Construction of Evaluation Index System for Ecotourism City Based on Information Entropy and AHP

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Abstract The development status of ecotourism city was analyzed from the aspects of the ecotourism resources, ecological protection, urban conditions, city social factors, and international exchanges among cities, etc., and a three-level evaluation index system was constructed. The evaluation index system of ecotourism city was screened and optimized. The weights on the criterion level were obtained through analytic hierarchy process (AHP) and the expert consult method, but weights on the indicator lever proposed to get through the information entropy method. The combination of objective and subjective empowerment was the reasonable method.

Keywords Ecotourism city · Entropy · Evaluation index system · Weight

1 Introduction

With economic development, ecotourism city has become more prosperous, and evaluation of ecotourism city will become increasingly important. Ecotourism city should be the symbiosis of tourism and city, tourism and nature, tourism and social, present and future. What it pursuits is a harmonious, economy and sustainable development. It is to use ecological theory and ideas in city tourism system, in order to make the city economy, ecology and tourism sustainable

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development together. The term "ecotourism" was first proposed by special adviser Ceballas-Laskurain of the World Conservation Union (IUCN) in 1983. It was defined by The International Ecotourism Society in 1990 as a tourism behavior to protect the environment and improve the welfare of local residents in natural areas. It was defined by The International Ecotourism Society in 1993 as dual responsibility of tourism activities to protect the natural environment and maintain the local people's life. The connotation of ecotourism is more emphasis on the protection of the natural landscape and the sustainable development of tourism. The latest definition was to take the ecological environment with characteristics as major landscape tourism. It was also defined as a tourism way to carry out the ecological experience, ecological education, ecological awareness and get the psychosomatic good, based on the concept of sustainable development, protecting the ecological environment as a precondition, taking the development of man and nature in harmony as guidelines, relying on the natural environment and unique cultural ecosystem, and taking the ecofriendly way.

2 The Status of Ecotourism City at Home and Abroad

Domestic and international tourism is making strides forward, but the development basis of each country and the pace of progress is not the same. However, the starting point is all to take "tourism of returning to nature," "green tourism," "protecting tourism," and "sustainable development of tourism" as a main idea. At the same time, all countries in the world are carrying out ecotourism, developing ecotourism city, and a distinctive ecotourism, according to their national conditions.

Foreign developed countries with a better development of ecotourism should be the United States, Canada, Australia, and so on. Ecotourism objects of these countries had transferred from the cultural landscape and urban scenery to the natural scenery specified by Xiebeiluosi Lasikarui. It is to maintain the original nature. These natural features refer to national parks with the excellent natural ecosystems in its domestic and the good ecosystem-based virgin forest in foreign countries. It makes a lot of developing countries to become ecotourism destination, of which Caribbean and African safari became the ecotourism hot spot areas. European countries with better ecotourism cities are France, Germany, Italy, Sweden, etc. In these developed countries, traveling to nature has become a fashion in weekends and holidays. In ecotourism activities, they paid great importance to protect the natural landscape and the environment and proposed the resonant slogan of protecting the environment, such as "only footprints left, only photo taken away."

China's ecotourism was developed, mainly based on nature reserves, forest parks, and scenic spots. In 1982, China's first national forest park—Zhangjiajie National Forest Park was established, which made the good combination of

tourism development and ecological environmental protection. Since then, the construction of forest parks and forest ecotourism achieved a rapid development. Although the forest tourism to be developed at this time was not an ecotourism in the strict sense, it provided a good foundation for the development of ecotourism. The ecotourism started in Hunan and Sichuan and then developed in all the country gradually. However, the ecotourism of county-level cities with a number of ecotourism resources did not enhance the tourism economy and had no chance to display specific resources, due to unwelcome tourism market, the lack of promotion and publicity [1]. At present, ecotourism areas opened to public in the domestic were mainly forest parks, scenic spots, nature reserves, etc. The ecotourism areas developed earlier and with more mature development include Shangri-La (Zhongdian), Xishuangbanna, the Changbai Mountain, the Lancang River Basin, Dinghushan, Zhaoqing of Guangdong and Xinjiang Kanas.

3 The Evaluation Index System of Ecotourism City

The rapid development of urban tourism has brought changes in the ecological environment. The evaluation of the ecotourist city often involves in the theories of ecology, economic, tourism, environment, education, and urban geography. At the same time, the degree of urban ecological civilization was also considered. Therefore, various factors, such as ecotourism resources, urban conditions, ecological protection, and sociality, will be considered to build the integrated evaluation index system of ecotourism cities. Then, the information entropy method was used to filter the many indicators.

3.1 The Principles of Constructing the Evaluation Index System for Ecotourism Cities

In recent years, there were more and more research results on the ecotourism city in domestic and foreign countries, but the evaluation index of the ecological tourist city was only studied by a minority of scholars. The studying mostly limited to conceptual, not to quantify and refine the indicators. Zhou [2] studied the standard of international scenic tourist city. Li and Bin studied the theoretical standard of building Guilin international tourist city [3]. Yan and Wang [4] summarized 27 indicators of the international tourist city, but did not do case research. Lin Qiao studied the functional criteria of international tourist city and taken Hangzhou as an example to quantify the indicators. In the paper, the methods of questionnaires and interviews were proposed to obtain data, but it was not easy to popularize due to the limitations of research methods [5].

The principles of construction of index system were as follows:

1. Concise principle. The selection of indicators should not be excessive and too detailed, and it is fine to reduce redundancy to only illustrate the problem in the case of not missing index information.
2. Scientific principles. The determination of the weight coefficient of the index system, data selection, calculation, etc., should be based on accepted scientific methods, and the evaluation has high reliability and validity.
3. Dynamic principle. The evaluation index system of ecotourism city is not immutable. It can be adjusted slightly with policies, regulations, and social environment changes. The index system must fully reflect the general characteristics of the ecotourism in all aspects. At the same time, it should also be dynamic to ensure the index system to update with the times.
4. The principle of combining qualitative and quantitative. Index systems should quantify if they can be quantifiable, but taking into account complex factors and a wide range of evaluation index system, some of the subjective evaluation need to be adopted. Therefore, it should follow the principle of combining qualitative and quantitative.

3.2 The Evaluation Index System of Ecotourism City

The integrated evaluation system was constructed by combining with the theory of ecology, sociology, economics, and sustainable development [6]. The evaluation index (Table 1) was obtained through the screening and optimization of several evaluation indexes [2, 4].

4 The Determination of Weights for the Evaluation Index System

Weights on the criterion level were obtained through analytic hierarchy process (AHP) and the expert consult method, but weights on the indicator level were obtained through information entropy. That is the combining of subjective and objective methods. The information entropy was an objective method, by which the weights were totally calculated through the data on indicator level. AHP and the expert consult method were subjective methods. Therefore, the weights on the criterion level were determined by the evaluator or experts, which can be accordance with the evaluation objective at the highest degree.

Table 1 Evaluation index of ecotourism city

Objective level	Criterion level	Labels of indicators	Indicator level
Evaluation of ecotourism city	Ecotourism resources (A1)	Tourism landscape resources	Geographical landscape resources
			The biological landscape resources
			Geographical landscape resources
		Tourism products	Tourism products richness
			Tourism product update rate
			Leisure products update rate
		Tourism services	Proportion of three-star and above hotels
			Number of service per square kilometer
			Satisfaction degree of tourism and catering
			Clearance rate of travel complaints
		Service personnel	Proportion of personnel with college and over college educational background accounted for the tourism practitioners
			Proportion of personnel with a tourism professional qualification certificate accounted for total employees
			Penetration rate of english proficiency for tourism industry employees
		Tourism achievements	Total tourism income/year
			Growth rate of total tourism revenue over the previous year
			Tourism foreign exchange earnings
			Ratio of tourism foreign exchange earnings to total income
	Ecological protection (A2)	Urban environment	City air quality index
			City noise index
			Reaching standard rate of water quality of drinking water sources
			Annual appropriate tourism days
			Public green area per capita
			Owning number of public transport vehicles per ten thousand people
		Environmental awareness	Waste disposal rate
			Environmental awareness of residents and tourists
			Times of scenic staff trained for ecology and environmental protection

(continued)

Table 1 (continued)

Objective level	Criterion level	Labels of indicators	Indicator level
	City conditions (A3)	Policy support	Ratio of government appropriate funds to scenic inputs
			Ratio of investments in environmental protection to scenic inputs
			Ratio of conservation monitoring to scenic inputs
		City public facilities	City size
			Road area per capita
			Providing rate of the public toilets per ten thousand capita
			Access service rate of international communication
	The city social conditions (A4)	The quality of residents	Coverage of resident high school education
			Friendly degree of residents
		The city social conditions	Number of police force per 10,000 person in city
			Safety and insurance of city tourism
			Number of city travel agency
	International exchange support (A5)	Marketing competition	Acceptance degree of international tourism market
			Visualization integrated index of international tourism city
			Number of English Web site of tourist class
			Number of foreign tourism enterprises
			Convenient degrees of international transportation
			Number of overseas tourism business/office
		Meeting condition	Number of large annual meeting/exhibition
			International convention and exhibition sites/total exhibition area

4.1 The Basic Theory of the Information Entropy

The information entropy in the information system is a measure of the disorder information. The greater the information entropy, the higher the degree of disorder of the information is. The utility value of the information is smaller. Conversely, the smaller the information entropy, the lower the degree of disorder of the information is, and the utility value of the information is the greater [7].

Assumed that the status of the development of tourism in a region in m years needs to be evaluated, and the evaluation index system consists of n indicators. This is a comprehensive evaluation by m samples, n indicators. The mathematical model is as follows:

The domain:

$$U = \{u_1, u_2, u_3, \ldots, u_i, \ldots u_m\} \quad (i = 1, 2, 3, \ldots, m) \tag{1}$$

Each sample (evaluation object) U_i is expressed with the data with n indices:

$$U_i = \{X_{i1}, X_{.i2}, \ldots, X_{im}\} \quad (j = 1, 2, 3, \ldots, n) \tag{2}$$

Thus, initial data matrix X of the evaluation system was given:

$$X = \{X_{ij}\}_{m \times n} \tag{3}$$

On where X_{ij} represents the value in the ith samples and jth evaluation indicator. Standardization matrix of data was calculated on the basis of standardized data [8], and P and information utility values of g were obtained. The information entropy P_j in jth indicator is as follows:

$$P_j = -K \sum_{i=1}^{m} y_{ij} \ln y_{ij} \tag{4}$$

In a completely disordered information system, the order degree is zero, and its entropy is maximum, $P_i = 1$. When m samples were in a completely disordered distribution state, $y_{ij} = 1/m$, here,

$$P = -K \sum_{i=1}^{m} \frac{1}{m} \ln \frac{1}{m} = K \ln m = 1,$$

so

$$K = \frac{1}{\ln m}, \quad 0 \le P_j \le 1 \tag{5}$$

The utility value g_j of some indicator depends on the difference between the information entropy P_j of the index and 1:

$$g_j = 1 - P_j \tag{6}$$

Last, the weight in *j*th indicator can be obtained:

$$W_j = \frac{g_j}{\sum_{j=1}^{n} g_j} \tag{7}$$

The utility values of various indicators in each class were added, and then, the total utility values G_k ($k = 1,2,\ldots$) were obtained. Furthermore, the total utility value of all indicators was obtained, $G = \sum_{j=1}^{n} g_j$.

The weight of corresponding class is as follows:

$$W_K = \frac{G_k}{G} \tag{8}$$

4.2 The Principle of Analytic Hierarchy Process

AHP is a combination of qualitative and quantitative analysis, multifactor decision analysis methods. AHP has four basic steps: First, after the decision-making objective was determined, the factors affecting the target decision were classified and a multilayered structure constructed. Second, pairwise comparison matrix was constructed through comparing the relative importance of each factor on the same level with the same factor on the upper level. Third, the consistency of the pairwise comparison matrix was tested by the calculation. When necessary, the pairwise comparison matrix can be modified in order to make the consistency accepted. Fourth, under the premise of conforming to the consistency testing, the eigenvector corresponding to the maximum eigenvalue in the pairwise comparison matrix was calculated to determine the weight of each factor corresponding to the factor on the upper level. Then, the total ranking weight of each factor to system objective was calculated.

4.3 Determination of Weights

The weights on the criterion level were obtained based on the AHP theory and the expert consult method. Statistic and analyzed result was as follows: (A_1, A_2, A_3, A_4, A_5) = (0.4, 0.25, 0.15, 0.15, 0.05). The weights indicated that ecotourism resource (A_1) is most important to the evaluation of ecotourism city, ecotourism protection (A_2) was second important, paid higher attention, city condition (A_3) and city social condition (A_4) were the same important, and International exchange support (A_5) was less important relatively to other index. The weights on the indicator level will be obtained through the information entropy, combined with the evaluation case. In this paper, the weights on the indicator level were omitted.

5 Conclusion

The evaluation index system of ecotourism city with five criterions and 46 indicators was constructed. The screened evaluation index system covered the major aspect of the ecotourism city, which is the general evaluation index system. The major feature is to adopt the combination of subjective and objective method to get weights on the evaluation index system. It is easy to meet the total evaluation objective of evaluators to obtain weights on the criterion level by AHP and expert consult methods—subjective methods. Forty-six weights on the indicator level obtained with objective information entropy were much more reasonable.

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