (D4), Convenience of meal delivery service (D6), Ambulance accessibility (D18), and Accessibility of convenient services (D19).

The common factor F3 including D3, D5, D7–D12, D14–D17 reflects "Security and convenience of elderly care/elderly care services", covering Housekeeping service security (D3), Convenience of Housekeeping service (D5), Convenience of on-site maintenance (D7), Agent purchasing goods (D8), Accompanying to see doctor (D9), Assistance for travelling (D10), Convenience of elderly care facilities (D11), completeness of elderly care facilities (D12), Emergency treatment service (D14), Mental health counseling (D15), Address confidentiality (D16), and Confidentiality of personal information (D17).

The common factor F4 includes A1–A7, and D13, reflecting "Community infrastructure security", covering Road safety (A1) ， Firefighting facilities (A2), Monitoring facilities (A3), Anti-theft facilities (A4), Electrical safety (A5), Completeness of public lighting facilities (A6), Provision of intelligent security system (A7), and Security Services (D13).

Table 5. Extraction of common factors.

	Component					**Component**			
	F1	F2	F3	F4		F1	F2	F3	F4
A1				0.687	C6		0.67		
A2				0.754	C7		0.778		
A3				0.733	C8		0.619		
A4				0.752	C9		0.645		
A5				0.701	C10		0.586		
A6				0.653	D1		0.509		
A7				0.588	D2		0.48		
B1	0.725				D3			0.517	
B2	0.786				D4		0.553		
B3	0.794				D5			0.576	
B4	0.804				D6		0.577		
B5	0.661				D7			0.527	
B6	0.664				D8			0.635	
B7	0.711				D9			0.672	
B8	0.712				D10			0.675	
B9	0.666				D11			0.673	
B10	0.794				D12			0.661	
B11	0.787				D13				0.497
B12	0.645				D14			0.625	
B13	0.716				D15			0.587	
C1		0.807			D16			0.576	
C2		0.801			D17			0.56	
C3		0.789			D18		0.599		
C4		0.841			D19		0.601		
C5		0.813							

(3) The average value of each factor

The average radar chart of the indicators under each common factor is shown in **Figure 3**. From the perspective of descriptive analysis, the mean score ranges from 1 to 7 points. The better the aging effect, the higher the evaluation score of residents.

Figure 3a, through calculation, it can be seen that the score of F1 "the elderly comfort of community public facilities" is 4.43, of which the index Community greening rate is the highest with a score of 4.84 while the lowest index is facility provision for wheelchair accessibility with a score of 4.17. **Figure 3b**, the score of F2 "Completeness and convenience of surrounding living services" is 4.76, of which the index public transport convenience is the highest with a score of 5.09 while the lowest index is On-site medical delivery service with a score of 4.38. **Figure 3c**, the score of F3 "Security and convenience of elderly care/elderly care services" is 4.34, of which the index Agent purchasing goods is the highest with a score of 4.61 while the lowest index is Mental health counseling with a score of 4.01. **Figure 3d**, the score of F4 "Community infrastructure security" is 4.76, of which the index Electrical safety is the highest with a score of 5.09 while the lowest index is Completeness of public lighting facilities with a score of 4.31.

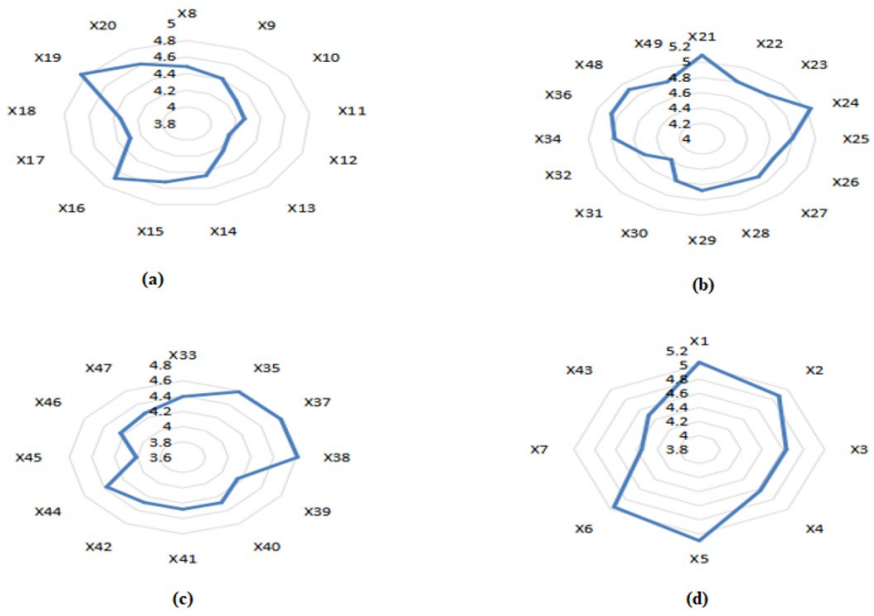

Figure 3. The average value of each index for the extracted components. **(a)** F1 the elderly comfort of community public facility; **(b)** F2 Completeness of surrounding living services; **(c)** F3 Security and convenience of elderly care/elderly care services; **(d)** F4 Community infrastructure security.

From the above calculation, it can be seen that the average values of the four factors are around 4.5 and close to each other. Hence, it is not easy to differentiate which factor needs more attention to be paid to for the old community transformation. The next section is conducted to further calculate the factor scores.

(4) Factor score

To provide a more precise representation of the impact of aging community renovation, the study calculates factor scores based on the factor score coefficient

matrix, as outlined in **Table 6**. This approach allows for a more in-depth analysis of the influence of renovation efforts in addressing the challenges posed by an aging population within the community. The factor scores coefficient matrix, a critical component of this process, provides a structured framework for assessing and quantifying the impact of various factors on the success of renovation initiatives. By utilizing this methodology, the research aims to offer a comprehensive evaluation of the effectiveness of these renovation efforts in enhancing the quality of life for elderly residents.

$$\begin{aligned} F1 = {} & -0.056 \times A1 - 0.068 \times A2 - 0.06 \times A3 - 0.069 \times A4 - 0.053 \times A5 \\ & - 0.042 \times A6 + 0.015 \times A7 + 0.129 \times B1 + 0.0172 \times B2 \\ & + 0.186 \times B3 + 0.186 \times B4 + 0.109 \times B5 + 0.089 \times B6 \\ & + 0.118 \times B7 + 0.137 \times B8 + 0.128 \times B9 + 0.167 \times B10 \\ & + 0.158 \times B11 + 0.132 \times B12 + 0.155 \times B13 - 0.019 \times C1 \\ & + 0.043 \times C2 + 0.004 \times C3 - 0.036 \times C4 - 0.037 \times C5 \\ & + 0.008 \times C6 - 0.005 \times C7 - 0.032 \times C8 - 0.014 \times C9 \\ & - 0.006 \times C10 - 0.02 \times D1 - 0.044 \times D2 - 0.036 \times D3 \\ & - 0.067 \times D4 - 0.061 \times D5 - 0.088 \times D6 - 0.023 \times D7 \\ & - 0.056 \times D8 - 0.012 \times D9 - 0.007 \times D10 + 0.005 \times D11 \\ & + 0.002 \times D12 - 0.062 \times D13 - 0.073 \times D14 + 0.001 \times D15 \\ & - 0.06 \times D16 - 0.06 \times D17 - 0.043 \times D18 - 0.068 \times D19 \end{aligned} \tag{3}$$

Table 6. Component score coefficient.

	Component					**Component**			
	F1	F2	F3	F4		F1	F2	F3	F4
A1	–0.056	0.007	–0.134	0.258	C6	0.008	0.102	–0.028	–0.045
A2	–0.068	–0.045	–0.078	0.28	C7	–0.005	0.162	–0.072	–0.057
A3	–0.06	–0.055	–0.053	0.257	C8	–0.032	0.087	–0.064	0.062
A4	–0.069	–0.064	–0.042	0.268	C9	–0.014	0.085	–0.019	–0.005
A5	–0.053	–0.023	–0.086	0.244	C10	–0.006	0.063	–0.012	0.005
A6	–0.042	–0.02	–0.069	0.208	D1	–0.02	0.015	0.075	–0.014
A7	0.015	–0.059	–0.042	0.155	D2	–0.044	0.002	0.052	0.059
B1	0.129	–0.043	–0.036	–0.015	D3	–0.036	–0.01	0.092	0.018
B2	0.172	–0.024	–0.068	–0.059	D4	–0.067	0.03	0.107	–0.011
B3	0.186	–0.008	–0.073	–0.09	D5	–0.061	–0.002	0.138	–0.01
B4	0.186	–0.026	–0.053	–0.09	D6	–0.088	0.046	0.09	0.013
B5	0.109	–0.054	0.011	–0.029	D7	–0.023	0.013	0.092	–0.025
B6	0.089	–0.062	0.015	0.004	D8	–0.056	–0.022	0.205	–0.067
B7	0.118	–0.02	–0.05	–0.009	D9	–0.012	–0.076	0.235	–0.089
B8	0.137	0.014	–0.111	–0.013	D10	–0.007	–0.065	0.228	–0.099
B9	0.128	0.017	–0.105	–0.014	D11	0.005	–0.077	0.22	–0.091
B10	0.167	–0.039	–0.033	–0.069	D12	0.002	–0.06	0.214	–0.102
B11	0.158	–0.05	–0.005	–0.075	D13	–0.062	–0.027	0.067	0.097
B12	0.132	0.063	–0.155	–0.021	D14	–0.073	–0.03	0.172	0.004
B13	0.155	0.038	–0.125	–0.05	D15	0.001	–0.06	0.158	–0.039
C1	–0.019	0.21	–0.138	–0.036	D16	–0.06	–0.066	0.156	0.045

Table 6. (*Continued*).

	Component					Component			
C2	0.043	0.201	–0.144	–0.092	D17	–0.06	–0.052	0.142	0.043
C3	0.004	0.184	–0.111	–0.056	D18	–0.043	0.097	–0.036	0.025
C4	–0.036	0.211	–0.135	–0.016	D19	–0.068	0.061	0.061	0.001
C5	–0.037	0.177	–0.079	–0.029					

In the same way, the score expressions of the subsequent common factors can be obtained. The calculation results show: F1 = 2.651, F2 = 4.112, F3 = 0.846, F4 = 3.423 will account for the variance contribution rate of each factor. The proportion of variance contribution rate of each factor to the total variance contribution rate is used as a weight to obtain the formula for the appropriate aging degree:

$$F = 0.29 \times F1 + 0.21 \times F2 + 0.30 \times F3 + 0.20 \times F4 \quad (4)$$

By calculation, it can be concluded that F = 1.82.

Through the above analysis, the overall score of aging effect of old communities in Chongqing is 1.82 points, which tends to be less satisfied. Given that the main goal of the renovation of old residential areas in Chongqin is to improve the overall functionality of the community, there is limited content related to aging adaptation renovation, which is basically in line with the reality. Among the four detected factors, F2 “Completeness and convenience of surrounding living services” (4.112) scored the highest, followed by F4 “Community infrastructure security” (3.423). This is in line with the government policy of promoting the convenience of the people’s 5-mimnute life circle radiating from the community and also emphasizing the security of people’s life and property. On the other hand, F1 “the elderly comfort of community public facilities” (2.651) scored relatively low and F3 “Security and convenience of elderly care/elderly care services” (0.846) scored the lowest. These two factors are special for considering the elderly group and their low scores indicate the urgency of transformation of the old communities.

(5) The weight of each indicator of the degree of aging

The data is normalized to obtain the weight of each indicator on the corresponding common factor, which can more clearly observe the impact of each indicator on the satisfaction of the aging renovation effect of the old community.

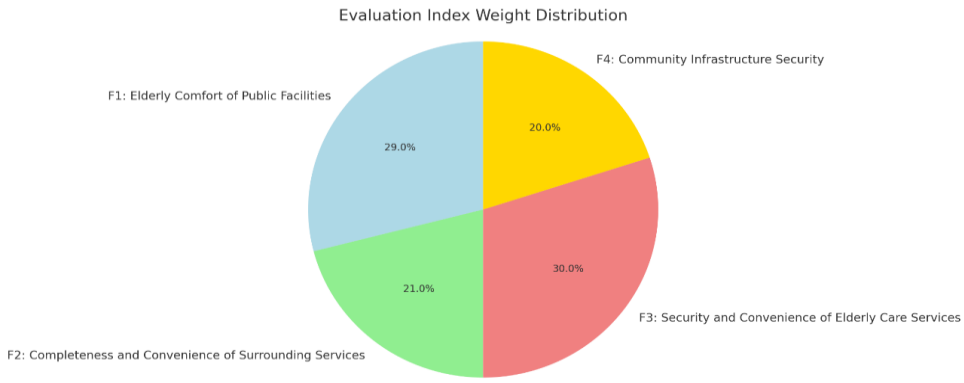

Figure 4. Evaluation index weight.

According to the analysis of the factor load results, the order of importance of the 4 common factors is as follows: F3 security and convenience of elderly care/elderly care services > F1 elderly comfort of community public facilities > F2 completeness and convenience of surrounding living services > F4 Community infrastructure security. In other words, the security and convenience of elderly care/elderly care services (F3) and the elderly comfort of community public facilities (F1) have a more significant impact on public evaluation (see **Figure 4**).

In the common factor of the security and convenience of elderly care/elderly care services (F3), residents are very concerned about address confidentiality (D16), Confidentiality of personal information (D17), Emergency treatment service (D14) and housekeeping service security (D3) received more attention.

In the common factor of the elderly comfort of community public facilities (F1), the interviewees pay more attention to Community greening rate (B12), Configuration of plant varieties (B13), Comfort of public facilities (B7), Comfort of leisure square (B8), Comfort of public green space (B9) and Provision of activity equipment (B3). This also confirms the research results of some investigations that residents are most dissatisfied with green spaces and activity venues.

In the common factor of the completeness and convenience of surrounding living services (F2), people pay more attention to Completeness of service facilities (C6), Convenience of service facilities (C9), Convenience of sanitary facilities (C10), On-site medical delivery service (D1), On-site maintenance safety (D2), Convenience of medical facilities (C2) and Completeness of sanitary facilities (C8). This coincides with the rapid development of the elderly population in Chongqing, and also reflects the the urgency of the demand for door-to-door services.

In the common factor of the Community infrastructure security (F4), people have more demand for Security Services (D13), Anti-theft facilities (A4) and Provision of intelligent security system (7).

5. Discussion

Prominent Challenges in the process of community transformation as follows:

1) Resistance to Elevator Installation:

The installation of elevators in old residential buildings is a critical need, particularly for elderly and mobility-impaired residents. However, significant resistance is encountered during the promotion process. The subsidy cost for each elevator installation ranges from 5000 to 24,000 yuan (Ministry of Housing and Urban-Rural Development of the People's Republic of China. 2024). Even after subsidies, each household is required to bear a cost of approximately 2000 to 5000 yuan, posing a financial burden for many residents (Li and Wang, 2023). Moreover, design constraints in older buildings often result in elevators that can only start from the half-floor, rendering them inaccessible to those with mobility challenges (Zhang and Chen, 2022). Additionally, the diverse needs of different groups within the community lead to difficulties in reaching a consensus on renovation plans (Liu, 2023).

2) Insufficient Public Activity Space:

Old communities often lack adequate public activity spaces, particularly green areas and leisure facilities. The elderly, in particular, have higher demands for public

leisure and entertainment spaces, as well as access to green spaces. However, due to limited space and the presence of illegal constructions within old residential areas, issues related to parking, public leisure spaces, and green areas become more prominent and challenging to address. These challenges are exacerbated by the need to balance urban development with the preservation of existing community structures (Sustainable Cities Collective, 2023).

3) Property Management Issues:

Older communities often lack a comprehensive property management system, leading to problems such as poor sanitation, insufficient maintenance of public facilities, and difficulties in collecting utility fees. Factors such as low property fees, a low number of residents, and neglect of management contribute to inadequate property management. This results in the "Matthew effect," where property companies are unwilling to invest in or manage old communities (Urban Renovation Journal, 2023).

4) Coordination of Interests:

Coordinating the interests of different stakeholders poses a significant challenge during the transformation of old communities. For instance, there is often opposition to converting facilities slated for demolition, such as boiler rooms and bicycle sheds, into elderly care service facilities, even when it does not affect fire protection designs. Similarly, renovating a single household can reveal that the overall state of the building necessitates renovating the entire structure due to aging infrastructure, complicating coordination efforts. Additionally, the removal of anti-theft nets is another contentious issue that affects the advancement of old community renovation projects (Urban Design Research, 2023).

The Sustainable Urban Renovation Assessment Model (SURAM) provides a significant advancement over existing models by offering a comprehensive multi-dimensional approach specifically tailored to enhance elderly-friendly environments in old communities. SURAM incorporates a wide range of dimensions crucial for elderly well-being, such as public facility comfort, service safety, medical travel services, infrastructure security, and accessibility to amenities, which ensures a holistic assessment of elderly residents' needs. Unlike general urban renovation models, SURAM's specific focus on the elderly addresses their unique requirements and promotes aging in place, enabling them to remain in their homes as they age (Aging Research, 2023). Additionally, SURAM employs advanced methodologies like factor analysis to streamline the evaluation process, leading to more precise assessments and effective allocation of resources. The model's practical application extends to providing actionable insights for policymakers and urban planners, thereby enhancing the impact and relevance of urban renovation efforts (Policy Planning Journal ,2023).

Based on the comprehensive research findings and data analysis, this study proposes a set of measures and suggestions aimed at promoting the renovation of old communities to meet the needs of the aging population. These recommendations address the specific challenges encountered during the aging renovation process.

1) Stakeholder Engagement and Consensus Building: Given the diverse needs and opinions within old communities, it is crucial to actively engage residents and stakeholders in the decision-making process. Conducting comprehensive surveys and

holding community meetings can help identify specific requirements and concerns of different groups. By involving residents in the planning and design stages, their concerns can be addressed, and consensus can be built to ensure successful renovation outcomes.

2) Enhancing Public Activity Spaces: Recognizing the importance of public activity spaces for the elderly, efforts should be made to improve the availability and quality of such spaces within old communities. This can be achieved by redesigning and optimizing existing areas, increasing green spaces, and creating dedicated leisure and entertainment facilities. Collaboration with landscape architects and urban planners can help maximize the utilization of limited space while catering to the specific needs of the elderly population.

3) Strengthening Property Management: To address the issues related to property management, it is essential to establish a comprehensive and effective property management system within old communities. This can be achieved by encouraging the formation of residents' committees or homeowner associations to actively participate in decision-making and oversee property maintenance. Providing training and support to property management companies can enhance their capabilities and ensure efficient service delivery.

4) Innovate Working Mechanisms for Elevator Installation: Streamline policies related to elevator installation, renovation of old communities, and home care for the elderly to eliminate overlapping and conflicting regulations. Explore diverse funding sources, such as raising funds through owners' committees and community owners, expanding the use of special maintenance funds for residential buildings, and allowing the withdrawal of provident funds for elevator installation. Consider introducing shared elevator models, where elevator companies advance funds for installation and residents pay through rental or usage fees, utilizing flexible payment models.

5) Utilize Flexible Transformation Methods: Tailor aging-appropriate transformation efforts to local conditions and individual needs. Focus on key areas, such as increasing green spaces and fitness activity areas, and provide personalized services for the elderly, including psychological counseling, travel assistance, and medical accompaniment. Make use of nearby public resources and develop differentiated and flexible facilities based on community characteristics and housing ownership. Emphasize high-quality demonstration projects to drive overall progress in renovation efforts. Explore the concept of "removing walls and merging courtyards" to create livable communities and optimize the utilization of public housing.

6) Introduce Innovative Property Management: Introduce professional property services in old communities to ensure long-term maintenance and improved services for the elderly post-renovation. Activate underutilized community service rooms and align their purpose with the needs of the elderly. Property service organizations should adjust their positioning, innovate service content, and enhance service levels to better cater to the elderly population.

6. Conclusion

The increasing aging population has posed a significant challenge, requiring the transformation of old communities to create environments that cater to the needs of

the elderly. This study addresses this pressing issue and provides a comprehensive assessment of sustainable urban renovation for elderly residents in Chongqing City. It introduces the Sustainable Urban Renovation Assessment Model (SURAM), which serves as a specialized framework for enhancing the quality of life for the aging population. The main conclusions of this paper are as follows:

1) The aging population in Chongqing City necessitates the transformation of old communities to make them more elderly-friendly.
2) A Sustainable Urban Renovation Assessment Model (SURAM) was proposed to enhance the living conditions for elderly residents in these communities.
3) The model takes into account various dimensions, including the comfort of public facilities, service safety and convenience, medical travel services, infrastructure security, life service convenience, neighbor relations, ambulance aid accessibility, commercial service facilities, privacy protection, elderly care facilities and service supply, and medical and health facilities.
4) Factor analysis was used to identify key factors influencing the successful renovation of old communities for the elderly.
5) The study found that ensuring age-appropriate comfort in public facilities is crucial for achieving successful aging-appropriate renovations.
6) The outcomes of this research offer valuable guidance for policymakers, urban planners, and community stakeholders, enabling them to implement targeted initiatives for sustainable and inclusive urban development in Chongqing City.
7) By understanding resident needs and incorporating the identified factors into the renovation process, future large-scale aging-adaptive renovations can benefit from the experiences and policy references derived from this study.

The limitations of this study can be summarized as follows:

1) The study does not establish a system for continuous monitoring and evaluation of the effectiveness of aging-friendly renovations over time.
2) While the study touches on aging-friendly renovations, it does not thoroughly investigate the implementation of supportive policies and regulations, nor does it assess their long-term impact on the community.
3) The study does not provide mechanisms for sharing the insights and best practices gained with other cities that face similar aging population challenges.

Author contributions: Conceptualization, RY and MY; methodology, RY and MY; validation, FZI, RY and MY; formal analysis, PC; investigation, YJ; resources, MY; writing—original draft preparation, RY and FZI; writing—review and editing, RY. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

References

Abdul, H. Q., Wesam, S. A., Muhammad, A. M. (2023). Sustainable Development and Urban Design. Reference Module in Earth Systems and Environmental Sciences, Elsevier.

Aging Research. (2023). Models for elderly-friendly environments. Aging Research. Available online: https://www.agingresearch.org (accessed on 18 May 2024).

Alam, Md. S., & Haque, S. M. (2022). Multi-dimensional earthquake vulnerability assessment of residential neighborhoods of Mymensingh City, Bangladesh: A spatial multi-criteria analysis based approach. Journal of Urban Management, 11(1), 37–58. https://doi.org/10.1016/j.jum.2021.09.001

Chen, X., de Vries, S., Assmuth, T., et al. (2019). Research challenges for cultural ecosystem services and public health in (peri-)urban environments. Science of The Total Environment, 651, 2118–2129. https://doi.org/10.1016/j.scitotenv.2018.09.030

Cheshmehzangi, A., Butters, C., Xie, L., et al. (2021). Green infrastructures for urban sustainability: Issues, implications, and solutions for underdeveloped areas. Urban Forestry & Urban Greening, 59, 127028. https://doi.org/10.1016/j.ufug.2021.127028

Chongqing Municipal Government. (2020). Guidelines for the Implementation of the 15-Minute Retirement Circle Policy in Old Communities. Chongqing Municipal Government.

Coxon, S., Napper, R., & Richardson, M. (2019). Introduction – Urban Mobility Design. Urban Mobility Design, 1–22. https://doi.org/10.1016/b978-0-12-815038-2.00001-3

Domisch, S., Kakouei, K., Martínez-López, J., et al. (2019). Social equity shapes zone-selection: Balancing aquatic biodiversity conservation and ecosystem services delivery in the transboundary Danube River Basin. Science of The Total Environment, 656, 797–807. https://doi.org/10.1016/j.scitotenv.2018.11.348

Femenías, P., Mjörnell, K., & Thuvander, L. (2018). Rethinking deep renovation: The perspective of rental housing in Sweden. Journal of Cleaner Production, 195, 1457–1467. https://doi.org/10.1016/j.jclepro.2017.12.282

Field, A. (2018). Discovering Statistics Using IBM SPSS Statistics. SAGE Publications.

Fu, Q. (2022). Too big to succeed: Mega neighborhoods, depression, and actually existing urban governance. Cities, 126, 103711. https://doi.org/10.1016/j.cities.2022.103711

Gaglione, F., Gargiulo, C., & Zucaro, F. (2022). Where can the elderly walk? A spatial multi-criteria method to increase urban pedestrian accessibility. Cities, 127, 103724. https://doi.org/10.1016/j.cities.2022.103724

Hasegawa, Y., & Lau, S. K. (2022). Comprehensive audio-visual environmental effects on residential soundscapes and satisfaction: Partial least square structural equation modeling approach. Landscape and Urban Planning, 220, 104351. https://doi.org/10.1016/j.landurbplan.2021.104351

Ibarloza, A., Malles, E., Ibarloza, E., et al. (2018). The needs and effects of housing renewal policies in Spain: Implications for sustainability and accessibility. Sustainable Cities and Society, 40, 244–253. https://doi.org/10.1016/j.scs.2018.01.037

Jia, P., Zhuang, J., Vaca Lucero, A. M., et al. (2022). Does the energy consumption revolution improve the health of elderly adults in rural areas? Evidence from China. Science of The Total Environment, 807, 150755. https://doi.org/10.1016/j.scitotenv.2021.150755

Kaiser, H. F. (1974). An index of factorial simplicity. Psychometrika, 39(1), 31–36. https://doi.org/10.1007/bf02291575

Korkou, M., Tarigan, A. K. M., & Hanslin, H. M. (2023). The multifunctionality concept in urban green infrastructure planning: A systematic literature review. Urban Forestry & Urban Greening, 85, 127975. https://doi.org/10.1016/j.ufug.2023.127975

Lee, C., Giannelos, N., Curran, D., et al. (2023). Lifetime risk of herpes zoster in the population of Beijing, China. Public Health in Practice, 5, 100356. https://doi.org/10.1016/j.puhip.2023.100356

Li, Y., & Wang, J. (2023). Economic analysis of elevator retrofit in old residential areas. Urban Development Studies, 45(2), 112-123.

Liu, M., Yan, J., & Dai, T. (2023). A multi-scale approach mapping spatial equality of urban public facilities for urban design. Heliyon, 9(8), e18281. https://doi.org/10.1016/j.heliyon.2023.e18281

Liu, Q. (2023). Community participation and consensus building in urban renewal projects. Social Development Research, 29(3), 150-163.

Luo, X., Ren, M., Zhao, J., et al. (2022). Life cycle assessment for carbon emission impact analysis for the renovation of old residential areas. Journal of Cleaner Production, 367, 132930. https://doi.org/10.1016/j.jclepro.2022.132930

Ma, X., Tian, Y., Du, M., et al. (2021). How to design comfortable open spaces for the elderly? Implications of their thermal perceptions in an urban park. Science of The Total Environment, 768, 144985. https://doi.org/10.1016/j.scitotenv.2021.144985

Mandi, R., & Bansod, D. W. (2023). Exploring the nexus of health and happiness: A study on the life satisfaction of urban elderly in India. Clinical Epidemiology and Global Health, 21, 101308. https://doi.org/10.1016/j.cegh.2023.101308

Maslesa, E., Jensen, P. A., & Birkved, M. (2018). Indicators for quantifying environmental building performance: A systematic literature review. Journal of Building Engineering, 19, 552–560. https://doi.org/10.1016/j.jobe.2018.06.006

Mercader-Moyano, P., Morat, O., & Serrano-Jiménez, A. (2021). Urban and social vulnerability assessment in the built environment: An interdisciplinary index-methodology towards feasible planning and policy-making under a crisis context. Sustainable Cities and Society, 73, 103082. https://doi.org/10.1016/j.scs.2021.103082

Ministry of Housing and Urban-Rural Development of the People's Republic of China. (2024). Guidelines for Elevator Installation in Existing Residential Buildings. Available online: http://www.mohurd.gov.cn (accessed on 15 May 2024).

Monzón, M., & López-Mesa, B. (2018). Buildings performance indicators to prioritise multi-family housing renovations. Sustainable Cities and Society, 38, 109–122. https://doi.org/10.1016/j.scs.2017.12.024

Pallant, J. (2020). SPSS Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS. Open University Press.

Poh-Chin, L., Martin, W., Ming-Houng, C., et al. (2009). An ecological study of physical environmental risk factors for elderly falls in an urban setting of Hong Kong. Science of The Total Environment, 407(24), 6157–6165. https://doi.org/10.1016/j.scitotenv.2009.08.042

Policy Planning Journal. (2023). Practical applications of urban renovation models. Policy Planning Journal. Available online: https://www.policyplanningjournal.org (accessed on 11May 2024).

Serrano-Jiménez, A., Barrios-Padura, Á., & Molina-Huelva, M. (2018). Sustainable building renovation for an ageing population: Decision support system through an integral assessment method of architectural interventions. Sustainable Cities and Society, 39, 144–154. https://doi.org/10.1016/j.scs.2018.01.050

Sheikh, W. T., & van Ameijde, J. (2022). Promoting livability through urban planning: A comprehensive framework based on the "theory of human needs." Cities, 131, 103972. https://doi.org/10.1016/j.cities.2022.103972

Strulak-Wójcikiewicz, R., & Deja, A. (2022). A concept for an IT platform to assess the impact of transport infrastructure investments on ecological safety and security. Procedia Computer Science, 207, 4258–4267. https://doi.org/10.1016/j.procs.2022.09.489

Sun, B., Liu, J., Yin, C., et al. (2022). Residential and workplace neighborhood environments and life satisfaction: Exploring chain-mediation effects of activity and place satisfaction. Journal of Transport Geography, 104, 103435. https://doi.org/10.1016/j.jtrangeo.2022.103435

Sustainable Cities Collective. (2023). Balancing urban development and community preservation. Sustainable Cities Collective. Available online: https://www.sustainablecitiescollective.com (accessed on 13 May 2024).

Tabachnick, B. G., & Fidell, L. S. (2019). Using Multivariate Statistics, 7th ed. Pearson.

Tolfo, G., & Doucet, B. (2022). Livability for whom?: Planning for livability and the gentrification of memory in Vancouver. Cities, 123, 103564. https://doi.org/10.1016/j.cities.2022.103564

United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development. Available online: https://www.un.org/sustainabledevelopment/ (accessed on 2 April 2024).

Urban Design Research. (2023). Multi-dimensional approaches in urban renovation. Urban Design Research. Retrieved from Available online: https://www.urbandesignresearch.org (accessed on 1 June 2024).

Urban Renovation Journal. (2023). Issues with removing anti-theft nets in old community renovations. Urban Renovation Journal. Available online: https://www.urbanrenovationjournal.org (accessed on 1 June 2024).

Wang, Y., & Chen, Q. (2020). Survey on residents' willingness in the renovation of traffic environments in old communities. Transportation Research Interdisciplinary Perspectives, 5, 100132. https://doi.org/10.1016/j.trip.2020.100132

Wang, Y., Chen, H., Long, R., et al. (2023). How does population aging affect urban green transition development in China? An empirical analysis based on spatial econometric model. Environmental Impact Assessment Review, 99, 107027. https://doi.org/10.1016/j.eiar.2022.107027

World Health Organization (WHO). (2017). Age-friendly environments in Europe: A handbook of domains for policy action. Available online: http://www.euro.who.int/en/health-topics/Life-stages/healthy-ageing/publications/2017/age-friendly-environments-in-europe.-a-handbook-of-domains-for-policy-action-2017 (accessed on 6 May 2024).

Wu, H.W., Kumar, P., & Cao, S. J. (2022). Implementation of green infrastructure for improving the building environment of elderly care centres. Journal of Building Engineering, 54, 104682. https://doi.org/10.1016/j.jobe.2022.104682

Xie, R., Yao, S., Han, F., et al. (2022). Does misallocation of land resources reduce urban green total factor productivity? An analysis of city-level panel data in China. Land Use Policy, 122, 106353. https://doi.org/10.1016/j.landusepol.2022.106353

Yang, P., Liu, X., Hu, Y., et al. (2022). Entrepreneurial ecosystem and urban economic growth-from the knowledge-based view. Journal of Digital Economy, 1(3), 239–251. https://doi.org/10.1016/j.jdec.2023.02.002

Yazici, M., & Durmus Ozturk, S. (2023). An analysis of Rem Koolhaas's discourses on architecture and urban design using a corpus-based model. Frontiers of Architectural Research, 12(2), 222–241. https://doi.org/10.1016/j.foar.2022.08.003

Yıldız, M., Varol, E., Elkoca, A., et al. (2023). Determining the correlation between old age adaptation, aging in place and depression in older adults: A descriptive correlational study. Archives of Psychiatric Nursing, 43, 153–161. https://doi.org/10.1016/j.apnu.2023.02.004

Yung, E. H. K., Conejos, S., & Chan, E. H. W. (2016). Social needs of the elderly and active aging in public open spaces in urban renewal. Cities, 52, 114–122. https://doi.org/10.1016/j.cities.2015.11.022

Zhang, H., & Chen, L. (2022). Challenges and solutions in community transformation projects. Journal of Urban Planning, 38(4), 256-269.

Zhuang, T., Qian, Q. K., Visscher, H. J., et al. (2019). The role of stakeholders and their participation network in decision-making of urban renewal in China: The case of Chongqing. Cities, 92, 47–58. https://doi.org/10.1016/j.cities.2019.03.014.

Appendix A

Evaluation of Old Residential

Please indicate (by circling the appropriate box) the extent to which you are satisfied with each of the statements from captions. The following scale is applied for all statements:

		Level of Satisfaction **Low----------high**						
A. Community infrastructure security		1	2	3	4	5	6	7
A1	Road safety	1	2	3	4	5	6	7
A2	Fire fighting facilities	1	2	3	4	5	6	7
A3	Monitoring facilities	1	2	3	4	5	6	7
A4	Anti-theft facilities	1	2	3	4	5	6	7
A5	Electrical safety	1	2	3	4	5	6	7
A6	Completeness of public lighting facilities	1	2	3	4	5	6	7
A7	Provision of intelligent security system	1	2	3	4	5	6	7
B. Elderly comfort of community public facilities		1	2	3	4	5	6	7
B1	Safety of sports facilities	1	2	3	4	5	6	7
B2	Convenience of sports and entertainment facilities	1	2	3	4	5	6	7
B3	Provision of activity equipment	1	2	3	4	5	6	7
B4	Completeness of sports and entertainment facilities	1	2	3	4	5	6	7
B5	Facility Provision for Wheelchair Accessibility	1	2	3	4	5	6	7
B6	Personalization of community style	1	2	3	4	5	6	7
B7	Comfort of public facilities	1	2	3	4	5	6	7
B8	Comfort of leisure square	1	2	3	4	5	6	7
B9	Comfort of public green space	1	2	3	4	5	6	7
B10	Personalization of sports and entertainment facilities	1	2	3	4	5	6	7
B11	Leisure square Personalization	1	2	3	4	5	6	7
B12	Community greening rate	1	2	3	4	5	6	7
B13	Configuration of plant varieties	1	2	3	4	5	6	7
C. Completeness and convenience of surrounding living services		1	2	3	4	5	6	7
C1	Public transport convenience	1	2	3	4	5	6	7
C2	Convenience of medical facilities	1	2	3	4	5	6	7
C3	Convenience of commercial facilities	1	2	3	4	5	6	7
C4	Completeness of Public transport	1	2	3	4	5	6	7
C5	Completeness of commercial facilities	1	2	3	4	5	6	7
C6	Completeness of service facilities	1	2	3	4	5	6	7
C7	Completeness of medical facilities	1	2	3	4	5	6	7
C8	Completeness of sanitary facilities	1	2	3	4	5	6	7
C9	Convenience of service facilities	1	2	3	4	5	6	7
C10	Convenience of sanitary facilities	1	2	3	4	5	6	7

		Level of Satisfaction **Low----------high**						
D. Security and convenience of elderly care/elderly care services		1	2	3	4	5	6	7
D1	On-site medical delivery service	1	2	3	4	5	6	7
D2	On-site maintenance safety	1	2	3	4	5	6	7
D3	Housekeeping service security	1	2	3	4	5	6	7
D4	Safety of meal delivery service	1	2	3	4	5	6	7
D5	Convenience of Housekeeping service	1	2	3	4	5	6	7
D6	Convenience of meal delivery service	1	2	3	4	5	6	7
D7	Convenience of on-site maintenance	1	2	3	4	5	6	7
D8	Agent purchasing goods	1	2	3	4	5	6	7
D9	Accompanying to see doctor	1	2	3	4	5	6	7
D10	Assistance for travelling	1	2	3	4	5	6	7
D11	Convenience of elderly care facilities	1	2	3	4	5	6	7
D12	completeness of elderly care facilities	1	2	3	4	5	6	7
D13	Security Services	1	2	3	4	5	6	7
D14	Emergency treatment service	1	2	3	4	5	6	7
D15	Mental health counseling	1	2	3	4	5	6	7
D16	Address confidentiality	1	2	3	4	5	6	7
D17	Confidentiality of personal information	1	2	3	4	5	6	7
D18	Ambulance accessibility	1	2	3	4	5	6	7
D19	Accessibility of convenient services	1	2	3	4	5	6	7
E. Overall Satisfaction		1	2	3	4	5	6	7

Appendix B

老房子评价

请注明（在适当的方框中打圈）您对标题中的每一个陈述的满意程度。所有报表都适用以下比例尺：

		满意度水平 Low----------high						
F. 社区基础设施安全		1	2	3	4	5	6	7
A1	道路安全	1	2	3	4	5	6	7
A2	消防设施	1	2	3	4	5	6	7
A3	监控设施	1	2	3	4	5	6	7
A4	防盗设施	1	2	3	4	5	6	7
A5	电气安全	1	2	3	4	5	6	7
A6	公共照明设施的完整性	1	2	3	4	5	6	7
A7	提供智能安全系统	1	2	3	4	5	6	7
F. 社区公共设施的老年人舒适性		1	2	3	4	5	6	7
B1	体育设施安全	1	2	3	4	5	6	7
B2	体育娱乐设施	1	2	3	4	5	6	7
B3	提供活动设备	1	2	3	4	5	6	7
B4	体育、娱乐设施齐全	1	2	3	4	5	6	7
B5	轮椅无障碍设施设置	1	2	3	4	5	6	7
B6	社区风格的个性化	1	2	3	4	5	6	7
B7	公共设施的舒适	1	2	3	4	5	6	7
B8	休闲广场的舒适	1	2	3	4	5	6	7
B9	公共绿地的舒适性	1	2	3	4	5	6	7
B10	体育设施和娱乐设施的个性化设置	1	2	3	4	5	6	7
B11	休闲广场个性化	1	2	3	4	5	6	7
B12	社区绿化率	1	2	3	4	5	6	7
B13	植物品种配置	1	2	3	4	5	6	7
F. 周边生活服务的完整性和便利性		1	2	3	4	5	6	7
C1	公共交通便利	1	2	3	4	5	6	7
C2	医疗设施的便利性	1	2	3	4	5	6	7
C3	商业设施的便利性	1	2	3	4	5	6	7
C4	公共交通的完整性	1	2	3	4	5	6	7
C5	商业设施的完整性	1	2	3	4	5	6	7
C6	服务设施的完整性	1	2	3	4	5	6	7
C7	医疗设施的完整性	1	2	3	4	5	6	7
C8	卫生设施的完整性	1	2	3	4	5	6	7
C9	服务设施的便利性	1	2	3	4	5	6	7
C10	卫生设施的便利性	1	2	3	4	5	6	7

		满意度水平 Low----------high						
F. 养老服务的安全与便利		1	2	3	4	5	6	7
D1	现场医疗服务	1	2	3	4	5	6	7
D2	现场维护安全	1	2	3	4	5	6	7
D3	客房服务安全	1	2	3	4	5	6	7
D4	送餐服务的安全	1	2	3	4	5	6	7
D5	方便客房服务服务	1	2	3	4	5	6	7
D6	方便的送餐服务	1	2	3	4	5	6	7
D7	便于现场维护	1	2	3	4	5	6	7
D8	代理采购货物	1	2	3	4	5	6	7
D9	陪同看医生	1	2	3	4	5	6	7
D10	旅行援助	1	2	3	4	5	6	7
D11	方便的养老设施	1	2	3	4	5	6	7
D12	养老设施的完整性	1	2	3	4	5	6	7
D13	安全服务	1	2	3	4	5	6	7
D14	应急处理服务	1	2	3	4	5	6	7
D15	心理健康咨询	1	2	3	4	5	6	7
D16	地址保密性	1	2	3	4	5	6	7
D17	个人信息的保密性	1	2	3	4	5	6	7
D18	救护车可达性	1	2	3	4	5	6	7
D19	可提供便捷的服务	1	2	3	4	5	6	7
F. 整体满意度		1	2	3	4	5	6	7