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Research Article

Application of Multilevel Gray Model in Tourism Economic Performance Evaluation

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The tourism industry is contributing to the rise in the national economy because of its outstanding advantages in increasing employment and winning regional economic vitality. But, there is no study to systematically evaluate the performance of China's tourism economy. Therefore, this paper adopts a multilevel gray model and scientifically constructs a tourism economic performance evaluation index system. It is found that China's tourism economic performance has the advantages of excellent development infrastructure conditions and abundant tourism resources but still has deficiencies in the aspects of social environment support, international market demand, and tourism environment support. The sustainable development potential of China's tourism industry needs to be strengthened in three aspects in the future, namely, strengthening the government's macroguidance, expanding the tourism high-quality talent pool, and enhancing the construction of tourism infrastructure and service facilities.

1. Introduction

Over the past 30 years of reform and opening up, China's tourism industry has experienced the process from scratch and from small to large and the scale of tourism economy has been expanding. According to statistics, in 2019, the total revenue of China's tourism industry was as high as 6.63 trillion yuan, with a comprehensive contribution of 11.05% to the national economy, which is on par with the world average, and tourism has been integrated into the overall development of the national economy and become a strategic pillar industry of the national economy. Tourism plays its prominent and irreplaceable role in industrial economic contribution with its high correlation with other related industries, strong drive, and outstanding traction and radiation. Tourism economic performance refers to the benefits or effects obtained by engaging in tourism-related economic activities [1]. Theoretically, the prediction and evaluation of tourism economic performance also have a very important impact on improving the tourism industry system and achieving structural optimization and transformation and upgrading of the tourism industry [2]. Therefore, evaluating China's tourism economic performance has important theoretical and practical significance for understanding the level of China's tourism economic development and promoting the sustainable and coordinated development of China's tourism industry.

Numerous scholars have adopted different indicators and used various research methods to conduct a large number of studies on the differences in China's tourism economy at different spatial and temporal scales and its processes, patterns, and mechanisms. With the development of research, the selection of indicators for tourism economy has become more comprehensive, shifting from single-factor indicators such as tourism foreign exchange earnings and domestic tourism income to multifactor composite indicators that combine both inbound and domestic tourism income to measure the level of tourism economic development [3–5]. The scale of research has been refined, gradually shifting from national to intraprovincial and focusing on the decomposition of differences in nested zoning relationships, with national and interbelt differences [6], development of important economic zones [7], and intraprovincial development [8] becoming the focus of current research. The research methodology has been diversified, from traditional methods such as coefficient of variation and Gini coefficient to principal component analysis and spatial statistical analysis [9–11], and the explanation of the causes of regional tourism economic differences has been shifted from qualitative to quantitative analysis using multiple linear regression methods. However, despite some progress in this field, there is still a lack of systematic evidence for comprehensive evaluation studies of tourism economic performance. Therefore, this paper constructs an evaluation system of tourism economic performance indicators, adopts a multilevel gray model, and discusses in depth the development status of China's tourism economic performance, which can provide theoretical guidance to guide the sustainable development of tourism.

This paper is divided into the following five parts: Sections 1 and 2 discuss the necessity of the study and the progress of related research. Section 3 introduces the research methodology and the selection of the index system. Section 4 provides the mathematical and theoretical results of the study and the discussion. Section 5 summarizes the research findings and points out the future research directions.

2. Literature Review

2.1. Progress on the Tourism Economic Performance Evaluation. Throughout the research on the economic performance of tourism industry at home and abroad, scholars focus on the economic performance of regional tourism industry as the research object, mostly on the effect of certain factors of tourism destination on the tourism industry, the construction of tourism industry economic performance evaluation model, and its own development and change characteristics.

Based on the definition of the concept of tourism industry economic performance, it is clear that economic efficiency of the tourism industry is an essential element in the discussion of performance. Therefore, many scholars have studied the economic performance of the tourism industry using economic efficiency as an entry point. For example, Aydin and Emeksiz [12] used the small tourism enterprises as an object of study to evaluate the clustering of tourism enterprises and industrial economy, and the results showed that the clustering of the small tourism enterprises can increase the industrial efficiency of tourism.

The economic performance evaluation model of tourism industry is one of the most popular aspects of tourism industry economic performance research, as it constructs an evaluation system through the selection of different dimensional evaluation indicators and uses panel data to measure and analyze the economic performance of the regional tourism industry. For example, Jin and Wei [13] constructed the evaluation index system of tourism industry performance based on the development mechanism of the regional tourism industry to evaluate the basic condition of tourism industry economic performance.

The analysis of factors affecting the economic performance of the tourism industry is also a hot topic of research both domestically and internationally. By analyzing single or multiple factors affecting the economic performance of the tourism industry, scholars at home and abroad have explored the mechanisms of influence of various factors on the economic performance of the tourism industry in different regions and guided the selection of indicators for the construction of economic performance evaluation models of the tourism industry. However, the focus of scholars differs, with foreign scholars focusing on the effect of certain factors on the tourism industry in tourism destinations, while domestic researchers focus on the review of factors influencing tourism economic performance and their degree of influence. For example, Pulido-Fernández and Cárdenas-García [14] were concerned with studying the relationship between tourism and economic development, limiting themselves to analyzing a possible unidirectional relationship between tourism, economic growth, and economic development. Adu-Ampong [15] takes a historical approach in examining the conception of tourism development in Ghana within successive national economic development plans. Dogru and Bulut [16] found that there is bidirectional causality between growth in tourism receipts and economic growth, suggesting that economic growth and tourism development are interdependent and that tourism development stimulates economic growth and vice versa in these countries.

The research on the specific content of the economic performance of the tourism industry has been expanding from the research focusing on the construction of the evaluation system of the economic performance of tourism industry and its influencing factors to the spatial and temporal evolution of the economic performance of tourism industry. The perspective of relevant research falls to the macrolevel, and on the basis of constructing regional tourism industry economic performance evaluation models and making horizontal measurements, spatial econometric models have been used to analyze the spatial distribution and spatial differences of tourism industry economic performance over time and space. For example, Wang et al. [17] carried out a comprehensive measure of urban tourism performance and explored in depth the spatial distribution characteristics of regional urban tourism performance represented by tourism economic performance and its evolution process.

2.2. Progress on the Quantitative Research Method. As we can see from the summary of the relevant literature, the use of research methods by scholars is mostly based on the research objects and contents of the articles, and the overall research trend is mainly quantitative research, supplemented by qualitative research, showing the use of basic, single econometric models to frontier, multidisciplinary methods.

In terms of qualitative methods, domestic and foreign scholars have focused on the analysis and evaluation of the factors influencing economic performance, qualitatively describing the relationship between relevant factors and the economic performance of the tourism industry. For example, Butnaru [18] analyzes the factors influencing the development of tourism performance through the content analysis of ethnography, with the aim of identifying best practices for the application of economic and managerial performance in the development of tourism.

Because the economic performance of the tourism industry is easy to quantify, quantitative research dominates this field. In terms of measuring the economic performance of tourism industry, for example, Quan [19] used a regression model to construct a system of evaluation indicators that affect the factors related to the economic performance of regional tourism and their intrinsic relationships and analyzed the basic working principles for optimizing the economic performance of the tourism industry. Anagnostou et al. [20] empirically explored the impact of tourism density concentration on tourism performance in each province through a dynamic panel data model and concluded that differences in tourism density concentration could be used to explain the differences in tourism performance development. Kumar [21] analyzed the determinants of tourism industry performance and explored the relative importance of each factor by using data envelopment analysis (DEA) and Bootstrap regression models. In addition, some scholars have used different quantitative methods to investigate the factors that affect the performance of tourism industry [22, 23]. Perles-Ribes et al. [4] studied the relationship between output and economic performance of hotel industry and measured the economic performance of hotel industry by using unit root test, analysis of covariance, and causality test, taking the number of tourists and exchange rate as the objects.

The use of research methods on the economic performance of tourism industry has been accompanied by the innovation of methods and the expansion of contents, showing new developments. The use of Bayesian methods in this field is innovative based on the use of more standardized research methods, while domestic scholars have introduced spatial econometric models and other methods to analyze the economic performance of the tourism industry based on the intervention of the spatial dimension and spatial-temporal evolution of the research perspective. For example, Assaf and Tsionas [24] developed the first Bayesian stochastic frontier model to include destination quality in the estimation of tourism industry performance system, benchmarked the performance of tourism industry based on technical and quality performance, and discussed the impact of technical performance on tourism industry performance. After that, Assaf et al. [25] further reviewed and discussed the advantages and flexibility of Bayesian methods in evaluating highly complex performance models and presented the application of Bayesian methods to tourism industry performance.

The economic performance of tourism industry, as an important measure of the process and effect of tourism industry production activities, has received extensive attention from scholars in China and abroad, and many valuable research results have been obtained. As tourism continues to become an important and indispensable industry in the national economic system, it is particularly important to deepen and improve the research on the economic performance of tourism industry. A clear research direction has been developed in this field, with in-depth empirical research mainly focused on the factors influencing the economic performance of the tourism industry and the evaluation system of the tourism industry's economic performance. The research methodology draws on multidisciplinary innovation, currently represented by the use of Bayesian methods and other cutting-edge research methods, and continues to lead the innovation of research methods in this field. Therefore, the current research should strengthen the exploration of basic theories, standardize the system of indicators for assessing the economic performance of tourism industry, establish a set of scientific and advanced performance evaluation methods, and consider the possible effects of economic, social, and environmental factors on the economic performance of the tourism industry.

3. Research Method

The research process is divided into six steps and two modules, starting with data collection and processing, followed by analysis and results (Figure 1).

3.1. Multilevel Gray Evaluation. Gray system theory has the advantage that general mathematical and statistical methods do not have, that is, the use of a number of experts to analyze the research object can obtain objective and credible evaluation results, and therefore is often used to solve the "information uncertainty" and "small sample" problem. Furthermore, the gray criterion method can better systemize the gray relationship between the factors and indicators in the complex evaluation system, with higher resolution.

3.2. Indicator Weights

3.2.1. AHP Method

(1) Weighting of the Indicator Layer to the Factor Layer. The judgment matrix is constructed by the 9-scalar method, and the weights are obtained by the eigenvector method. Then, the weight v_k of the k_{th} indicator under each criterion layer is

$$v_k = \frac{v_k'}{\sum_{i=1}^{M} v_k'}, \tag{1}$$

where v_k is the weight of the k_{th} indicator in the factor layer; $v_k^{'}$ is the k_{th} eigenvector corresponding to the maximum eigenvalue of the judgment matrix; and M is the number of indicators in the factor layer. If the results pass the consistency test, the weights are reasonably assigned. Otherwise, the judgment matrix is reconstructed to find the weights.

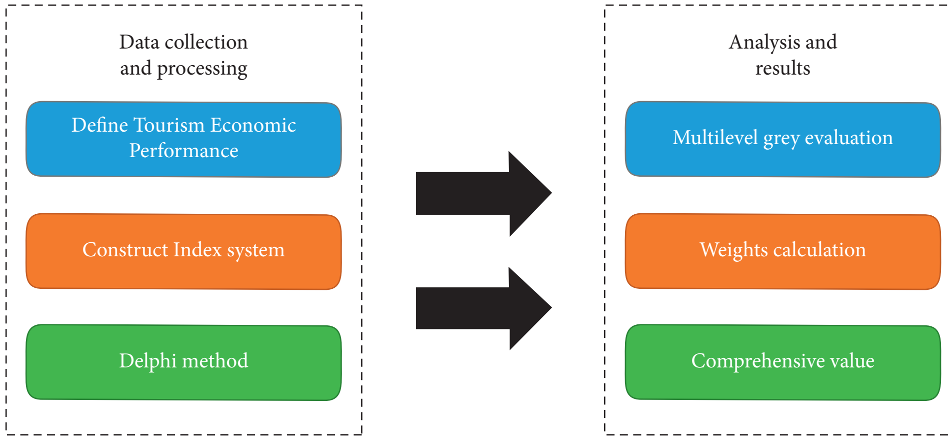

FIGURE 1: Research process.

(2) Weighting of the Indicator Layer to the Target Layer. p_k is the weight of the k_{th} indicator in the j_{th} factor layer to the target layer; v_k is the weight of the k_{th} indicator in the j_{th} factor layer to the j_{th} factor layer; v_j is the weight of the j_{th} factor layer to the target layer ($j = 1, 2, \ldots, 6$; $k = 1, 2, \ldots, M$):

$$p_k = v_k \times v_j. \tag{2}$$

3.2.2. Coefficient of Variation Method. Let u_k be the weight of the k_{th} indicator obtained by the coefficient of variation method, m be the number of evaluation indicators, and n be the number of evaluation experts. The formula for finding the weight according to the coefficient of variation is as follows:

$$v_k = \frac{\sqrt{\sum_{i=1}^{n} \left(V_{ki} - \overline{V_k}\right)^2 / n} / \overline{V_k}}{\sum_{k=1}^{m} \sqrt{\sum_{i=1}^{n} \left(V_{ki} - \overline{V_k}\right)^2 / n} / \overline{V_k}}, \tag{3}$$

where v_{ki} is the value of the i_{th} expert on the k_{th} indicator and $\overline{V_k}$ is the average of the values of all experts on the k_{th} indicator.

3.2.3. Comprehensive Weights. Let the objective weights of the i_{th} indicator, w_{si} and w_{oi}, respectively, be calculated by the following formula:

$$w_i = \frac{w_{si} \times w_{oi}}{\sum_{i=1}^{m} w_{si} \times w_{oi}}. \tag{4}$$

3.3. Evaluation Sample Matrix. The number of evaluation experts is k, $k = 1, 2, 3, \ldots, n$; i.e., there are n evaluation experts. Each evaluation expert evaluates the system of indicators. (If one object is evaluated, then a matrix is created for each first-level indicator; if multiple objects are evaluated, then a matrix is created for each set of indicators. In case of multiple targets, the evaluation matrix is created with a set of indicators corresponding to different targets; i.e., one target can be evaluated or multiple targets can be evaluated.)

Here, taking multiple evaluation targets as an example, x scores the evaluation index U_{ij} of the first project with the rating scale $d_{ij}^{(x)}$ and x fills in the expert rating form to get the evaluation sample matrix $D^{(x)}$ of the first project according to this form.

$$D^{(x)} = \begin{bmatrix} d_{111}^{(x)} & d_{112}^{(x)} & d_{113}^{(x)} & \cdots & d_{11n}^{(x)} \\ d_{121}^{(x)} & d_{122}^{(x)} & d_{123}^{(x)} & \cdots & d_{12n}^{(x)} \\ d_{131}^{(x)} & d_{132}^{(x)} & d_{133}^{(x)} & \cdots & d_{13n}^{(x)} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ d_{ij1}^{(x)} & d_{ij2}^{(x)} & d_{ij3}^{(x)} & \cdots & d_{ijn}^{(x)} \end{bmatrix} \begin{matrix} U_{11} \\ U_{12} \\ U_{13} \\ U_{14} \end{matrix}. \tag{5}$$

3.4. Evaluation Gray Category. Due to the influence of human factors, experts can only give a whitening value of the gray number. In order to truly reflect the degree of belonging to a certain category, it is necessary to determine the level of the evaluation gray category, the gray number of the gray category, and the whitening weight function of the gray number. Let the evaluation gray class number be e, $e = 1, 2, 3, \ldots, m$; that is, there are m evaluation gray classes. Usually, according to the actual needs of the research content, the evaluation gray class is divided into five levels (from high to low), $m = 5$. In such a case, it is necessary to determine the whitening weight function for evaluating the gray classes for characterizing the above gray classes.

The first gray category, high level ($e = 1$): set the gray number as $\otimes_1 \in [0, 1, 2]$ and the whitening weight function as f_1:

$$f_1\left(d_{ijk}^{(x)}\right) \begin{cases} 1, & d_{ijk}^{(x)} \in [0, 1], \\ \dfrac{\left(2 - d_{ijk}^{(x)}\right)}{1}, & d_{ijk}^{(x)} \in [1, 2], \\ 0, & d_{ijk}^{(x)} \in [0, 2]. \end{cases} \tag{6}$$

The second gray category, very high level ($e = 2$): set the gray number as $\otimes_1 \in [0, 2, 4]$ and the whitening weight function as f_2

$$f_2\left(d_{ijk}^{(x)}\right)\begin{cases}\dfrac{d_{ijk}^{(x)}}{2}, & d_{ijk}^{(x)} \in [0,2],\\ \dfrac{\left(4-d_{ijk}^{(x)}\right)}{1}, & d_{ijk}^{(x)} \in [2,4],\\ 0, & d_{ijk}^{(x)} \in [0,4].\end{cases} \tag{7}$$

The third gray category, high level ($e = 3$): set the gray number as $\otimes_1 \in [0, 3, 6]$ and the whitening weight function as f_3:

$$f_3\left(d_{ijk}^{(x)}\right)\begin{cases}\dfrac{d_{ijk}^{(x)}}{3}, & d_{ijk}^{(x)} \in [0,3],\\ \dfrac{\left(6-d_{ijk}^{(x)}\right)}{1}, & d_{ijk}^{(x)} \in [3,6],\\ & d_{ijk}^{(x)} \in [0,6].\\ 0, & \end{cases} \tag{8}$$

The fourth gray category, normal level ($e = 4$): set the gray number as $\otimes_1 \in [0, 4, 8]$ and the whitening weight function as f_4:

$$f_4\left(d_{ijk}^{(x)}\right)\begin{cases}\dfrac{d_{ijk}^{(x)}}{4}, & d_{ijk}^{(x)} \in [0,4],\\ \dfrac{\left(8-d_{ijk}^{(x)}\right)}{4}, & d_{ijk}^{(x)} \in [4,8],\\ & d_{ijk}^{(x)} \in [0,8].\\ 0, & \end{cases} \tag{9}$$

The fifth gray category, very low level ($e = 5$): set the gray number as $\otimes_1 \in [0, 5, 10]$ and the whitening weight function as f_5:

$$f_5\left(d_{ijk}^{(x)}\right)\begin{cases}\dfrac{d_{ijk}^{(x)}}{5}, & d_{ijk}^{(x)} \in [0,5],\\ \dfrac{\left(8-d_{ijk}^{(x)}\right)}{4}, & d_{ijk}^{(x)} \in [5,10],\\ & d_{ijk}^{(x)} \in [0,10].\\ 0, & \end{cases} \tag{10}$$

3.5. Gray Evaluation Coefficient. For the evaluation indicator U_{ij}, the gray evaluation coefficient of the x_{th} item belonging to the e_{th} evaluation gray category is denoted as $M_{ije}^{(x)}$:

$$M_{ije}^{(x)} = \sum_{k=1}^{n} f_e\left(d_{ijk}^{(x)}\right). \tag{11}$$

For the evaluation indicator U_{ij}, the gray coefficient of the x_{th} item belonging to each evaluation gray category is denoted as $M_{ije}^{(x)}$:

$$M_{ij}^{(x)} = \sum_{k=1}^{n} M_{ije}^{(x)}. \tag{12}$$

3.6. Gray Evaluation Weight Vector and Weight Matrix. For all evaluation experts on the evaluation index U_{ij}, the evaluation weight of the e_{th} gray category of the x_{th} project is noted as $r_{ije}^{(x)}$, where $r_{ije}^{(x)} = M_{ije}^{(x)}/M_{ij}^{(x)}$.

Considering that there are 5 gray categories, i.e., $e = 1$, 2, 3, 4, and 5, we have a gray evaluation weight vector $r_{ij}^{(x)}$ for each gray category for the evaluation indicator U_{ij} of the x_{th} evaluated item.

$$r_{ij}^{(x)} = \left(r_{ij1}^{(x)}, r_{ij2}^{(x)}, r_{ij3}^{(x)}, r_{ij4}^{(x)}, r_{ij5}^{(x)}\right). \tag{13}$$

This gives the gray evaluation weight matrix $R_i^{(x)}$ for each evaluation gray category for the indicator U_i of the x_{th} evaluated project.

$$R_i^{(x)} = \begin{bmatrix} r_{i1}^{(x)} \\ r_{i2}^{(x)} \\ r_{i3}^{(x)} \\ \vdots \\ r_{i5}^{(x)} \end{bmatrix} = \begin{bmatrix} r_{i11}^{(x)} & r_{i12}^{(x)} & r_{i13}^{(x)} & r_{i14}^{(x)} & r_{i15}^{(x)} \\ r_{i21}^{(x)} & r_{i22}^{(x)} & r_{i23}^{(x)} & r_{i24}^{(x)} & r_{i25}^{(x)} \\ r_{i31}^{(x)} & r_{i32}^{(x)} & r_{i33}^{(x)} & r_{i34}^{(x)} & r_{i35}^{(x)} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ r_{i51}^{(x)} & r_{i52}^{(x)} & r_{i53}^{(x)} & r_{i54}^{(x)} & r_{i55}^{(x)} \end{bmatrix}. \tag{14}$$

3.7. Comprehensive Evaluation. The evaluation index U_{ij} of the x_{th} project is evaluated comprehensively, and the result is recorded as $B_i^{(x)}$.

$$B_i^{(x)} = A_i \times R_i^{(x)} = \left(b_{i1}^{(x)}, b_{i2}^{(x)}, b_{i3}^{(x)}, b_{i4}^{(x)}, b_{i5}^{(x)}\right). \tag{15}$$

The gray evaluation weight matrix $R^{(x)}$ of the U_i indicators of the x_{th} evaluated project for each evaluation gray category is obtained from the combined evaluation results $B_i^{(x)}$ of U_{ij}.

$$R^{(x)} = \begin{bmatrix} B_1^{(x)} \\ B_2^{(x)} \\ B_3^{(x)} \\ \vdots \\ B_5^{(x)} \end{bmatrix} = \begin{bmatrix} b_{i11}^{(x)} & b_{i12}^{(x)} & b_{i13}^{(x)} & b_{i14}^{(x)} & b_{i15}^{(x)} \\ b_{i21}^{(x)} & b_{i22}^{(x)} & b_{i23}^{(x)} & b_{i24}^{(x)} & b_{i25}^{(x)} \\ b_{i31}^{(x)} & b_{i32}^{(x)} & b_{i33}^{(x)} & b_{i34}^{(x)} & b_{i35}^{(x)} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ b_{i51}^{(x)} & b_{i52}^{(x)} & b_{i53}^{(x)} & b_{i54}^{(x)} & rb_{i55}^{(x)} \end{bmatrix}. \tag{16}$$

Thus, for the x_{th} evaluated item, the indicator U_i is evaluated comprehensively and the result is recorded as $B^{(x)}$.

$$B^{(x)} = A_i \times R_i^{(x)} = \left(b_1^{(x)}, b_2^{(x)}, b_3^{(x)}, b_4^{(x)}, b_5^{(x)}\right). \tag{17}$$

3.8. Comprehensive Evaluation Value. Let each evaluation gray class level be assigned by "gray level"; then, each evaluation gray class level valuation vector $C = (1, 2, 3, 4, 5)$. Thus, the comprehensive evaluation value $Z^{(x)}$ of the x_{th} evaluated item is calculated by the following formula:

$$Z^{(x)} = B^{(x)} \times C^T. \tag{18}$$

3.9. Index System Construction and Data Sources

3.9.1. Index Selection. The process of constructing the indicator system should follow the general scientific paradigm and implement the principles of systematicity, scientificity, comparability, and feasibility (Table 1). Based on the previous literature, this paper divides tourism economic performance into six components, which are tourism resource conditions, tourism market capacity, tourism development benefits, socioeconomic support, development condition support, and environmental carrying support (Figure 2).

3.9.2. Data Source. The data in this paper are mainly from the China Tourism Statistical Yearbook, the Statistical Bulletin of National Economic and Social Development, and the State Ministry of Culture and Tourism.

4. Results and Discussion

According to the experts' scores for each indicator, the following gray evaluation sample matrix was established:

$$R_1^{(1)} = \begin{vmatrix} 0 & 0.0213 & 0.2455 & 0.3197 & 0.2566 \\ 0 & 0.0124 & 0.2344 & 0.2197 & 0.3144 \\ 0 & 0.2267 & 0.3125 & 0.3346 & 0.3987 \\ 0 & 0.1345 & 0.2647 & 0.4127 & 0.2987 \\ 0 & 0.2234 & 0.2144 & 0.1876 & 0.3762 \end{vmatrix},$$

$$R_2^{(1)} = \begin{vmatrix} 0 & 0.0312 & 0.0231 & 0.2987 & 0.3897 \\ 0 & 0.1897 & 0.0128 & 0.3589 & 0.1278 \\ 0 & 0.1987 & 0.1287 & 0.1654 & 0.6725 \\ 0 & 0.2465 & 0.3864 & 0.1972 & 0.2837 \\ 0 & 0.1767 & 0.3789 & 0.2987 & 0.1273 \end{vmatrix},$$

$$R_3^{(1)} = \begin{vmatrix} 0 & 0.0128 & 0.4189 & 0.3178 & 0.1297 \\ 0 & 0.1278 & 0.1894 & 0.2193 & 0.1278 \\ 0 & 0.3987 & 0.2875 & 0.1283 & 0.1283 \\ 0 & 0.3876 & 0.3178 & 0.2187 & 0.2398 \\ 0 & 0.3986 & 0.3127 & 0.2893 & 0.2378 \end{vmatrix},$$

$$R_4^{(1)} = \begin{vmatrix} 0 & 0.2893 & 0.1244 & 0.1278 & 0.2476 \\ 0 & 0.1245 & 0.1283 & 0.1231 & 0.2586 \\ 0 & 0.2613 & 0.2857 & 0.3344 & 0.3713 \\ 0 & 0.1287 & 0.2765 & 0.2987 & 0.1347 \\ 0 & 0.7891 & 0.2756 & 0.1235 & 0.4122 \end{vmatrix},$$

$$R_5^{(1)} = \begin{vmatrix} 0 & 0.1237 & 0.3145 & 0.1289 & 0.4812 \\ 0 & 0.2455 & 0.3763 & 0.4178 & 0.4128 \\ 0 & 0.1244 & 0.3786 & 0.3071 & 0.4198 \\ 0 & 0.2499 & 0.3786 & 0.4871 & 0.4178 \\ 0 & 0.1237 & 0.1827 & 0.4198 & 0.4122 \end{vmatrix},$$

$$R_6^{(1)} = \begin{vmatrix} 0 & 0.1345 & 0.2412 & 0.3156 & 0.2234 \\ 0 & 0.1293 & 0.2422 & 0.2176 & 0.4512 \\ 0 & 0.0872 & 0.2987 & 0.3178 & 0.4178 \\ 0 & 0.0912 & 0.2615 & 0.3187 & 0.4187 \\ 0 & 0.1124 & 0.2189 & 0.3176 & 0.4176 \end{vmatrix}, \tag{19}$$

$$R_7^{(1)} = \begin{vmatrix} 0 & 0.1237 & 0.2678 & 0.3652 & 0.3167 \\ 0 & 0.1874 & 0.2764 & 0.3587 & 0.4187 \\ 0 & 0.1627 & 0.2187 & 0.3176 & 0.4127 \\ 0 & 0.1768 & 0.1768 & 0.3874 & 0.4176 \\ 0 & 0.1765 & 0.2576 & 0.2387 & 0.4475 \end{vmatrix}.$$

For tourism economic performance, the whitening weight function of each gray category is first calculated according to the division of the evaluation gray category. When $e = 1$,

$$M_{111}^{(1)} = \sum_{e=1}^{5} r_{11}^{(1)} = \left(r_{111}^{(1)} + r_{112}^{(1)} + r_{113}^{(1)} + r_{114}^{(1)} + r_{115}^{(1)}\right) = 0. \tag{20}$$

Then, the total gray evaluation coefficient $M_{11}^{(1)}$ of tourism economic performance belonging to each evaluation gray category is

$$M_{11}^{(1)} = \sum_{e=1}^{5} M_{11e}^{(1)} = \left(M_{111}^{(1)} + M_{112}^{(1)} + M_{113}^{(1)} + M_{114}^{(1)} + M_{115}^{(1)}\right). \tag{21}$$

According to the formula for the gray weight vector, the tourism economic performance weight vector can be obtained as

$$r_{11}^{(1)} = \left(r_{111}^{(1)} + r_{112}^{(1)} + r_{113}^{(1)} + r_{114}^{(1)} + r_{115}^{(1)}\right). \tag{22}$$

The evaluation vector of each subperformance is calculated based on the weight of each indicator and the weight vector of each performance (Figures 3–8).

$$\begin{aligned} B_1^{(1)} &= F_1 \times R_1^{(x)} = (0, 0.0478, 0.2234, 0.3124, 0.3198), \\ B_2^{(1)} &= F_2 \times R_2^{(x)} = (0, 0.0871, 0.2987, 0.3122, 0.2587), \\ B_3^{(1)} &= F_3 \times R_3^{(x)} = (0, 0.1281, 0.2987, 0.3152, 0.4182), \\ B_4^{(1)} &= F_4 \times R_4^{(x)} = (0, 0.1212, 0.1952, 0.3812, 0.4123), \\ B_5^{(1)} &= F_5 \times R_5^{(x)} = (0, 0.1237, 0.1287, 0.2674, 0.3892), \\ B_6^{(1)} &= F_6 \times R_6^{(x)} = (0, 0.1231, 0.2578, 0.3128, 0.3122), \\ B^{(1)} &= P \times R^{(1)} = (0, 0.0974, 0.1241, 0.2587, 0.2852). \end{aligned} \tag{23}$$

Table 1: Index system of tourism economic performance.

O	F	I	AHP weights	Coefficient of variation weights	Comprehensive weights	
					F	P
Tourism economic performance (O)	Tourism resource conditions (F_1)	I_{11} number of scenic spots above A grade	0.0237	0.0397	0.1124	0.0321
		I_{12} number of 5A-class scenic spots	0.0311	0.0412	0.2671	0.0245
		I_{13} number of 4A-class scenic spots	0.0456	0.0290	0.0982	0.0160
		I_{14} percentage of scenic spots above 4A level	0.0479	0.0312	0.2214	0.0123
	Tourism market capacity (F_2)	I_{21} number of inbound tourists	0.0133	0.0376	0.1369	0.0457
		I_{22} average number of days of stay of inbound tourists	0.0246	0.0349	0.1422	0.0112
		I_{23} per capita consumption of inbound tourists	0.0389	0.0267	0.2344	0.0090
		I_{24} number of domestic tourists	0.0677	0.0134	0.4127	0.0144
	Tourism development benefits (F_3)	I_{31} total tourism revenue	0.0324	0.0444	0.2899	0.0152
		I_{32} tourism foreign exchange revenue	0.0478	0.0324	0.3675	0.0148
		I_{33} domestic tourism revenue	0.0579	0.0409	0.2415	0.0267
		I_{34} tourism enterprise full productivity	0.0264	0.0312	0.1027	0.0312
	Socioeconomic support (F_4)	I_{41} government fiscal expenditure	0.0134	0.0224	0.2122	0.0258
		I_{42} GDP per capita	0.0365	0.0317	0.2348	0.0297
		I_{43} number of students in general higher education	0.0374	0.0139	0.2678	0.0333
		I_{44} number of employees in tourism industry	0.0267	0.0461	0.2597	0.0234
	Development condition support (F_5)	I_{51} number of star-rated hotels	0.0642	0.0332	0.2643	0.0127
		I_{52} number of tourist rooms, overview of travel agencies	0.0558	0.0134	0.3679	0.0116
		I_{53} number of tourism colleges	0.0294	0.0125	0.1968	0.0159
		I_{54} number of students in tourism colleges	0.0132	0.0444	0.3245	0.0431
	Environmental carrying support (F_6)	I_{61} forest coverage rate	0.0309	0.0724	0.1654	0.0332
		I_{62} number of scenic parks	0.0212	0.0451	0.1378	0.0427
		I_{63} green base area per capita	0.0513	0.0512	0.3569	0.0289
		I_{64} centralized sewage treatment rate	0.0421	0.0364	0.4120	0.0412

Note. O = objective level, F = factor level, and I = indicator level.

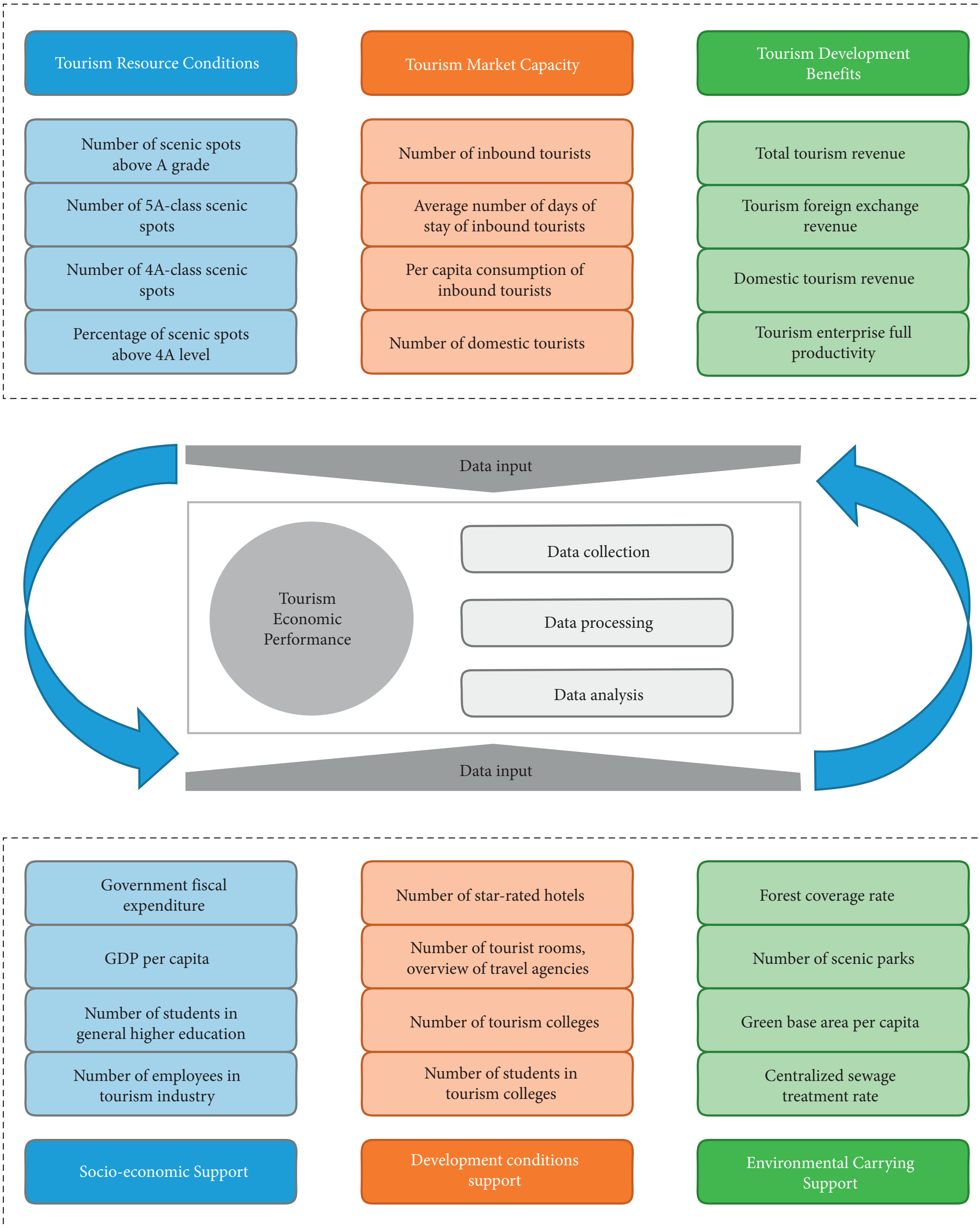

Figure 2: Index system.

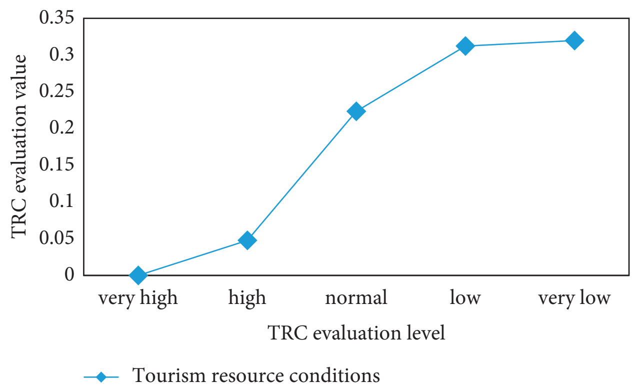

Figure 3: Tourism resource condition evaluation value.

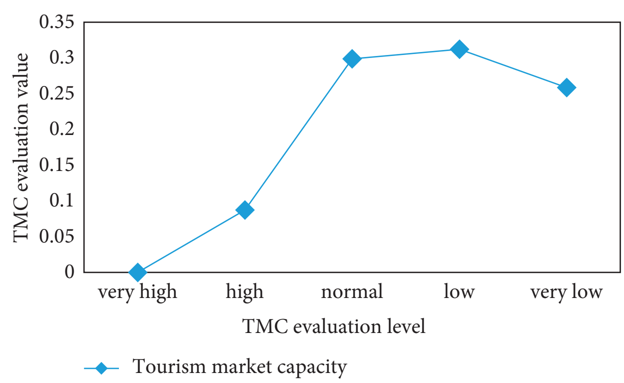

Figure 4: Tourism market capacity evaluation value.

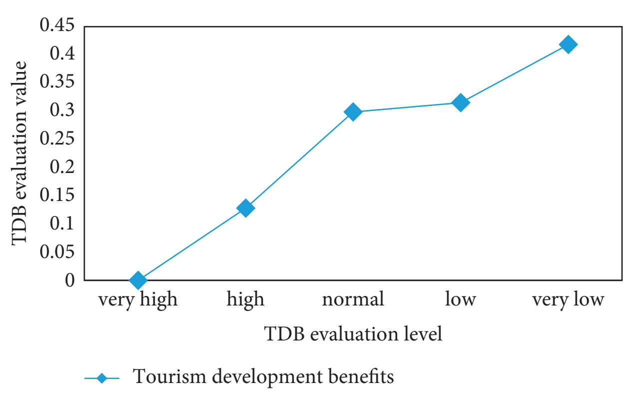

Figure 5: Tourism development benefit evaluation value.

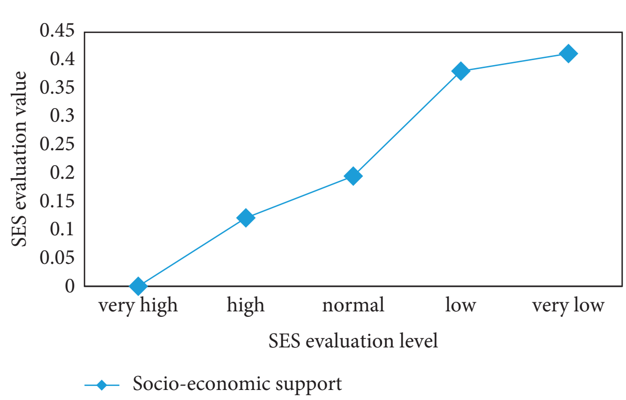

Figure 6: Socioeconomic support evaluation value.

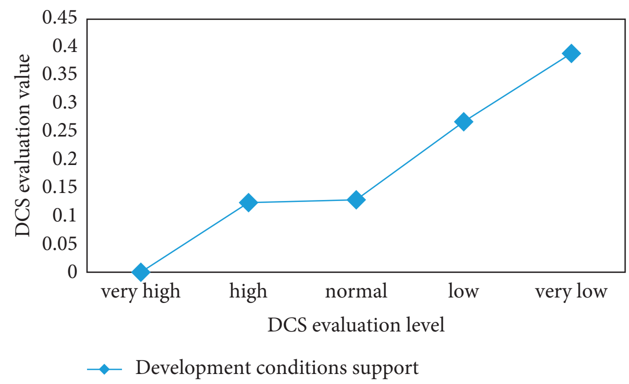

Figure 7: Development condition support evaluation value.

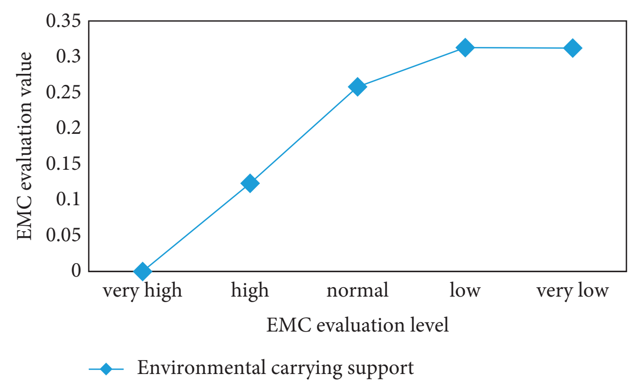

Figure 8: Environmental carrying support evaluation value.

Table 2: Results of tourism economic performance evaluation.

TEP	Evaluation					CEV
	Very high	High	Normal	Low	Very low	
Development condition support	0	0.1237	0.1287	0.2674	0.3892	3.9542
Tourism resource conditions	0	0.0478	0.2234	0.3124	0.3198	3.9231
Tourism development benefits	0	0.1281	0.2987	0.3152	0.4182	3.9134
Socioeconomic support	0	0.1212	0.1952	0.3812	0.4123	3.6724
Tourism market capacity	0	0.0871	0.2987	0.3122	0.2587	3.4389
Environmental carrying support	0	0.1231	0.2578	0.3128	0.3122	3.2398
Comprehensive performance	0	0.1052	0.2338	0.3169	0.3517	3.6903

Note. TEP = tourism economic performance and CEV = comprehensive evaluation value.

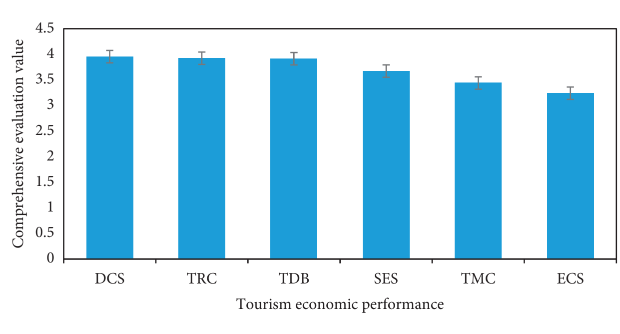

Figure 9: Comprehensive evaluation value rank.

Finally, based on the performance level and the weight vector of each performance, the tourism economic performance evaluation value and the total performance are calculated as follows:

$$\begin{aligned}
Z_1^{(1)} &= B_1^{(1)} \times C^{\mathrm{T}} = (0, 0.0478, 0.2234, 0.3124, 0.3198) \\
&\quad \cdot (1, 2, 3, 4, 5)^{\mathrm{T}} = 3.9231, \\
Z_2^{(1)} &= B_2^{(1)} \times C^{\mathrm{T}} = (0, 0.0871, 0.2987, 0.3122, 0.2587) \\
&\quad \cdot (1, 2, 3, 4, 5)^{\mathrm{T}} = 3.4389, \\
Z_3^{(1)} &= B_3^{(1)} \times C^{\mathrm{T}} = (0, 0.1281, 0.2987, 0.3152, 0.4182) \\
&\quad \cdot (1, 2, 3, 4, 5)^{\mathrm{T}} = 3.9134, \\
Z_4^{(1)} &= B_4^{(1)} \times C^{\mathrm{T}} = (0, 0.1212, 0.1952, 0.3812, 0.4123) \\
&\quad \cdot (1, 2, 3, 4, 5)^{\mathrm{T}} = 3.6724, \\
Z_5^{(1)} &= B_5^{(1)} \times C^{\mathrm{T}} = (0, 0.1237, 0.1287, 0.2674, 0.3892) \\
&\quad \cdot (1, 2, 3, 4, 5)^{\mathrm{T}} = 3.9542, \\
Z_6^{(1)} &= B_6^{(1)} \times C^{\mathrm{T}} = (0, 0.1231, 0.2578, 0.3128, 0.3122) \\
&\quad \cdot (1, 2, 3, 4, 5)^{\mathrm{T}} = 3.2398, \\
Z^{(1)} &= B^{(1)} \times C^{\mathrm{T}} = (0, 0.0974, 0.1241, 0.2587, 0.2852) \\
&\quad \cdot (1, 2, 3, 4, 5)^{\mathrm{T}} = 3.6477.
\end{aligned} \tag{24}$$

Table 2 shows the specific scores for the different evaluation dimensions, ranked from highest to lowest. Specifically, the first place is the development condition support, followed closely by the tourism resource conditions and the tourism development benefits, and the last place is the environmental carrying support. In general, China has good basic conditions for tourism economic performance and great development potential (Figure 9).

Figure 9 gives the high and low ratings for the different dimensions, and it can be seen that development condition support has the highest rating and environmental carrying support has the lowest rating.

5. Conclusions

Tourism economic performance evaluation is an important tool to analyze the sustainability of China's tourism economic development. Based on a multilevel gray model, this paper evaluates the performance of China's tourism economy in terms of tourism resource conditions, tourism market capacity, tourism development benefits, socio-economic support, development condition support, and environmental carrying support. The results of the study have some guiding significance for the sustainable development of China's tourism industry. This paper constructs a systematic and scientific index evaluation system, which is the first comprehensive and systematic evaluation of China's tourism economic performance and makes up for the lack of attention to tourism economic performance in previous studies. To my knowledge, this paper is the first to use gray multilevel analysis for systematic evaluation of tourism economic performance.

China's tourism economy has excellent basic conditions for development, rich resource endowments, and great potential for tourism development. However, it needs to continue to strengthen the following areas: First is the strengthening of the policy guidance. The government's industrial objectives, investment policies, and openness policies are essential to the development of the tourism industry. Active policies are necessary to increase the potential of tourism industry. The role of government policy is not only to guide and regulate the system of tourism resources development, utilization, and protection, investment guidance, macroeconomic regulation, and social and political stability, but also the degree of standardization of government management and methods and means to promote tourism development are also conducive to the formation of the overall synergy of the regional tourism industry and further affect the potential of the tourism industry. Secondly, various industries and departments should play their own advantages to grasp the development of the tourism industry; for example, construction, transportation, forestry, agriculture, marine, culture, religion, civil affairs commission, and science and technology departments should play their own advantages according to the needs of the tourism market and the development and construction of tourism products with their own characteristics, to achieve the "docking" with the tourism industry to expand the connotation of the tourism industry, through the integration between industries to create a high-grade, diversified boutique to enhance the potential of the tourism industry. Furthermore, in order to cultivate more tourism business clusters to create good conditions for the development of tourism industry clusters, the development of relevant local regulations is attained to regulate and maintain the "trust relationship" between enterprises within the cluster. At the same time, government departments need to consider establishing tourism information collection and dissemination agencies to obtain timely information on the latest products, services, markets, peer dynamics, etc., and disseminate it to neighboring tourism enterprises to build a good information exchange mechanism for tourism enterprises and provide a basis for enterprise innovation.

In terms of the construction of tourism talents, to improve the level of innovation in tourism technology, it is ultimately achieved through people. The development of the tourism industry requires the entry of talents with comprehensive qualities. In particular, it is necessary to have people with high technology skills to realize the leapfrog development of the tourism industry. At present, although the overall quality of the tourism industry has been improved, there is still a considerable gap compared with that of developed countries. With the continuous expansion of the tourism industry, the demand for talents in the tourism industry is constantly increasing and there is no doubt that the development of science and technology requires talents. The tourism industry is a labor-intensive industry, and the rapid turnover of talents in the tourism industry makes the demand for talents even greater. Therefore, building a high-quality tourism workforce is the key to improving the level of innovation in tourism technology. Education is the foundation for building a high-quality tourism workforce. In particular, school education solves the problem of the source of high-quality personnel. At the present stage, the country should integrate the resources of tourism education to realize the integration of tourism teaching and scientific research. The training of high-level tourism personnel with new technologies and ideas should be increased, and the training of existing personnel should be intensified. The training of talents with high theoretical training and strong practical ability, and ultimately, through public opinion and policy guidance, to accelerate the training of talents, ensure the prosperity of tourism talents and realize the high-quality development of the tourism industry.

In terms of strengthening the tourism environment, tourism industry potential is the comprehensive ability of the tourism industry to create value. Importantly, infrastructure is a strategic priority to increase tourism potential and is an important safeguard to promote tourism development. First, the construction of technical infrastructure is vigorously promoted to improve the infrastructure environment of transportation, communication, and information to create a good hard environment for the management and development of tourism industry. Second is the provision of tourism industry infrastructure. The government should carefully design and plan the infrastructure objectives according to the public infrastructure required for tourism industry clusters and focus on implementation steps and specific programs. Third, the investment and construction of science and technology infrastructure are further increased to attract science and technology resources to improve the strength of science and technology to foster the technical environment for the development of tourism industry.

This paper still has some shortcomings. Firstly, different types of indicator systems can be further considered in the future and different methods can be used to evaluate and verify each other with the research findings of this paper. Second, this paper does not discuss the influencing factors of tourism economic performance, and multiple regression analysis can be used in the future to further measure and verify the key factors affecting tourism economic performance.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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