`Original Research Article`

Research on the evaluation of sustainable development of rural tourism in henan province based on improved entropy Weight-TOPSIS model

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Abstract: Rural tourism has an important impact on the development of the whole rural area. The article selects 26 indicators in four dimensions, including economic benefits, ecological benefits, social benefits and market environment of rural tourism, to construct a comprehensive assessment criteria system for the development of rural tourism in Henan Province, and adopts the TOPSIS holistic assessment approach to analyse the sustainable growth of rural tourism in select cities and municipalities in Henan Province; and applies the 'impediment level' model to analyse the hindrances impeding rural development in Henan Province.

Keywords: TOPSIS; Entropy weighting (physics); Rural tourism; Level of development

1. Introduction

Under the theme of rural revitalization, rural tourism in China is garnering increasing attention from various sectors. At the beginning of the 21st century, the United Kingdom for the first time put forward PPT (pro-poor tourism) that is, 'tourism poverty alleviation' indicators [1], the effect of poverty alleviation in rural tourism as an important indicator for evaluating the economic development of the countryside, and continue to optimise Improve the evaluation index system [2]. Scholars in China mostly assess and measure the degree of tourism development from the perspectives of 'resource conditions, environmental conditions, site conditions, products, transport construction' [3], and 'social support, infrastructure, service system, application and innovation system' [4]. In the evaluation method, Liu Hui (2022) uses TOPSIS method, based on economic, cultural and social aspects to evaluate and analyse the advancement status of rural tourism in exemplary villages in Jilin Province and puts forward suggestions for rectification [5]. As for the establishment of the tourism assessment criteria system, Wang Jianjun (2023) proposes that the tourism evaluation system is based on three subsystems, namely the urban foundation system, the urban function system and the urban benefit system [6].

2. Research design

The representative cities selected for the article include Anyang City in the north of Henan Province, Zhengzhou City and Kaifeng City in the centre, Luoyang City in the west, Nanyang City in the south-west, and Zhoukou City in the east, which all have a certain degree of popularity in Henan Province, with a relatively mature urban development system, and there are rural tourism sites in the region that have been selected as part of the 'First Batch of the National List of Key Villages for Rural Tourism', to guarantee the typicality of the advancement of rural tourism in the study cities.

2.1. Data Sources and rural tourism evaluation indicator system

The source of data for this study is mainly based on the relevant data released by the Henan Provincial

Department of Culture and Tourism and the tourism bureaus of various cities in Henan Province, supplemented by relevant data from China's Statistical Yearbook and Henan's Cultural and Touris, as well as cadres' interviews and field research and other methods to obtain relevant data.

This paper takes the sustainable growth of rural tourism as the goal, and selects four guidelines related to agricultural tourism based on the 'Classification and Evaluation of Agricultural Tourism Demonstration Villages in Henan Province', and constructs an all-encompassing assessment framework for rural tourism development, which is divided into four sub-systems and 26 indexes, namely, economic benefits of rural tourism, ecological benefits of rural tourism, social benefits of rural tourism, and the market environment of rural tourism.

2.2. Research methodology

2.1.1. Entropy weight TOPSIS method

This paper adopts the entropy-weighted TOPSIS approach, on the one hand, to improve the value formula, on the other hand, to avoid the shortcomings of determining the weights subject to subjective influencing factors. The detailed calculation procedures are outlined below.

The first step is to standardise the indicators. The standardised calculation formula is:

$$\text{Positive indicators: } X'_{ij}=(X_{ij}-minX_{ij})/(maxX_{ij}-minX_{ij}) \tag{1}$$

$$\text{Negative indicators: } X'_{ij}=(maxX_{ij}-minX_{ij})/X'_{ij}=(X_{ij}-minX_{ij}) \tag{2}$$

In the second step, determine h_j as the information entropy value:

$$h_j=-\frac{1}{\ln m}\sum_{i=1}^{m}p_{ij}\ln p_{ij} \tag{3}$$

In the third step, the indicator weights W_j will be determined:

$$w_j=\frac{1-h_j}{\sum_{j=1}^{m}1-h_j} \tag{4}$$

In the fourth step, a decision matrix V with assigned weights is formulated:

$$V=w_j*X'_{ij} \tag{5}$$

In the fifth step, the two ideal solutions of the indicator will be determined:

$$X^+=(max\{a_{11},a_{21},a_{i1}\},max\{a_{12},a_{22},a_{i2}\},max\{a_{1j},a_{2j},a_{ij}\}=(X_1^+,X_2^+,X_j^+) \tag{6}$$

$$X^-=(max\{a_{11},a_{21},a_{i1}\},max\{a_{12},a_{22},a_{i2}\},max\{a_{1j},a_{2j},a_{ij}\}=(X_1^-,X_2^-,X_j^-) \tag{7}$$

In the sixth step, calculate the Euclidean distance:

$$D^+=\sqrt{\sum_{i=1}^{m}z_i(X_I^+-a_i)^2} \tag{8}$$

$$D^-=\sqrt{\sum_{i=1}^{m}z_i(X_I^--a_i)^2} \tag{9}$$

In the seventh step, the closeness C_j is calculated as:

$$C_i=\frac{D_i^-}{D_i^++D_i^-} \tag{10}$$

Referring to the relevant literature, this paper divides the closeness into five levels for the purpose of evaluating the rural development status in representative cities of Henan Province (**Table 1**).

Table 1. Criteria for judging the extent of rural progression.

level of development	poorly	mediocre	usual	favourable	desirable
closeness	[0~0.20)	[0.20~0.40)	[0.40~0.60)	[0.60~0.80)	[0.80~1.00)

2.2.2. Handicap model

In order to derive the constraints affecting the advancement of rural tourism in each region, this research examines the hindrances to rural development using the impediment level model [7]. The obstacle degree model adopts three indicators of 'index deviation', 'factor contribution' and 'obstacle degree' for analysis and evaluation. Taking 'Classification and Evaluation of Agricultural Tourism Demonstration Villages in Henan Province' as the reference basis, the calculation formula is:

$$o_{ij}=1-X_{ij}^{'} \tag{11}$$

$$F_j=w_j \times R_k \ (k=1, 2, , 4, 5) \tag{12}$$

$$M_{ij}=F_j \times o_{ij} \times 100\% / \sum_{i=1}^{m} F_j \times o_{ij} \tag{13}$$

After calculation, the weights of indicators in the evaluation index system of the development status of rural tourism in Henan Province are demonstrated .

3. Empirical analysis

3.1. Subsystem evaluation

Table 3 presents the assessment outcomes of rural tourism development in representative cities of Henan Province, it indicates the existence of notable disparities in rural tourism development levels in Henan Province, while the rural tourism development remains at an intermediate level [8]. In the evaluation of tourism economic benefits, Zhengzhou City ranks the highest with a score of 0.690. In the evaluation of ecological benefits, Luoyang City ranks first. In the evaluation of social and cultural benefits, Zhengzhou City, Kaifeng City and Luoyang City ranked the top three. In the analysis and evaluation of the market environment, Zhengzhou City ranked first.

3.2. Overall assessment

The calculation results in an overall assessment of rural tourism development in six representative cities in Henan Province (**Table 2**). In conclusion, the average score of rural tourism development of representative cities in Henan Province is 0.439, which is at the middle-low level, which means that Henan Province does not have a notable advantage in rural tourism development.

Table 2. Overall assessment of Rural Tourism Development Levels in Advanced Cities of Henan Province.

Typical cities	D^+	C^-	C_i	sort
Luoyang	0.581	0.693	0.498	2
Nanyang	0.323	0.409	0.378	4
Anyang	0.604	0.318	0.271	6
Kaifeng	0.418	0.402	0.432	3
Zhengzhou	0.389	0.581	0.683	1
Zhoukou	0.502	0.346	0.368	5

3.3. Barrier factor analysis

Through analysis using the obstacle degree model, the factors hindering rural tourism development in six typical regions of Henan Province were ranked, with the top three obstacles identified and presented in **Table 3**.

Table 3. Top three barrier factors.

Typical cities	Luoyang	Nanyang	Anyang	Kaifeng	Zhengzhou	Zhoukou
Factor 1	De	Cg	Ab	Da	Bb	De
Factor 2	Cg	De	Cg	Bg	Bg	Cg
Factor 3	Da	Da	Db	Ba	Ab	Ba

As observed in **Table 3**, regarding the primary obstacle factor, the main barrier factor of Luoyang and Zhoukou is the ratio of developing rural tourism, the main barrier factor of Zhengzhou is the number of days of high quality air quality, the main barrier factor of Kaifeng is the radiation range of rural tourism, and the main barrier factor of Anyang City is the economic benefit of developing rural tourism. In the second obstacle factor, the obstacle factor for Luoyang, Anyang and Zhoukou is the ratio of villages developing rural tourism, and the hindrance factor for Kaifeng and Zhengzhou is the level of ecological greening in the region. In the third barrier factor, the barrier factor of Luoyang and Nanyang is the radiation range of rural tourism, the barrier factor of Zhoukou is the richness of landscape, and the barrier factor of Anyang is the richness of tourism resources.

4. Conclusion

In terms of the development of typical cities, notable disparities exist in the current state of rural tourism development among Zhengzhou, Luoyang, Kaifeng, Nanyang, Zhoukou, and Anyang. Among these cities, Zhengzhou and Luoyang exhibit a relatively high level of comprehensive rural tourism development, Kaifeng and Nanyang are at a moderate level, while Zhoukou and Anyang have a relatively low level of rural tourism development. In terms of the overall geographical development of Henan Province, the relatively advantageous areas of development are the central and northwestern regions of the province, the middle development areas are the central and southern regions, and the relatively disadvantaged areas are the eastern and northern regions.

From the analysis of obstacle factors, the main obstacle factors can be divided into four categories. From the viewpoint of economic benefits of rural tourism, the revenue generated from rural tourism and its contribution to GDP are the main obstacle factors; from the viewpoint of ecological benefits of rural tourism, the richness of rural landscape, rural air quality and greening rate in the region constitute the primary hindrance factors; from the viewpoint of social benefits of rural tourism, the proportion of villages that have carried out rural tourism reception is the main obstacle factor; from the viewpoint of market environment of rural tourism, the radiation of rural tourism range and the share of international visitors, the abundance of tourism resources, the proportion of financial investment in rural characteristics and culture, and the ratio of rural development tourism are the main obstacle factors

Firstly, improve the level of industrial development planning. Localities should conduct precise positioning and planning of rural tourism around industrial advantages. Industry plays a crucial role in rural eco-tourism, addressing the development of rural tourism in relation to the agricultural sector, the relationship between rural tours and scenic tours, relying on local characteristics and advantages of the industry to develop rural tourism. Secondly, improve the level of comprehensive management of the industry. From the city, district, township, from top to bottom in order to carry out functional positioning, classification guidance, to create regional characteristics, to foster diverse development in rural touris, complementary functions, to avoid disorderly development, repeated construction. Finally, adhere to a balanced approach to economic development, to ensure that the ecological environment is not damaged. To deal with the relationship between development and protection, the biggest advantage of the countryside lies in the environment, the most valuable wealth is

resources. The nature and purpose of rural tourism dictate that not all rural areas are suitable for rural tourism.

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