

# Research on Uncertain Comprehensive Evaluation of Tourism Public Service Level

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**Abstract:** Tourism public service is the window that reflects the comprehensive level of tourism of a country or a region, and it is the lifeline of tourism. In a sense, the competition of tourism is the competition of tourism public service level. It is of great practical significance to construct a scientific and reasonable evaluation system of tourism public service level. In view of the uncertainty of evaluation factors, this paper transforms the evaluation index into uncertain variable, and puts forward the uncertain comprehensive evaluation method of tourism public service level. Finally, an example is given to analyze the level of tourism public service.

**Keywords:** uncertain comprehensive evaluation, tourism public service, uncertainty theory, comprehensive evaluation

## 1 Introduction

With the continuous development of China's economy and the continuous improvement of people's living standards, tourism has also been rapidly developed, and tourism has become one of the important industries of China's national economy. In 2023, the number of domestic tourists has reached 2.53 billion, and the domestic tourism revenue has reached 2,0444.4 billion yuan. Scientific construction of comprehensive evaluation system of tourism public service and cultivation of tourism public service awareness are related to the prosperity of a regional tourism market and have important practical significance for the development of local tourism.

In 2011, China issued the first outline document on tourism public services, "China's 12th Five-Year Plan for Tourism Public Services", which defines tourism public services as basic and public tourism products and services provided by the government and other social and economic organizations to meet the public needs of domestic and foreign tourists, emphasizing the characteristics of basic and public welfare. Many foreign scholars are committed to the study of tourism service evaluation<sup>[1-2]</sup>, but the evaluation of tourism public service level is a multi-attribute and multi-index issue, which inevitably involves many factors. After qualitative analysis, mathematical knowledge is required for quantitative research. There

are often some uncertain factors in this process, and the evaluation of these factors is difficult to quantify accurately, and often can only be described in uncertain language. Yaoting Zhang and Kaitai Fang<sup>[3]</sup> proposed the multivariate statistical analysis method. Multivariate statistical analysis methods need enough sample number and high sample quality to estimate the population well, but the dependence on a large number of data also limits its application. The fuzzy comprehensive evaluation method proposed by Wang Peizhuang<sup>[4]</sup>. Song Shide et al.<sup>[5]</sup> pointed out some unreasonable or ineffective phenomena of this method and carried out analysis and discussion. Fu Qiang et al.<sup>[6]</sup> put forward improvement suggestions, but they could not fundamentally solve the above problems.

The evaluation of traditional probability theory can only use precise data, while in fuzzy comprehensive evaluation, the operation of taking large value or small value can only be carried out on the same theory domain, which has certain limitations. Different from subjective probability and fuzzy theory, the uncertainty theory proposed by Liu<sup>[7]</sup> can well solve the uncertainty problem in practical problems. The uncertainty comprehensive evaluation method proposed by Liu<sup>[9]</sup> regards the weights of evaluation indicators and the evaluation grades of evaluation factors as uncertain variables, and the evaluation results are the grades of evaluation objects determined according to the principle of maximum membership degree. Because some index factors in the evaluation of tourism public service level have obvious uncertainty, the exact score can not be given. For example, public landscape facilities, in the traditional method, we can give it a better 85 points, then 86 points is not good? How about 84? This kind of evaluation index has no strict boundary, and it is more reasonable to use the judgment interval to express, that is, imprecise data. Uncertainty theory can use uncertain variables to represent uncertain data. Aiming at the uncertainty of related index factors in the evaluation of tourism public service level, this paper proposes an uncertain comprehensive evaluation method of tourism public service level. The comprehensive evaluation method can systematically evaluate the level of tourism public service according to the uncertainty theory, and make the evaluation result more scientific and reasonable.

## **2 Uncertain comprehensive evaluation method**

The comprehensive evaluation includes two aspects of uncertainty. On the one hand, when experts determine the weight, they always have personal preferences, expectations and other information, and the difficulty of determining the weight of each indicator is different, so we take the weight as an uncertain variable. On the other hand, the comments in the comments set, such as "very satisfied" and "more satisfied", are all uncertain language, and we need to convert the comments into uncertain variables. To make a comprehensive evaluation of a certain system, we must first clarify the evaluation objectives and establish the evaluation index system, where the indicators are independent of each other. Secondly, determine the weight of each indicator and the weight of the judges. Finally, we establish the uncertainty evaluation matrix and propose the uncertain comprehensive evaluation method.

The parameters used in this paper's model and their descriptions are shown in Table 1.

**Table 1.** Parameter symbols and their descriptions.

parameters	descriptions
$i$	Evaluation index $i = 1, 2, \dots, m$ ;
$j$	Judge $j = 1, 2, \dots, n$ ;
$\omega_i$	The weight of the $i$ -th index, $\sum_{i=1}^m \omega_i = 1, W = (\omega_1, \omega_2, \dots, \omega_m)$ ;
$v_j$	The weight of the $j$ -th judge, $\sum_{j=1}^n v_j = 1, V = (v_1, v_2, \dots, v_n)^T$ ;
$\xi_{ij}$	Uncertain evaluation of the $i$ -th index by the $j$ -th judge is an uncertain variable
$\Phi_{ij}$	Uncertainty distribution of $\xi_{ij}$ ;
$\Phi_{ij}^{-1}$	Inverse uncertainty distribution of $\xi_{ij}$ ;
$\xi_j$	Comprehensive uncertain evaluation of the evaluation object by the $j$ -th judge is an uncertain variable;
$\Phi_j$	The uncertainty distribution of $\xi_j$ ;
$\Phi$	The uncertainty distribution of $\xi$ ;

The matrix  $R$  composed of uncertain variables  $\xi_{ij}$  ( $i = 1, 2, \dots, m; j = 1, 2, \dots, n$ ) called the uncertain evaluation matrix, it is expressed as

$$R = \begin{pmatrix} \xi_{11} & \xi_{12} & \dots & \xi_{1n} \\ \xi_{21} & \xi_{22} & \dots & \xi_{2n} \\ \vdots & \vdots & \dots & \vdots \\ \xi_{m1} & \xi_{m2} & \dots & \xi_{mn} \end{pmatrix}. \quad (1)$$

The above matrix  $R$  is multiplied by the weight matrix  $W$  of the indicator to obtain a new matrix  $B$ , whose elements  $\xi_j$  ( $j = 1, 2, \dots, n$ ) represent the  $j$ -th judge's comprehensive uncertain evaluation of the rated object.

$$B = W \cdot R = (\omega_1, \omega_2, \dots, \omega_m) \cdot \begin{pmatrix} \xi_{11} & \xi_{12} & \dots & \xi_{1n} \\ \xi_{21} & \xi_{22} & \dots & \xi_{2n} \\ \vdots & \vdots & \dots & \vdots \\ \xi_{m1} & \xi_{m2} & \dots & \xi_{mn} \end{pmatrix} = \left( \sum_{i=1}^m \omega_i \xi_{i1}, \sum_{i=1}^m \omega_i \xi_{i2}, \dots, \sum_{i=1}^m \omega_i \xi_{in} \right) = (\xi_1, \xi_2, \dots, \xi_n) \quad (2)$$

of which,  $\xi_j = \sum_{i=1}^m \omega_i \xi_{ij}$  ( $j = 1, 2, \dots, n$ ).

Then, the product of matrix  $B$  and vector  $V$  is the uncertain comprehensive evaluation of the judging object, that is, the uncertain variable  $\xi$ .

$$B \cdot V = (\xi_1, \xi_2, \dots, \xi_n) \cdot \begin{pmatrix} v_1 \\ v_2 \\ \vdots \\ v_n \end{pmatrix} = v_1 \xi_1 + v_2 \xi_2 + \dots + v_n \xi_n = \sum_{j=1}^n v_j \xi_j. \quad (3)$$

Therefore, there are

$$\xi = \sum_{j=1}^n v_j \sum_{i=1}^m \omega_i \xi_{ij} = \sum_{j=1}^n \sum_{i=1}^m v_j \omega_i \xi_{ij}. \quad (4)$$

According to the above method, the uncertain comprehensive evaluation of each evaluation object can be regarded as an uncertain variable. Since the size of uncertain variables cannot be compared, we need to propose comparison criteria in order to obtain the comparison results among several evaluation objects.

Theorem 2.1<sup>[8]</sup>. Let  $\xi$  be an uncertain variable with regular uncertainty distribution  $\Phi$ , the inverse function  $\Phi^{-1}(\alpha)$  is called the inverse uncertainty distribution of  $\Phi$ , and  $E[\xi] = \int_0^1 \Phi^{-1}(\alpha) d\alpha$ .

Theorem 2.2<sup>[10]</sup>. Assumes that  $\xi_{ij}$  are independent uncertain variables whose uncertainty distributions are  $\Phi_{ij}$  and inverse uncertainty distributions are  $\Phi_{ij}^{-1}$ ,  $\xi = \sum_{j=1}^n \sum_{i=1}^m v_j \omega_i \xi_{ij}$ , where  $v_j$  and  $\omega_i$  are non-negative real numbers. Then there is

$$E[\xi] = \sum_{j=1}^n \sum_{i=1}^m v_j \omega_i E[\xi_{ij}] = \sum_{j=1}^n \sum_{i=1}^m v_j \omega_i \int_0^1 \Phi_{ij}^{-1}(\alpha) d\alpha. \quad (5)$$

Suppose that  $\xi$  and  $\eta$  are two independent uncertain variables, both of which have finite expected values. If  $E[\xi] > E[\eta]$ , then  $\xi$  is better than  $\eta$ . If  $E[\xi] = E[\eta]$ , you need to compare the uncertain variance of the two variables<sup>[8]</sup>.

According to the above uncertain comprehensive evaluation method, we can establish the evaluation index system, construct the uncertain evaluation matrix, calculate the comprehensive evaluation of the evaluation object, and can rank multiple evaluation objects according to the comprehensive evaluation comparison criterion.

### 3 Example of tourism public service level evaluation

The tourism public service system should have the following characteristics: first, the products or services provided by the publicity, government and related organizations are widely oriented to the society, rather than targeting a certain class or group; The second is the service, the products and services provided by the government and related organizations are to meet the needs of all aspects related to tourism; Third, non-profit, the products and services provided by the government and related organizations are not for the purpose of pursuing profit, but for the purpose of pursuing the common good. Therefore, according to these three characteristics of tourism public service content, this paper obtains the first-level evaluation index of tourism public service level, and then refines the second-level evaluation index to establish a two-fold evaluation system. Since the focus of this paper is to introduce a new evaluation method, for the sake of simplicity, we only use expert ratings for evaluation and invite three experts field of tourism as judges, and the field of tourism as judges, and the

weight matrix of experts is  $V = (v_1, v_2, v_3)^T = \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right)^T$ . In the following example, we use

linear uncertainty variables<sup>[7]</sup> to describe the uncertain evaluation of the evaluation indicators, and assume that the evaluation indicators are independent of each other. Collect and sort out the index data of tourism public service level evaluation, and determine the evaluation factor index system. Three experts give the weights of each index respectively, and Table 2 is obtained after calculation and sorting. The index system and weights are shown in Table 2<sup>[11]</sup>.

**Table 2.** The index system and weights.

Target layer	criteria layer	weight	indicator layer	weight
Tourism public Service Level	Tourism information level (A)	public service $\omega_1 = 0.1$	network information service	$a_1 = 0.4$
			Tourist information Service center	$a_2 = 0.3$
			Tourist service hotline	$a_3 = 0.3$
	Service level of tourism public facilities (B)	$\omega_2 = 0.2$	Public landscape facilities	$b_1 = 0.3$
			Public health facility	$b_2 = 0.2$
			Public sitting-out facilities	$b_3 = 0.2$
			Financial service facility	$b_4 = 0.1$
			Communication service facility	$b_5 = 0.1$
			Tourist medical facilities	$b_6 = 0.1$
	Tourism transport service level (C)	$\omega_3 = 0.25$	Tourism distribution center	$c_1 = 0.2$
			Tourism and transportation planning	$c_2 = 0.2$
			Tourism transportation network	$c_3 = 0.1$
			Scenic spot transportation service	$c_4 = 0.4$
			Green channel service	$c_5 = 0.1$
	Service level of tourism public safety (D)	$\omega_4 = 0.35$	Safety management of scenic spots	$d_1 = 0.5$
Emergency rescue service			$d_2 = 0.2$	
Travel insurance service			$d_3 = 0.2$	
Tourist safety sign			$d_4 = 0.1$	
Service level of tourism quality supervision (F)	$\omega_5 = 0.1$	Tourism price supervision service	$f_1 = 0.5$	
		Tourist accommodation supervision service	$f_2 = 0.3$	
		Tourism complaint acceptance service	$f_3 = 0.2$	

We use uncertain variable  $\xi$  to represent the tourism public service level. We evaluate layer by layer, and first evaluate each secondary index of the index layer. The uncertainty evaluation matrix  $R_1, R_2, R_3, R_4$  and  $R_5$  of the secondary indexes corresponding to the primary indexes  $A, B, C, D$  and  $F$  of the criterion layer are respectively

$$R_1 = \begin{pmatrix} L(80,84) & L(81,85) & L(82,86) \\ L(82,86) & L(80,82) & L(80,84) \\ L(78,82) & L(78,84) & L(19,83) \end{pmatrix}, R_2 = \begin{pmatrix} L(82,86) & L(84,86) & L(84,88) \\ L(83,85) & L(80,82) & L(81,85) \\ L(80,82) & L(81,83) & L(80,82) \\ L(82,84) & L(80,82) & L(80,84) \\ L(80,82) & L(79,83) & L(80,82) \\ L(78,84) & L(80,82) & L(78,84) \end{pmatrix},$$

$$R_3 = \begin{pmatrix} L(82,84) & L(81,85) & L(82,86) \\ L(81,83) & L(80,82) & L(81,85) \\ L(80,82) & L(80,84) & L(81,83) \\ L(82,86) & L(83,85) & L(83,85) \\ L(80,82) & L(80,82) & L(81,83) \end{pmatrix}, R_4 = \begin{pmatrix} L(82,84) & L(82,86) & L(84,86) \\ L(81,85) & L(81,83) & L(80,82) \\ L(80,82) & L(81,83) & L(82,84) \\ L(79,83) & L(80,82) & L(81,83) \end{pmatrix},$$

$$R_5 = \begin{pmatrix} L(82,84) & L(82,86) & L(83,85) \\ L(80,82) & L(81,83) & L(81,83) \\ L(80,82) & L(80,82) & L(79,85) \end{pmatrix}.$$

According to Theorem 2.1, we can calculate the expected value of each variable in a matrix  $R_1$ , listed in matrix form as

$$E[R_1] = \begin{pmatrix} 82 & 83 & 84 \\ 84 & 81 & 82 \\ 80 & 81 & 81 \end{pmatrix}.$$

According to the evaluation data, we calculate the evaluation situation of 5 first-level indicators in the criterion layer, and take 5 first-level indicators as 5 small goals, and solve them according to the evaluation matrix of corresponding second-level indicators. According to the uncertain comprehensive evaluation method in Section 2, we obtain

$$E[A] = (a_1, a_2, a_3) \begin{pmatrix} 82 & 83 & 84 \\ 84 & 81 & 82 \\ 80 & 81 & 81 \end{pmatrix} (v_1, v_2, v_3)^T = (0.4, 0.3, 0.3) \begin{pmatrix} 82 & 83 & 84 \\ 84 & 81 & 82 \\ 80 & 81 & 81 \end{pmatrix} \left( \frac{1}{3}, \frac{1}{3}, \frac{1}{3} \right)^T = 82.1000.$$

According to the calculation method of evaluation index  $A$ , we can calculate the expected value of uncertain evaluation of primary index  $B, C, D$  and  $F$ , which are  $E[B] = 82.7000, E[C] = 82.9667, E[D] = 82.9333$  and  $E[F] = 82.6000$ , respectively.

Finally, the uncertain comprehensive evaluation result of tourism public service level is calculated as

$$\begin{aligned}
E[\xi] &= (\omega_1, \omega_2, \omega_3, \omega_4, \omega_5)(E[A], E[B], E[C], E[D], E[F])^T \\
&= (0.1, 0.2, 0.25, 0.35, 0.1)(82.1000, 82.7000, 82.9667, 82.9333, 82.6000)^T \\
&= 82.7783.
\end{aligned}$$

From the results of the example, the final evaluation score of tourism public service is 82.7783, which indicates that the uncertain comprehensive evaluation method can better deal with the uncertainty in the evaluation of tourism public service, and the evaluation result is good.

This section introduces the evaluation process of uncertain comprehensive evaluation method. The comprehensive evaluation generally includes five service levels: tourism public information, tourism public facilities, tourism public transportation, tourism public safety and tourism quality supervision. The uncertain comprehensive evaluation method firstly evaluates each service level, and then carries out weighted summation, so as to ensure the objective and fair evaluation results.

## 4 Conclusions

Through the comprehensive evaluation of tourism public service level, targeted measures can be taken to improve the quality and level of tourism public service, improve service awareness and service efficiency, and promote the rapid development of local tourism. This paper puts forward the uncertainty comprehensive evaluation method, which is an improvement to the traditional evaluation method of tourism public service level. This method uses uncertain variables instead of the exact score given by the judges in the traditional method, and makes comprehensive evaluation according to the uncertain evaluation matrix, so it is more reasonable. Based on the expected value of the uncertain variable, we can also compare multiple evaluation objects. However, because the experts' comments may have artificial subjective factors, the comprehensive evaluation of uncertainty also has certain limitations.

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