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Research Article

Construction of Evaluation Index System of Rural Low-Carbon Tourism Development Based on Sustainable Calculation

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In recent years, as rural tourism has blossomed everywhere in the province, development in some places is difficult and stagnant, and the problems facing sustainable development have gradually emerged. For the sake of solving the problem of sustainable development of rural tourism, it is of great significance to study and construct the evaluation index system of rural low-carbon tourism development with the strength of sustainable calculation. This article aims to study the construction of an evaluation index system for rural low-carbon tourism development with the strength of sustainable calculations. To improve the accuracy and scientificity of the analysis, this article also carries out quantitative analysis while conducting qualitative analysis. Regarding the strength of the quantitative appraisal of the status quo of low-carbon ecological tourism development, the use of qualitative analysis methods to analyze the existing problems pointed out the direction for the development of rural low-carbon ecological tourism. This article constructs the DPSIR model theory; DPSIR is a model that combines the driving force-pressure-state-influence-response (DPSIR) framework, refers to the relevant requirements of existing low-carbon villages and tourist villages, and designs a low-carbon tourism village development evaluation index system. The experimental results of this article show that tourism transportation and tourist hotels should be the main link in the evaluation of the low-carbon development of tourism, and the most important strategic direction for achieving low-carbon development of the tourism industry, because the total carbon footprint of the two accounts for 90% of the total emissions of the entire tourism industry.

1. Introduction

1.1. Background. In the six tourism links, food, housing, transportation, sightseeing, shopping, and entertainment, each link inevitably produces CO_2 emissions, including direct and indirect CO2 emissions. Carbon footprints in the tourism process are mainly reflected in tourism catering, tourism accommodation, tourism transportation, and tourist attractions. According to relevant data, tourism catering, tourism accommodation, tourism transportation, tourism transportation, and tourist attractions account for more than 85% of the overall carbon footprint. The problem that needs to be solved is also an important topic worthy of study by adopting alternative energy sources, reducing carbon emissions from vehicle exhaust, constructing ecological parking lots, using fuel cell vehicles, pure electric vehicles, hybrid vehicles, and new energy trains, developing low-carbon building facilities, and carrying environmentally friendly luggage and housing in personal travel ecofriendly hotels. The essence of a low-carbon economy is to improve energy efficiency, develop clean energy, and pursue green goals. The low-carbon tourist industry is produced with the development of the low-carbon economy. In the face of global climate change and the advent of a low-carbon economy, the low-carbon tourist industry, as an important part of the national economy, as green tourism with the strength of low energy consumption and low pollution, has also become the focus of attention in the tourist industry. In the face of these problems, we should keep pace with the times, seek innovation, and make corresponding reforms to the tourism situation under the new situation, such as smart tourism combining the Internet and the method of the Internet and low-carbon tourism.

1.2. Significance. We develop a series of measurable indicator systems to provide standards for the development, planning, and management of rural tourism destinations to assess their comprehensive development standards, provide a scientific basis for the appraisal of rural tourism demonstration areas, and promote the sustainable development of the rural low-carbon tourist industries. Indicators include the following: (1) air quality; (2) scale and abundance of rural tourism resources; (3) water mass; (4) resident quality; (5) overall style of the village; (6) diversification of investment in tourist areas; (7) scale of rural accommodation beds; (8) waste treatment capacity. It is also envisaged that this research can promote the sustainable development of the rural low-carbon tourist industries. For the strength of the experience of low-carbon ecological tourism development from domestic and foreign, build a rural low-carbon ecological tourism development model, and make a certain evaluation of the current status of low-carbon ecological tourism development in the tourism industry, discover the key problems, and then seek the effective development of rural low-carbon ecological tourism. The calculation formula of sustainable growth rate is as follows: sustainable growth rate = return on equity × retained rate of return; the sustainable growth rate is the internal growth ability determined by the current operating efficiency and financial policy of the enterprise. Therefore, this research has great guiding significance for the transformation, upgrading, and sustainability of the development mode of rural tourism. At the same time, this research can provide a reference for the development of low-carbon ecological tourism in other rural areas in China.

1.3. Related Work. Ecological tourism is to solve the problem of not only vigorously developing ecological tourism but not destroying and polluting nature, culture, and environment so that both can be developed. Resmiye pointed out that this article examines the traditional form of tourism CT and discusses how to use sustainable rural tourism to transform it into a more diverse form of tourism DT. To realize the utilization of existing and emerging tourism capabilities, the classification of tourism methods was assessed to assess the degree of sustainable tourism diversification. On the strength of literature analysis and national surveys, including statistical data, questionnaire surveys, and seminars, this article identifies and discusses the formation and transformation of the tourism industry through the background and clarification of the tourism policy and planning process at the macro and micro levels. The development of the industry needs to be strengthened [1]. Zha et al. pointed out that many rural areas have reshaped their territorial development through tourism and turned to local heritage to ensure their future. However, it is condemned to make rural areas museumization and mythification and build rural areas into a romantic and imaginary past. This is not a sustainable way of tourism [2]. Gan et al. pointed out that to challenge the relatively weak key practice of community tourism (CBT) and create opportunities for the younger generation, it must be included in the development goal of cognitive behavioral therapy to achieve sustainable development. The development of community tourism aims to support high-quality participation in the development process [3]. Although the research of the above scholars has contributed to low-carbon tourism to some extent, most of it is based on theory and has a less practical use, so further exploration needs to be done.

1.4. Main Content. This article puts forward the concept of the rural low-carbon tourist industry and then analyzes the factors that affect the development of the rural low-carbon tourist industry, including economic standards, industrial structure, science and technology, energy consumption structure, and utilization efficiency. The driving force and development model of rural low-carbon tourist industry development are studied. Construct a planning indicator system for rural low-carbon tourist industry demonstration zones through the use of an analytic hierarchy process. To improve the practicability of the planning index system, the established planning indexes are assigned weights, and the attributes of the indexes and applicable scenic spots are classified. Construct the rural low-carbon tourist industry development appraised index system, guided by system theory, model ideas, etc., to ensure that the system is rigorous and reasonable in the logical structure, and at the same time, select the most important and representative factors.

2. Research Methods and Technical Routes

2.1. Research Method

2.1.1. Empirical Analysis Method. Because the low-carbon ecotourism theory [4] is still in its infancy in China and even in the world, through repeated research and discussion, this article proposes a set of appraised index systems for rural low-carbon ecotourism. However, to make the index system more scientific and relevant, experts have been consulted many times and were asked to analyze and judge the importance of the index system through questionnaire surveys. After many revisions, the current appraised index system was finally determined. At the same time, the author conducted many field investigations on major tourist attractions and talked with the staff of related units and obtained a large amount of first-hand information.

2.1.2. Combination of Qualitative Analysis and Quantitative Analysis. To improve the accuracy and scientificity of the analysis, this article carries out qualitative analysis while also carrying out quantitative analysis [5]. Qualitative means to distinguish the nature of an event or thing that happened and determine the nature of the event. Quantitative generally refers to the task amount determined for a production task. Regarding the strength of the quantitative appraisal of the status quo of low-carbon ecological tourism progress, the use of qualitative analysis methods to analyze the existing problems pointed out the direction for the progress of rural low-carbon ecological tourism.

According to the above criteria, the reference values for determining the three-level indicators are shown in Figure 1.

2.2. Screening to Appraised Indicators for Sustainable Development of Rural Low-Carbon Tourist Industry

2.2.1. Sustainable Tourism. Sustainable tourism means that within the carrying capacity of the natural ecosystem [6], it can not only meet people's needs for tourism natural

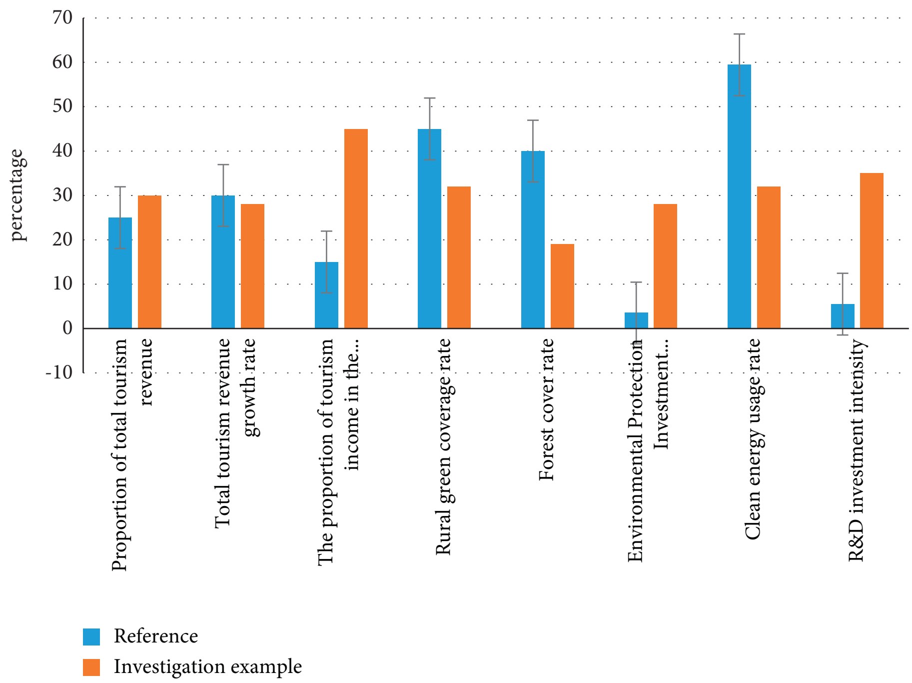

FIGURE 1: Reference values of quantitative indicators for the EIS of rural low-carbon tourist industry development.

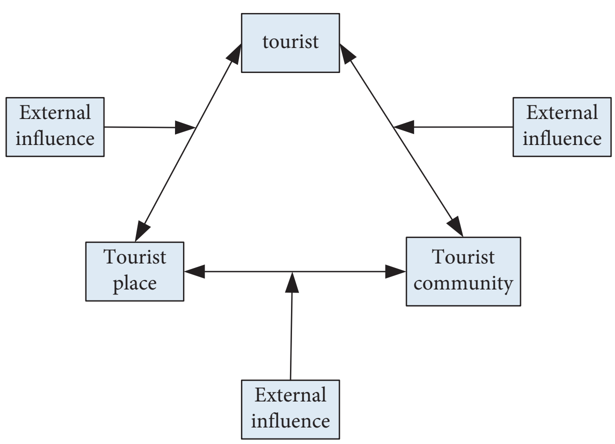

FIGURE 2: Sustainable tourism model.

experience but also does not affect the continuable progress of the natural environment and realize the coordinated development of tourism economic benefits, social benefits, and ecological benefits. The sustainable tourism model is shown in Figure 2.

2.2.2. Summary of Expert Opinions. Regarding the strength of the indicator system of 22 indicators, the author invited 21 experts in tourism and environmental sciences to provide opinions and suggestions on the research of the indicator system and asked the experts to fill in the questionnaire to make a judgment on the importance of the indicators. Experts refer to people with specialized skills or comprehensive professional knowledge in academic and technical aspects or professionals with high attainments who are exceptionally proficient in a certain discipline or skill. The evaluation of experts is based on professional knowledge.

2.2.3. Questionnaire Design. The expert opinion table has 22 indicators [7]. The importance of the indicators is divided into five grades: "important," "more important," "generally important," "less important," and "unimportant."

2.2.4. Analysis of Statistical Results. According to the five levels of "important," "more important," "generally important," "less important," and "unimportant," the judgment criteria here are derived from the experience and expertise of experts. Each indicator is given a score of 9, 7, 5, 3, 1 and is obtained using each indicator. The arithmetic mean of the scores represents the "concentration of opinions" of the experts.

$$S_j = \sqrt{\frac{1}{n-1}\sum_{i=1}^{m}\left(A_{ij}-T_j\right)^2},$$
$$T_j = \frac{1}{n}\sum_{i=1}^{n}A_{ij}. \quad (1)$$

Coefficient of variation calculation formula is as follows:

$$Z_j = \frac{S_j}{T_j}. \quad (2)$$

$Z_j.j$ is the index of variation coefficient; $S_j.j$ is the standard deviation of the indicator; $T_j.j$ is the arithmetic mean of the indicator.

The smaller Z_j, the higher the coordination degree of expert opinions of the J index [8].

According to the above method, the data obtained by the expert questionnaire is counted, and the "Opinion

Table 1: Appraised index system of sustainable development of rural tourism.

Target layer	Criterion layer	Index layer	Element layer	Opinion concentration	Opinion coordination scheduling
	Surroundings	Quality of rural tourism resources	(1) Air quality	8.47	0.41
			(2) The scale and abundance of rural tourism resources	6.33	0.41
			(3) Water mass	7.93	0.91
		Social environmental quality of rural tourism	(4) Quality of residents	3.13	0.51
			(5) The overall style of the village	7.13	0.42
			(6) Degree of investment diversification in tourist (7) areas	6.47	0.35
	Economic	Rural tourism facility construction	(8) Bed size of rural accommodation industry	6.87	0.20
			(9) Waste treatment capacity	6.60	0.33
			(10) Energy use structure	2.73	0.67
		Rural brigade	(11) Environmental awareness of rural tourism operators	7.40	0.21
			(12) The choice orientation of rural tourism operators on the layout of scenic spots	7.27	0.24
			(13) The establishment of the management system for rural tourism operators	6.73	0.31
		Rural tourism manager	(14) Environmental monitoring and analysis	7.41	0.21
			(15) Monitoring function of rural tourism	5.61	0.24
			(16) Rural risk	3.80	0.56
	Society	Rural environmental benefits and social benefits	(17) Biodiversity protection	6.20	0.44
			(18) Environmental awareness of tourists and residents	8.33	0.11
			(19) Villagers' per capita income from rural tourism	7.01	0.26
		Rural and social coordination	(20) Tourist satisfaction	7.27	0.81
			(21) Satisfaction of local villagers	7.80	0.13
			(22) The coordination of rural tourism and local culture	6.60	0.23

Concentration Degree" and "Opinion Coordination Degree" of 22 indicators are calculated. See Table 1.

According to the statistical analysis, there are 3 indicators with a concentration of opinions less than 6.0 : 4 residents' quality, 10 energy use structures, 15 rural tourism monitoring functions, and 16 rural risks.

The opinions of experts mainly focus on the following aspects:

The index system should be streamlined and highly maneuverable [9]and focus on key indicators, and some general or unimportant indicators should be reduced. If it can be reflected by a key indicator, no other relevant indicators will be set up, which mainly reflect the good state of the ecological environment and the content of harmony between man and nature in tourist activities.

If there are national standards or indicators that can be referred to by relevant laws and regulations [10], the national standards or standards in relevant laws and regulations shall be adopted.

2.3. Determination of the Weights of the Appraised Index System for the Development of Rural Low-Carbon Tourist Industry Development. Through expert analysis and consultation, an EIS for the sustainable progress of rural tourism has been established. The system has three standards, two indicators of environment, economy and social environment, 11 elements, two indicators of economy, 12 elements of rural tourism area construction and management, three indicators of society, 14 elements of rural tourism management, and rural tourism benefits, the degree of coordination between tourism and society.

2.3.1. Data Analysis. After summarizing the judgment results of the experts, the judgment matrix is constructed, as shown in Table 2.

Using computer software [11], the maximum eigenvalue of each matrix and its corresponding eigenvector were solved and normalized, and their consistency was tested. Consistency test refers to the test of each mean or variance calculated by different samples, and its purpose is to test the coordination between the importance of each element and avoid contradictions, which is recorded as follows:

$$D_i = \frac{\lambda_{\max} - n}{n - 1}. \quad (3)$$

When the order is greater than P_i, the ratio of the consistency index D_i of the judgment matrix to the

Table 2: Relative importance value table.

Relative importance value	Meaning
1	Have the same significance
3	Comparing the two goals, the former is slightly more significant than the latter
5	Comparing the two goals, the latter is slightly higher than the former
7	Matched with the two targets, the former is more significant than the latter
9	Matched with the two goals, the former is extremely significant than the latter
2, 4, 6, 8	The adjacent value of the above judgment

Table 3: Random consensus parameter P_i table.

Order (n)	1	2	3	4	5	6	7	8	9	10
P_i	0.10	0.32	0.58	0.91	1.13	1.04	1.32	1.41	1.35	1.19

average random consistency index 2 of the same order, that is, the random consistency ratio [12], is recorded as follows:

$$D_r = \frac{D_i}{P_i}. \quad (4)$$

As shown in Table 3, when Dr < 0.10, the result of ranking weight is considered to have satisfactory consistency.

Matrix 1, appraised index D of the sustainable process of rural tourism:

$$\begin{aligned} \lambda_{\max} &= 3.0385, \\ \text{Eigenvector} &= \begin{bmatrix} 2.4663 \\ 0.4056 \\ 1 \end{bmatrix}, \\ \text{Normalized} &= \begin{bmatrix} 0.6371 \\ 0.1046 \\ 0.2583 \end{bmatrix}, \\ D_r &= 0.0332 < 0.10. \end{aligned} \quad (5)$$

Matrix 2, environmental indicators D1:

$$\begin{aligned} \lambda_{\max} &= 2.000, \\ \text{Eigenvectors} &= \begin{bmatrix} 2.2362 \\ 0.4476 \end{bmatrix}, \\ \text{Normalized} &= \begin{bmatrix} 0.8332 \\ 0.1667 \end{bmatrix}, \\ D_{\mathrm{r}} &= 0 < 0.10. \end{aligned} \quad (6)$$

Matrix 3, economic indicator D2:

$$\begin{aligned} \lambda_{\max} &= 2.000, \\ \text{Eigenvectors} &= \begin{bmatrix} 1.7132 \\ 0.5773 \end{bmatrix}, \\ \text{Normalized} &= \begin{bmatrix} 0.7500 \\ 0.2500 \end{bmatrix}, \\ D_r &= 0 < 0.10. \end{aligned} \quad (7)$$

Matrix 4, social Indicators D3:

$$\begin{aligned} \lambda_{\max} &= 3.0386, \\ \text{Eigenvectors} &= \begin{bmatrix} 0.4055 \\ 2.4662 \end{bmatrix}, \\ \text{Normalized} &= \begin{bmatrix} 0.1067 \\ 0.6370 \\ 0.2543 \end{bmatrix}, \\ D_{\mathrm{r}} &= 0.0322 < 0.10. \end{aligned} \quad (8)$$

Matrix 5, resources and environmental quality F1:

$$\begin{aligned} \lambda_{\max} &= 7.0912, \\ \text{Eigenvectors} &= \begin{bmatrix} 1.0752 \\ 1.0757 \\ 2.8923 \\ 1.0782 \\ 2.8912 \\ 0.4910 \\ 0.2231 \end{bmatrix}, \\ \text{Normalized} &= \begin{bmatrix} 0.1113 \\ 0.1132 \\ 0.2564 \\ 0.2997 \\ 0.1113 \\ 0.0434 \\ 0.0237 \end{bmatrix}, \\ D_r &= 0.0115 < 0.10. \end{aligned} \quad (9)$$

Matrix 6, social and economic environmental quality F2:

$$\begin{aligned} \lambda &= 4.0431, \\ \text{Eigenvectors} &= \begin{bmatrix} 2.5900 \\ 0.3821 \\ 1 \\ 1 \end{bmatrix}, \\ \text{Normalized} &= \begin{bmatrix} 0.5201 \\ 0.7732 \\ 0.2011 \\ 0.2101 \end{bmatrix}, \\ D_r &= 0.0161 < 0.10. \end{aligned} \quad (10)$$

Matrix 7, rural tourism district construction F3:

$$\lambda_{\max} = 7.0628,$$

$$\text{Eigenvectors} = \begin{bmatrix} 0.7306 \\ 0.7306 \\ 0.3210 \\ 0.7231 \\ 2.0157 \\ 2.0157 \\ 2.0157 \end{bmatrix}, \quad \text{Normalized} = \begin{bmatrix} 0.0854 \\ 0.0854 \\ 0.0362 \\ 0.0854 \\ 0.2376 \\ 0.2376 \\ 0.2376 \end{bmatrix}, \quad D_r = 0.0081 < 0.10. \tag{11}$$

Matrix 8, rural tourism area maintenance F4:

$$\lambda = 5.1356,$$

$$\text{Eigenvectors} = \begin{bmatrix} 2.5365 \\ 2.5365 \\ 0.5421 \\ 1.1076 \\ 0.2563 \end{bmatrix}, \quad \text{Normalized} = \begin{bmatrix} 0.3618 \\ 0.3623 \\ 0.0275 \\ 0.1645 \\ 0.0354 \end{bmatrix}, \quad D_{\mathrm{r}} = 0.3021. \tag{12}$$

Matrix 9, rural tourism management F5:

$$\lambda = 5.0556,$$

$$\text{Eigenvectors} = \begin{bmatrix} 2.1231 \\ 0.3321 \\ 2.1549 \\ 0.8213 \\ 0.8213 \end{bmatrix}, \quad \text{Normalized} = \begin{bmatrix} 0.3567 \\ 0.0544 \\ 0.3485 \\ 0.1287 \\ 0.1267 \end{bmatrix}, \quad D_r = 0.0124 < 0.10. \tag{13}$$

Matrix 10, rural tourism benefit F6:

$$\lambda_{\max} = 5.1356,$$

$$\text{Eigenvectors} = \begin{bmatrix} 2.5674 \\ 2.5674 \\ 1.1098 \\ 0.2678 \\ 0.5643 \end{bmatrix}, \quad \text{Normalized} = \begin{bmatrix} 0.3628 \\ 0.4362 \\ 0.1563 \\ 0.0235 \\ 0.0735 \end{bmatrix}, \quad D_r = 0.0303 < 0.10. \tag{14}$$

Matrix 11, the degree of coordination between rural tourism and society:

$$\lambda_{\max} = 4.0423,$$

$$\text{Eigenvectors} = \begin{bmatrix} 0.3861 \\ 1.0001 \\ 2.6911 \\ 1.0002 \end{bmatrix}, \quad \text{Normalized} = \begin{bmatrix} 0.0771 \\ 0.2010 \\ 0.5312 \\ 0.2010 \end{bmatrix}, \quad D_r = 0.0161 < 0.10. \tag{15}$$

3. EIS Design Experiment

To assess its progress level scientifically and objectively, it is essential to construct a scientific and reasonable EIS [13]. This article will design a rural low-carbon tourist industry

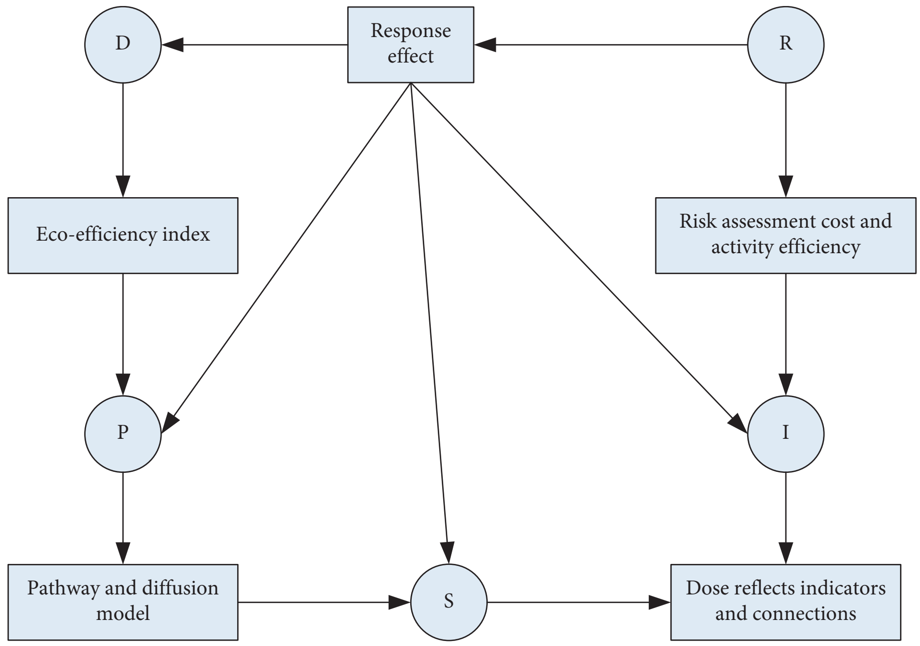

Figure 3: DPSIR model diagram.

progress appraised index system according to the characteristics of the rural low-carbon tourist industry progress system, referring to the relevant requirements of existing low-carbon rural and tourism villages. The overall experimental process of this article is as follows: first, design the DPSIR model, then determine the overall system framework, and then select the appropriate indicators, the questionnaire, and the best way to analyze the index data.

3.1. DPSIR Model Theory. The DPSIR model is a conceptual model of the appraised index system [14], which has a wide range of applications in the system environment. Figure 3 reflects the relationship between the driving force and pressure generated by economic activity, which is a function of the technology used and the ecological efficiency of the related system. If the ecological efficiency is improved, more driving forces will produce less pressure; the relationship between the impact of the ecosystem on humans or the ecosystem and the environmental conditions depends on the carrying capacity and threshold of the system [15]. Whether society will respond to the impact depends on how to recognize and assess the impact; the result of the social response to the driving force depends on the efficiency of the response. The construction of low-carbon rural tourism is a complicated process. To clarify the relationship between the elements in the system and better reflect the progress standard of low-carbon rural tourism, this article will use the DPSIR model to analyze the construction of low-carbon rural tourism.

3.2. Design Principles. The EIS is a system composed of multiple related indicators used to explain the dependence and restriction of various aspects of the research object and reflect its overall situation from different angles. To objectively and comprehensively measure the level of low-carbon rural tourism progress, the establishment of an EIS should follow the following principles.

3.2.1. Principles of Stability and Dynamics. The establishment of a low-carbon tourist industry village appraised index system (EIS) should reflect the standard characteristics of low-carbon tourist industry villages in a certain period of time, and the selected indicators should be stable within a certain period of time [16]. However, since progress is a dynamic process, dynamics should also be taken into consideration when selecting indicators to reflect the changing trend of rural progress.

3.2.2. Principles of Scientificity and Practicality. The establishment of the low-carbon tourism village EIS should objectively reflect its connotation characteristics and process standard; the index concept is clear, has scientific connotations, and avoids overlapping and listing of indexes. At the same time, it is necessary to fully consider the availability of indicators and the difficulty of calculation and build an easy-to-apply indicator system as much as possible.

3.2.3. The Principle of Comprehensiveness and Representativeness. As a system, the low-carbon tourist industry village EIS should fully reflect the main aspects of low-carbon tourism rural progress. Although the index system cannot cover all technical indicators, it must fully reflect the progress status of different standards. In a relatively comprehensive situation, select the most closely related and representative key indicators, and compress the

Table 4: EIS of low-carbon rural tourism progress.

First level indicator (A)	Secondary indicators (B)	Three-level indicators (C)
Basic indicators (A1)	Tourism economic indicators (B1)	The total income from tourism accounts for the proportion of the village's GDP (C1)
		Total tourism revenue growth rate (C2)
		The proportion of the village's tourism income in the province's total tourism income (C3)
	Ecological environment indicators (B2)	Rural green coverage rate (C4)
		Forest cover rate (C5)
		Environmental protection investment index (C6)
Status indicator (A2)	Energy consumption indicators (B3)	Energy consumption of tourism accommodation of 10,000 yuan operating income (C7)
		Number of green tourist hotels (C8)
		Energy consumption elasticity coefficient (C9)
		Clean energy usage rate (C10)
	Carbon emission indicators (B4)	Effectiveness of low-carbon construction in tourist attractions (C11)
		CO_2 emissions per capita (C12)
		Average annual growth rate of CO_2 emissions (C13)
Impact index (A3)	Low-carbon technical indicators (B5)	Intelligent energy-saving technology application (C14)
		Number of green buildings (C15)
		R&D investment intensity (C16)
	Low-carbon policy indicators (B6)	Support policies for energy conservation and emission reduction (C17)
		Tourism energy-saving and emission reduction plan (C18)

number of indicators as much as possible [17] to facilitate analysis and calculation.

3.3. System Framework. The progress of low-carbon rural tourism should focus on the strength of high-quality tourism [18, 19] and a good rural environment, with energy-saving utilization and low-carbon footprint as the performance and low-carbon technologies and policies as the starting point. The construction of low-carbon tourist industry rural progress EIS should comprehensively include the content requirements of tourism villages and low-carbon villages and systematically reflect the progress status, potential, and trends of low-carbon tourism villages. Regarding the strength of the above-mentioned low-carbon tourism and rural progress appraising indicators, fully considering the representativeness, importance, and availability of each indicator, combined with existing research results and relevant expert opinions, this article is constructed based on three aspects: basic indicators, current indicators, and impact indicators and developed a low-carbon tourist industry rural progress appraised index system. The system includes three levels, six second-level indicators, and 18 third-level indicators. The final comprehensive progress index is used to assess the comprehensive progress standard of low-carbon rural tourism (see Table 4).

3.4. Indicator Analysis. The ratio of total tourism revenue to the village's GDP (C1) indicates the ratio of tourism GDP to village GDP, reflecting the economic contribution of rural tourism; the growth rate of total tourism revenue [20] (C2) refers to the total tourism revenue in the same year. The annual ratio reflects the progress speed of rural tourism; the proportion of rural tourism revenue in the province's total tourism revenue (C3) reflects the progress of rural tourism. The greater the value, the greater the proportion of rural tourism.

Among them, the rural green coverage rate (C4) is the ratio of the vertical projection area of trees and shrubs and perennial herbaceous plants for greening in rural built-up areas. Due to the strong adsorption of dioxin carbon by green plants, the forest coverage rate (C5) reflects the abundance and greening degree of rural forest resources. The environmental protection investment index (C6) is the ratio of rural environmental protection investment to rural GDP. Generally speaking, environmental protection investment includes environmental pollution control investment, environmental management investment, and pollution prevention technology investment, reflecting the relative standard of environmental protection investment.

The energy consumption of tourism accommodation of 10,000 yuan operating income (C7) reflects the relationship between the energy consumption of tourism accommodation and operating income. According to the existing research, the energy consumption of tourism is mainly concentrated in tourism transportation and tourism accommodation. The number of green tourist hotels (C8) is an indicator that can reflect the low-carbon construction enthusiasm of the tourism accommodation industry; energy consumption elasticity coefficient (C9) is the ratio of the average annual growth rate of energy consumption to the average annual growth rate of GDP over the same period, reflecting the reduction of carbon footprint. With the relationship between the quantity and economic progress, along with technological progress, energy efficiency improvement, and industrial structure adjustment, the elasticity coefficient will generally decline. Clean energy use rate (C10) refers to the ratio of rural clean energy use to the total

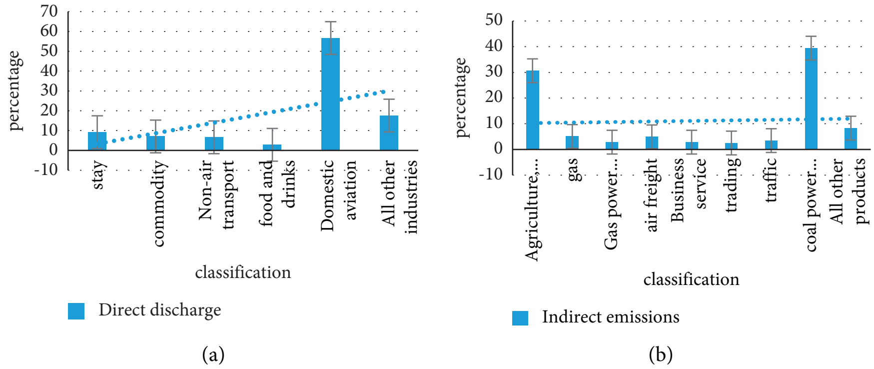

FIGURE 4: Comparison of direct (a) and indirect (b) emission pathways of CO_2 emission ratio.

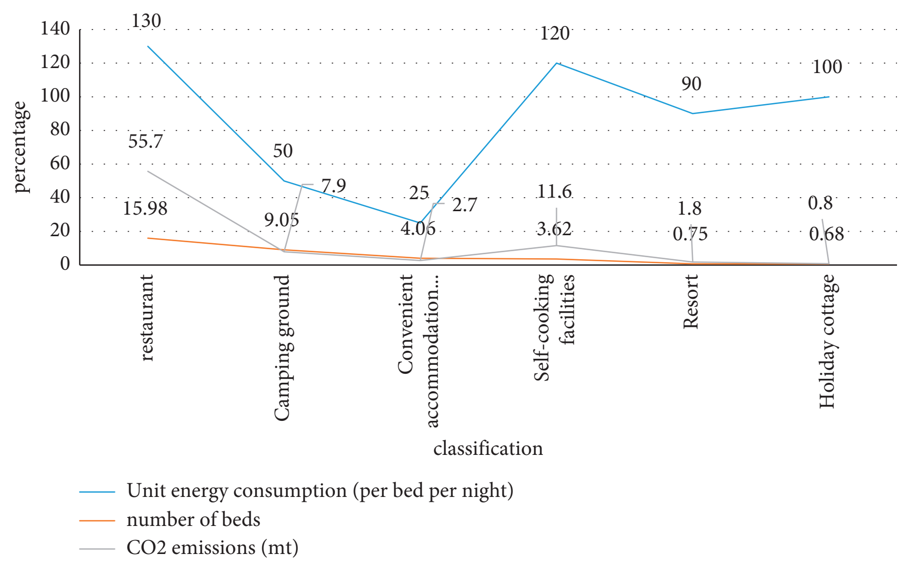

FIGURE 5: CO_2 emissions from the global accommodation industry.

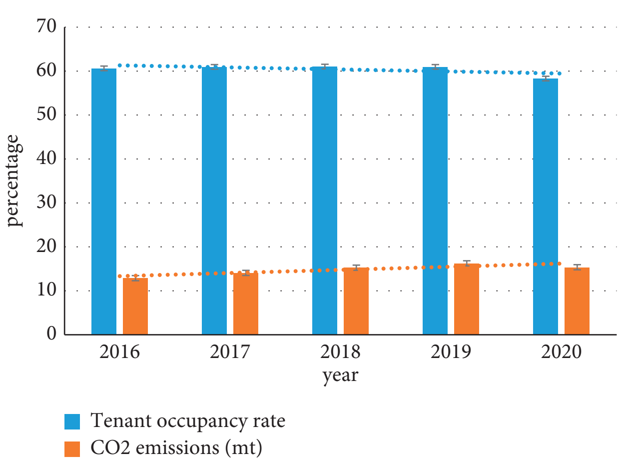

FIGURE 6: CO_2 emissions of star-rated tourist hotels in my country.

final energy consumption in rural areas, reflecting the degree of optimization of rural energy consumption structure.

Per capita CO_2 emissions (C12) reflect the intensity of CO_2 emissions; the average annual growth rate of CO_2 emissions (C13) is the rate of change of annual CO_2 emissions and is a dynamic indicator that reflects low-carbon progress.

The application of smart energy-saving technology (C14) is a technology to reduce emissions in the production process of tourism in rural areas, which can reduce the energy consumption and carbon footprint of the production unit products. The number of green buildings (C15) can measure the standard of the progress of energy-saving technologies in rural buildings. Green building technology is the main technical means for energy saving and emission reduction of tourism in rural buildings.

4. Status Quo of Tourism Carbon Footprint and Appraise Indicators

4.1. Status Quo of CO_2 Emissions from the Tourism Industry

4.1.1. Industrial Characteristics of Tourism. The tourism industry is characterized by a high degree of relevance, and the industrial chain is long, involving all aspects of society, such as food, housing, transportation, travel, shopping, and entertainment. The tourism industry is related to the CO2 emissions of almost all industries.

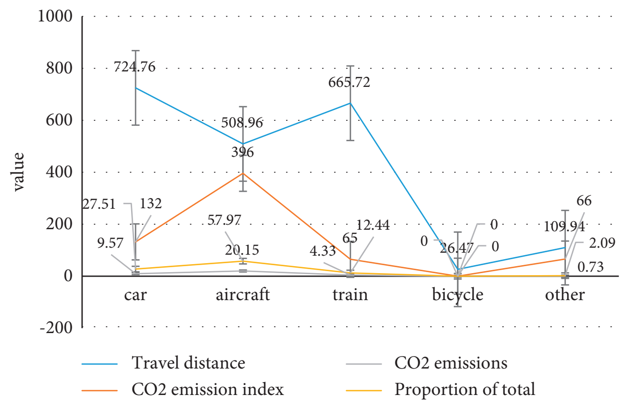

FIGURE 7: CO_2 emissions from the tourism and transportation industry.

TABLE 5: Judgment matrix of ecological environment indicators.

Ecological environment indicators	C4	C5	C6	C7
C4	1	1/3	1/3	1/3
C5	3	1	1	1
C6	3	1	1	1
C7	3	1	1	1

C4: rural green coverage rate; C5: forest coverage rate; C6: environmental protection Investment index; C7: tourism and accommodation energy consumption, 10,000 yuan operating income.

TABLE 6: Consistency test results of ecological environment indicators.

Ecological environment indicators	C4	C5	C6	C7
Weights	0.1	0.3	0.3	0.3

$\lambda_{max} = 3$ CI = 0 CR = 0 ($\leq$ 0.10); the matrix has satisfactory consistency.

Direct and indirect emissions are the two basic ways of CO_2 emissions in the tourism industry. Among them, the direct CO_2 emissions refer to the emission of tourism activities, such as the CO_2 emissions caused by the energy consumption of restaurants and tourist attractions and the CO_2 emissions caused by the fossil fuel consumption of tourism transportation. Indirect CO_2 emissions refer to emissions from indirect tourism activities, such as the indirect carbon dioxide generated by the consumption of office supplies in travel agencies and the consumption of toothbrushes, toothpaste, sweaters, etc. in tourist hotels, as shown in Figure 4.

In terms of tourism and accommodation, restaurants, camping grounds, convenient accommodation facilities, self-cooking facilities, resorts, and holiday cabins, respectively, unit energy consumption (per bed per night), the number of beds, and CO_2 emissions (mt) are taken into account, as shown in Figure 5.

4.1.2. Current Status of CO_2 Emissions from Tourism. As for the tourism accommodation industry, according to the estimated number of star-rated tourist hotels in my country and the current status of CO_2 emissions, the highest emissions of the tourism accommodation industry in 2019 reached 16.25 mt, as shown in Figure 6.

TABLE 7: Judgment matrix of carbon emission indicators.

Carbon emission indicators	C11	C12	C13	C14
C13	0.5	2.5	1/3	1
C14	1/3	0.5	1/5	1/3
C15	3	5	1	3
C16	1	3	1/3	1

C11: the effectiveness of low-carbon construction in tourist attractions; C12: per capita CO_2 emissions; C13: average annual growth rate of CO_2 emissions; C14: intelligent energy-saving technology application.

TABLE 8: Consistency inspection results of carbon emission indicators.

Carbon emission indicators	C13	C14	C15	C16
Weights	0.201	0.0776	0.5205	0.201

$\lambda_{max} = 4.0434$ CI = 0.0072 CR = 0.008 ($\leq$ 0.10); the matrix has satisfactory consistency.

In terms of tourism and transportation, the current mode of travel for Chinese tourists is still mainly airplanes, accounting for 57.97%, followed by cars and train, which accounted for 27.51% and 12.44%, respectively, and other travel modes such as self-driving cars and bicycles. According to the proportion of tourists who choose the mode of transportation and the related CO_2 emissions index, the CO_2 emissions situation of my country's tourism and transportation industry in 2020 is shown in Figure 7.

Through the analysis of the CO_2 emission and emission path of the tourism industry in China and the world, it is found that the CO_2 emission of the tourist industry is relatively large.

Although carbon footprints account for a small proportion of social CO_2 emissions, as time goes by, the total emissions tend to increase. The trend is obvious. Therefore, the realization of a low-carbon and environmentally friendly process in the tourist industry may have a significant role in reducing CO_2 emissions in my country and the world, which is worthy of scholars' research attention. Through the analysis of the basic channels of CO_2 emissions in the tourism industry, it can be seen that tourism transportation is the most important channel of CO_2 emissions, followed by the tourist hotel industry.

4.2. Determination of Indicator Weights

4.2.1. Construct a Judgment Matrix. When determining the weight of factors in all standards, if it is only a qualitative result, it is not easy to be recognized by others. The judgment matrix can compare all factors in this layer to get the relative importance of the upper layer factors.

4.3. Three-Level Index Judgment Matrix

(1) The weights of ecological environment indicators are determined, as shown in Table 5.

Carry out the consistency test, and the results are shown in Table 6.

(2) The weights of carbon emission indicators are determined, as shown in Table 7.

The consistency test is carried out, and the results are shown in Table 8.

5. Conclusions

The low-carbon tourist industry is the main direction of my country's tourism progress in the future. This article attempts to assess the progress standards of the low-carbon tourist industry by constructing the rural low-carbon tourist industry index system. On a certain theoretical basis, the expert consultation method and the AHP are used to select low-carbon appraised indicators for tourist attractions. Through the construction of a judgment matrix, the weight of each specific indicator is determined by the scaling method, and then a single indicator is established according to relevant standards and general practice appraisal criteria. Finally, through the comparative analysis of the research of related scholars, a method for dividing the progress standards of the low-carbon tourist industry is proposed. The low-carbon tourist industry in rural areas involves many factors, and the establishment of the low-carbon tourist industry in rural areas is a complex and challenging task. In view of the limitations of the author's ability, time, and resources, this research is only a preliminary result in this research field, and there is still a lot of room for future research.

Data Availability

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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Conflicts of Interest

The authors state that this article has no conflicts of interest.

References

[1] P. Huang and S. L. Zeng, "Evolution of green development pattern in western China," *Ecological Economy*, no. 03, pp. 202–214, 2016.

[2] J. Zha, L. He, Y. Liu, and Y. Shao, "Evaluation on development efficiency of low-carbon tourism economy: a case study of Hubei Province, China," *Socio-Economic Planning Sciences*, vol. 66, pp. 47–57, 2019.

[3] C. Gan, Y. Ou, and H. L. Liu, "[Low-carbon behavioral performance of scenic spots and the driving mechanism: a case study of Zhangjiajie World Heritage Site," *Ying yong sheng tai xue bao = The journal of applied ecology*, vol. 30, no. 1, pp. 266–276, 2019.

[4] T.-Y. Hsiao, "Developing a dual-perspective low-carbon tourism evaluation index system for travel agencies," *Journal of Sustainable Tourism*, vol. 24, no. 12, pp. 1604–1623, 2016.

[5] S. Kariminia, S. Motamedi, S. Shamshirband, D. Petkovic, C. Roy, and R. Hashim, "Adaptation of ANFIS model to assess thermal comfort of an urban square in moderate and dry climate," *Stochastic Environmental Research and Risk Assessment*, vol. 30, no. 4, pp. 1189–1203, 2016.

[6] W. W. Ma, M. G. Rasul, G. Liu, M. Li, and X. H. Tan, "Climate change impacts on techno-economic performance of roof PV solar system in Australia," *Renewable Energy*, vol. 88, pp. 430–438, 2016.

[7] M. Klauco, B. Gregorova, P. Koleda, U. Stankov, V. Markovic, and P. Lemenkova, "Land planning as a support for sustainable development based on tourism: a case study of Slovak rural region," *Environmental Engineering and Management Journal*, vol. 16, no. 2, pp. 449–458, 2017.

[8] F. Zhao, F. Liu, Z. Liu, and H. Hao, "Research on evaluation index system for low-carbon development of China's automobile industry," *Chinese Journal of Engineering Science*, vol. 20, no. 1, pp. 104–112, 2018.

[9] L. Shi and J. Sun, "Study on the methods of assessment for low-carbon development of Chinese cities," *Acta Ecologica Sinica*, vol. 38, no. 15, pp. 5461–5472, 2018.

[10] S. Lou, L. Zhang, and Y. Wu, "Coordination operation of electric vehicles and power system under low-carbon economy," *Diangong Jishu Xuebao/Transactions of China Electrotechnical Society*, vol. 32, no. 5, pp. 176–183, 2017.

[11] M. G. A. D. Cruz, T. M. Budnyak, V. Bruno, and M. Rodrigues, "Biocoatings and additives as promising candidates for ultra low friction systems," *Green Chemistry Letters and Reviews*, vol. 14, no. 2, pp. 356–379, 2021.

[12] L. F. Chen, "Green certification, e-commerce, and low-carbon economy for international tourist hotels," *Environmental Science and Pollution Research*, vol. 26, no. 18, pp. 17965–17973, 2018.

[13] B. Xia and X. Li, "Analysis and comparison on the potential of low-carbon architectural design strategies," *Sustainable Computing: Informatics and Systems*, vol. 21, pp. 204–211, 2019.

[14] B. Yang, "China's low-carbon economy development and carbon finance market supervision mechanism," *Low Carbon Economy*, vol. 08, no. 4, pp. 97–105, 2017.

[15] T. Hibino, K. Kobayashi, S. Teranishi, and T. Hitomi, "Solid oxide fuel cell using municipal solid waste directly as fuel: biomass, resin, plastic, and food waste," *ACS Sustainable Chemistry & Engineering*, vol. 9, no. 8, pp. 3124–3136, 2021.

[16] V. V. S. S. Sarma, M. H. K. Prasad, and H. B. Dalabehera, "Influence of phytoplankton pigment composition and primary production on pCO2 standards in the Indian Ocean," *Journal of Earth System Science*, vol. 130, no. 2, pp. 1–16, 2021.

[17] A. González-Garay, N. M. Dowell, and N. Shah, "A carbon neutral chemical industry powered by the sun," *Discover Chemical Engineering*, vol. 1, no. 1, pp. 1–22, 2021.

[18] C. Mirle, V. Medabalmi, and K. Ramanujam, "Electrode and conductive additive compatibility yielding excellent rate capability and long cycle life for sustainable organic aqueous Zn-ion batteries," *ACS Applied Energy Materials*, vol. 4, no. 2, pp. 1218–1227, 2021.

[19] C.-Y. Tsai, Y.-T. Pan, Y.-H. Tseng, C.-W. Liu, T.-H. Kuo, and H.-C. Hsi, "Influence of carbon-functional groups with less hydrophilicity on a TiO 2 photocatalyst for removing low-level elemental mercury," *Sustainable Environment Research*, vol. 27, no. 2, pp. 70–76, 2017.

[20] P. Zhang, H. Liu, and X. Li, "Plasmonic CuCo/carbon dots: an unconventional photocatalyst used for photocatalytic overall water splitting," *ACS Sustainable Chemistry & Engineering*, vol. 8, no. 49, pp. 17979–17987, 2020.