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Evaluation of Tourism Environmental Carrying Capacity of Natural Environment Area Based on Artificial Intelligence

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Abstract: With the rapid development of the economy, the tourism industry has been rapidly promoted, and the environmental pollution problems caused by the serious overloading of tourists have emerged in various tourist areas. Although it has effectively improved the development speed of tourism economy, it is not conducive to the ecological stability of local tourism areas. The sustainable economic growth of tourism needs to analyze the scenic resources and calculate the Carrying Capacity (CC) of the scenic resources. This refers to the level of tourism activities that can be supported by a specific tourism destination. The number of tourists that can be accommodated in the scenic spot can be estimated by investigating the environmental CC of the natural scenic spot, so as to ensure that the tourism development would not damage the environment of the scenic spot. The traditional analysis of Tourism Environmental Carrying Capacity (TECC) is based on artificial analysis indicators, which leads to inaccurate analysis of the environmental CC of tourism areas. With the development of Artificial Intelligence (AI) technology, this paper applied AI technology to the analysis of TECC of natural environment areas. This paper compared the traditional analysis of TECC with the analysis of TECC based on AI technology. The accuracy of the analysis of the TECC of the traditional natural environment area was the highest of 86.8%, and the accuracy of the analysis of the TECC of the natural environment area based on AI was the highest of 94.2%. Therefore, the application of AI technology to comprehensive analysis of various resource indicators of scenic spots could effectively improve the accuracy of environmental CC analysis of scenic spots.

1. Introduction

With the improvement of social living standards, a large number of tourism marketing and

people's yearning for ecotourism areas have led to more and more people enjoying natural environment tourism. The quality of people's life and the way of life are more and more closely related to the ecological environment. Ecotourism has effectively promoted the economic development of the tourist area and also provided a comfortable environment for people. However, due to the unreasonable development and lagging management, the ecotourism resources in some places have been damaged to varying degrees. This mainly includes too much tourist flow and a large number of uncivilized tourism in tourist areas. The littering of garbage, the destruction of the ecological environment and the over-exploitation of tourism resources all lead to the destruction of tourism ecological resources. Most natural environment tourist destinations are often crowded with tourists. Although a large number of tourists can significantly increase the income of the industry, they would also seriously pollute the surrounding areas because they exceed the ability of the environment to support them. This short-sighted behavior of abandoning environmental protection for the sake of economic development would eventually shorten the life cycle of tourist attractions. With the establishment of the concept of sustainable development, the ecology of tourist areas needs to be effectively protected. In order to effectively limit the number of tourists and ensure the sustainable development of the tourist attractions, the environmental CC of the tourist attractions in the natural environment zone is assessed by checking the resources in the natural environment zone. Therefore, this paper had research significance.

The tourism environment in the natural environment area is being seriously damaged. The main reason is that the TECC is not clear. Therefore, many people have analyzed the TECC of the natural environment area. Among them, Butler Richard William made statistics on the factors that affected the environmental CC of tourist areas. There were many factors that affected the tourism CC, and the coverage was also diversified, including the CC of scenic resources, the CC of the number of tourists and the CC of economic development [1]. Li Rui-min examined China's groundwater, mineral, and other geological resources as well as the country's environmental CC, and proposed an evaluation method based on technical ideas. Through comprehensive analysis of China's geological environmental indicators, the environmental CC of the study area could be calculated [2]. Muler Gonzalez Vanessa made statistics on residents' views on the impact of tourism through questionnaires. Residents' willingness to enter and maintain exchange relations was mainly affected by tourism dependence, which was to a lesser extent affected by gender and education [3].

Through the comprehensive evaluation of various indicators affecting the environment of the scenic spot, the calculation of the environmental CC of the local scenic spot can effectively improve the environmental sustainable development capacity of the tourist area, but it lacks the use of intelligent technology to analyze the TECC.

AI is an effective analysis method. Relevant research has applied AI to the analysis of TECC in natural environment areas. Among them, Cai Zhenrao used digital technology to digitize Lushan cultural landscape heritage, and integrated all elements. He created a virtual tourism subsystem, and developed sustainable heritage tourism according to the CC of tourism environment [4]. Sati Vishwambhar Prasad investigated the CC of tourist routes and the development of destinations, and collected data on the flow of tourists/pilgrims, accommodation, transportation and infrastructure using qualitative and quantitative methods. Sustainable tourism development could promote tourism economic activities [5]. Holden Andrew's research pointed out that excessive tourism activities and the development of tourism resources seriously damaged the environment. Adherence to sustainable development and analysis of TECC could improve the stability of economic development in tourism areas [6]. The acquisition of the environmental CC indicators of tourist areas and the corresponding management strategies could effectively reduce the damage to the environment of tourist areas, but the analysis of the environmental CC indicators of tourism was not detailed enough.

Due to the large number of tourists in the tourist area, the environment has been seriously damaged. This paper constructed the index of environmental CC of tourism areas, and used AI technology to comprehensively evaluate the environmental CC of tourism to realize the sustainable development of natural environmental areas.

2. Evaluation Method of TECC in Natural Environment Area

2.1. CC of Tourism Environment

Tourism is the process of interaction between tourists and the ecological environment. Human beings relax their body and mind by feeling the natural beauty, while tourist areas can accelerate the economic development by tickets and driving the surrounding industries. Tourism promotes the development of social economy and the integration of culture [7-8]. Due to the scale of the global tourism industry, the conflict between the expansion of the tourism industry and the natural environment is becoming more and more serious. Now people begin to pay attention to the previously underestimated environmental impact, thus resulting in the idea of the CC of the tourism industry to the environment. In recent decades, the tourism industry has developed rapidly. The tourism industry earns ticket fees by sharing natural beauty with tourists and diverts resources from the society through scenic spots, thus effectively driving the economic development of surrounding areas. However, with the development of tourism, the tourism resources of many scenic spots have been over-exploited, and the ecological environment of the scenic spots has also been damaged. The tourism industry centered on economy is not feasible. The development of tourism needs to make a comprehensive evaluation of the environmental resources of tourist areas, and must pay attention to the relationship between the environment and economic development of tourist areas.

Ecotourism is one of the tourism modes. The core idea is to protect the environment and the natural environment landscape, and coordinate the development of tourism economy and the sustainable development of the natural environment [9-10]. The impact of overload of TECC is shown in Figure 1.

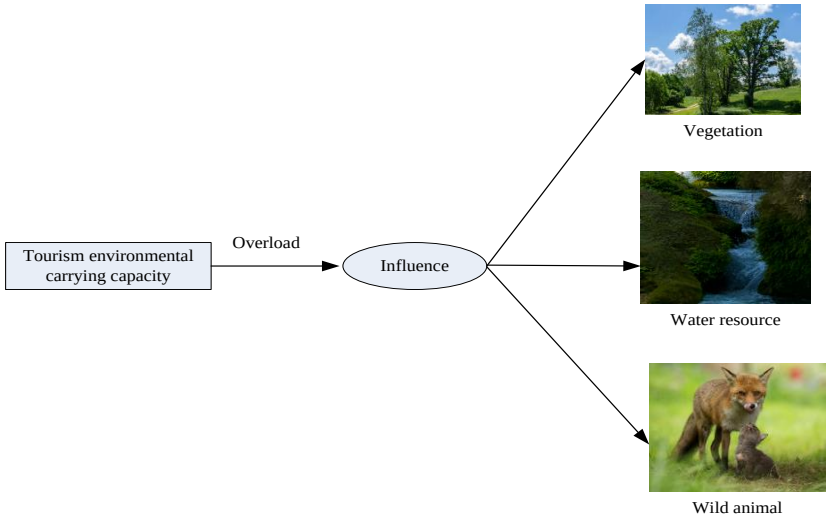


Figure 1. Impact of overload of TECC

In Figure 1, the consequences of serious overloading of various indicators in the tourist area are described. The impact of overloading of TECC is very serious, which mainly affects the vegetation resources, water resources and wildlife in the tourist area.

2.2. Assessment System of Resources and Environment CC of Scenic Spots

The CC of the resources and environment of the scenic spot is a comprehensive evaluation of all aspects of the resources of the scenic spot and an analysis of the degree of tourists. Through the analysis of the scenic spot resources, the maximum tourist flow and the frequency of opening tourism in the tourism park can be inferred. There are many indicators for the analysis of the resources of tourist parks, including vegetation coverage, water quality and air environment. Tourism is a very comprehensive industrial model, which contains a lot of contents, including tourism scenery, tourism ticket sales, tourism catering, etc. The analysis of the CC of scenic spots' resources and environment is based on the evaluation and description of scenic spots' resources, and the CC is calculated by determining various indicators that affect the environment of the scenic spots. Therefore, the Analytic Hierarchy Process (AHP) can be used to comprehensively evaluate the various resources that affect the environment of the scenic spots.

AHP is to refine complex problems qualitatively and quantitatively, and finally calculate the weight of indicators [11-12]. The structure of AHP is shown in Figure 2.

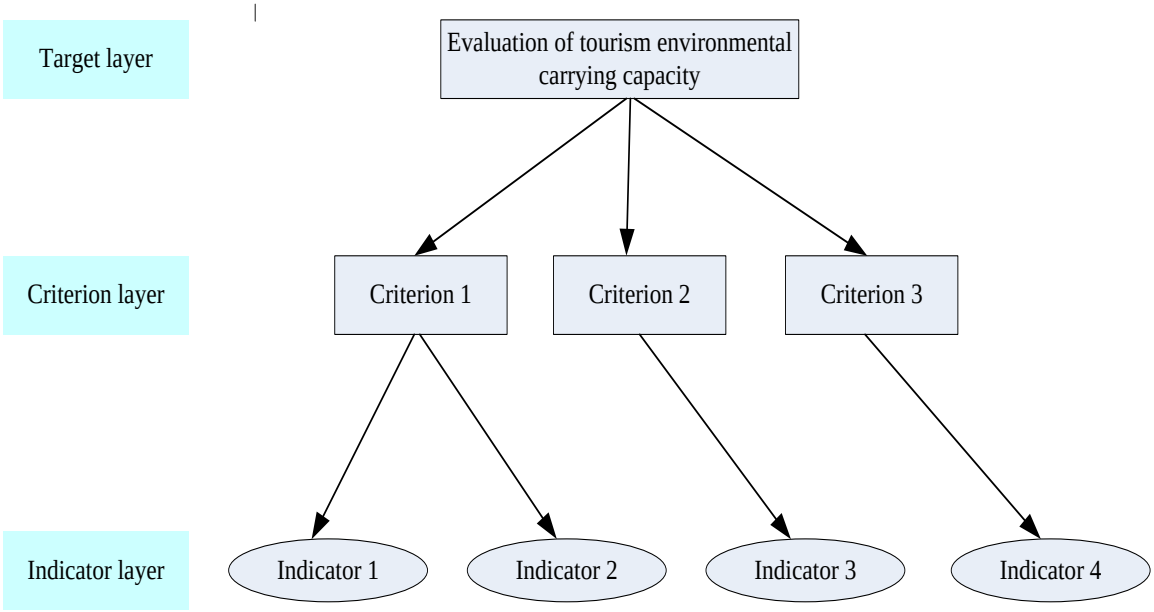


Figure 2. Structure diagram of AHP

In Figure 2, the AHP has three layers in total. The structure from top to bottom is subordinate relationship. The lower layer is the analysis of the content of the upper layer, and the same layer is the same level relationship. The indicators of the same layer do not affect each other, but jointly determine the analysis of the scenic area's resources and environmental CC.

The analytic process of AHP is very logical. By analyzing the complex logical problems in detail and determining the influence between the indicators, the relative weight of each indicator can be obtained, and the water resource environment, land resource environment and vegetation resource environment of the tourist area can be analyzed.

2.3. Artificial Intelligence Technology

AI is widely used in many fields by simulating the thinking mode of human brain and the processing process of complex transactions [13-14]. AI technology has excellent multi-factor analysis ability, and can be used to intelligently analyze the CC of tourism environment.

Artificial neural network is a research method of AI. It is widely used in many fields by

simulating the thinking mode of human brain and the processing process of complex transactions [15].

It is assumed that the index affecting the TECC is $S = (s_1, s_2, \cdots, s_n)$, and the connection weight between the TECC index and the artificial neuron is $H = (h_1, h_2, \cdots, h_n)$. The result of artificial neuron processing is expressed as follows:

$$t = \sum_{j=1}^{n} s_j h_j \quad (1)$$

In Formula 1, s_j represents the jth indicator of TECC, such as land resources. h_j represents the connection weight of the jth TECC index and neurons.

The activation function is expressed as follows:

$$f(x) = \frac{1}{1+e^{-x}} \quad (2)$$

The results of artificial neuron processing should be processed by activation function. After substituting the results in Formula 1 into Formula 2, the formula is as follows:

$$f(t) = \frac{1}{1+e^{-t}} \quad (3)$$

The use of artificial neural network can quickly and accurately analyze the indicators of TECC, and effectively analyze the TECC of natural environment areas.

3. Experiment on Bearing Capacity Evaluation of Natural Scenic Spots

3.1. Environmental Indicators of Scenic Spots

Tourist attractions can accommodate a large number of tourists. Overcrowding of tourists would have a great impact on the long-term sustainability of the local tourism industry, the economic development of the scenic area, and the impact of tourists on the scenic area. Under the long-term overload tourism environment, the environmental resources of natural scenic spots have been greatly damaged. The analysis of the CC of scenic spots can effectively avoid the excessive development and use of scenic resources and improve the sustainable development effect of scenic spots. The results of the evaluation of the CC indicators of tourist attractions by using the AHP are shown in Table 1.

Table 1. Evaluation indicators of TECC

Target layer	Criterion layer	Indicator layer	Weight
TECC	Environmental CC	Water resource	16%
		Vegetation resources	22%
	Economic CC	Tourist income	12%
		Proportion of tourism investment	16%
	Social and cultural CC	Tourist experience	16%
		Landscape aesthetic feeling	18%

In Table 1, the evaluation indicators of TECC were described. A total of 6 indicators were described. Among them, vegetation resources accounted for the highest weight of 22%, and tourism income accounted for the lowest weight of 12%.

3.2. Experimental Design of TECC Evaluation in Natural Environment Areas

In order to effectively analyze the TECC of the natural environment zone, this paper adopted the form of setting up a control group for analysis. Among them, the control group was the traditional TECC analysis, which was mainly artificial judgment of indicators; the experimental group was the analysis of TECC of natural environmental areas based on AI. Through the artificial neural network, the impact indicators of tourist attractions were comprehensively analyzed.

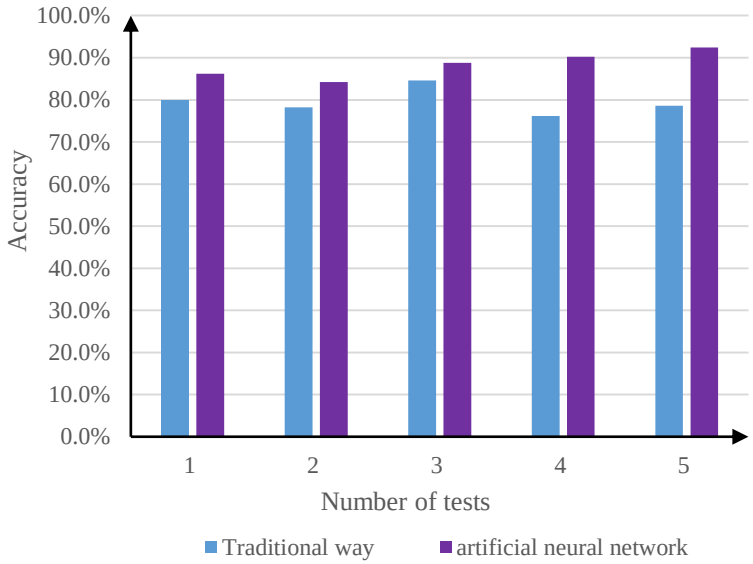
In order to effectively analyze the TECC of natural environmental zones, this paper analyzed the environmental CC of two natural environmental zones in China. Among them, the scale of natural environment zone A was large, and that of natural environment zone B was small. The traditional analysis of TECC and the analysis of TECC of natural environmental areas based on AI were used to analyze the accuracy of environmental CC and tourism resources.

4. Results of the Evaluation of TECC in Natural Environment Areas

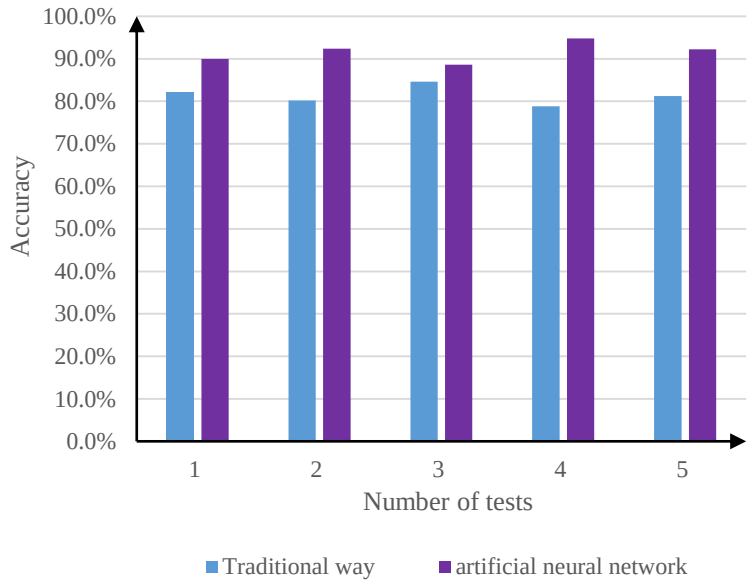
4.1. Accuracy of Tourism Resources Evaluation

There are many kinds of tourism resources in natural environment areas, and the analysis of tourism resources in natural environment areas would help to realize the sustainable development of tourism areas. This paper compared the accuracy of traditional tourism resources analysis and tourism resources analysis based on artificial neural network, and the comparison results were shown in Figure 3.

In Figure 3 (a), the accuracy comparison between traditional tourism resource analysis and tourism resource analysis based on artificial neural network in natural environment zone A was described. The accuracy rate of traditional tourism resources analysis reached the lowest in the fourth time, which was 76.2%. It reached the highest level in the third time, which was 84.6%. The average analysis accuracy was 79.52%. The accuracy rate of tourism resources analysis based on artificial neural network reached the lowest of 84.2% in the second time and the highest of 92.4% in the fifth time, with an average analysis accuracy of 88.36%. In Figure 3 (b), the accuracy comparison between traditional tourism resource analysis and tourism resource analysis based on artificial neural network in natural environment zone B was described. The accuracy rate of traditional tourism resources analysis reached the lowest in the fourth time, which was 78.8%. It reached the highest level in the third time, which was 84.6%. The average analysis accuracy was 81.40%. The accuracy of tourism resources analysis based on artificial neural network reached the lowest of 90.0% in the first time and the highest of 94.8% in the fourth time, with an average accuracy of 91.60%. Therefore, the use of artificial neural network to analyze tourism resources could improve the accuracy of analysis.



(a) Accuracy of tourism resources analysis in natural environment zone A



(b) Accuracy of tourism resources analysis in natural environment zone B

Figure 3. Comparison results of accuracy of tourism resources analysis

4.2. Accuracy of Environmental Bearing Capacity Evaluation

The unlimited tourism in natural environment areas has led to the destruction of a large number of natural resources, so it is very necessary to analyze the CC of tourism environment in natural environment areas. This paper analyzed the resource indicators of natural scenic spots with two bearing capacity analysis methods and compared the accuracy of the analysis. The comparison results were shown in Figure 4.

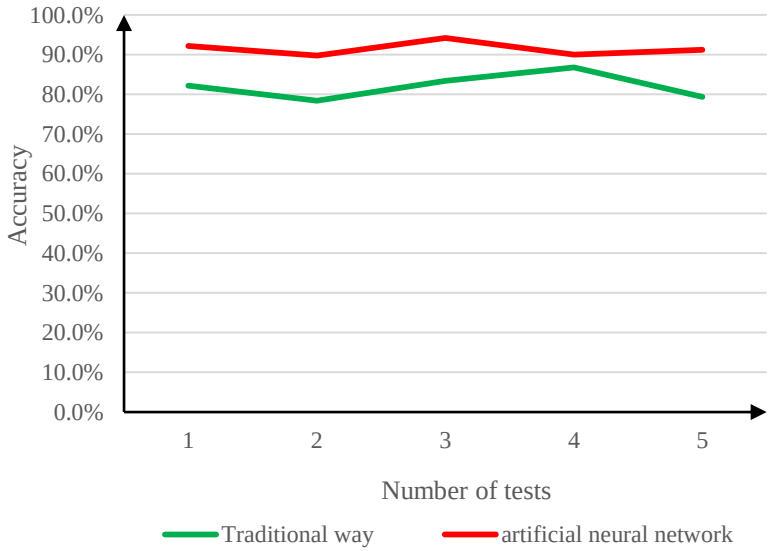


Figure 4. Comparison results of accuracy of environmental bearing capacity analysis

In Figure 4, the comparison results of the accuracy of the analysis of the TECC of the traditional natural environment area and the analysis of the TECC of the natural environment area based on AI were described. Among them, the accuracy rate of the analysis of TECC of traditional natural environment areas reached the lowest in the second time, which was 78.4%. It reached the highest level in the fourth time, which was 86.8%. The average analysis accuracy was 82.04%. The accuracy rate of the analysis of TECC of natural environment areas based on AI reached the lowest in the second time, which was 89.8%. It reached the highest level in the third time, which was 94.2%. The average analysis accuracy was 91.48%. Therefore, the analysis of TECC of natural environmental areas based on AI could effectively improve the accuracy of the analysis of TECC.

5. Conclusion

With the continuous development of society, the tourism industry has also been rapidly improved. People are more willing to travel in order to relax and improve the quality of life. The development of tourism can improve the popularity of tourist areas, and promote tourists' economic consumption and cultural integration. However, with the lack of understanding of resources in natural environment areas, unreasonable resource exploitation and lagging management, tourism resources have been destroyed. The ecology of the natural environment area is extremely unbalanced. In order to make the natural environment area sustainable development, it is necessary to conduct a comprehensive analysis of the resources of the natural scenic area. While ensuring the economic development of tourist attractions, it is also necessary to avoid excessive destruction of scenic resources. The traditional analysis was compared with the AI based analysis of TECC of natural environment areas. The results showed that using AI and other technologies to comprehensively analyze the resources and environment of tourist attractions and the indicators affecting the environmental development of tourist attractions could more accurately judge the CC of the study area. The sustainable development of natural environment areas could be effectively realized by analyzing the CC of tourism environment in natural environment areas and carrying out targeted tourism activities. However, when analyzing the CC of scenic resources in this paper, the analysis of scenic resources indicators was still not comprehensive, so the setting of more and more

comprehensive tourism resources indicators for comprehensive analysis would be the direction of future research.

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Data Availability

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

Conflict of Interest

The author states that this article has no conflict of interest.

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