Evaluation of Rural Tourism Resources Based on AHP-Fuzzy Mathematical Comprehensive Model

Shihe Yang¹ and Xiangtong Kong²

¹Hefei Vocational and Technical College, Economic and Trade Tourism College, Hefei, Anhui 230012, China
²Qufu Fareast Vocational and Technical College, Qufu, Shandong 273100, China

Correspondence should be addressed to Xiangtong Kong; 2016120047@jou.edu.cn

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With the rapid development of science and technology and the steady recovery of the economy, rural ecotourism has become the first choice for many residents for tourism and entertainment. As an integral part of urban-rural integration planning, rural ecotourism can play a positive role in promoting the development of the township economy and farmers’ entrepreneurship and employment. In recent years, rural ecotourism has been vigorously developed and promoted under the supportive policies and the high attention of local governments. Based on in-depth research on the comprehensive evaluation index system of sustainable development of rural tourism resources at home and abroad, this paper selects 15 3-level indicators from four aspects of management planning, economic development, environmental protection, and social value to evaluate the rural tourism in Huangqiao Town. A fuzzy comprehensive evaluation is carried out on the sustainable development level of resources. The evaluation results show that the comprehensive score of the sustainable development level of rural tourism resources in Huangqiao Town is “good,” which indicates that Huangqiao Town pays more attention to the development and utilization of rural tourism resources.

1. Introduction

Rural tourism is a series of tourism activities carried out based on the traditional rural regional space. It is a new development model of “modern tourism + traditional agriculture.” A brand-new industrial form under the background of “Beautiful China Construction” and “Rural Revitalization Strategy” [1]. The development of rural ecotourism has a history of more than 100 years in the West, but it started relatively late in China. However, in recent years, rural ecotourism has been vigorously promoted in China and has developed rapidly. It can be said that the emergence of rural ecotourism is inevitable. Due to the pressure of work and life, residents increasingly regard returning to nature as a trend of new life [2, 3]. People look forward to getting out of the oppressive urban life circle, discovering beauty in the pleasant nature, and appreciating the beauty in the rapid development of rural ecotourism, which greatly stimulates the development of rural ecotourism. It is undeniable that, to a certain extent, the development of rural ecotourism will bring about a series of environmental and resource problems, so we should adhere to the strategic core idea of sustainable development to make it develop healthily and smoothly [4, 5]. In this sense, rural ecotourism is a scientific tourism development model. In order to effectively combine environmental, economic, and social interests and make it an effective way of sustainable development, we must innovate the development of rural ecotourism, the development management and guiding ideology concepts, etc., so that it can conform to the trend and trend of regional tourism development. Foreign research on rural tourism and tourism resources is mainly in three aspects, one is the community participation and interest subject research in rural tourism, the second is research on geological resources in rural tourism resources, and the third is research on rural tourism development and protection [6–8]. Domestic
research on rural tourism and tourism resources focuses on four aspects: one is the research on the connotation and characteristics of rural tourism; the second is the research on the development mode, path, and strategy of rural tourism; the third is the research on the influencing factors of rural tourism development; and the fourth is research on the development mode and development evaluation of rural tourism resources [9, 10]. By sorting out the existing literature, it is not difficult to find that domestic scholars’ research on the evaluation of rural tourism resources has formed a certain scale. In addition, the types of rural tourism resources are also divided, mainly including coastal type, forest type, agricultural type, village folk type, and other aspects [11, 12]. Some scholars have sorted out the existing methods for evaluating the development of concentrated rural tourism resources and found that in the existing evaluation index system dimensions, the selection of indicators is very different, and it is difficult to unify [13, 14]. The evaluation of resources is more likely to be ignored, and it is concluded that it is a trend of future development to strengthen the application of various comprehensive evaluation methods in the evaluation of rural tourism resources development in the future [15, 16].

To sum up, the literature on rural tourism and tourism resources is relatively rich, mainly focusing on the conceptual characteristics of rural tourism, stakeholders, and geological resources in rural tourism resources [17]. SWOT analysis method, literature review method, tourism ecological footprint method, and tourism sustainable barometer method are mostly used in the evaluation and analysis of rural tourism resources and development. However, there are relatively few studies on the sustainable development of rural tourism resources, and there are fewer related literature studies based on the township level [18, 19]. Especially with the continuous development of national urbanization, towns, as an important unit, have been paying more and more attention to the particularity of their resources. Therefore, in order to enable better development of rural tourism and achieve sustainable rural tourism resources, it is crucial and important to study the rural tourism resources with the township as the inspection unit.

Huangqiao Town is located in Taixing City, Jiangsu Province, with rich tourism resources and rich red cultural resources. This paper will analyze the connotation of sustainable development of rural tourism resources on the basis of domestic research and construct a reasonable evaluation index system by using the literature review method, frequency statistics method, expert consultation method, etc., to reflect the sustainable development level of rural tourism resources. The in-depth development of its theoretical research will help to further explore the interaction and influence mechanism of various elements of sustainable development of rural tourism resources.

2. Methods and Theory

2.1. Data Sources. The research mainly adopts the method of combining structured questionnaires and semistructured interviews to investigate the administrative staff of tourism-related government departments, tourism enterprise managers, and teachers of tourism management in colleges and universities in Huangqiao Town. There are 190 questionnaires, and the effective rate of the questionnaire is 95%, which ensures the scientificity and validity of the survey results.

2.2. Evaluation Method

2.2.1. AHP Model. This paper establishes the sustainable development index system of rural tourism resources by studying the relevant theories, using the AHP model, and referring to the conceptual model of the “target layer-criterion-level-indicator layer.” That is, according to the idea of step-by-step decomposition, a hierarchical structure is formed [20]. The index system consists of three levels: the top level of the index system is the target level, that is, the comprehensive evaluation of the sustainable development of rural tourism resources in Yuanquan Town. The second layer is the criterion layer, which expresses the relationship structure of the behavior of each subsystem in the system layer. Four criterion layers are determined, mainly including management planning, economic development, environmental protection, and social value as the criterion layer elements for evaluating the sustainable development of rural tourism resources [21]. The third layer is the index layer, which is the basic layer of the entire index system. This layer is the most basic evaluation factor in the evaluation system to achieve the evaluation goal. The selection of evaluation indicators will have a direct impact on the evaluation results, for it can truly and accurately reflect the comprehensive situation of its sustainable development [22].

We carefully study the index evaluation system of sustainable development of tourism resources at home and abroad to grasp the essence of the index system of sustainable development. According to the above-given evaluation index selection principles, combined with the connotation and characteristics of rural tourism resources, the evaluation index is selected. The index layer includes a total of 15 to construct an evaluation index system for the sustainable development level of rural tourism resources in Huangqiao Town. The comprehensive evaluation index system for sustainable development of rural tourism resources in Huangqiao Town consists of four criteria-level indicators, namely, management planning, economic development, environmental protection, and social value. Management planning is an important engine for the sustainable development of rural tourism resources. The level of management planning has a significant impact on whether rural tourism resources can achieve sustainable development. Therefore, it is taken as an independent dimension and has three indicators, namely, the circulation of tourism land situation, the layout of commercial attractions, and the soundness of the management organization.

Economic development is an important driving force for the sustainable development of rural tourism resources and has a significant impact on the speed and quality of the sustainable development of rural tourism resources. We
select the ability to stimulate employment, the scale of capital investment, the economic contribution of the tourism industry, and the integration of rural tourism resources as its index level indicators. Environmental protection is the basic condition and important pursuit of sustainable development of rural tourism resources, and it reflects the quality of development. Among them, vegetation coverage, industrial project transformation, scenic environment, and resource and environmental carrying capacity can best reflect the level of environmental protection. Social value shows the height of sustainable development of rural tourism resources in Huangqiao Town and is an important manifestation of sustainable development. This paper selects indicators from the dimensions of red cultural influence, cultural heritage, beautiful villages, the renovation of dry toilets, and folk characteristics as index layer indicators. The construction order of the judgment matrix is generally the criterion layer, followed by the index layer. This operation can help us use the Defer method to weigh the corresponding data. Finally, according to the importance of judgment results, we get the quantitative standard table (Table 1).

According to the sum method, we first sum up each column of the judgment matrix \( \sum_{i=1}^{n} a_{ij} \), let \( b_{ij} = a_{ij}/\sum_{i=1}^{n} a_{ij} \), so as to calculate \( w_{i} = \frac{1}{n} \sum_{j=1}^{n} b_{ij} \), so that \( (w_{1}, w_{2}, w_{3}, \ldots, w_{n})^{T} \) is calculated, and normalized to get the following equation:

\[
    w_{i} = \frac{w_{i}}{w_{j}}
\]

(1)

We calculate the maximum eigenvalue \( \lambda_{\text{max}} \) of each matrix. In order to reduce the influence of subjective judgment on the accuracy of \( a_{ij} \) value and reduce the error, this paper adopts the method of calculating the consistency ratio \( CR \) to test the consistency of the matrix, and the consistency index \( CI \) needs to be calculated as follows:

\[
    CI = \frac{\lambda_{\text{max}} - n}{n - 1}
\]

(2)

The average random consistency index (RI) is obtained from Table 2.

The consistency ratio is as follows:

\[
    CR = \frac{CI}{RI}
\]

(3)

When \( CR < 0.10 \), it means that the judgment matrix is consistent, and when \( CR > 0.1 \), it is necessary to adjust the judgment matrix to be appropriate.

Hierarchical total ranking generally refers to the ranking value obtained by calculating the relative importance of each factor at a certain level relative to all factors at the previous level. In general, the overall ranking process is carried out layer by layer from the highest level to the lowest level, and the overall goal is the highest level. Therefore, the overall ranking of the hierarchy can also be regarded as a ranking weight by calculating the relative importance of each influencing factor at a certain level relative to the overall goal value. Hierarchical total ordering also needs to be checked for consistency. The process of checking the consistency of the total ranking of the hierarchy is the same as the total ranking of the hierarchy, and it is also carried out layer by layer from the highest level to the lowest level. If the single ranking consistency test index of several influencing factors in the C level relative to a certain influencing factor \( B_{j} \) in the previous level is \( C_{ij} \), then the corresponding average random consistency index is \( R_{ij} \), so the total ranking consistency ratio of the C level is

\[
    CR = \frac{\sum_{j=1}^{m} b_{ij} C_{ij}}{\sum_{j=1}^{m} b_{ij} R_{ij}}
\]

(4)

By analogy, when \( CR < 0.10 \), it can be considered that the results of the total ranking of the hierarchy have satisfactory consistency; otherwise, it is necessary to readjust the judgment matrix to make it have satisfactory consistency.

2.2.2. Fuzzy Comprehensive Evaluation. In the comprehensive evaluation of the sustainable development of rural tourism resources in Huangqiao Town, this paper adopts the fuzzy comprehensive evaluation method. The fuzzy comprehensive evaluation uses the fuzzy mathematics method to weigh and consider each factor and then conduct a scientific evaluation of the factors. The whole evaluation process is more concise and the evaluation results will be more accurate.

First, we scientifically set the comment set \( V = \{ V_{1}, V_{2}, \ldots, V_{m} \} \) and then quantify the evaluated items from the perspective of each influencing factor \( U_{i} (i = 1, 2, \ldots, n) \), that is, to determine the membership degree \( R_{ij} \) (\( r_{11}, r_{22}, \ldots, r_{nn} \)) of the evaluated item to each comment set obtained from the perspective of a single factor, so as to obtain the fuzzy relationship matrix \( R \), where \( r_{ij} \) is the membership of the index \( U_{i} \) to the evaluation set \( V_{j} \) degree.

\[
    R = \begin{bmatrix}
        R_{11} & r_{12} & \cdots & r_{1m} \\
        R_{21} & R_{22} & \cdots & r_{2m} \\
        \vdots & \vdots & \ddots & \vdots \\
        R_{nm} & r_{n2} & \cdots & r_{nm}
    \end{bmatrix}
\]

(5)

Forms containing evaluation indicators and evaluation grades are distributed, and members of the evaluation team register the evaluation records and then collect the forms and organize them. The evaluation set \( V = \{ V_{1}, V_{2}, \ldots, V_{m} \} \) consists of five evaluation grades: excellent, good, average, poor, and very poor. After sorting out the expert evaluation opinions, each grade corresponding to each evaluation index can be obtained. The formula is as follows:

\[
    r_{ij} = \frac{V_{ij}}{\sum_{j=1}^{m} V_{ij}} (i = 1, 2, \ldots, n).
\]

(6)

Comprehensive evaluation refers to the use of an appropriate fuzzy synthesis operator to combine \( X \) and \( R \), so as to obtain the result vector B of the fuzzy comprehensive evaluation of the thing to be evaluated. Among them, different rows in \( R \) represent the degree of membership of an evaluated object to each level of fuzzy subsets from different
The evaluated elements to the rural tourism resources in Huangqiao Town (Table 4).

Evaluation indicators for the sustainable development of rural tourism resources in Huangqiao Town. Guided by experts’ scores and opinions, the judgment matrices are obtained by this method.

First, the relative importance judgment matrix of the first-level indicators is made in Table 3, and other related matrices are calculated, and then the transposition of the weight vector $X$ obtained by the AHP and the matrix $R$ are multiplied to obtain the fuzzy comprehensive evaluation result vector $B$.

$$B = X^T R = \begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{pmatrix} \times \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_m \end{pmatrix}$$

$$= (b_1, b_2, \ldots, b_m).$$

By calculating the transposition of $X$ and the $j$ th column of $R$, $b_j$ can be obtained, that is, the membership degree of the evaluated elements to the $V_j$-level fuzzy subset comprehensively.

### 3. Results and Discussion

#### 3.1. Weight Analysis

Combined with the analytic hierarchy process, through the established comprehensive evaluation index system for the sustainable development of rural tourism resources in Huangqiao Town, according to the scores made by experts, different pairwise comparison matrices are calculated, and then the corresponding weights are obtained by using the yaahp software and the consistency check. First, we interview 40 experts in the evaluation of sustainable development of rural tourism resources and ask them to rate the relevant indicators of the target layer, criterion layer, and index layer involved in this article according to the quantitative standards of the judgment matrix. Of course, different experts judge the importance of different indicators differently. In order to solve this problem, this paper selects 40 experts to assign scores for the importance of different indicators for calculation. Finally, the specific judgment matrix of different indicators is shown below. First, the relative importance judgment matrix of the first-level indicators is made in Table 3, and other related judgment matrices are obtained by this method.

This paper conducts an empirical study on the evaluation of sustainable development of rural tourism resources in Huangqiao Town. Guided by expert scores and opinions, the yaahp10.5 software was used to calculate the weights of the evaluation indicators for the sustainable development of rural tourism resources in Huangqiao Town (Table 4).

#### 3.2. Empirical Research on Fuzzy Comprehensive Evaluation

Following the set research method, 40 experts in related fields are invited to evaluate each indicator based on theories and local conditions.

We set the evaluation level range of each factor: $V = \{V_1, V_2, \ldots, V_n\}$, $V_1$ = excellent = 0.95, $V_2$ = good = 0.85, $V_3$ = average = 0.75, $V_4$ = poor = 0.65, and $V_5$ = very poor = 0.55.

All members of the evaluation team were distributed with survey forms printed with evaluation indicators and evaluation grades. The evaluation team first registers the evaluation records and then sorts out all the collected survey forms to obtain the number of comments at each level corresponding to each evaluation index. After normalization, the fuzzy relation matrix $R$ is obtained.

Under the circumstance that the weight $X$ value of each fuzzy vector is determined, the first-level fuzzy evaluation result vector can be obtained according to the following fuzzy comprehensive evaluation formula $B = X \times R$:

$$B_1 = X_1 \times R_1 = (0.1759, 0.4023, 0.2714, 0.0546, 0.0762)$$
$$B_2 = X_2 \times R_2 = (0.5029, 0.2126, 0.1435, 0.0778, 0.0684)$$
$$B_3 = X_3 \times R_3 = (0.1065, 0.4371, 0.2759, 0.1189, 0.0654)$$
$$B_4 = X_4 \times R_4 = (0.1126, 0.3456, 0.4104, 0.0787, 0.0572)$$

Based on the first-level fuzzy evaluation results, the second-level fuzzy evaluation is comprehensively evaluated, and the comprehensive evaluation results can be obtained as shown in Table 5.

According to the comprehensive evaluation score of the sustainable development of rural tourism resources in Huangqiao Town, it is divided into excellent (>90), good (>80, <90), fair (>70, <80), poor (>60, <70), and very poor (less than 60). The comprehensive score of the sustainable development level of rural tourism resources in Huangqiao Town is 83.1534 points, which is "good," indicating that Huangqiao Town pays more attention to the sustainable development of rural tourism resources and has achieved certain results in the sustainable development of rural tourism, but still there are some problems, and the results are in line with basic cognition. The comprehensive score of the sustainable development of rural tourism resources in Huangqiao Town is 83.1534. The sustainable development level of rural tourism resources in Huangqiao Town is at a "good" level, only slightly higher than the "average" level. There is still room for development. The government must play a leading role and take the lead to enhance the level of management and planning. All parties increase capital investment to promote economic development, collectively strengthen environmental protection work to promote

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**Table 1:** Quantitative standard of judgment matrix.

| Number | Explanation |
|--------|-------------|
| 1      | The two factors are equally important in comparison |
| 2      | Compared with the two factors, the former factor is slightly more important |
| 3      | Compared with the two factors, the former factor is obviously more important |
| 4      | Compared with the two factors, the former factor is strongly important |
| 5      | Compared with the two factors, the former factor is extremely important |
| 6, 7, 8| Represents the median value of adjacent judgments |

**Table 2:** Values of the average random consistency index RI.

| $n$ | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
|-----|----|----|----|----|----|----|----|----|----|
| RI  | 0  | 0  | 0.58 | 0.9 | 1.12 | 1.2 | 1.32 | 1.41 | 1.45 |

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References and further reading on sustainable development in rural tourism.
sustainable development, and vigorously promote red culture social value. The score of management planning is 78.6540, which is at the “average” level. Combined with the distribution of weights and membership degrees, it shows that there is a lack of comprehensive management of tourism areas in the sustainable development of rural tourism resources in Huangqiao Town. The layout of commercial attractions is not good, and the management organization is not sound enough. The score of economic development is 84.6954, which is at the “good” level, indicating that rural tourism has a good ability to stimulate employment. The government, financial institutions, enterprises, and individuals have a certain scale of investment in tourism, but there is still much room for improvement. The contribution is good, and the integration ability of rural tourism resources and other industries is good. The score of environmental protection is 77.6152, which is at the “average” level, indicating that there are problems in the development of rural tourism in Huangqiao Town, and there is still room for improvement in the vegetation coverage. According to the data, the transformation of industrial projects is acceptable, while the scenic environment is not beautiful enough. The overall carrying capacity of resources and environment is average. The score of social value is 81.2451, which is on the verge of a “good” level, indicating that Huangqiao Town has achieved certain results in the mining of social value in the process of sustainable development of rural tourism. The influence of red culture is high, and the cultural value has not been well developed. In general, there is room for improvement in the use of cultural and recreational activities or programs with regional characteristics.

4. Conclusion

(1) The comprehensive score of the sustainable development level of rural tourism resources in Huangqiao Town is 81.1899 points, which is “good,” indicating that Huangqiao Town pays more attention to the sustainable development of rural tourism resources and has achieved certain results in the sustainable development of rural tourism.

(2) Judging from the comprehensive evaluation results of the sustainable development of rural tourism resources in Huangqiao Town, the following problems exist in the sustainable development of tourism resources in Huangqiao Town: unreasonable management and development planning, low level of capital investment and development, environmental protection work needs to be further improved, and the construction of tourism culture is not enough.

(3) In the past, most of the related research studies on the sustainable development of tourism resources were analyzed from the level of concept and theory,
and some of them were related to the introduction of relevant work experience on the sustainable development of tourism resources. There are few related studies on evaluation indicators. This research uses the AHP-Fuzzy mathematical method to study the comprehensive evaluation method and its indicators of the sustainable development of tourism resources in Huangqiao Town and conducts a comprehensive evaluation of the sustainable development of tourism resources in Huangqiao Town.

Data Availability

The data used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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