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Sustainable Design Strategy of Regional Revitalization Based on AHP–FCE Analysis: A Case Study of Qianfeng in Guangzhou

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Abstract: As urbanization progresses, large cities continue to attract population, causing depopulation and regional development imbalances, especially in remote rural areas facing sustainability challenges. This study aims to explore local resource potential and assess critical factors for regional revitalization, offering design strategies to promote local sustainability. The study is based on the UN Sustainable Development Goals (SDGs) and assesses the status of regional development through field research. The Delphi method was employed to interview experts and build a multi-tiered sustainable development evaluation indicator framework (Level 1: *B1–B3*, Level 2: *C1–C8*, Level 3: *D1–D16*), covering economic, social, and environmental dimensions. The weights of the indicators were determined through the analytic hierarchy process (AHP), and the fuzzy comprehensive evaluation (FCE) method was applied to comprehensively assess the sustainable development status of Qianfeng Community. The research findings revealed that due to population outflow and a lack of participation in co-building channels, the region scored lowest in "local employment & entrepreneurship (*D2*)", "innovation & entrepreneurship culture (*D10*)", and "endogenous development (*D16*)". Consequently, the study proposes the establishment of a regional revitalization co-creation platform based on "life projects" as part of a sustainable design strategy. These research results provide valuable case studies and strategic references for future regional revitalization and sustainable design initiatives.

Keywords: regional revitalization; analytic hierarchy process; fuzzy comprehensive evaluation; sustainable design; sustainable development goals

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1. Introduction

Industrialization and urbanization have brought numerous benefits, such as increased employment opportunities, improved public service infrastructure, and enhanced economies of scale [1]. However, they have also led to a concentration of population in metropolises, resulting in issues such as aging rural populations, ecological crises, and regional development disparities [2]. Consequently, research focusing on regional revitalization and sustainable development has become paramount.

Since the 1970s, theories concerning regional development have continuously evolved. Initially, endogenous development theory emphasized the intrinsic value of regions, advocating for a bottom-up approach to regional development [3]. This model underscored the utilization of local resources and industries as a foundation for achieving sustainable economic and social development [4]. Subsequently, the emergence of the neo-endogenous development theory placed further emphasis on connectivity and collaboration between localities and external networks to effectively harness internal and external resources for regional sustainable development [5–7]. Manzini (2010) described these open and interconnected regional development networks as SLOC Scenario (small, local, open, connected), which seek sustainable solutions for regional development [8]. With increasing attention

on regional resources and the deepening of sustainable development concepts, research has also focused on regional revitalization, promoting economic development in remote areas, and encouraging youth entrepreneurship in their hometowns [9,10]. However, as highlighted by Agarwal et al., rural economies are influenced by complex interactions among economic, human, social, cultural, and environmental capitals, each exhibiting its own variations [11]. In the process of regional revitalization, crucial indicators determining the success or failure of regional development require more attention, and criterion-based sustainable development assessment plays a crucial role in policymaking and decision processes [12,13]. The prominent research issue manifests in the challenge of diverse local attributes in the field of regional revitalization, where multiple stakeholders find it difficult to reach a development consensus and lack scientifically valid evaluation criteria to provide design strategy references for regional sustainable development. This study aims to construct a regional sustainable development evaluation indicator as a basis and propose regional revitalization design strategies based on the evaluation results.

To achieve this, this study applies the theory of regional revitalization and integrates the United Nations Sustainable Development Goals (SDGs) to construct an evaluation indicator system. Taking Qianfeng Community in Guangzhou as an example, a structured approach utilizing the analytic hierarchy process (AHP) is employed to address the complex, multi-criteria development decision problem in Qianfeng. Additionally, the fuzzy comprehensive evaluation (FCE) method is utilized to comprehensively assess the various indicators influencing the development of Qianfeng, enhancing the flexibility and adaptability of the decision-making process to real-world conditions. The outcomes of this research not only enrich the relevant evaluation indicator system for regional revitalization but also offer sound design strategies for the sustainable development of Qianfeng, thereby providing valuable research references for regional revitalization planning and implementation. Amid the current global endeavor to achieve sustainable development, this research holds significant implications for integrating regional revitalization with sustainable development.

2. Sustainable Development Goals in Regional Revitalization

2.1. Regional Revitalization

The concept of regional revitalization was first proposed by Japan in 2014, in response to a series of regional revitalization policies initiated by the Japanese government. These policies aimed to address issues such as population reduction, over-concentration of the population in Tokyo, and local economic recession [14,15]. The primary objective of regional revitalization is to harness the unique strengths of each region and build a sustainable local economic ecosystem [16,17]. It seeks to create opportunities for individuals to choose employment and entrepreneurship in towns and their hometowns, in addition to major cities, thereby addressing challenges like an aging population, declining birth rates, regional disparities in urban and rural development, and regional equity [18,19].

As regional development imbalances have become more pronounced, research has increasingly focused on local concerns, including issues related to aging populations, cultural heritage, and industrial development [20–22]. This research aims to explore paths towards sustainable development encompassing the local economy, society, environment, and culture [23]. In the initial stages of local development, community building took center stage, with research primarily emphasizing cultural aspects, social capital, and landscape transformation, while giving less emphasis to improving local industrial performance [24,25]. However, due to the multifaceted investments required for industrial development, communities have lacked effective models for generating local economic benefits, leading to an inevitable influx of population towards major cities [26]. Consequently, despite years of community building efforts, the problem of declining regions remains unresolved.

Regional revitalization seeks to help local areas develop distinctive industrial and economic activities based on their specific conditions, attract industries and population inflows, and promote local prosperity. From the perspective of sustainable development,

regional revitalization places significant focus on overall economic, social, cultural, and environmental development [27–29], aligning with the objectives of the Sustainable Development Goals (SDGs) [30]. Therefore, aligning regional revitalization efforts with the SDGs and establishing a sustainable development indicator system for regional revitalization can provide valuable references for developing sustainable design strategies at the local level.

2.2. The Three Dimensions of Sustainable Development

The United Nations' Sustainable Development Goals (SDGs) were introduced in 2015. These goals are designed to address global challenges comprehensively, and encompass 17 targets that must be attained by 2030. They include promoting economic growth, tackling issues related to education, health, and employment, combating climate change, as well as safeguarding the environment [31,32].

The Rio+20 Summit's outcome document, titled The Future We Want, explicitly delineated sustainable development into three dimensions: economic, social, and environmental. These dimensions are considered as the foundation of sustainable development [33]. The Sustainable Development Solutions Network (SDSN) published An Action Agenda for Sustainable Development, fully endorsing the three dimensions proposed in the Rio+20 Summit. It emphasized that sustainable development should be approached as a holistic concept to address real-world issues, including economic development, social inclusion, environmental sustainability, and good governance [34].

The collaboration of participating actors within a common framework is crucial for the sustainable development of regional revitalization efforts. The United Nations' SDGs provide a value guide and assessment indicators for the sustainable design of regional layouts [35,36]. This facilitates dialogue, focus, and consensus building among the various stakeholders involved in collaboration within a common framework. The SDGs consist of 17 goals, 169 targets, and 232 indicators, covering universal issues across three dimensions: economic, social, and environmental [37]. This provides research references for the construction of evaluation indicators for sustainable development in regional revitalization (Figure 1).



Figure 1. Vacant space and ecological resources of Qianfeng Community.

(1) Economic dimension: Regional revitalization aims to maximize regional potential by mobilizing local resources through the involvement of local residents [38,39], leading to the revitalization and development of industries. It also aims to attract young people to return to their hometowns for entrepreneurship, employment, and living, thereby fostering collective production and consumption within the local region [40] and promoting sustainable regional economic growth. From an economic dimension, the SDGs related to sustainable development in regional revitalization include SDG 7, SDG 8, and SDG 12.

(2) Social dimension: An inclusive regional revitalization mechanism that focuses on the well-being of the people and partnerships can enhance residents' sense of place identity and their motivation to contribute to local welfare affairs [41]. Furthermore, promoting coordinated urban–rural development to facilitate resource flow between regions helps foster joint development between cities and surrounding towns [42]. Simultaneously, enhancing local innovation and entrepreneurial capabilities through skill training and talent development, including among youth, women, the elderly, and vulnerable groups, creates a fair social participation system [43]. From a social dimension, the SDGs related to sustainable development in regional revitalization include SDG 1, SDG 2, SDG 3, SDG 4, SDG 5, SDG 10, SDG 16, and SDG 17.

(3) Environmental dimension: Regional development requires attention to the rational utilization and protection of local ecological resources [44] and the establishment of sound basic public service facilities. Eliminating the urban–rural gap through endogenous growth approaches helps create inclusive, safe, resilient, and sustainable local living environments [45,46], ultimately leading to ecologically livable surroundings that encompass natural landscapes, historical relics, and service systems. From an environmental dimension, the SDGs related to sustainable development in regional revitalization include SDG 6, SDG 9, SDG 11, SDG 13, SDG 14, and SDG 15.

This study focuses on the development significance of the three dimensions of sustainable development, namely economic, social, and environmental, in regional revitalization. Its objective is to construct a clear, concise, and practical evaluation system for sustainable development in regional revitalization. This evaluation system aims to help regions understand their development status, assess their resource conditions, identify issues, and take measures to promote regional sustainable development. Additionally, the evaluation system can enhance social participation, attract public involvement in regional development, and strengthen consensus and collaboration in community development.

3. Methodology

3.1. Research Framework

This paper is structured into five stages of research. In Stage 1, the research problem and relevant definitions are clarified through literature review and field research. It explains that the decline of remote areas has become a global issue under the context of industrialization and urbanization, and the concept of regional revitalization is proposed as a sustainable solution. In Stage 2, the Delphi Method is used to conduct two rounds of questionnaire surveys and expert interviews with 15 experts in the field to screen and adjust the evaluation indicators, resulting in a reasonable Level 1, Level 2, and Level 3 indicator system. In Stage 3, the analytic hierarchy process (AHP) is used to analyze the indicators and determine their weights. In Stage 4, questionnaire data is collected from local people, including residents, government personnel, and social workers. Then, the fuzzy comprehensive evaluation (FCE) method is used to calculate and analyze the indicators at each level, and a comprehensive evaluation is made based on the relative weights of the indicators, resulting in an overall assessment. In Stage 5, the results are analyzed and discussed, and regional revitalization sustainable design strategies and development paths are proposed for Qianfeng Community. The research findings, limitations, and prospects are summarized.

3.2. Research Problem

Qianfeng Community is located in Zhujiang Street, Nansha District, Guangzhou City, Guangdong Province, China, at coordinates 22°44′21.07″ N and 113°31′49.98″ E. It covers an area of 11.06 square kilometers. The registered population of the community is 4231, with an estimated floating population of about 6000. The local area is abundant in natural resources and historical culture, and has traditionally relied on a water-based lifestyle and overseas Chinese farms as the main production methods (Figure 1). Most residents of Qianfeng Community are returned overseas Chinese, including those who returned from Malaysia, Singapore, Indonesia, and other places in the 1950s, as well as refugees who returned from Vietnam in the 1970s. Currently, there are over 1400 returned overseas Chinese and their families, accounting for approximately one-third of the total registered population. The community boasts a rich overseas Chinese culture. Nonetheless, Qianfeng Community is currently confronted with substantial challenges, marked by pronounced population outmigration, a diminishing overseas Chinese cultural heritage, and a dearth of consensus among stakeholders, all contributing to a deceleration in local development. The challenges confronted by Qianfeng Community are emblematic of numerous regional dilemmas with unique historical and cultural heritage that have suffered due to population loss. Therefore, considering changes in the local population structure and production methods, exploring a path of regional revitalization suitable for local development becomes crucial in promoting sustainable development in the region.

To obtain authentic data and first-hand information, the research team conducted multiple field research activities, resident interviews, and questionnaire surveys in Qianfeng Community to investigate local resources (local characteristics, folk culture, life services, etc.) from 15–29 May 2023. During the survey process, several issues were identified, including the majority of local youth seeking employment in the city, a significant number of empty-nest elderly in the area, the gradual decline of local overseas Chinese cultural customs due to the relocation of most overseas residents to urban areas, and the underutilization of abundant vacant spaces and ecological resources with overseas Chinese characteristics. These issues have had an impact on the regional development and require corresponding solutions based on the sustainable development evaluation indicators.

3.3. Research Method

This study is grounded in the theory of local revitalization and employs the AHP–FCE method to assess key elements of regional sustainable development (Figure 2). Firstly, the objectives and questions of the study were clearly defined through a literature review and field research (questionnaires and semi-structured interviews), and initial impact indicators were proposed. Secondly, experts in the field of local revitalization were interviewed to rank these indicators and establish an indicator system. The panel of experts consisted of local community leaders, policymakers, scholars, and senior social workers, all of whom have extensive experience and research backgrounds in this field. Subsequently, a Likert scale-designed questionnaire was distributed to collect assessment scores. The research sample was drawn from randomly selected residents of frontier communities who volunteered to participate, representing diverse socioeconomic backgrounds, including local residents, social workers, government officials, and laborers, among others. The analytic hierarchy process (AHP) was applied to calculate the weight values of the indicators, followed by fuzzy comprehensive evaluation (FCE) to conduct a comprehensive assessment of the indicator system. Finally, based on the results of the analysis, sustainable design strategies for regional revitalization in Qianfeng Community were proposed.

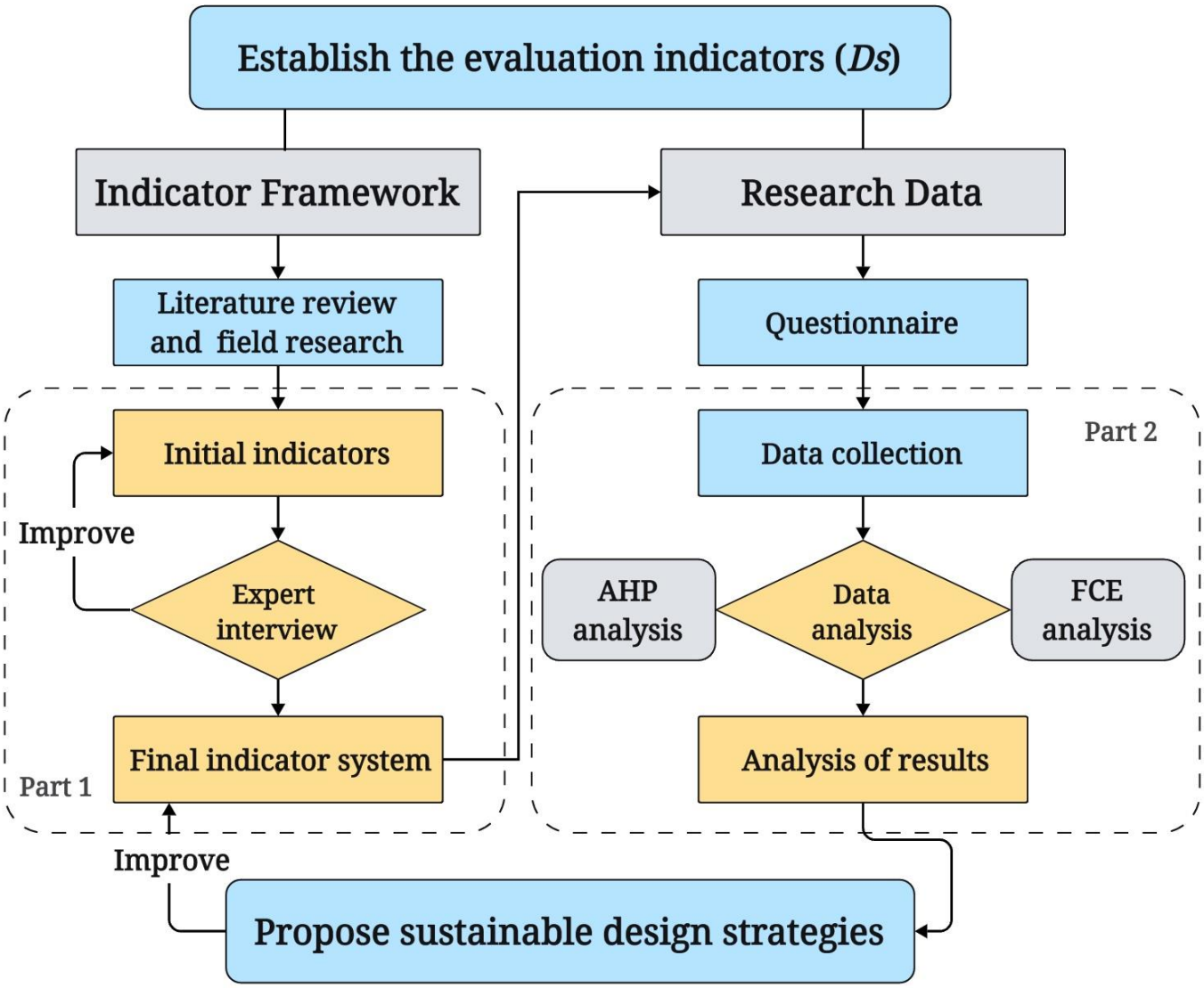


Figure 2. Research method process.

3.3.1. Construction of the Evaluation Index

By reviewing the literature on the concept of regional revitalization and the Sustainable Development Goals (SDGs), combined with data obtained from field research in Qianfeng Community, an initial evaluation framework was proposed based on three dimensions (economic, social, and environmental) as Level 1 indicators. Based on the on-site research, 11 Level 2 indicators and 22 Level 3 indicators were identified from the 17 SDGs, forming the initial evaluation system. Subsequently, the Delphi method was employed to consult 15 relevant experts and conduct two rounds of screening and adjustments for all indicators. Through scientific and reasonable optimization of the indicators that are highly relevant to this study, the final evaluation index system was established (Table 1) comprising three Level 1 indicators, eight Level 2 indicators, and 16 Level 3 indicators.

Table 1. Evaluation indicators for the sustainable development of Qianfeng Community.

Target	Level 1	Level 2	Level 3
Qianfeng Community Sustainable Development Evaluation Indicators	Economic *B1*	SDG 8: Decent work and economic growth *C1*	Activation of local resources *D1*
			Local employment & entrepreneurship *D2*
		SDG 12: Responsible consumption and production *C2*	The rules of 3R *D3*
			Co-production *D4*
	Social *B2*	SDG 3: Good health and well-being *C3*	Local caring *D5*
			Urban & rural resource flow *D6*
		SDG 4: Quality education *C4*	Talent cultivation *D7*
			Skills training *D8*
		SDG 16: Peace, justice and strong institutions *C5*	Policy mechanisms *D9*
			Innovation & Entrepreneurship culture *D10*
		SDG 17: Partnership for the goals *C6*	Multiple social networks *D11*
			Co-constructing & Sharing *D12*
	Environmental *B3*	SDG 9: Industry, Innovation and Infrastructure *C7*	Essential public services *D13*
			Digital platform *D14*
		SDG 11: Sustainable cities and communities *C8*	Proximity life circle *D15*
			Endogenous development *D16*

3.3.2. Reliability and Validity Analysis

The collected questionnaire data was subjected to reliability and validity tests using SPSS 26.0 software. Reliability analysis was conducted on 16 indicators, with a reliability coefficient of 0.983, which is greater than 0.9. This indicates that the data has high reliability and can be used for further analysis.

The validity of the collected data was also examined, and the Kaiser–Meyer–Olkin (KMO) measure was calculated to be 0.962, exceeding the generally accepted threshold of 0.6. This indicates that the data meets the prerequisites for factor analysis. Additionally, the data passed the Bartlett's test of sphericity ($p < 0.05$), indicating that the research data is suitable for factor analysis and possesses a high level of validity.

3.3.3. Construction of the Judgment Matrix and Calculation of Index Weights

Once the key indicators for sustainable development in Qianfeng Community were determined, the indicators were evaluated using Saaty's 1–9 ratio scale method. Fifteen experts from relevant fields, including government officials, social workers, and academic scholars, were involved in the evaluation process. The expert ratings were then compiled and analyzed to obtain the assigned values for each indicator [47]. Based on the Analytic Hierarchy Process (AHP) model, combined with the use of Yaahp 10.1 software, the weight values for each indicator were calculated. The calculation process is as follows:

Calculate the product M_i for each row of the judgment matrix.

$$M_i = \prod_{j=1}^{m} a_{ij} (j = 1, 2, ..., m) \quad (1)$$

Calculate the nth root W_i of M_i.

$$W_i = \sqrt[n]{M_i} (i = 1, 2, ..., n) \quad (2)$$

Normalize W_i to obtain the eigenvector ω_i.

$$w_i = \frac{W_i}{\sum_{j=1}^{m} W_j} (j = 1, 2, ..., m) \tag{3}$$

Calculate the maximum eigenvalue $\lambda_{\max}$ of the judgment matrix A, where n is the order of the matrix, A is the judgment matrix, and ω_i represents the weight of the i-th indicator.

$$\lambda_{max} = \sum_{i=1}^{n} \frac{[Aw_i]}{nw_i} \tag{4}$$

Finally, a consistency check is performed. For the obtained eigenvectors and eigenvalues, the consistency index CI is calculated. A smaller CI value indicates higher consistency. If the consistency check is passed, it means that the judgment matrix is reasonable and has explanatory value. The consistency index is defined as:

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{5}$$

Using the average random index (RI) value (Table 2), the consistency ratio (CR) is calculated to determine the consistency [48].

$$CR = \frac{CI}{RI} \tag{6}$$

Table 2. Random index (RI) value.

n	3	4	5	6	7	8	9	10	11	12
RI Value	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54

According to $CR < 0.1$, the judgment matrix is considered to pass the consistency check; otherwise, it does not possess satisfactory consistency.

Taking the Level 1 indicators as an example, the specific calculation method for the weights of these three indicators is as follows:

Establish the judgment matrix for the Level 1 (Table 3) indicator layer based on the scoring results.

Table 3. Level 1 indicator layer judgment matrix.

Level 1	***B1***	***B2***	***B3***
B1	1	26/15	89/45
B2	15/26	1	22/15
B3	45/89	15/22	1

Calculate the eigenvectors and eigenvalues using Formulas (1)–(4).

$$B1 \Rightarrow \begin{bmatrix} 1 \times 25/15 \times 89/45 \\ 15/26 \times 1 \times 22/15 \\ 45/89 \times 15/22 \times 1 \end{bmatrix} \Rightarrow \begin{bmatrix} 3.2963 \\ 0.8462 \\ 0.3447 \end{bmatrix} \Rightarrow \begin{bmatrix} 1.4882 \\ 0.9459 \\ 0.7012 \end{bmatrix} \tag{7}$$

The eigenvectors are obtained standardized as:

$$w_i = \begin{bmatrix} 0.4779 \\ 0.2998 \\ 0.2223 \end{bmatrix} \tag{8}$$

Calculate the maximum eigenvalue.

$$(Aw)_i = \begin{bmatrix} 1 & 25/15 & 89/45 \\ 15/26 & 1 & 22/15 \\ 45/89 & 15/22 & 1 \end{bmatrix} \times \begin{bmatrix} 0.4779 \\ 0.2998 \\ 0.2223 \end{bmatrix}$$
$$\lambda_{\max} \sum_{i=1}^{3} \frac{[Aw_i]}{nw_i} = 3.0070 \quad (9)$$

Calculate the consistency index (*CI*) using Formula (5).

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{3.0070 - 3}{3-1} = 0.0035 \quad (10)$$

Determine the average random index *RI* (3) = 0.52 for the judgment matrix based on Table 2. Calculate the random consistency ratio (*CR*) using the formula, resulting in a value of 0.0067.

$$CR = \frac{CI}{RI} = \frac{0.0035}{0.52} = 0.0067 \quad (11)$$

Since $CR < 0.1$, it meets the consistency test criterion, indicating that the judgment matrix is constructed reasonably. The same method is applied to calculate the weights of the remaining key indicators and perform consistency checks. The specific results are shown in Tables 4–6.

(1) Level 1 indicator weight

Table 4. Level 1 indicator weight.

Level 1	***B1***	***B2***	***B3***	***Wi***	***CR***
B1	1	26/15	89/45	0.4779	0.0067
B2	15/26	1	22/15	0.2998	
B3	45/89	15/22	1	0.2223	

(2) Level 2 indicator weight

Table 5. Level 2 indicator weight.

Level 2/*B1*	***C1***		***C2***		***Wi***	***CR***
C1	1		32/15		0.6809	0
C2	15/32		1		0.3191	
Level 2/*B2*	***C3***	***C4***	***C5***	***C6***	***Wi***	***CR***
C3	1	5/9	5/3	4/9	0.1839	0.0189
C4	9/5	1	13/5	14/9	0.3765	
C5	3/5	5/13	1	13/30	0.1279	
C6	9/4	9/14	30/13	1	0.3117	
Level 2/*B3*	***C7***		***C8***		***Wi***	***CR***
C7	1		13/15		0.4643	0
C8	15/13		1		0.5357	

(3) Level 3 indicator weight

Table 6. Level 3 indicator weight.

Level 3/*C1*	***D1***	***D2***	***Wi***	***CR***
D1	1	9/5	0.6429	0
D2	5/9	1	0.3571	

According to the calculation method of *C1* indicator weights, all Level 3 indicator weights are obtained in Figure 3.

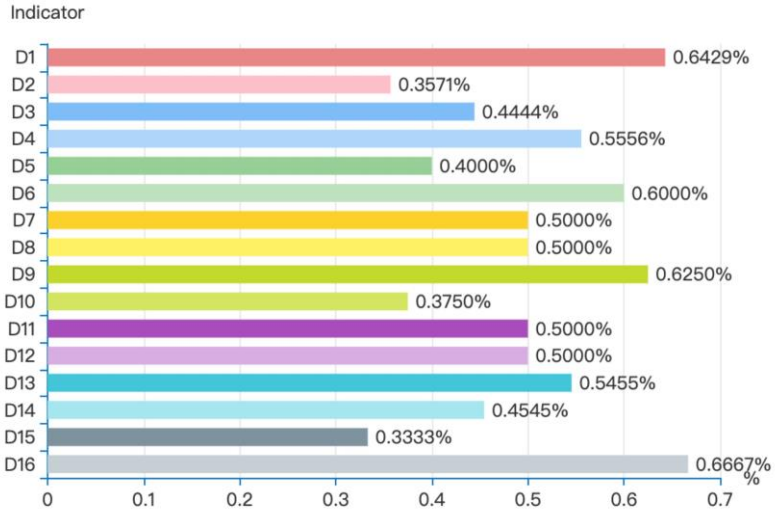


Figure 3. The weight value of Level 3 indicators.

Finally, the weights of the indicators at each level in the evaluation framework for sustainable development in Qianfeng Community are shown in Table 7.

Table 7. Weights of sustainable development evaluation indicators of Qianfeng Community.

Level 1	Level 2	Weights	Rank	Overall Weights	Weights Rank	Level 3	Weights	Rank	Overall Weights	Weights Rank
B1 (0.4779)	*C1*	0.6809	1	0.3254	1	*D1*	0.6429	1	0.2092	1
						D2	0.3571	2	0.1162	2
	C2	0.3191	2	0.1525	2	*D3*	0.4444	2	0.0678	5
						D4	0.5556	1	0.0847	3
B2 (0.2998)	*C3*	0.1839	3	0.0551	7	*D5*	0.4000	2	0.0221	15
						D6	0.6000	1	0.0331	13
	C4	0.3765	1	0.1129	4	*D7*	0.5000	1	0.0564	6
						D8	0.5000	1	0.0564	7
	C5	0.1279	4	0.0383	8	*D9*	0.6250	1	0.0240	14
						D10	0.3750	2	0.0144	16
	C6	0.3117	2	0.0935	6	*D11*	0.5000	1	0.0467	10
						D12	0.5000	1	0.0467	11
B3 (0.2223)	*C7*	0.4643	2	0.1032	5	*D13*	0.5455	1	0.0563	8
						D14	0.4545	2	0.0469	9
	C8	0.5357	1	0.1191	3	*D15*	0.3333	2	0.0397	12
						D16	0.6667	1	0.0794	4

3.3.4. Constructing a Fuzzy Comprehensive Evaluation Model

(1) Establishing the Evaluation Factor Set and Comment Set

Based on the weights of the evaluation index system, the factor set for fuzzy comprehensive evaluation is obtained. The sustainable development evaluation factor set for Qianfeng Community is divided into three levels: Level 1 factor set, Level 2 factor set, and Level 3 factor set. Specifically, it can be represented as follows: $A = \{B1, B2, B3\}$, $B1 = \{C1, C2\}$, $B2 = \{C3, C4, C5, C6\}$, $B3 = \{C7, C8\}$, $C1 = \{D1, D2\}$, $C2 = \{D3, D4\}$, . . ., $C8 = \{D15, D16\}$.

The comment set is generally established based on the five-point fuzzy mathematics scale. In this study, the comment set for the sustainable development evaluation of Qianfeng Community is determined as V = (V1, V2, V3, V4, V5) = {"Very Poor", "Poor", "Fair", "Good", "Excellent"}. It is quantified and processed into a scale vector, where the comment set is assigned five levels of values.

(2) Determining the Membership Degree of Evaluation Indexes

To ensure the objectivity and accuracy of the data, questionnaire surveys were distributed to experts in relevant fields (urban and rural planning, social work, design), community residents, and government staff based on the constructed evaluation indicators for sustainable development of Qianfeng Community. They were invited to evaluate the indicators of sustainable development in Qianfeng Community based on the established evaluation criteria. A total of 320 questionnaires were distributed in this survey, of which 301 were valid, resulting in an effective response rate of 94%. The scores of each evaluation index were compiled and summarized, and the results were normalized to obtain the membership degrees of each evaluation index. A fuzzy matrix was constructed based on the normalized values, as shown in the table below (Table 8).

Table 8. Membership matrix of sustainable development evaluation indicators.

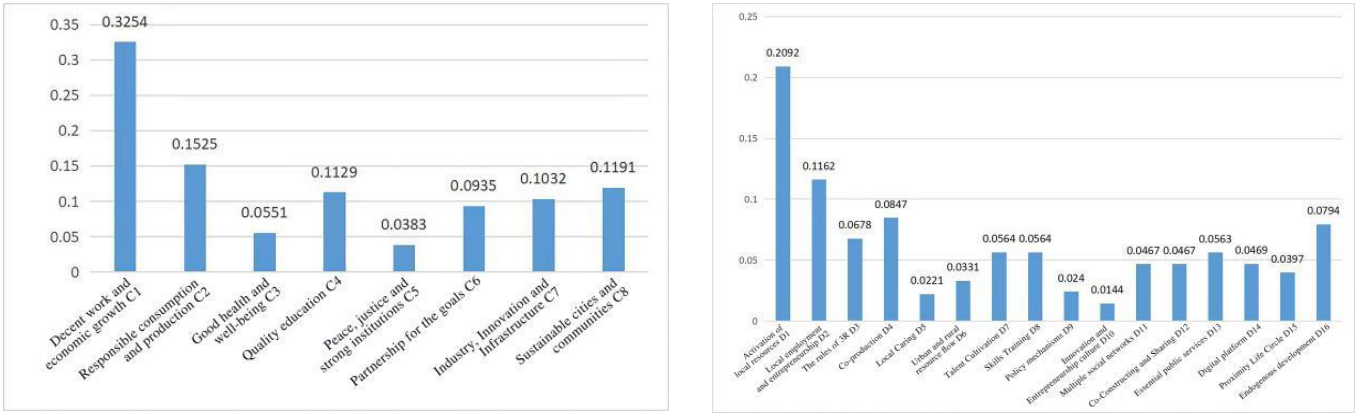
Indicators	V1	V2	V3	V4	V5
D1	0.0199	0.0831	0.2924	0.2691	0.3355
D2	0.0166	0.0997	0.3422	0.2625	0.2791
D3	0.0166	0.0764	0.3389	0.2658	0.3023
D4	0.0133	0.0465	0.3787	0.2658	0.2957
D5	0.0066	0.0199	0.2658	0.3422	0.3654
D6	0.0133	0.0664	0.3555	0.2525	0.3123
D7	0.0133	0.0997	0.3522	0.2392	0.2957
D8	0.0066	0.1030	0.3422	0.2724	0.2757
D9	0.0100	0.0133	0.3322	0.3389	0.3056
D10	0.0100	0.1096	0.3322	0.2724	0.2757
D11	0.0100	0.0365	0.4053	0.2558	0.2924
D12	0.0100	0.0631	0.3621	0.2691	0.2957
D13	0.0166	0.1163	0.2957	0.2791	0.2924
D14	0.0166	0.0332	0.3488	0.3023	0.2990
D15	0.0199	0.0399	0.3488	0.2791	0.3123
D16	0.0100	0.0997	0.3887	0.2492	0.2525

4. Results and Discussion

4.1. Research Results

4.1.1. Weight Analysis of the Evaluation Index System

The weights of the indicators reflect their importance in the evaluation process and serve as a comprehensive measure of subjective evaluation and objective reflection. From the results in Table 7 (see Figure 4), it can be observed that among the eight indicator weights at the Level 2 index, *C1* > *C2*> *C8* > *C4* > *C7* > *C6* > *C3* > *C5*, indicating that decent work and economic growth (SDG 8) > responsible consumption and production (SDG 12) > sustainable cities and communities (SDG 11) > quality education (SDG 4). This implies that in the process of regional revitalization in Qianfeng Community, it is important to focus on local employment and economic growth, including activating local resources (D1) and promoting local employment and entrepreneurship (D2). Simultaneously, emphasis should be placed on the development of the green economy through co-production (D4) to achieve responsible production and consumption patterns. The creation of sustainable communities relies on an endogenous development model (D16). Furthermore, attention should also be given to the quality of local education, which can be addressed by providing skill training to continuously cultivate local talents and address issues such as talent outflow and insufficient innovation in Qianfeng Community.



(**a**) (**b**)

Figure 4. (**a**) Weighted values of eight Level 2 indicators; (**b**) Weighted values of 16 Level 3 indicators.

4.1.2. Analysis of Fuzzy Comprehensive Evaluation Results

The synthesis of the weight vector W and the membership matrix R represents the final evaluation result of the evaluated object. The calculation formula is as follows:

$$B = W \circ R = (b_1, b_2, ..., b_m) \tag{12}$$

Evaluate each indicator accordingly:

B_{C1} =	$W_{C1}R_{C1}$ = [0.0187, 0.0890, 0.3102, 0.2667, 0.3154]
B_{C2} =	$W_{C2}R_{C2}$ = [0.0148, 0.0598, 0.3610, 0.2658, 0.2986]
B_{C3} =	$W_{C3}R_{C3}$ = [0.0106, 0.0478, 0.3196, 0.2884, 0.3336]
B_{C4} =	$W_{C4}R_{C4}$ = [0.0100, 0.1013, 0.3472, 0.2558, 0.2857]
B_{C5} =	$W_{C5}R_{C5}$ = [0.0100, 0.0494, 0.3322, 0.3140, 0.2944]
B_{C6} =	$W_{C6}R_{C6}$ = [0.0100, 0.0498, 0.3837, 0.2625, 0.2940]
B_{C7} =	$W_{C7}R_{C7}$ = [0.0166, 0.0785, 0.3198, 0.2896, 0.2954]
B_{C8} =	$W_{C8}R_{C8}$ = [0.0133, 0.0797, 0.3754, 0.2591, 0.2724]

Obtain the secondary indicator evaluation matrix:

$$R_{B1} = \begin{bmatrix} B_{C1} \\ B_{C2} \end{bmatrix}, R_{B2} = \begin{bmatrix} B_{C3} \\ B_{C4} \\ B_{C5} \\ B_{C6} \end{bmatrix}, R_{B3} = \begin{bmatrix} B_{C7} \\ B_{C8} \end{bmatrix} \tag{13}$$

B_{B1} =	$W_{B1}R_{B1}$ = [0.0175, 0.0797, 0.3264, 0.2664, 0.3100]
B_{B2} =	$W_{B2}R_{B2}$ = [0.0101, 0.0688, 0.3516, 0.2713, 0.2982]
B_{B3} =	$W_{B3}R_{B3}$ = [0.0148, 0.0782, 0.3496, 0.2733, 0.2831]

Obtain the overall evaluation matrix:

$$R = \begin{bmatrix} B_{B1} \\ B_{B2} \\ B_{B3} \end{bmatrix} \tag{14}$$

$$B = W \circ R = (0.0147, 0.0763, 0.3391, 0.2691, 0.3005)$$

Then the comprehensive evaluation grade score of R is calculated as:

$$F = \sum_{i=1}^{n} v_i B (i = 1, 2, ..., n) \tag{15}$$

The corresponding evaluation results can be obtained:

$$F = 1 \times 0.0147 + 2 \times 0.0763 + 3 \times 0.3391 + 4 \times 0.2691 + 5 \times 0.3005 = 3.7648 \quad (16)$$

Based on the above calculations and analysis, the overall score is 3.7648, indicating an overall evaluation of "Good". Using the fuzzy comprehensive evaluation mathematical model, the evaluation results for each indicator in the evaluation system for the sustainable development of Qianfeng Community are shown in Table 9.

Table 9. Comprehensive evaluation results of all indicators.

Level 1	Score	Grade	Level 2	Score	Grade	Level 3	Score	Grade
B1	3.7719	V4	*C1*	3.7710	V4	*D1*	3.8173	V4
						D2	3.6877	V4
			C2	3.7737	V4	*D3*	3.7608	V4
						D4	3.7841	V4
B2	3.7788	V4	*C3*	3.8864	V4	*D5*	4.0399	V5
						D6	3.7841	V4
			C4	3.7060	V4	*D7*	3.7043	V4
						D8	3.7076	V4
			C5	3.8335	V4	*D9*	3.9169	V4
						D10	3.6944	V4
			C6	3.7807	V4	*D11*	3.7841	V4
						D12	3.7774	V4
B3	3.7306	V4	*C7*	3.7686	V4	*D13*	3.7143	V4
						D14	3.8339	V4
			C8	3.6977	V4	*D15*	3.8239	V4
						D16	3.6346	V4

(1) Evaluation of the economic dimension.

In the evaluation of the sustainable development dimensions of Qianfeng Community, the economic dimension (*B1*) has an overall score of 3.7719, which falls under the "Good" evaluation category. Among the Level 3 indicators, "Local employment and entrepreneurship (*D2*)" received the lowest score (3.6877). Through on-site research, it was found that due to the re-planning of land in Qianfeng Community, a significant number of residents have been relocated, resulting in a decline in local employment and entrepreneurship. It is worth noting that with the outflow of population, the original local way of life and cultural customs (such as water town lifestyle, overseas Chinese culture, etc.) have gradually faded away.

(2) Evaluation of the social dimension.

In the evaluation of Qianfeng Community, the social dimension (*B2*) has an overall score of 3.7788, which falls under the "Good" evaluation category. The highest score (3.8864) is obtained in the aspect of "Good health and well-being (*C3*)", particularly in the Level 3 indicator of "Local caring (*D5*)", which received the highest score (4.0399). Zhujiang Street, where Qianfeng Community is located, has social work service stations that provide diverse and specialized services to vulnerable groups and residents in need. Additionally, the government has implemented some "Policy mechanisms (*D9*)" that benefit the people, which further promote the development of local well-being initiatives. However, due to the outflow of a significant portion of the population to other areas, the comprehensive score for "Innovation and entrepreneurship culture (*D10*)" at the local level is not high, which corresponds to the relatively low score of the "Local employment and entrepreneurship (*D2*)" indicator in the economic dimension.

(3) Evaluation of the environmental dimension.

In the evaluation of Qianfeng Community, the environmental dimension (*B3*) has an overall score of 3.7306, which falls under the "Good" evaluation category. Among them,

"Sustainable cities and communities (*C8*)" has the lowest score among the indicators in the Level 2 indicator layer (3.6977). This reflects the continuous outflow of population from Qianfeng Community and the current development gap. Through field visits, it was found that the local population lacks channels and service platforms for democratic participation in the collective construction of the region, and they are not sufficiently concerned about local ecological resources and basic public services. As a result, the score for "Endogenous development (*D16*)" is the lowest (3.6346).

4.2. Sustainable Design Strategy for Qianfeng Community

Based on the results of the above analysis, this study proposes a theoretical model for building a regional revitalization platform based on "Life Projects" (Figure 5) as a sustainable design strategy, which includes the following design strategies:



Figure 5. Regional revitalization strategy model based on life projects.

4.2.1. Activation of Local Cultural Resources and Talent Cultivation

Qianfeng Community possesses a unique and profound overseas Chinese culture that warrants full exploration and activation. Firstly, it is essential to conduct a comprehensive survey and assessment of cultural resources in the community, encompassing traditional craftsmanship, cultural relics, and historical aspects. Valuable cultural resources should be preserved and revitalized through innovative approaches. Secondly, organizing cultural activities and exhibitions is crucial to showcase the distinctive features of the overseas Chinese culture. Initiatives such as craft fairs, cultural events, and entertainment activities should be organized to engage both community residents and tourists. This will encourage active participation and appreciation of the local culture. Moreover, promoting cultural education and exchange, particularly by establishing overseas Chinese cultural education programs, holds significant importance. Talent cultivation and skills training can be facilitated through teaching classes and workshops, thereby enhancing the innovative and entrepreneurial capabilities of the local population [49,50]. Additionally, the creation of a digital and virtual exhibition platform becomes essential, utilizing digital technology and social media to present overseas Chinese culture and cultural and creative products. This approach will effectively attract social attention and engagement.

4.2.2. Using Life Projects as Triggers for Regional Revitalization

Regional revitalization utilizes local resources and the participation of diverse stakeholders to address issues of local development decline [51]. Based on Wright's theory of social empowerment through socio-economics, it is proposed that social entities can achieve social empowerment by directly participating in economic activities and sharing the benefits of development [52]. Therefore, we suggest promoting the self-organization and participation of residents in local economic co-production through the proposal of life projects that revolve around the local needs and issues in Qianfeng Community, gradually enhancing local talent empowerment. In other words, life projects can serve as triggers for empowering diverse stakeholders to participate in regional revitalization, representing a shared agenda for democratic participation and cooperation among local people [53–55]. Typically, life projects are based on the exploration and development of local resources, adopting a bottom-up open innovation model [56]. Diverse stakeholders collaboratively promote the incubation of life projects, developing local products and services to meet local needs. Therefore, an open innovation platform that facilitates the incubation of life projects is essential.

4.2.3. Establishing an Open Innovation Platform for Regional Revitalization

To enhance the management of life projects in Qianfeng Community, it is recommended to establish an open innovation platform for regional revitalization. This platform will provide comprehensive support services for innovative entrepreneurship by the public, including funding support, business guidance, preparation of business plans, and legal advice. Furthermore, a Qianfeng Community resource repository can be implemented within the platform to integrate and manage various resources, such as innovative projects, local resources, and collaborative partners [57]. Leveraging the platform, a diverse collaborative network can be established to connect and cooperate with government entities, academic institutions, and businesses, thereby facilitating the sharing of resources and information [58–60]. All projects are managed on the platform, and participants will assume different roles and engage in a socialization process of learning and innovation, consequently fostering opportunities for collaboration and innovation [61]. Importantly, as an incubator for life projects, the platform will play a pivotal role in transforming promising projects into local products and services, thereby promoting the development of local revitalization.

4.2.4. Creating an Endogenous Life Circle

Regional revitalization necessitates the establishment of a sustainable and livable community environment. Qianfeng Community benefits from a favorable natural ecological environment and a convenient transportation system. However, the local basic public service facilities are not yet complete, such as the absence of a community service center and a migrant culture center. From a sustainable development perspective, it is essential to develop local basic public services through new endogenous approaches [62]. Specifically, relevant service entrepreneurship can be pursued based on life projects, further incubating products and services that cater to local needs. Additionally, the encouragement of local small and micro enterprises can provide employment opportunities and entrepreneurial support. To achieve this, an open, inclusive, and supportive neighborhood network centered around local migrants can be established. Through innovative project collaboration and sharing, a proximity life circle with comprehensive basic public services can gradually take shape. This approach will ensure that Qianfeng Community addresses its shortcomings in basic public services while fostering a sustainable and vibrant living environment.

4.2.5. Building a Rural–Urban Collaborative Innovation Service Design Mechanism

Regional revitalization aims to address the issues of economic decline and urban–rural development imbalance caused by excessive population concentration in urban areas. To

promote the two-way flow of rural–urban resources and encourage population return to Qianfeng Community, it is essential to explore the establishment of a collaborative rural–urban innovation service design mechanism. By applying service design thinking and methods, a social innovation design model and system can be constructed to facilitate the two-way flow of resources, collaborative innovation, and joint entrepreneurial development between urban and rural areas in Qianfeng Community. This includes developing a rural–urban revitalization service model based on life projects, an innovative crowdfunding platform, incentives for young talent to return to their hometowns, and evaluation mechanisms.

5. Conclusions

This study applies the analytic hierarchy process (AHP) and fuzzy comprehensive evaluation (FCE) method to conduct a comprehensive evaluation of the sustainable development of regional revitalization in Qianfeng Community. A sustainable development evaluation model for regional revitalization is constructed based on the three dimensions of the Sustainable Development Goals (SDGs): economic, social, and environmental. Key indicators that require attention and improvement in the sustainable development of Qianfeng Community are analyzed, including local employment and entrepreneurship, innovation culture, and endogenous growth. Based on the analysis results, optimized design strategies are proposed, including the activation of distinctive cultural resources, the establishment of an open innovation platform for regional revitalization based on life projects, the creation of a local life circle, and the construction of a rural–urban collaborative innovation service design mechanism. This study preliminarily constructs a sustainable development evaluation system for regional revitalization, which is suitable for conducting preliminary assessments of regional development to identify strengths and weaknesses. However, due to the dynamic and complex nature of regional revitalization, the current evaluation process still has certain limitations. These include difficulty in fully accounting for interactions across different time and space scales, leading to limited relevance in specific contexts. Moreover, information and resource imbalances among diverse stakeholders may result in unequal participation opportunities. In future practical development processes of regional revitalization, it is necessary to further adjust and optimize evaluation indicators based on specific circumstances to enhance the scientific and practical nature of sustainable design strategies.

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