Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Resilience Evaluation of Old Community Renovation Projects from the Perspective of Urban Renewal

Guihong Liu
Chengdu Jincheng College
Hong Jia
Chengdu Jincheng College
Minqian
137306217730163.com

Chengdu Jincheng College
Xiaoxue Yang
Chengdu Jincheng College
Ziwei Shen
Chengdu Jincheng College

Case Report

Keywords: Urban Renewal, Older Community Renovation Projects, Resilient Communities, Integrated Empowerment Approach, Cloud Modeling

Posted Date: September 29th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10500008/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Resilience Evaluation of Old Community Renovation Projects from the Perspective of Urban Renewal

Guihong Liu [1], Hong Jia [1] ,Minqian Song [1] *, Xiaoxue Yang [1] ,Ziwei Shen[1]

*Correspondence: Minqian Song 13730621773@163.com
[1]College of Civil Engineering and Architecture, Chengdu Jincheng College, Chengdu 611731, China
Guihong Liu: 1634565915@qq.com
Hong Jia: 673824292@qq.com
Xiaoxue Yang: 18384275101@163.com
Ziwei Shen: 1258289926@qq.com

Abstract: In order to effectively promote sustainable urban development, China has gradually elevated the construction of resilient cities to the level of national development strategy. As one of the residential types with a large number and stock of established communities, old communities have become a weak point in the development of resilient cities, and their resilient renovation is still characterized by unstable infrastructure, insufficient public space, inadequate service facilities, and a lack of emotional creation in neighborhoods. Therefore, this paper discusses the resilience evaluation system of old community renovation projects based on the urban renewal perspective. Firstly, the evaluation index system is established by reviewing a large amount of literature and referring to relevant standards; Secondly, fuzzy analytical hierarchy process and entropy weight method are selected as the comprehensive weight calculation method of evaluation indexes, and the cloud model is utilized to establish the evaluation model; Finally, the feasibility and applicability of the evaluation model were verified by a real case study in Chengdu, Sichuan Province, China. The results of the study innovatively optimize the resilience theory system of the old community renovation project, and provide scientific ideas and methods for the resilience construction of future old community renovation projects.

Keywords: Urban Renewal; Older Community Renovation Projects; Resilient Communities ; Integrated Empowerment Approach ; Cloud Modeling

1. Introduction

Urban Construction in China has entered the middle and late stages of urbanization [1], and urban development has gradually crossed over from “incremental expansion” to “stock optimization” [2]. In order to avoid the problems of inefficient land use for urban construction[3], scarcity of land resources and serious environmental pollution that have arisen during the period of “incremental expansion”, the relevant departments have proposed that urban planning should follow the law of urban development and gradually turn to internal stock optimization and urban renewal[4]. The “implementation of urban renewal action” proposed in the “14th Five-Year Plan” emphasizes that the old neighborhood renovation project is a national key livelihood project, a number of contiguous ren-

ovation of the neighborhood can be regarded as the old community renovation[5]. Therefore, in the context of “stock optimization”, the renovation of old communities is an important part of the promotion of urban renewal.

Resilient cities are one of the current goals of urban renewal and renovation, and enhancing community resilience is an important part of that[6,7]. The basic requirements of a resilient community are a well-developed infrastructure and service support facilities, a fine-tuned renewal and maintenance function, a harmonious and stable social participation, and an organized teamwork force[8–12]. Older communities are one of the residence types with a large number and stock of established communities in China, which is the short board of resilient city construction [13], and the quality of renovation of older communities determines whether the communities in which they are located meet the standards of resilient cities, but there is still a lack of criteria for evaluating the effect of resilient renovations of older communities after renovation under the perspective of urban regeneration.

Scholars have studied the old community renovation projects based on the perspectives of economy, green building, energy conservation, ageing, social governance and sponge city [14–19], including the dimensions of renovation participants, forms of renovation, long-term management mechanism, renovation difficulties, and renovation risks. In terms of the evaluation index system of the old community renovation projects, it mainly focuses on green renovation, sustainability, residents' satisfaction, comprehensive benefits, renovation risks[20–25], but lacks the resilience evaluation of the old community renovation projects. Based on the community resilience perspective, current research is dominated by the evaluation of the resilience of older neighborhoods prior to remodeling. In summary, this paper evaluates the old community renovation projects in Chengdu City, China, from a resilience perspective, analyzes the results of the renovation, and provides guidance for the subsequent renovation projects to avoid blindness and improve the efficiency of the renovation, so as to promote the sustainable operation of urban renewal.

2. Materials and Conceptual Framework

2.1 Study Area

Chengdu, Sichuan Province, China is located in Southwest China and is the core city of the Chengdu-Chongqing City Cluster, one of the five major city clusters in China, and one of China's “New First Tier Cities”, which was selected as one of China's first pilot cities for urban renewal in 2024[26]. Since 2020, Chengdu has invested a cumulative total of 82.7 billion yuan committed to old community renovation projects in 20 districts and counties[27]. Based on the concept of organic renewal of the city, the renovation project puts the protection of people's lives and property safety in the first place, makes every effort to eliminate major safety risks and hidden dangers such as building structure and gas, comprehensively implements rainwater and sewage diversion renovation, fully solicits the wishes of the residents, and focuses on renovating and perfecting the courtyard support and municipal infrastructure, upgrading the level of community retirement, child care, medical care, and other public services, and promoting the construction of a safe and healthy community with sound facilities and a livable life, the construction of complete residential communities that are safe, healthy, well-equipped, pleasant to live in and well-managed is being promoted[28].

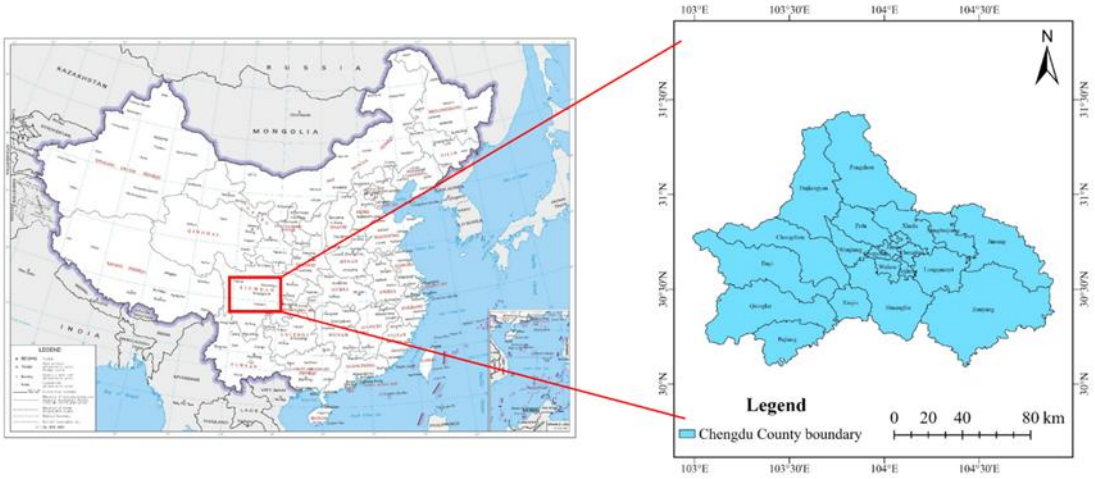


Figure 1. The location of the study area in China.

2.2 Research Framework

This study is based on an urban renewal perspective to conduct a resilience assessment of old community improvement projects in order to provide insights for better management and development, the framework of the study is shown below:

Through literature research, field research, and Delphi method to select evaluation indexes with high reliability and professionalism, establish the resilience evaluation index system and evaluation index grading standard for old community renovation projects.

The weights of the indicators are quantified through the comprehensive assignment method and the cloud model evaluation method to determine the resilience evaluation level of the actual case projects, verify the practicality of the evaluation model, and put forward the relevant suggestions for resilience enhancement.

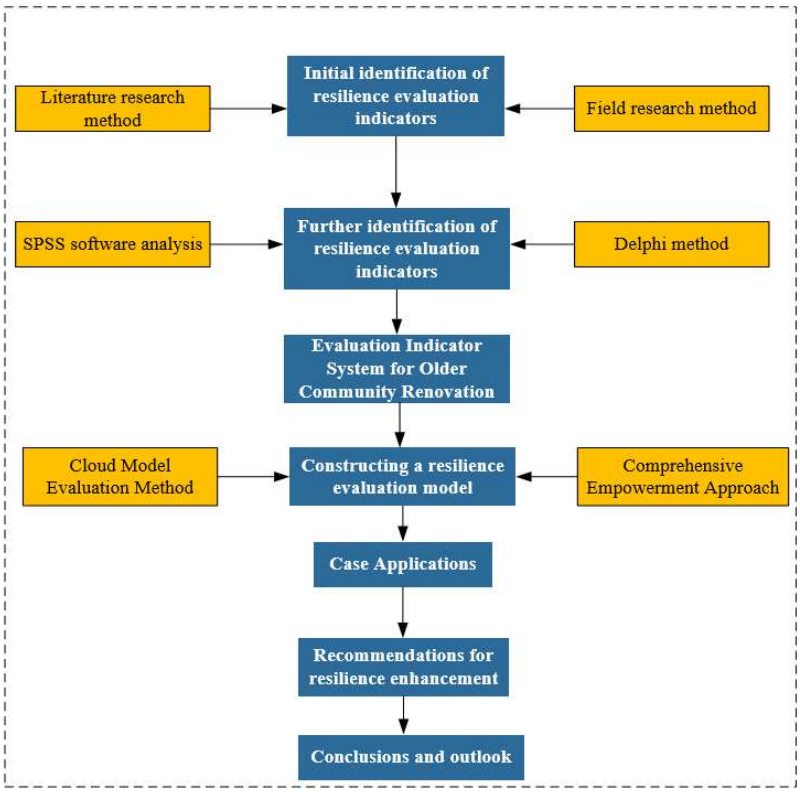


Figure 2. Research framework.

2.3 Indicator System

2.3.1 Evaluation index system construction dimensions

The evaluation dimensions of the resilience of the old community renovation projects currently lack a unified standard, and most of the existing studies are based on the dimensions of community resilience evaluation, as shown in Table 1. These related community resilience evaluation models typically address four dimensions: social, environmental, facility, and organizational [29–33]. Combining the actual situation of Chinese communities and field visits to survey managers of old communities, this paper selects four dimensions of social resilience, environmental resilience, facility resilience and organizational resilience as the evaluation dimensions of resilience of old community renovation projects.

Table 1. Community resilience evaluation dimensions.

Assessment model	Dimensionality			
	social resilience	**environmental resilience**	**facility resilience**	**organizational resilience**
Disaster Resilience of Place Model (DROP)	√	√		√
Baseline Resilience Indicators for Communities (BRIC)	√	√	√	
Community Disaster Resilience Framework (CDRF)	√			√
Population, Environment, Organized, Physical, Lifestyle, Economic, Social (PEOPLES)	√	√	√	√
Conjoint Community Resilience Assessment Measurement (CCRAM)	√			√

2.3.2 Evaluation indicator system screening

In order to ensure the applicability of the evaluation index system, 29 evaluation indexes with strong relevance to the resilience of the old community renovation projects were initially identified through literature research and analysis, summarization of the standard specifications, and field visits and surveys. As the initial indicator system has the characteristics of subjective and objective indicators coexisting, this paper adopts the Delphi method to optimize the initial evaluation indicator system [34]. Firstly, 10 experts from the Older Community Rehabilitation Program were invited to score the importance of the indicators according to the Likert scale scoring rules; secondly, the questionnaires were recovered and the SPSS26.0 software was used to analyze the data from the questionnaires and eliminate the unqualified indicators.

Prior to inviting the 10 experts mentioned above to score, their competence was tested by inviting them to fill out a questionnaire on their situation, using an authority factor. The degree of authority of the expert is determined by the basis on which the expert makes the judgment and the expert's familiarity with the issue[35], and the quantitative values are shown in Table 2.

Table 2. Assignment of expert judgment basis.

Basis of judgment	Degree of basis for judgement			Familiarity	Factor
	large	middle	little	extremely familiar	1.0
practical experience	0.5	0.4	0.3	relatively familiar	0.8
theoretical analysis	0.3	0.2	0.1	generally familiar	0.6
domestic and international references	0.1	0.1	0.1	unfamiliar	0.4
subjective judgment	0.1	0.1	0.1	highly unfamiliar.	0.2

The degree of expert authority Cr is the arithmetic mean of the basis of judgment coefficient Ca and the familiarity coefficient Cs .The calculation formula is: $Cr = (Ca + Cs)/2$, $Cr > 0.7$ is generally considered acceptable. Statistically, the expert advice in this study was $Ca = 0.9, Cs = 0.9$, and the average expert authority Cr was 0.9. The result of the study is greater than 0.7, which indicates that the results obtained from the expert consultation of this study are authoritative.

After the scoring results of the 10 experts were collected, the data were processed using SPSS26.0 software to calculate the mean, standard deviation, coefficient of variation, and confidence intervals for each secondary indicator. The results of the expert scoring data need to satisfy the following three conditions at the same time[36]: mean value ≥ 3.5; coefficient of variation ≤ 0.3; and lower limit of the confidence interval ≥ 3.0. Therefore, the three indicators of "residents' education level", "sense of community identity" and "community cultural activities" were excluded, and a system of evaluation indicators was established, which included 9 first-level indicators such as infrastructure stability and 26 second-level indicators such as the completion rate of sewage tasks. At the same time, in order to ensure the accuracy of expert scoring when conducting case studies, government norms and standard documents[37–40] such as the Technical Standards for Comprehensive Renovation of Old Urban Residential Areas were consulted to construct a hierarchical evaluation standard for the secondary indicators of resilience evaluation. See Appendix A.1 for more details.

3. Methodology

In order to avoid the subjectivity of the evaluation index assignment, fuzzy analytical hierarchy process is used as the subjective assignment method[41], and the entropy weight method is used as the objective assignment method[42]. The former combines expert scoring values with fuzzy mathematics to weaken the dependence of the results on data; the latter uses entropy to determine the degree of dispersion of the indicators and utilizes the variability of the indicators to determine the weights. Based on the above two methods to calculate the weights of the indicator system, the principle of minimum discriminatory information is introduced into the combination assignment to determine the comprehensive weights of the indicators. As the evaluation index system has more qualitative indicators, the indicators will interact with each other and have an impact on each other, leading to the ambiguity and complexity of the evaluation process, the cloud model[43] is chosen to evaluate the resilience of the old community renovation project, so as to realize the mutual conversion of qualitative indicators and quantitative data.

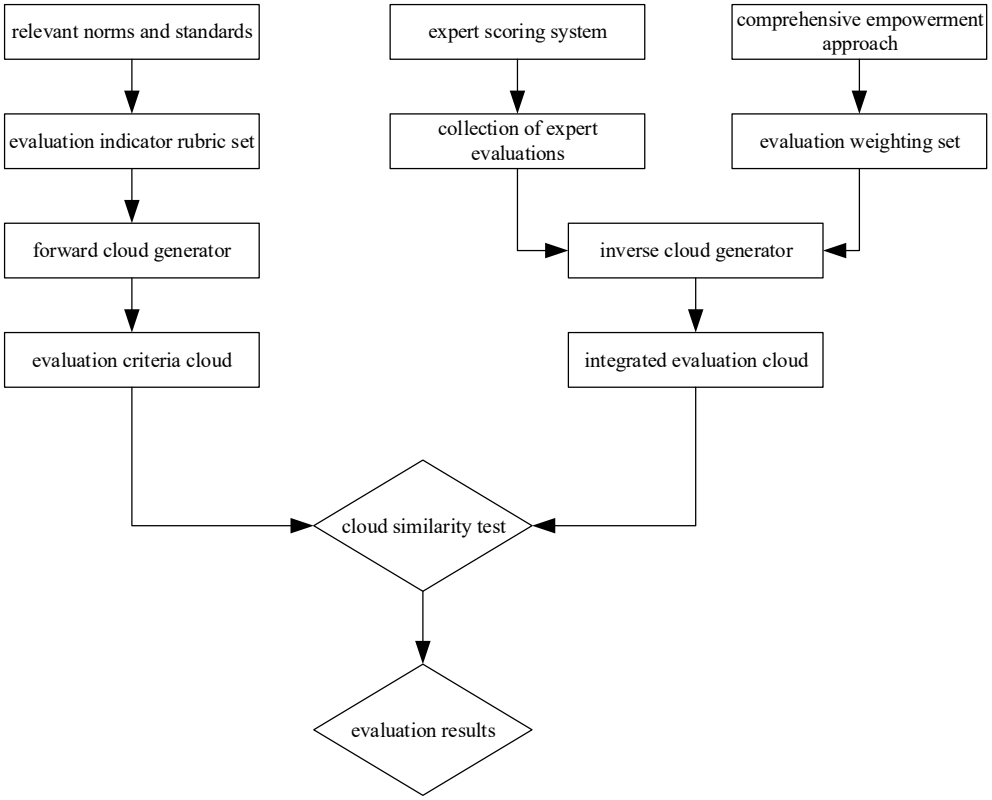


Figure 3. Evaluation methodology and process.

3.1 Comprehensive Empowerment Approach

3.1.1 Subjective weighting calculation

Based on the evaluation indicator system constructed in the previous section, the subjective weights of the indicators are determined according to the following steps:

(1) Constructing a matrix of prioritized relationships at each level

Prioritization matrix for each level of indicators was constructed by means of the quantitative scale shown in table 3. The matrix of prioritized relationships is shown in equation (1), followed by a two-by-two comparison of the indicators at the same level in turn, which $q_{ij} + q_{ji} = 1, (i, j = 1, 2, 3..., n)$.

$$Q = (q_{ij}) = \begin{pmatrix} q_{11} & \cdots & q_{1n} \\ \vdots & \ddots & \vdots \\ q_{n1} & \cdots & q_{nn} \end{pmatrix} \quad (1)$$

Table 3. Prioritized Relationship Matrix Quantitative Scaling Methods.

Scale	Connotation	Instruction
0.5	Equally important	i and j are of equal importance compared to each other
0.6	Slightly important	i is slightly more important than j when compared to i and j
0.7	More important	i and j are more important than j
0.8	very important	i and j are very important compared to j
0.9	Absolutely important.	i is absolutely more important than j.
0.1、0.2、0.3、0.4	j compared to i	Counter-comparison of the above comparison

(2) Constructing a fuzzy agreement matrix

Firstly, the relationship values in the prioritized relationship matrix are converted to fuzzy relationship values based on formula (2), in which R_{ij} denotes the fuzzy relationship

value; q_i denotes the sum of the elements in the ith row of the prioritized relationship matrix; q_j denotes the sum of the elements in the jth column of the prioritized relationship; and n denotes the order of the prioritized and fuzzy consistency matrices. Then the fuzzy consistency matrix can be obtained, the two matrices correspond to each other and are of the same order, the fuzzy consistency matrix is calculated according to equation (3).

$$r_{ij} = 0.5 + \frac{q_i - q_j}{2n} \quad (2)$$

$$R = (r_{ij})_{n\times n} = \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{nn} \end{pmatrix} \quad (3)$$

(3) Determine raw weights and raw weight vectors

According to formula (4), the product of each row of the fuzzy consistency matrix can be calculated to determine the original weight of each indicator, where g_i represents the product of the elements of the first row of the fuzzy consistency matrix, R_i represents the original weight of the first evaluation indicator, and n represents the number of orders of the fuzzy consistency matrix; ultimately, according to formula (5), we can obtain the original weight vector N corresponding to the fuzzy consistency matrix.

$$g_i = \sqrt[n]{R_i} \quad (4)$$

$$N = (g_1, g_2, g_3, ..., g_n)^T, i = (1, 2, 3, ..., n) \quad (5)$$

(4) Determination of normalization weights

In order to ensure the consistency and wholeness of the weight calculation, the original weights are normalized according to Equation (6), and the normalized weights of the evaluation indicators in each level can be obtained through calculation $\omega = (\overline{g_1}, \overline{g_2}, \overline{g_3}, ..., \overline{g_n})^T$

$$\overline{g_i} = \frac{g_i}{\sum_{i=1}^{n} g_i}, i = (1, 2, 3, ..., n) \quad (6)$$

3.1.2 Objective weighting

In order to ensure the objectivity and practicability of the index weights, 10 old community renovation projects located in different districts and counties of Chengdu City were selected as the research samples in this study, and all 10 projects have been completed renovation and belong to the typical old community renovation projects in Chengdu City[44]. Using entropy weighting method for data calculation, field research is conducted first, while experts corresponding to each old community renovation project are invited to score the importance of each evaluation index in the project using expert consultation questionnaire, and then the questionnaires are recovered to summarize the data, and finally the objective weights of the evaluation indexes are derived.

1-Lotus Community, Happiness Street
2-Old courtyard at No. 7 Xinle North Street
3-Hongyi Home, Huayang Street
4-Southwest Street Area, Fuqin Street
5-Wangcong neighborhood,Pitong Street
6-Old Station Area, Liucheng Street
7-Wujin-nan Road, Wujin Street
8-No.5, Yushuang Road,Mengzhuiwan Street
9-No.168 House, Linglong Road, Shiling Street
10-Courtyard No. 15, East Government Street, Jiancheng Street

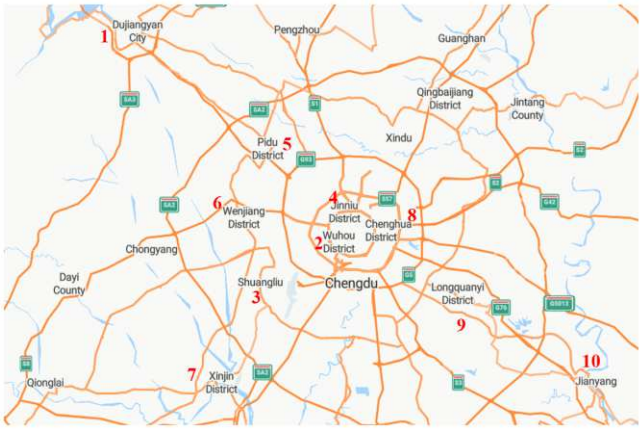


Figure 4. Ten Older Community Renovation Projects in Chengdu City.

(1) Constructing the original evaluation matrix

Assuming that there are m experts and n evaluation indicators, r_{ij} refers to the value assigned by the ith expert to the jth evaluation indicator and satisfies $r_{ij} \geq 0(i=1,2,3,...,m;1,2,3,...,n)$ the original evaluation matrix R can be obtained according to Equation (7).

$$R = \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} \tag{7}$$

(2) Data standardization

According to the effect of the evaluation indicators on the evaluation results will be divided into positive indicators and reverse indicators, the larger the evaluation value of the positive indicators is the better the evaluation results, the smaller the evaluation value of the negative indicators is the better the evaluation results, and at the same time after the standardization of the data size of the standardized treatment between $[0,1]$, standardization of the processing formula as shown in (8) and (9).

Standardization of positive indicators: $r_{ij} = \dfrac{r_{ij} - \min(r_{ij})}{\max(r_{ij}) - \min(r_{ij})}$ (8)

Negative indicators are standardized: $r_{ij} = \dfrac{\max(r_{ij}) - r_{ij}}{\max(r_{ij}) - \min\left(r_{ij}\right)}$ (9)

(3) Determining the magnitude of entropy

The size of entropy value is negatively correlated with the degree of dispersion, the larger the entropy value of the evaluation index the smaller its degree of dispersion, the smaller the contribution to the evaluation results, representing the smaller the weight of the evaluation index, where y_{ij} represents the weight of the eigenvector of the jth index in the ith evaluation, and e_j meets the weight of the $e_j > 0$, the computational formula is shown in (10).

$$\lambda = \frac{1}{\ln m}$$

$$y_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \quad (10)$$

$$e_j = -\lambda \sum_{i=1}^{m} y_{ij} \ln(y_{ij})$$

(4) Determination of the coefficient of variation

The difference index represents the size of the redundancy of the evaluation indicators, the larger the difference index, the more information the indicator provides, indicating that the indicator has a greater impact on the evaluation results and the more valuable the indicator is, and the formula is shown in (11).

$$\mu_j = 1 - e_j \quad (11)$$

(5) Determination of objective weights for indicators

By calculating the difference index of the indicators, the weight of the jth evaluation indicator can be finally determined, and the calculation formula is shown in (12).

$$\omega_j = \frac{\mu_j}{\sum_{i=1}^{n} \mu_j} \quad (12)$$

3.1.3 Composite weighting calculation

In this study, the principle of minimum discriminatory information is introduced into the portfolio assignment to determine the combined weights of the indicators. Let ω_i be the comprehensive weight, $\omega_i^{(1)}$ be the subjective weight calculated by fuzzy analytical hierarchy process, and $\omega_i^{(2)}$ be the objective weight calculated by entropy weight method. In order to ensure the optimal value of the integrated weights, the optimal objective function $\min F$ is constructed, and the objective function is solved by the Lagrange multiplier algorithm, and the integrated weight value of the ith evaluation index is finally obtained[45]. The specific formula is shown below:

$$\min F = \sum_{i=1}^{n} \omega_i \left(\ln \frac{\omega_i}{\omega_i^{(1)}}\right) + \sum_{i=1}^{n} \omega_i \left(\ln \frac{\omega_i}{\omega_i^{(2)}}\right), \sum_{i=1}^{n} \omega_i = 1 \quad (13)$$

$$\omega_i = \frac{\sqrt{\omega_i^{(1)} \omega_i^{(2)}}}{\sum_{1}^{n} \sqrt{\omega_i^{(1)} \omega_i^{(2)}}} \quad (14)$$

Therefore, using the above methodology, the weight values of the indicators at each level can be calculated as shown below:

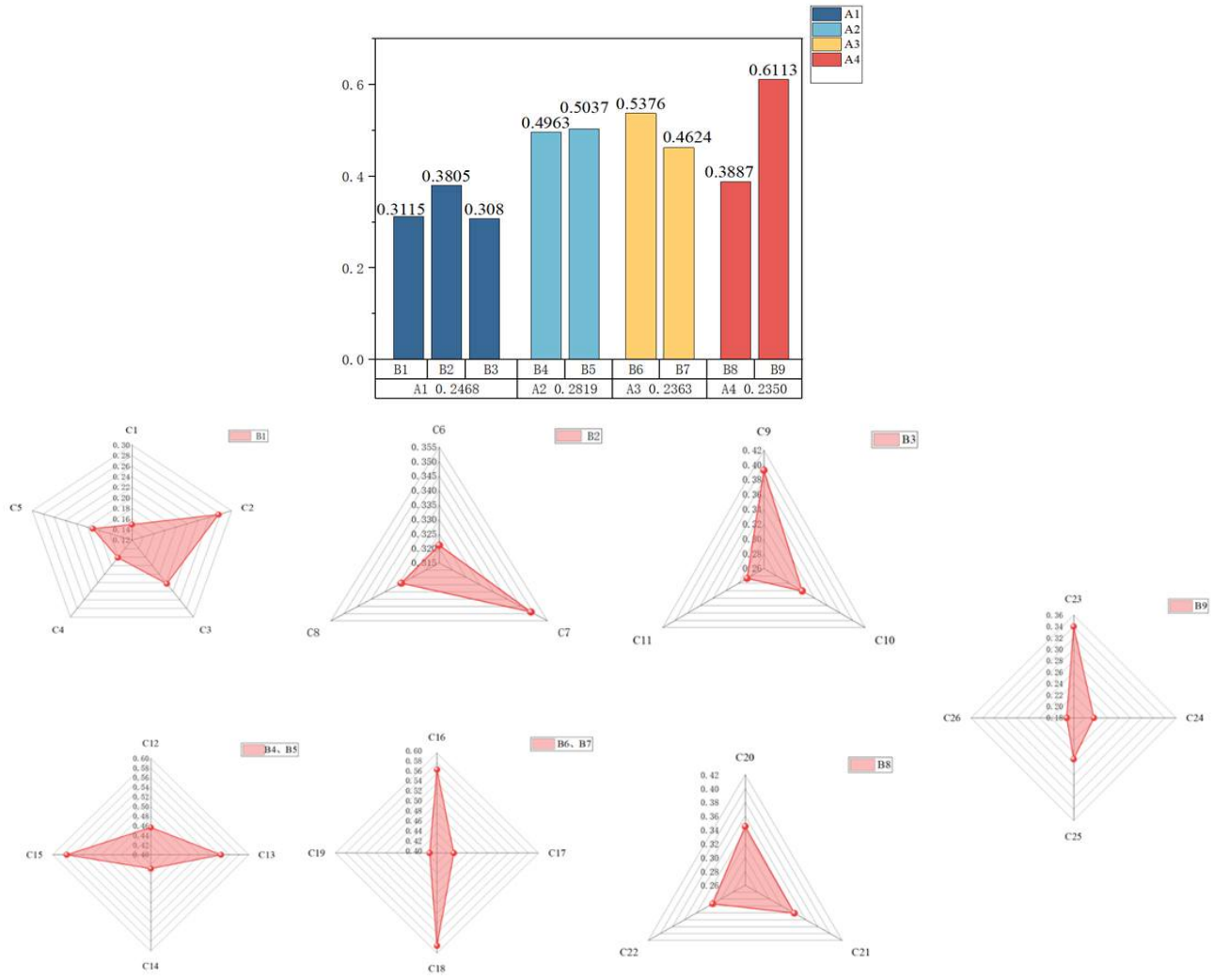


Figure 5. The weight values of the indicators.

3.2 Cloud Model Evaluation Method

3.2.1 Determination of the evaluation rating criteria cloud

According to the Criteria for grading resilience evaluation indicators and resilience evaluation grade interval of the old community renovation project, firstly, we determine the digital characteristics of the standard cloud map for five evaluation grades, assuming that the range of values of the ith evaluation interval is $\left[x_i^{\min}, x_i^{\max}\right]$, then we can determine the standard expectation Ex, entropy En, and super-entropy He according to Equation (15).

Where expectation Ex represents the middle value of the argument interval, entropy En is the range of values of the evaluation index, the value of super entropy He is a constant, which is generally determined according to the fuzzy threshold of the evaluation variable, referring to the relevant literature, this paper selects one percent of the maximum value of the evaluation index as the standard cloud super entropy value He, and then substitutes the resulting digital features into the forward cloud generator to randomly generate the standard cloud map[46]. The specific formula is shown below.

$$Ex_i = \frac{x_i^{\min} + x_i^{\max}}{2}$$
$$En_i = \frac{x_i^{\max} - x_i^{\min}}{6} \quad (15)$$
$$He_i = k$$

3.2.2 Identification of expert evaluation clouds

Relevant experts of the old community renovation project are invited to score the second-level indicators according to the resilience evaluation criteria classified in the previous section, and then the scoring results of each expert are converted into the expectation Ex, entropy En, and super entropy He of the expert evaluation through the inverse cloud generator. Then, according to the comprehensive weights of indicators at all levels, the expectation Ex, entropy En, and super entropy He of the first-level indicators, guideline-level indicators, and target level are calculated according to Equation (16). Finally, the evaluation cloud map of each level of indicators is obtained by the forward cloud generator [47].

$$Ex = \frac{\sum_{i=1}^{n}(Ex_{ui} \times En_{ui} \times \omega_i)}{\sum_{i=1}^{n}(En_{ui} \times \omega_i)}$$
$$En = \sum_{i=1}^{n}(En_{ui} \times \omega_i) \quad (16)$$
$$He = \frac{\sum_{i=1}^{n}(He_{ui} \times En_{ui} \times \omega_i)}{\sum_{i=1}^{n}(En_{ui} \times \omega_i)}$$

3.2.3 Cloud similarity test

On the basis of calculating the resilience evaluation level standard cloud and the expert evaluation cloud, in order to get the final evaluation results, it is necessary to calculate the similarity between the standard cloud and the evaluation cloud. Existing calculation methods mainly include the angle cosine method, the cloud droplet distance method, and the expectation curve method, which consider the similarity from some single angle and the calculation process is complicated. Drawing on the research methods of previous scholars, this paper synthesizes the distance and shape of the cloud diagrams on the basis of the expectation curve method, in which the distance similarity is determined by the difference in the expected distance between the standard cloud and the evaluation cloud; the shape similarity is determined by the entropy and super entropy values between the standard and evaluation clouds. In this paper, we set the evaluation grade standard cloud as $C_v(Ex_i, En_i, He_i)$, expert evaluation of Cloud as $C_v(Ex_j, En_j, He_j)$.The specific calculation process is shown below:

(1) Determination of distance similarity

Assuming that the expected value of the evaluation grade standard cloud is Ex_i, the expected value of the expert evaluation cloud is Ex_j, the expected difference distance between the two is $d = \left|Ex_i - Ex_j\right|$, the overlap area of the two expectation curves is $S(d)$, and the overlap area of the two expectation curves is $Ex_i = Ex_j$ when , so the distance similarity $Sim_d(C_v, C)$ of the cloud map is calculated according to Equation (17).

$$Sim_d = (C_v, C) = \frac{S(d)}{S(0)} \quad (17)$$

(2) Determination of shape similarity

By determining the entropy and super entropy values of the evaluation level standard cloud and the expert evaluation cloud, the shape similarity of the cloud map is calculated according to Equation (18).

$$Sim_s = (C_v, C) = \frac{\min(\sqrt{Ex_i^2 + He_i^2}, \sqrt{Ex_j^2 + He_j^2}}{\max(\sqrt{Ex_i^2 + He_i^2}, \sqrt{Ex_j^2 + He_j^2}} \quad (18)$$

(3) Determination of combined similarity

By calculating the distance similarity $Sim_d(C_v, C)$ and shape similarity $Sim_s = (C_v, C)$, the final comprehensive similarity is calculated according to Equation (19), and the resilience evaluation results of the old community renovation project are derived according to the principle of maximum affiliation.

$$Sim(C_v, C) = Sim_d \times Sim_s \quad (19)$$

4. Results and Discussion：a case study in Chengdu City

4.1 Overview of cases

The old community renovation project selected for this paper is located in The New Gui Dong community renovation project in Xindu District, Chengdu, China, which was built in the 1980s. Through field research, we found that this community is an old courtyard community with historical and cultural value in the old city of Chengdu, and at the same time, there are a large number of unused spaces and unutilized buildings in the community; the community buildings and facilities are constructed by the independent investment of various units, and the community's complex population, insufficient investment, lack of professional guidance, insufficient maintenance and management, and illegal construction of residents have led to the lack of community living functions and services, poor quality of living environment, lack of green landscape, and serious blockage of traffic and road space. environment, lack of greening and landscaping, and serious traffic and road space congestion. Therefore, The New Gui Dong community, which has typical problems of old communities, has taken social service leadership as the core, and has carried out the exploration of urban organic renewal with the goals of improving community hardware and software facilities, creating a quality living environment in the community, enhancing the strength of community management services, and improving the satisfaction of the residents.

4.2 Resilience Evaluation of Older Community Renovation Projects Based on Cloud Modeling

4.2.1 Determining the evaluation criteria cloud

First of all, we refer to the classification of community resilience and the numerical value of the rating scale in the Evaluation Guidelines for Safe and Resilient Cities and Community Resilience Evaluation Criteria for Old Cities, and divide the resilience scale into five evaluation levels: “poor resilience”, “general resilience”, “moderate resilience”, “good resilience” and “excellent resilience”. The scoring intervals for each resilience level are (0,20], (20,40], (40,60], (60,80], (80,100]. This leads to the evaluation criteria cloud model eigenvalues. Secondly, the numerical characteristics of the evaluation criteria cloud are computed, and the intervals where unilateral constraints exist are first determined by determining the boundary parameter or the default expectation value Ex, and then the entropy value En is computed. For example, “poor resilience” has a default

expectation of 0 because the scoring interval is unilaterally constrained. Finally, according to this paper set the super entropy to take 1% of the maximum evaluation value can determine the super entropy value He is 1, the above determined cloud model feature value input into the forward cloud generator, set the number of cloud droplets for 3000, through the MATLAB software to generate the standard cloud map of resilience evaluation level [48].

Table 4. Classification of resilience.

commentaries	**rating level**	**rating scale**	Ex, En, He	**Explanation of resilience levels**
v_1	poor resilience	(0,20]	(0,3.33,1)	The transformed community is not a resilient community, does not meet the minimum requirements for the living needs of the residents, and the community is in an unsafe condition that requires immediate rehabilitation and restoration
v_2	general resilience	(20,40]	(30,3.33,1)	Transformed communities do not meet resilient communities, a small portion of the construction meets the needs of residents' lives, communities are in a precarious state, and there is a need for gradual improvement of community renovation
v_3	moderate resilience	(40,60]	(50,3.33,1)	The transformed community is generally in line with a resilient community and meets the basic safety and living needs of the residents, but requires routine maintenance and updating
v_4	good resilience	(60,80]	(70,3.33,1)	The transformed community better meets the resilient community, can improve the residents' living needs, enhance the convenience and comfort of the residents' life, and can better maintain the effectiveness of the renovation
v_5	excellent resilience	(80,100]	(90,3.33,1)	The transformed community fully meets the requirements of a resilient community with sound supporting facilities, a safe and comfortable living environment, healthy public activity space, efficient management organization and a harmonious atmosphere, which can maintain the effectiveness of the renovation and achieve sustainable development

4.2.2 Determination of the integrated evaluation cloud

The aforementioned 10 experts were invited to score The New Gui Dong Community Transformed Project based on the designed Expert Scoring Sheet for Resilience Evaluation of Older Community Transformed Projects. The scoring results of the experts on the second-level indicators are input into the inverse cloud generator, and the expected value Ex, entropy value En, and super-entropy value He of the digital features of the second-level indicators are computed, and the evaluation cloud digital features of the first-level indicators and the indicators of each guideline layer are obtained according to the comprehensive weight of the indicators, and the comprehensive evaluation cloud digital features of the resilience evaluation index system are finally computed.

(1) Determine the value of cloud digital features for evaluation of second-level indicators

The scoring results of the experts on the second-level indicators are input into the inverse cloud generator, and the expected value of the digital features of the second-level indicators, the entropy value, and the super-entropy value are calculated, and the digital feature values of some of the second-level indicators are shown in Table 5.

Table 5. Evaluation of cloud digital eigenvalues for second-level indicators.

Indicators	*Ex*	*En*	*He*
Emissions task completion rate C1	75.6000	2.3061	1.8093
Fire-fighting equipment provision rate C2	76.5000	2.8200	2.3350
Vulnerability of power supply networks C3	79.5000	2.3186	1.8222
……			
Security risk assessment C24	84.6000	3.0581	2.5770
Mental health education C25	78.9000	2.1181	1.6151
Community disaster drills C26	59.9000	1.8674	1.3534

（2）Determine the value of cloud digital features for evaluation of first-level indicators

According to the digital eigenvalues of the second-level indicators shown in Table 5, the evaluation cloud digital features of the first-level indicators are obtained, and some of the evaluation cloud digital eigenvalues of the first-level indicators are shown in Table 6.

Table 6. Evaluation of cloud digital eigenvalues for first-level indicators.

Indicators	*Ex*	*En*	*He*
Stability of infrastructure B1	74.2742	2.4678	2.0095
Soundness of public services B2	75.9461	2.0994	1.7180
Emergency facility security B3	74.0495	1.5005	1.0887
……			
Community Relationships B7	76.1347	3.3148	3.4979
Organizational inputs B8	85.3317	3.0892	2.7161
Organizational management B9	78.4312	2.1874	1.7861

（3）Determine the value of cloud digital features for evaluation of Guideline-level indicators

According to the numerical characteristic values of the first-level indicators shown in Table 6, in accordance with the comprehensive weights of the resilience evaluation indicators determined above, the evaluation cloud numerical characteristics of the indicators of each guideline layer can be obtained in turn, as shown in Table 7.

Table 7. Evaluation of cloud digital eigenvalues for guideline-level indicators.

Indicators	*Ex*	*En*	*He*
Social Resilience A1	74.8810	2.0297	1.6851
Environmental Resilience A2	57.3119	1.9073	1.6382
Facility Resilience A3	75.3896	3.7484	3.5953
Organizational Resilience A4	81.6961	2.5379	2.2262

(4) Determination of cloud digital eigenvalues for comprehensive evaluation of the target layer

According to the numerical characteristics values of the guideline layer indicators shown in Table 7, the comprehensive evaluation cloud numerical characteristics of the resilience evaluation index system of the old community renovation project are calculated in accordance with the comprehensive weights of the resilience evaluation indicators determined above, as shown in Table 8.

Table 8. Comprehensive evaluation of cloud digital eigenvalues for the target layer.

Name of the target layer	*Ex*	*En*	*He*
Resilience in Older Communities Renovation Project	74.2742	2.4678	2.0095

The calculated resilience evaluation index system of the old community renovation project resilience evaluation of the comprehensive evaluation cloud digital features into the forward cloud generator, you can get the resilience evaluation of the old community renovation project resilience evaluation of the comprehensive evaluation of the cloud,

from the figure can be seen that the resilience evaluation grade and the "good resilience" grade is the closest, specifically as shown in Figure 6.

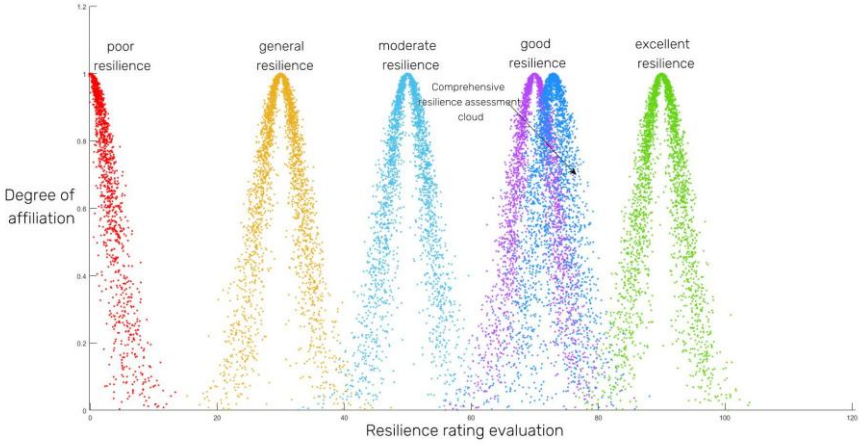


Figure 6. Resilience levels for older community renovation project.

4.2.3 Similarity calculation

In this paper, the shape and distance of the evaluation cloud map are considered comprehensively, and the similarity calculation method of the comprehensive cloud model is used to determine the similarity between the cloud map of each evaluation index and the standard cloud map, and the resilience level of the evaluation index is determined in accordance with the principle of maximum affiliation.

The results show that the resilience R of this old community renovation project has the highest similarity with " good resilience", with a similarity value of 0.6768; the environmental resilience (A2) has the highest similarity with " moderate resilience", with a similarity value of 0.1651; the facilities resilience (A1) and social resilience (A3) have the highest similarity with " good resilience", with similarity values of 0.3523 and 0.3352 respectively; and organizational resilience (A4) has the highest similarity with " excellent resilience", with similarity value of 0.1644. Most of the first-level indicators is in the "good resilience", of which the transportation environment (B4), ecological environment (B5) and the "moderate resilience" has the highest similarity, similarity value of 0.2765, 0.0443; the organizational input (B8) has the highest similarity with "good resilience", with a similarity value of 0.1206. The results of the similarity results of each level of the indicators and the resilience level are shown in Table 9.

Table 9. Similarity results of resilience evaluation indicators for older community renovation project.

Indicators	Poor	General	Moderate	Good	Excellent	Similarity
R	0.0000	0.0000	0.0000	0.6768	0.0028	good
A1	0.0000	0.0000	0.0000	0.3523	0.0022	good
A2	0.0000	0.0000	0.1651	0.0092	0.0000	moderate
A3	0.0000	0.0000	0.0000	0.3352	0.0256	good
A4	0.0000	0.0000	0.0000	0.0445	0.1644	excellent
B1	0.0000	0.0000	0.0000	0.4733	0.0052	good
B2	0.0000	0.0000	0.0000	0.2709	0.0054	good
B3	0.0000	0.0000	0.0000	0.3455	0.0000	good
B4	0.0000	0.0000	0.2765	0.0216	0.0000	moderate
B5	0.0000	0.0000	0.0443	0.0079	0.0000	moderate
B6	0.0000	0.0000	0.0000	0.3625	0.0263	good

B7	0.0000	0.0000	0.0000	0.2545	0.0261	good
B8	0.0000	0.0000	0.0000	0.0142	0.3934	excellent
B9	0.0000	0.0000	0.0000	0.1206	0.0277	good
C1	0.0000	0.0000	0.0000	0.3453	0.0065	good
C2	0.0000	0.0000	0.0000	0.3067	0.0256	good
C3	0.0000	0.0000	0.0000	0.0880	0.0562	good
C4	0.0000	0.0000	1.0185	0.0000	0.0000	moderate
C5	0.0000	0.0000	0.0000	0.0000	0.6819	excellent
C6	0.0000	0.0000	0.0000	0.0000	0.5225	excellent
C7	0.0000	0.0000	0.0000	0.3214	0.0022	good
C8	0.0000	0.0000	0.0012	0.9405	0.0000	good
C9	0.0000	0.0000	0.0000	0.0144	0.0110	good
C10	0.0000	0.0000	0.0000	0.2137	0.0070	good
C11	0.0000	0.0000	0.0000	0.3302	0.0000	good
C12	0.0000	0.0000	0.0034	0.4468	0.0000	good
C13	0.0000	0.0000	0.9378	0.0012	0.0000	moderate
C14	0.0000	0.0000	0.4325	0.0000	0.0000	moderate
C15	0.0000	0.0000	0.0000	0.2747	0.0000	good
C16	0.0000	0.0000	0.0036	0.5994	0.0060	good
C17	0.0000	0.0000	0.0000	0.0884	0.1604	excellent
C18	0.0000	0.0000	0.0000	0.2934	0.0036	good
C19	0.0000	0.0000	0.0000	0.2843	0.0630	good
C20	0.0000	0.0000	0.0000	0.0000	0.3647	excellent
C21	0.0000	0.0000	0.0000	0.1094	0.1036	good
C22	0.0000	0.0000	0.0000	0.0271	0.2940	excellent
C23	0.0000	0.0000	0.0000	0.0117	0.1158	excellent
C24	0.0000	0.0000	0.0000	0.0191	0.3436	excellent
C25	0.0000	0.0000	0.0000	0.0892	0.0310	good
C26	0.0000	0.0000	0.0437	0.0392	0.0000	moderate

4.3 Evaluation results and analysis

The results of the study show that the resilience evaluation grade of the case project is "good resilience", which can better meet the standards of resilient community construction, and the evaluation results are in line with the actual situation of the project and the expected results of the experts, and the specific results are analyzed as follows:

The facility resilience rating is "good resilience", indicating that The New Gui Dong community can meet the needs of residents after the renovation, and at the same time provide diversified public services and emergency services with safety and security. Analyzing the secondary indicators, it is found that the community renovation attaches great importance to the public safety of residents and the health needs of the elderly, but the coverage rate of the communication network is poor.

The environmental resilience rating is "moderate resilience", indicating that the environmental aspects of The New Gui Dong community renovation basically meet the demands of residents. Analysis of the secondary indicators shows that the community has been able to solve serious parking problems, achieve separation of motorized and non-motorized parking, and implement orderly separation of household garbage, but areas such as public green space, green space next to houses, and road green space have not yet met the requirements of Chengdu for the human environment in old communities.

The social resilience rating is “good resilience”, indicating that the renovation of The New Gui Dong community can enhance residents' sense of belonging and improve their cohesion. Analysis of the secondary indicators shows that the community can realize residents' self-supervision, self-service, self-study and self-management, and that residents have a high sense of security and pay great attention to the safety of life.

Organizational resilience is rated as “excellent resilience”, indicating that The New Gui Dong community focuses on improving organizational investment and organizational management services. Analysis of the secondary indicators shows that the community has set up a diverse party building service program and a community building program to improve the quality of life of residents through the implementation of social self-governance organizations, but it has not conducted many disaster prevention drills due to the complexity of the community's population and its location in the center of the old city.

5. Conclusions

In order to optimize, sound and innovate the theoretical system of resilience evaluation of old community renovation projects, this paper proposes a resilience evaluation model for the effectiveness of old community renovation projects based on the perspective of urban renewal. The evaluation system advocates timely attention to and understanding of the real use feelings of the relevant subjects, in order to judge the rationality and accuracy of the renovation strategy program. The evaluation system takes into account different standards in different countries as well as national and international research literature, while incorporating the results of the community field research. The main conclusions drawn from this study are summarized below:

(1) Establishment of an evaluation indicator system. Firstly, a list of factors affecting the resilience of renovation projects in older communities was established through a combination of literature research and field research. Secondly, based on the evaluation dimensions of community resilience at home and abroad, an evaluation index system containing 9 first-level indicators, such as infrastructure stability, and 26 second-level indicators, such as the completion rate of sewage tasks, was identified using the four dimensions of facility resilience, environmental resilience, social resilience and organizational resilience as the evaluation guideline layer. Unlike previous studies, this evaluation system fully encompasses the understanding and knowledge of urban renewal, while providing a more simplified and balanced assessment tool for the renovation of older communities. fuzzy analytical hierarchy process and entropy weight method

(2) Constructing a resilience evaluation model. Fuzzy analytical hierarchy process and entropy weight method are selected to combine the calculation of indicator weights, and this comprehensive assignment method can reduce the subjectivity of the calculation of fuzzy hierarchical analysis method as well as the extremity of the calculation of entropy weight method. Secondly, the cloud model is used to determine the resilience evaluation level of indicators at all levels and the resilience evaluation level of the research object, and the cloud model can convert quantitative data and qualitative concepts to each other, so as to accurately calculate the project resilience evaluation results.

(3) A renovation project for an older community in an area was selected as a case for analysis. Using the evaluation model established in this paper, the resilience evaluation result of the project is “good resilience”, and the construction meets the construction standard of resilient community. The results of the study are basically consistent with the actual situation, indicating that the evaluation model established in this paper is feasible and practical.

The renovation of old neighborhoods is an important part of urban renewal. This study is able to provide a scientific and reasonable evaluation of the renovation project of

the old community, which is not only conducive to the continuous tracking of the resilience change of the old community, but also able to provide a decision-making basis for the renewal and renovation work to improve the quality of life of the local residents in the long term. This study focuses on the rationalization of data sources, but there are some limitations. At present, the renovation project of the old community mostly focuses on a single project, which is territorial and limited, while the goal of the renovation of the old community will change dynamically with the development of the times. In future research, differentiated resilience evaluation models based on geographic and temporal distinctions will also be considered to deepen resilience research on the development of older communities.

Appendix A

Appendix A.1

Table A1. Criteria for grading resilience evaluation indicators.

Dimension	First-level index	Second-level index	Description	Unit	Poor	General	Moderate	Good	Excellent
Social Resilience (A1)	Stability of infrastructure (B1)	Emissions task completion rate (C1)	User satisfaction with whether sewage discharges affect daily life	%	<60	[60,70)	[70,80)	[80,90)	≥90
		Fire-fighting equipment provision rate (C2)	Availability of qualified fire-fighting facilities	%	<70	[70,80)	[80,90)	[90,95)	≥95
		Vulnerability of power supply networks (C3)	Time to restore power to customers after a power outage occurs in the community	Hours	≥9	[5,9)	[3,5)	[1,3)	<1
		Communications network coverage (C4)	User access to the network as a percentage of the total resident population	%	<85	[85,90)	[90,95)	[95,98)	≥98
		Public area surveillance coverage (C5)	Coverage of surveillance devices installed in public areas	%	<50	[50,60)	[60,80)	[80,90)	≥90

Dimension	First-level index	Second-level index	Description	Unit	Poor	General	Moderate	Good	Excellent
Social Resilience (A1)	Soundness of public services (B2)	Elderly Care Services (C6)	Community support services for the elderly	/	Unmatched	Fewer services provided	Provision of services generally complete	Fuller provision of services	Provides a very full range of services
		Elderly Care Services (C6)	Community support services for the elderly	/	Unmatched	Fewer services provided	Provision of services generally complete	Fuller provision of services	Provides a very full range of services
		Medical services (C7)	Community medical services	/	Medical services with clinics and pharmacies	Medical institutions with health service stations, clinics and pharmacies	With community health service centers	Community health service centers and city (district) hospitals to form a medical consortium construction	Community health service centers and provincial hospitals form a medical consortium building
		Intelligent Management Services (C8)	Community wisdom management service level	/	Unmatched	Less complementary smart management services	Comes with basic smart management services	A more complete set of intelligent management services	Well-supported intelligent management services
	Emergency facility security(B3)	Emergency shelter area per capita (C9)	Ratio of emergency shelter area to total resident population	m^2/person	<1	[1,1.5)	[1.5,1.8)	[1.8,2.1)	≥2.1

512

513

Dimension	First-level index	Second-level index	Description	Unit	Poor	General	Moderate	Good	Excellent

Social Resilience (A1)	Emergency facility security(B3)	Emergency stockpile(C10)	Adequacy of community preparedness for emergencies	/	No stockpile of emergency supplies	Insufficient material reserves	Guarantee of emergency supplies to meet needs	Adequate amount of materials in the emergency stockpile to basically meet the needs of the population	The emergency stockpile is well stocked with materials that fully meet the needs of residents, and there is also cooperation with supermarkets, restaurants, hospitals and other service points
		Emergency access (C11)	Access for the protection of human life in the event of emergencies	/	Large amount of debris and vehicles occupying the passageway, which is not accessible on a daily basis	Small amount of debris and vehicles occupying the passageway, which is not accessible on a daily basis	There are a small number of blocking and occupying the road, the daily traffic conditions are average	There is no blocking and occupation of the road, daily access is good, to meet the emergency vehicle traffic	There is no blocking and occupying the road, the daily traffic condition is good, to meet the emergency vehicle traffic, the road surface is not broken, with perfect road marking
Environmental Resilience(A2)	Transportation environment(B4)	Parking space rationalization (C12)	Ratio of number of parking spaces to total number of dwelling units	%	＜30	[30,50)	[50,65)	[65,70)	≥70
		Community road network density (C13)	Ratio of total road mileage in the community to the area of the community	km/km²	＜4	[4,6)	[6,8)	[8,10)	≥10
Dimension	**First-level index**	**Second-level index**	**Description**	**Unit**	**Poor**	**General**	**Moderate**	**Good**	**Excellent**

Environmental Resilience(A2)	Ecological environment(B5)	Community Greening Rate (C14)	Percentage of community area covered by various types of green space in the community	%	<15	[15,25)	[25,35)	[35,40)	≥40
		Waste Sorting(C15)	Community management of waste segregation	/	No waste separation and disposal system in place	Lack of supporting facilities and pollution of the community environment	Supporting equipment for the domestic waste collection and disposal system is inadequate, and individual waste separation collection containers and waste removal tools are untidy	There is a perfect system for collecting, transporting and disposing of domestic garbage, supporting the setting up of public notice boards and publicity columns, and the removal of garbage does not produce secondary pollution.	There is a perfect system for collecting, transporting and disposing of domestic garbage, with a reasonable layout of garbage classification collection containers, and the surrounding area is kept clean and tidy, not broken or overflowing, and the removal of garbage does not produce secondary pollution.
Facility Resilience (A3)	Learning capacity of the population(B6)	Awareness of disaster prevention and self-help among the population (C16)	Percentage of residents with awareness of disaster prevention and self-help as a percentage of the total resident population	%	<60	[60,70)	[70,80)	[80,90)	≥90

514

Dimension	**First-level index**	**Second-level index**	**Description**	**Unit**	**Poor**	**General**	**Moderate**	**Good**	**Excellent**
	Learning capacity	Emergency skills for residents (C17)	Percentage of residents with emergency response	%	<20	[20,40)	[40,60)	[60,80)	≥80

Facility Resilience (A3)	of the population(B6)		skills out of the total resident population						
	Community Relationships(B7)	Resident anticipation (C18)	Percentage of residents regularly participating in community activities as a percentage of the total resident population	%	<10	[10,20)	[20,30)	[30,40)	≥40
		10,000 Number of emergency volunteers (C19)	Ratio of the number of emergency volunteers to the total resident population	Persons per 10000	<2	[2,4)	[4,6)	[6,8)	≥8
Organizational Resilience (A4)		Community Leadership (C20)	Comprehensive evaluation of community management in the community	/	The absence of community-based party organizations and the very weak capacity to deal with emergencies	Absence of community-based party organizations and weak capacity to deal with emergencies	The existence of community-based party organizations with an average capacity to deal with emergencies	Community-based party organizations are in place and have a strong capacity to deal with emergencies	Community grassroots party organizations are well established and have a very strong capacity to deal with emergencies
Dimension	**First-level index**	**Second-level index**	**Description**	**Unit**	**Poor**	**General**	**Moderate**	**Good**	**Excellent**
	Organizational inputs(B8)	Community self-governing organizations (C21)	Richness of community self-governing organizations	a	<2	[2,4)	[4,6)	[6,8)	≥8

		Social institutions (C22)	Social institutions providing assistance to the community	a	＜1	[1,3)	[3,5)	[5,7)	≥7
	Organizational management(B9)	Emergency preparedness(C23)	The community has an operational emergency response plan	/	No emergency plan in place	Small number of irregularities in the preparation of emergency plans	Emergency preparedness basically meets the norms	Emergency plans are more operational	Formulation of different types and levels of emergency plans that are standardized and operable
		Security risk assessment (C24)	Frequency of safety hazard assessments in the community	Times/year	＜6	[6,8)	[8,10)	[10,12)	≥12
		Mental health education (C25)	Frequency of community-organized mental health-related educational activities	Times/year	＜6	[6,8)	[8,10)	[10,12)	≥12
		Community disaster drills (C26)	Frequency of community-organized publicity and education activities related to disaster prevention and mitigation	Times/year	＜1	[1,2)	[2,3)	[3,4)	≥4

Funding

We are not supported by any funding.

Data availability

All data generated or analysed during this study are included in this article.

Declarations

Ethics statement

Approval was obtained from the Academic Oversight Committee of the School of Civil and Architectural Engineering, Chengdu Jincheng College.Approval No.: 【CDJCSCAE-ASC-2026-01】.

Consent to participate

Informed consent was obtained form all subjects involved in the study.

Consent to publish

Not applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number

Not applicable.

References

1. Wang, W.; Yang, H.W.; Jing, S.W. The development of priority decision model for old urban community renovation in China. *SCI REP* **2024**, *14(1)*. DOI:10.1038/s41598-024-54883-3.
2. Liu, F.; Zhang, Z.X.; Zhao, X.L. Chinese cropland losses due to urban expansion in the past four decades. *SCI TOTAL ENVIRON* **2018**, *650(Pt 1),847-857*. DOI: 10.1016/j.scitotenv.2018.09.091.
3. Adams, D; Hastings, E.M. Urban renewal in Hong Kong: transition from development corporation to renewal authority. *LAND USE POLICY* **2001**, *18(3),245-258*. DOI:10.1016/S0264-8377(01)00019-9.
4. Zheng, W.; Shen, G.Q.; Wang, H. Decision support for sustainable urban renewal: A multi-scale model. *LAND USE POLICY* **2017**, *69,361-371.* DOI: 10.1016/j.landusepol.2017.09.019.
5. Lu, H.; Zhang, X. Assessing the adaptability of older communities for renovation: A structural equation model involving health sustainability. *P I CIVIL ENG-ENG SU* **2023**.DOI:10.1680/jensu.22.00049.
6. Xiang, H.X.; Heng, X.; Zhai, B.L.; Yang, LC.; Digital and Culture: Towards More Resilient Urban Community Governance. *Land* **2024**, *13(6).* DOI:10.3390/land13060758.
7. Gillespie-Marthaler, L.; Nelson, K.; Baroud, H. Selecting Indicators for Assessing Community Sustainable Resilience. *RISK ANAL* **2019**, *39, 2479-2498.DOI*:10.1111/risa.13344.
8. Xu, L.; Yang, K.; Xiong, T.T. Development of an evaluation list for older adult community-based rehabilitation needs through a Delphi method. *SCI REP* **2025**,*14, 1.DOI*:10.1038/s41598-024-75199-2.

9. Shu, L.; Mo, Y.J.; Zhao, D. Energy retrofits for smart and connected communities: Scopes and technologies. *RENEW SUST ENERG REV* **2024**, *199*.DOI: 10.1016/j.rser.2024.114510.
10. Wang, F.; Fang, Y.Y.; Deng, H.D. How community medical facilities can promote resilient community constructions under the background of pandemics. *INDOOR BUILT ENVIRON* **2022**, *31(4), 1018-1027.DOI*:10.1177/1420326X211048537.
11. Zhu, S.Y.; Li, D.Z.; Feng, H.B. AHP-TOPSIS-Based Evaluation of the Relative Performance of Multiple Neighborhood Renewal Projects: A Case Study in Nanjing, China. *Sustainability* **2019,** *11(17).*DOI:10.3390/su11174545.
12. A, L.H.; B, W.Z.; A, J.H. Paths and strategies for sustainable urban renewal at the neighbourhood level: A framework for decision-making - Science Direct. *SUSTAIN CITIES SOC* **2025,** *55.* DOI: 10.1016/j.scs.2020.102074.
13. Han. S.; Wang, B.; Ao, H.C. B. The coupling and coordination degree of urban resilience system: A case study of the Chengdu-Chongqing urban agglomeration. *ENVIRON IMPACT ASSES* **2023**, *101(Jul.): 107145.1-107145.14. DOI*: 10.1016/j.eiar.2023.107145.
14. Wang, P.; Chen, H.Y.; Si, Z.Y. Effectively solve the obstacle in the old residential building energy-saving renovation from the perspective of a four-party evolutionary game. *ENVIRON SCI POLLUT R* **2024,** *31(6).* DOI:10.1007/s11356-023-31591-5.
15. Sun, G.S.; Li, M.Z.; Dong, J.Y. Evaluation of Key Factors for Promoting Green Construction Practices Based on a Hybrid Decision-Making Framework: A Case Study on the Renovation of Old Residential Communities in China. *Axioms* **2023**, *12(10).* DOI:10.3390/axioms12100971.
16. Li, D.Z.; Du, B.Z.; Zhu, J. Evaluating old community renewal based on emergy analysis: A case study of Nanjing. *ECOL MODEL* **2021**, *449(1), 109550.DOI*: 10.1016/j.ecolmodel.2021.109550.
17. Zhang, Y.; Dong, L. Payment Behavioral Response Mechanisms for All-Age Retrofitting of Older Communities: A Study among Chinese Residents. *Behavioral Sciences* **2023**, *13(11).* DOI:10.3390/bs13110925.
18. Xu, X.F.; Xue, D.S.; Huang, G.Z. The Effects of Residents' Sense of Place on Their Willingness to Support Urban Renewal: A Case Study of Century-Old East Street Renewal Project in Shaoguan, China. *Sustainability* **2022**, *14(3).*DOI:10.3390/su14031385.
19. Liu, F.Y.; Dong, L.L.; Shao, Z.Y. EXPLORING THE RESILIENT DESIGN OF SPONGE TRANSFORMATION IN OLD COMMUNITIES OF MOUNTAINOUS CITIES: A CASE STUDY OF Y DISTRICT IN C CITY. *EEMJ* **2024**, *23(5).* DOI:10.30638/eemj.2024.073.
20. Li, W.; Li, Q.; Liu, Y. Decision-making factors for renovation of old residential areas in Chinese cities under the concept of sustainable development. *ENVIRON SCI POLLUT R* **2023.**DOI:10.1007/s11356-022-25043-9.
21. Shi, S.X.; Guan, Y.M. The construction of evaluation index system for upgrading old communities under the concept of future community. *Urban Development Research* **2024**,*31(6),134-140.*
22. L, Z.; X, S.C.; L, L.I. Research on the Influencing Factors of Residents' Satisfaction in the Renovation of Old Residential Communities. *Journal of Engineering Management* **2024**, *38(3).* DOI: 10.13991/j.cnki.jem.2024.03.011.
23. Guo, B.; Li, Y.; Wang, J.X. The improvement strategy on the management status of the old residence community in Chinese cities: An empirical research based on social cognitive perspective. *COGN SYST RES* **2018**, *52, 556-570.DOI*: 10.1016/j.cogsys.2018.08.002.
24. Y, W.T.; L, S. Study on Influence Factors of the Renovation Progress of Old Residential Communities. *Journal of Engineering Management* **2022**, *36(6).* DOI: 10.13991/j.cnki.jem.2022.06.012.
25. Huo, X.S.; Xue, H.; Xu, X.B. A risk sharing model for old community renewal project based on bargaining game model. *SCI REP* **2025**,*14(1).* DOI:10.1038/s41598-024-75315-2.
26. Ding, R.; Fu, J.; Zhang, Y.L.; Zhang, T.; Yin, J.; Du, Y.M; Zhou, T.; Du, L.Y. Research on the Evolution of the Economic Spatial Pattern of Urban Agglomeration and Its Influencing Factors, Evidence from the Chengdu-Chongqing Urban Agglomeration of China. *Sustainability* **2022,** *14(17), 10969.*
27. Zuo, J.; Fan, J.H.; Huang, X.Y.; Li, C.; Luo, J.C. Classification and Spatial Differentiation of Subdistrict Units for Sustainable Urban Renewal in Megacities: A Case Study of Chengdu. *Land* **2024**, *13, 164.* https://doi.org/10.3390/land13020164
28. Dong, Q.D.; Cai, J.; Chen, S.; He, P.M.; Chen, X.L. Spatiotemporal Analysis of Urban Green Spatial Vitality and the Corresponding Influencing Factors: A Case Study of Chengdu, China. *Land* **2022**, *11*, 1820. https://doi.org/10.3390/land11101820
29. Cutter, S.L.; Barnes, L.; Berry, M. A place-based model for understanding community resilience to natural disasters. *GLOBAL ENVIRON CHANG* **2008**, *18(4), 598-606.* DOI10.1016/j.gloenvcha.2008.07.013
30. Cutter, S.L.; Ash, K.D.; Emrich, C.T. The geographies of community disaster resilience. *GLOBAL ENVIRON CHANG* **2014**, 29, 65-77. DOI10.1016/j.gloenvcha.2014.08.005
31. Peacock, W.G.; Brody, S.D.; Seitz, W.A. Advancing resilience of coastal localities: Developing, implementing, and sustaining the use of coastal resilience indicators: A final report. *Hazard reduction and recovery center*, **2010,** *19(2),1-148.*

32. Gian, P.C.; Chris, R.; Andrei, M.R.; Lucy, A.P: A Framework for Evaluating Resilience. *J STRUCT ENG-ASCE* **2016**,*142(10),04016063-04016063.*
33. Odeya, C.; Dima, L.; Mooli, L.; Avishay,G.; Limor, A.D. The conjoint community resiliency assessment measure as a baseline for profiling and predicting community resilience for emergencies. *Technological Forecasting & Social Change* **2013**,*80(9),1732-1741.*
34. Li, C.; Solangi, Y.A.; Ali, S. Evaluating the Factors of Green Finance to Achieve Carbon Peak and Carbon Neutrality Targets in China: A Delphi and Fuzzy AHP Approach. *Sustainability* **2023**, *15, 2721.* https://doi.org/10.3390/su15032721
35. Hong, J.W.; Tang, L.; Research on Quality Evaluation Indicator System of Undergraduate Talent Cultivation in Journalism and Communication. *Journalism and Communication Review* **2021**,*74(06),5-19*
36. Li, B.P. Research on the construction and application of the index system for assessing the governance capacity of healthy communities. Shanxi University of Finance and Economics, Taiyuan, 2021.
37. Technical standards for comprehensive transformation of old urban residential areas, *T/CSUS 04-2019.*
38. Evaluation standards for transformation of old urban neighborhoods, *DB22/T 5174-2024.*
39. Pazhuhan, M.; Moradpour, N.; Hesarakizad, A. District-based Baseline Resilience Indicators for Communities (DBRIC) for Assessment of a Global South City. *SUSTAIN CITIES SOC* **2023**, *96*.DOI: 10.1016/j.scs.2023.104563.
40. Sharifi, A.; Allam, Z. On the taxonomy of smart city indicators and their alignment with sustainability and resilience. *ENVIRON PLAN B-URBAN* **2022**, *49(5),1536-1555.* DOI:10.1177/23998083211058798.
41. Zahedifar, M. Feasibility of fuzzy analytical hierarchy process (FAHP) and fuzzy TOPSIS methods to assess the most sensitive soil attributes against land use change. *ENVIRON EARTH SCI* **2023**.DOI:10.1007/s12665-023-10934-y.
42. Chen, Y.; Zhong, S.S; Liang, X.; Li, Y.; Cheng, J.; Cao, Y. The Relationship between Urbanization and the Water Environment in the Chengdu-Chongqing Urban Agglomeration. *Land* **2024**, *13, 1054.* https://doi.org/10.3390/land13071054
43. Luo, Z.H.; Guo, J.T.; Han, J.Q. Safety risk evaluation of assembled subway station construction based on cloud modeling. *Chinese Journal of Safety Science* **2023**,*33(6),88-95*
44. Luo, Z.H.; Guo, J.T.; Han, J.Q.; Wang, Y.H. Research on the construction safety risk assessment of prefabricated subway stations in China. *ENG CONSTR ARCHIT MA* **2022**, *31(4):,1751-1787*
45. W, S.; Xu, L.; Ke, G.X.; Hu, K.J. Optimization of GRA-TOPSIS deep-well roadway support scheme based on optimal combination weights. *Journal of Chongqing University* **2019**,*42(6),78-87*
46. He, L.P.; Xu, Y.D.; Hu, Q.J.; Cai, Q.J. Risk assessment of large deformation in soft rock tunnel based on game theory-cloud modeling. *Modern Tunneling Technology* **2021**,*58(06),85-94.*
47. Peng, B.; Zhou, J.M.; Peng, D.H. Cloud model based approach to group decision making with uncertain pure linguistic information. *J INTELL FUZZY SYST* **2017,** *32, 1959-1968.*
48. Wu, W.D.; Huang, P.; Zhong, M.Q.; Wan, X.S.; Pan, H.Z. Evaluation of Green Construction Grade of High-speed Railway Based on Cloud Modeling--Taking Southwest China as an Example. *Journal of Railway Science and Engineering* **2021**,*18(06),1418-1425.*