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A SPORTS TOURISM RESOURCES COMPREHENSIVE EVALUATION MODEL BASED ON AHP-FUZZY

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ABSTRACT

The non-objective and non-scientific evaluation of sports tourism resources has become a bottleneck which restricts the development of sports tourism industry. In order to make the evaluation of sports tourism resources have more comprehensiveness, accuracy and scientificalness and to promote the healthy and sustainable development of sports tourism industry, this paper, based on the AHP-FUZZY mathematics evaluation method, proposes a new sports tourism resources evaluation model through the investigation and research of experts and scholars. This model consists of three index systems and makes weight setting of factors of each index system according to FUZZY mathematics evaluation method, integrating AHP and FUZZY evaluation methods. This comprehensive evaluation model has the advantage of the combination of qualitative and quantitative analysis which avoids the subjectivity of AHP and the dichotomy of FUZZY evaluation method. The results show that using this sports tourism resources evaluation model to evaluate the sports tourism resources of Qinhuangdao is effective, scientific and feasible.

Keywords: *Sports Tourism Resources, AHP, Fuzzy Mathematics, Comprehensive Evaluation Model, Qinhuangdao*

1. INTRODUCTION

Sports tourism is a new field created by the joining of sports and tourism industries, which is a new tourism form based on sports resources, aiming to improve body health and attracting people to join in and experience sports activities and natural interest, is a special recreational life style combining sports and tourism and is an important part of sports, tourism and culture industry. Sports tourism resources are the core of developing sports tourism, the correct and objective evaluation of which is the base of developing sports tourism resources. At present, there are three evaluation methods of tourism resources including qualitative, quantitative and comprehensive evaluation, among which, the former two mainly include direct judgment, Analytic Hierarchy Process (AHP), Data Envelopment Analysis (DEA), mathematical programming method and fuzzy evaluation method. Nowadays, many scholars, in the study of evaluation methods, tend to apply comprehensive method, which is to combine two or more evaluation methods to improve the accuracy and objectivity [1-8]. Since sports tourism resources has uncertainty and fuzziness, if only applying quantitative analysis to sports tourism resources, the evaluation results are not accurate, therefore, this study adopts AHP-FUZZY mathematics evaluation method to construct evaluation model and makes empirical analysis combined with the situations of Qinhuangdao sports tourism resources.

2. SPORTS TOURISM RESOURCES EVALUATION MODEL

2.1 Construction Process of Sports Tourism Resources Evaluation Model

AHP-FUZZY mathematics comprehensive evaluation method is a comprehensive method combing AHP and FUZZY mathematics method to make evaluation, which decomposes the research issues to separate index sets according to layers, calculates index weight according to each index' relative importance given by experts and finally calculates the comprehensive score of indexes [9-17]. The steps are as follows:

① setting up the hierarchical structure of system index and index sets;

② constructing impor

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matrix of each two according to 1~9 proportional scaling method;
③ calculating the relative weight of each index;
④ making consistency test of index weight $C.R(C.R \prec 0.1)$;
⑤ constructing hierarchical fuzzy comprehensive evaluation model and calculating the comprehensive scores. See Figure 1.

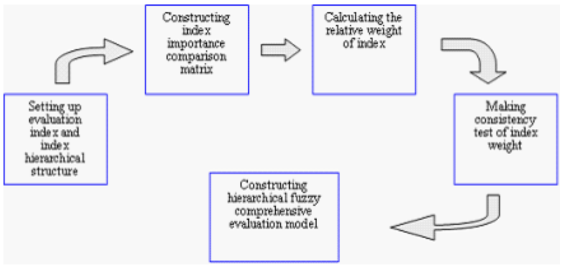

Figure 1. Construction Process Of Hierarchical Fuzzy Comprehensive Model

2.2 Sports Tourism Resources Evaluation System

This system is set up according to the principles of concise scientific, systematic integration, feasibility and comparability and adopts theory analysis and experts consultation method to select evaluation indexes. Theory analysis is mainly used to make relative analysis, comparison and integration of the related issues of sports tourism and to select important elements with strong pertinence as indexes; experts consultation method is used in this procedure: based on the primarily proposed evaluation indexes, 24 Chinese experts are consulted for advice during May to October, 2012 and the primary evaluation indexes are adjusted. The evaluation index system is finally achieved by comprehensively applying these two methods and the indexes, according to the attributes and hierarchical relationship, are divided into: target layer *A*, criterion layer *B* and index layer *C* [18-21]. See Figure 2.

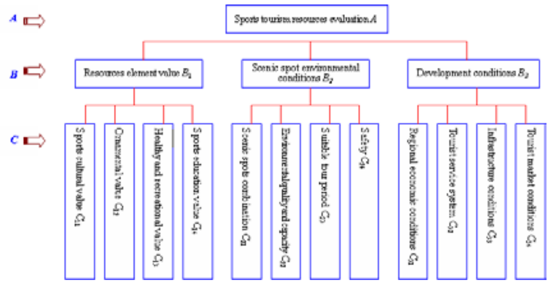

Figure 2. Hierarchical Structure Of Sports Tourism Resources Evaluation

2.3 The Determination of Sports Tourism Resources Evaluation Index Weights

2.3.1 Constructing judgment matrix

AHP is adopted to determine evaluation index weights and by sending out questionnaires, related experts are asked to make each two comparison of each element' importance degree in the evaluation of various layers, the results of which are used to establish the distribution weight of AHP judgment matrix. Take evaluation integration layer *B* for example and construct judgment matrix *A*.

$$A=\begin{pmatrix} 1 & \frac{7}{5} & 3 \\ \frac{5}{7} & 1 & \frac{7}{4} \\ \frac{1}{3} & \frac{4}{7} & 1 \end{pmatrix}$$

2.3.2 Solution judgment matrix

Take the calculation of the weight of layer *B* compared with layer *A* for example, making solution by applying Asymptotic Normalization Coefficient (ANC), the concrete steps are as follows:

① Standardizing each column of judgment matrix *A*:

$$\bar{a}_{11}=\frac{a_{11}}{\sum_{i=1}^{3}a_{i1}} \quad (1)$$

Get:

$$\bar{a}_{11}=\frac{a_{11}}{\sum_{i=1}^{3}a_{i1}}=\frac{1}{1+\frac{5}{7}+\frac{1}{3}}=0.4883$$

Calculating other items successively, get the following matrix:

$$\bar{A}=\begin{pmatrix} 0.4884 & 0.4712 & 0.5217 \\ 0.3488 & 0.3365 & 0.3043 \\ 0.1628 & 0.1923 & 0.1740 \end{pmatrix}.$$

② Adding the elements of $\bar{A}$ according to the row, get vector ϖ and its components are:

$$\varpi=(1.4813 \quad 0.9896 \quad 0.5291).$$

③ Normalization processing ϖ, get the weight of the related elements of layer *B* compared with layer *A*, which is:

$$\varpi=(0.4938 \quad 0.3298 \quad 0.1764).$$

④ Inputting judgment matrix *A* into matlab6.5 software, calculate and get the maximum characteristic root of judgment matrix *A*, which is:

$$\lambda_{max}=3.0046 .$$

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2.3.3 Single-layer sequencing and consistency test

Calculating the consistency index of judgment matrix and test the consistency index $C.I.$:

$$C.I. = \frac{\lambda_{\max} - n}{n-1} \quad (2)$$

Get:

$$C.I. = \frac{\lambda_{\max} - n}{n-1} = \frac{3.004\,6 - 3}{2} = 0.002\,3 \cdot$$

To test whether judgment matrix has satisfactory consistency, $C.I.$ will be compared with the mean random consistency index $R.I.$ and the random consistency proportion $C.R.$ of judgment matrix is got.

$$C.R. = \frac{C.I.}{R.I.} \quad (3)$$

Since the dimension is $n = 3$, $R.I. = 0.58$ is known from lookup table, then it has

$$C.R. = \frac{C.I.}{R.I.} = \frac{0.002\,3}{0.58} = 0.003\,9 \prec 0.1$$

Therefore, by consistency test, the above weight of the related elements of layer B compared with layer A is confirmed.

Adopting the same method, the weight of the index of layer C compared with layer B is confirmed. See Table 1.

Table 1. Weights Of Sports Tourism Resources Evaluation

Target layer A	Criterion layer B	Index weight	Index layer C	Index weight	General index weight
Sports tourism resources A	Resources element value B_1	0.493 8	Sports cultural value C_{11}	0.316 3	0.156 2
			Ornamental value C_{12}	0.201 7	0.099 6
			Healthy and recreational value C_{13}	0.343 2	0.169 5
			Sports education value C_{14}	0.138 8	0.068 5
	Scenic spot environmental conditions B_2	0.329 8	Scenic spots combination C_{21}	0.268 7	0.088 6
			Environmental quality and capacity C_{22}	0.206 5	0.068 1
			Suitable tour period C_{23}	0.301 5	0.099 4
			Safety C_{24}	0.223 3	0.073 6
	Development conditions B_3	0.176 4	Regional economic conditions C_{31}	0.386 6	0.068 2
			Tourist service system C_{32}	0.134 7	0.023 8
			Infrastructure conditions C_{33}	0.234 5	0.041 4
			Tourist market conditions C_{34}	0.244 2	0.043 1

2.4 Fuzzy Evaluation of Sports Tourism Resources

Determine the factor set and evaluation set of evaluation objects. The factor set refers to a common set composed of various factors which influence the evaluation objects.

Top layer evaluation set A={B_1, B_2, B_3}={resources element value, scenic spot environmental conditions, development conditions}.

Index evaluation set B_1={C_{11}, C_{12}, C_{13}, C_{14}}={sports cultural value, ornamental value, healthy and recreational value, sports education value}, B_2={C_{21}, C_{22}, C_{23}, C_{24}}={scenic spots combination, environmental quality and capacity, suitable tour period, safety}, B_3={C_{31}, C_{32}, C_{33}, C_{34}}={regional economic conditions, tourist service system, infrastructure conditions, tourist market conditions}.

Evaluation set is a quantity set composed of various evaluation results possibly made by evaluator to evaluation objects. When determining the evaluation index membership degree, expert investigation method is used, that is, making scalar quantization to the evaluation factor indexes. See Table2.

Table 2. Fuzzy Evaluation Table Of Sports Tourism Resources Quantitative Evaluation Indexes

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Evaluation factor	Weights	Evaluation grade				
Sports cultural value	0.156 2	Very high	High	Relatively high	General	Low
Ornamental value	0.099 6	Very high	High	Relatively high	General	Low
Healthy and recreational value	0.169 5	Very high	High	Relatively high	General	Low
Sports education value	0.068 5	Very high	High	Relatively high	General	Low
Scenic spots combination	0.088 6	Outstanding	Good	Fair	Poor	Inferior
Environmental quality and capacity	0.068 1	Extremely good	Good	Relatively good	General	Poor
Suitable tour period	0.099 4	Very long	Long	Relatively long	General	Short
Safety	0.073 6	Very high	High	Relatively high	General	Low
Regional economic conditions	0.068 2	Outstanding	Good	Fair	Poor	Inferior
Tourist service system	0.023 8	Outstanding	Good	Fair	Poor	Inferior
Infrastructure conditions	0.041 4	Outstanding	Good	Fair	Poor	Inferior
Tourist market conditions	0.043 1	Outstanding	Good	Fair	Poor	Inferior

3. THE COMPREHENSIVE EVALUATION OF QINHUANGDAO SPORTS TOURISM RESOURCES

3.1 Data Resources of Qinhuangdao Sports Tourism Resources

The adopted data of this study come from the questionnaires sent out during May to August, 2012, and parts of the data come from the Statistical Yearbook of Qinhuangdao 2009, 2010 and 2011. This investigation, according to the characteristics of Qinhuangdao sports tourism scenic spots, selects seven representative scenic spots, such as: national sports feature scenic spot --- Cape Mountain Great Wall; leisure sports scenic spots --- Nandaihe International Amusement Center, the Olympic Avenue Park, the Olympic Center, the Forest Sports Park, Golden Coast Sea Scenery Sports Leisure Park; fitness experience scenic spot --- Ziyun Mountain Skiing Resort, etc.. This study sends out 150 questionnaires to objects including experts engaged in tourism study, managers in the Travel Bureau of Qinhuangdao and of Hebei Province. 146 questionnaires are withdrawn, among which, 138 copies are effective. Then the validity and reliability of the questionnaires are tested.

3.2 The Fuzzy Comprehensive Evaluation of Qinhuangdao Sports Tourism Resources

3.2.1 Determining fuzzy evaluation matrix of indexes

Related questionnaire is designed according to evaluation indexes, and finally a collection of comments of qualitative indexes is achieved. The various evaluation factors of each scenic spot are evaluated by each evaluator according to determined evaluation grade standard, and the index membership degree value of each scenic spot is calculated by adopting arithmetic average.

Take Nandaihe International Amusement Center for example, 30% think its sports cultural value is "very high", the membership degree of which is 0.30; 32% think it is "high", the membership degree of which is 0.32; 26% think it is "relatively high", and its membership degree is 0.26; 10% think it is "general", and its membership degree is 0.10; 2% think it is "poor", and its membership degree is 0.02. Therefore, the fuzzy evaluation matrix of C_{11} is achieved: $[0.30,\ 0.32,\ 0.26,\ 0.10,\ 0.02]$.

3.2.2 Making comprehensive evaluation

First, making first order comprehensive evaluation according to the formula

$$Bi = Wi \times Ri \qquad (4)$$

In the formula: Bi is the comprehensive fuzzy calculation result of each subordinate factor included in i index of layer B compared with i index itself; Wi is the weight of each subordinate factor included in i index of layer B compared with i index itself; Ri is fuzzy comprehensive evaluation matrix, which represents the relationship of each subordinate factor included in i index of layer B compared with collection of comments. In the fuzzy evaluation table, all the evaluation grades of each single factor are marked as "extremely good, good, relatively good, general and poor". Take the fuzzy comprehensive evaluation of Nandaihe International Amusement Center's sports tourism resources for example. See Table 3.

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Table 3. Fuzzy Evaluation Of Nandaihe International Amusement Center's Sports Tourism Resources

Criterion layer*B*	Index layer*C*	Membership degree of evaluation value				
		Extremely good	Good	Relatively good	General	Poor
Resources element value B_1(0.493 8)	Sports cultural value C_{11}(0.316 3)	0.30	0.32	0.26	0.10	0.02
	Ornamental value C_{12}(0.201 7)	0.20	0.32	0.36	0.09	0.03
	Healthy and recreational value C_{13}(0.343 2)	0.28	0.42	0.18	0.12	0
	Sports education value C_{14}(0.318 8)	0.31	0.28	0.22	0.18	0.01
Scenic spot environmental conditions B_2(0.329 8)	Scenic spots combination C_{21}(0.268 7)	0.19	0.38	0.32	0.10	0.01
	Environmental quality and capacity C_{22}(0.206 5)	0.23	0.30	0.35	0.12	0
	Suitable tour period C_{23}(0.301 5)	0.32	0.34	0.30	0.04	0
	Safety C_{24}(0.223 3)	0.25	0.31	0.34	0.08	0.02
Development conditions B_3(0.176 4)	Regional economic conditions C_{31}(0.386 6)	0.18	0.48	0.26	0.06	0.02
	Tourist service system C_{32}(0.134 7)	0.20	0.43	0.32	0.04	0.01
	Infrastructure conditions C_{33}(0.234 5)	0.28	0.38	0.26	0.06	0.02
	Tourist market conditions C_{34}(0.244 2)	0.30	0.35	0.25	0.08	0.02

Notice: The data in brackets are the weight value of each index.

After calculation, it is found that the first order fuzzy comprehensive evaluation result B_1 has three single factor fuzzy comprehensive evaluation: B_{11}, B_{12}, B_{13}, then the second order comprehensive evaluation is made, the above first order comprehensive evaluation results of the three single factors together form second order fuzzy comprehensive evaluation judgment matrix *R2*, thus, the result of the second order fuzzy comprehensive evaluation is:

$$A = A_w \times R_i = (0.493\,8 \quad 0.329\,8 \quad 0.176\,4) \times \begin{pmatrix} 0.242\,7 & 0.380\,4 & 0.247\,2 & 0.115\,9 & 0.013\,8 \\ 0.250\,9 & 0.363\,5 & 0.335\,8 & 0.081\,6 & 0.007\,2 \\ 0.235\,4 & 0.418\,1 & 0.265\,6 & 0.062\,2 & 0.018\,7 \end{pmatrix}$$
$$= (0.243\,9 \quad 0.381\,5 \quad 0.267\,1 \quad 0.095\,1 \quad 0.012\,4).$$

A is the comprehensive evaluation result of Nandaihe International Amusement Center's sports tourism resources. According to the principle of maximum membership degree, it falls within the grade "good". Using the same method, the fuzzy evaluation results of other sports tourism scenic spots' tourism resources are achieved. See Table 4.

Table 4. Fuzzy Evaluation Situations Of Main Sports Tourism Scenic Spots' Resources Of Qinhuangdao

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Sports Tourism Scenic Spots	Fuzzy evaluation matrix	Single evaluation result			General evaluation result
		Resources element value	Scenic spot environmental conditions	Development conditions	
Nandaihe International Amusement Center	(0.243 9 0.381 5 0.267 1 0.095 1 0.012 4)	Good	Good	Good	Good
The Olympic Avenue Park	(0.235 6 0.361 8 0.287 1 0.086 7 0.028 8)	Good	Good	Relatively good	Good
The Olympic Center	(0.195 2 0.305 6 0.374 5 0.073 4 0.051 3)	Good	Relatively good	Relatively good	Relatively good
The Forest Sports Park	(0.123 5 0.306 7 0.334 3 0.086 6 0.148 9)	Relatively good	Relatively good	General	Relatively good
Ziyun Mountain Skiing Resort	(0.184 6 0.325 5 0.358 6 0.102 3 0.029 0)	Good	General	General	Relatively good
Cape Mountain Great Wall	(0.203 7 0.332 3 0.295 5 0.091 1 0.077 4)	Good	Good	Relatively good	Good
Golden Coast Sea Scenery Sports Leisure Park	(0.113 1 0.164 3 0.334 5 0.363 5 0.024 6)	Good	General	General	Relatively good

4. CONCLUSIONS

Constructing multi-layer fuzzy comprehensive model of sports tourism resources can help judge sports tourism resources, decide whether the value of resources is high or low, outstanding or inferior, which provides scientific basis for the development and protection of sports tourism resources. When using this model to make evaluation, the index system can be adjusted according to concrete situations to suit the evaluation of sports tourism resources in other areas. This study only selects seven representative sports tourism scenic spots in Qinhuangdao to make resources evaluation without involving all scenic spots, and in the future, further statistic, analysis and evaluation of resources can be made from more comprehensive angels, the conclusions of which will have greater practical guiding significance and pertinence.

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