

A Multi-attribute Evaluation Model of the Development Competitiveness of Tourism cities based on Grey Clustering Analysis

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Abstract

Enhancing the development competitiveness holds significance to the sustainable development of tourism cities. It is complex system engineering as the development competitiveness of tourism cities is influenced by many factors. Therefore, this paper studies the development competitiveness from ten dimensions, namely ecological factor, environmental factor, cultural factor, educational factor, scientific factor, civilizational factor, brand factor, economic factor, market factor and development potential factor. A multi-attribute evaluation model of the development competitiveness of tourism cities is established based on grey clustering analysis. Through the study of influence factors, grey clustering analysis function is established to obtain the grey clustering coefficient. Given that influence factors are distinct in terms of importance, the weighted grey clustering analysis model is established for the evaluation of development competitiveness of tourism cities. Finally, a case is studied to verify the model.

Keywords: *tourism cities, development competitiveness, grey clustering analysis, multi-attribute analysis of decision making, evaluation model*

1. Introduction

In modern times, science and technology bring changes to the society every passing day. Tourism cities should update themselves and follow the trend of the time in order to ensure sustainable development [1-2]. The development of tourist industry, on one hand, can enhance the comprehensive strength of the city by bringing more opportunities. On the other hand, it poses challenges on how to keep the engine of development and achieve sustainable development through effective measures [3-4]. These are the practical concerns of local government and the tourism agency. Because of so, how to enhance the development competitiveness of tourism cities and the analysis of influence factors has become a hot issue in the academic field. Many fruitful results present up and provide guidance on enhancing development competitiveness [5-8]. However, these studies are distinct with regard to research perspective. More often than not, they are result-oriented but neglect the process, which makes the studies one-sided. Thus, this paper proposes an evaluation model based on grey clustering analysis [9-12] to support the evaluation and the analysis of the development competitiveness of tourism cities.

2. Multi-attribute Analysis of the Development Competitiveness of Tourism Cities

After a careful study of previous research and consulting with experts in this field, and according to real situation of the development of tourism cities, this paper studies the development competitiveness from ten dimensions, namely ecological factor, environmental factor, cultural factor, educational factor, scientific factor,

civilizational factor, brand factor, economic factor, market factor and development potential factor.

Ecological factor: the modern society pays great attention to ecology and environment protection. Tourism cities should put more efforts on city landscaping and city building. The climate and living conditions are also an integrated part of the ecological factor.

Environmental factor: environment protection is a new challenge of modern tourism cities, which is in the form of green tourism. Green tourism stresses on environment protection measures about tourists and the tourist area and focuses on the contribution of tourism cities to the environment. It also stresses an effective control of enterprises and pollution sources such as products and the equipment, so as to reduce the negative effect on tourism cities.

Cultural factor: cultural factor can reflect the thickness of culture of a city. It combines traditional culture and emerging culture and promotes the integration of the two. It facilitates cultural inheritance of tourism cities and makes the city receive more recognition because of the cultural glamour, and enhance the development competitiveness as a result.

Educational factor: educational factor reflects the development state of education of a city. The level of education is a measurement of the accumulating ability of the city. In particular for tourism cities, it is important to improve the higher education, the secondary education and the primary education.

Scientific factor: science and technology are the primary driven force of production. They are also key factors of competitiveness. As the modern society is advancing and the tourism industry is expanding its scale and scope of business, scientific factor is playing a more and more important role in this connection.

Civilizational factor: from public library to cultural museum, from science museum to art group, from cultural facilities to public quality, and from government mechanism to system, all these can embody the civilization of tourism cities.

Brand factor: brands act just like a token to the city. Recognition from the mass on the brands of tourism cities propels the sustainable development of the cities. Thus, it is necessary to improve the satisfaction from people on the brands.

Economic factor: tourism cities need to develop on strong economic basis, including infrastructure, people's living standard, and transportation, eating, shopping and living. Higher economic level contributes to the tourism industry in its own way and wins the city more attraction and competitiveness.

Market factor: in the modern time, many cities strive to become tourism cities. They are distinct in features and tourists. It is important to understand how to attract more tourists with brands, coordinate the development of the tourism industry with other industries, take a larger share of the market and keep high growth rate of the market.

Development potential factor: this factor is related to the development ability of relevant industries, resources reorganization, service ability and tourism guarantee. It has an indirect influence on the development of tourism cities and key to enhancing the development competitiveness.

3. A Multi-attribute Evaluation Model of the Development Competitiveness of Tourism Cities based on Grey Clustering Analysis

3.1 Grey Clustering Analysis

In the grey clustering analysis, the objects under evaluation are categorized according to the value of the function and the value of grey category. Basic steps are described as bellow:

- (1) Indicators of grey clustering analysis are confirmed. Assume there are m indicators of grey clustering analysis;
- (2) Grey categories of grey clustering analysis are confirmed. Assume there are n grey categories;
- (3) Grey clustering analysis functions δ_{ij} of n grey categories of m indicators are confirmed;
- (4) According to real value or estimated value, values of grey clustering analysis $u_i^j(p)$ of p objects under evaluation are obtained and the matrix \mathbf{R} is formed;

$$\mathbf{R} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \cdots & \vdots \\ r_{p1} & r_{p2} & \cdots & r_{pm} \end{bmatrix} \quad (1)$$

- (5) According to value of grey clustering analysis, the matrix δ^t about m indicators of object t and n grey categories is obtained;

$$\delta^t = \begin{bmatrix} \delta_{11}^t & \delta_{12}^t & \cdots & \delta_{1n}^t \\ \delta_{21}^t & \delta_{22}^t & \cdots & \delta_{2n}^t \\ \vdots & \vdots & \cdots & \vdots \\ \delta_{m1}^t & \delta_{m2}^t & \cdots & \delta_{mn}^t \end{bmatrix} \quad (2)$$

- (6) Value γ_m^t of comprehensive grey clustering analysis function of the i -th grey category of object t is obtained. And the grey category of object t is confirmed according to the value of function.

$$\gamma_j^t = \frac{1}{m} \sum_{i=1}^m \delta_{ij}^t \quad (3)$$

3.2 Grey Category of the Development Competitiveness of Tourism Cities

According to 10 influence factors of the development competitiveness, experts are invited to score them and three categories are confirmed.

The first grey category of the development competitiveness of tourism cities is δ_I . Its corresponding grey clustering analysis function is shown as Figure 1.

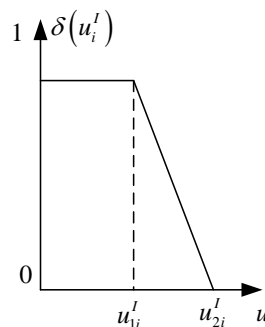


Figure 1. Grey Clustering Analysis Function of the First Category

The first grey category of the development competitiveness of tourism cities is δ_{II} . Its corresponding grey clustering analysis function is shown as Figure 2.

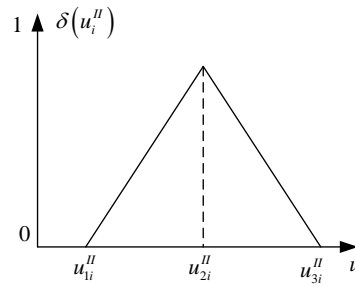


Figure 2. Grey Clustering Analysis Function of the Second Category

The first grey category of the development competitiveness of tourism cities is δ_{III} . Its corresponding grey clustering analysis function is shown as Figure 3.

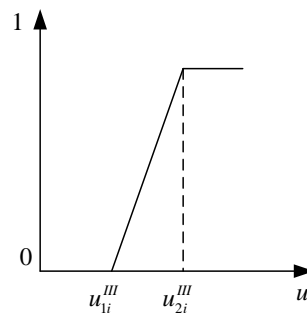


Figure 3. Grey Clustering Analysis Function of the Third Category

3.3 Grey Clustering Analysis Function of the Development Competitiveness of Tourism Cities

According to the abovementioned analysis, influence factors contribute to the development competitiveness of tourism cities in different ways. So the corresponding grey clustering analysis functions vary from each other. Combined with experts' opinions and the 0-1 ratio scale measurement, grey clustering analysis functions of 10 influence factors are confirmed.

Brand factor, market factor and development potential factor are the first-class factors. The definitions of three grey categories are defined as the following with Figure.1-3 as the reference:

$$\delta_{(u_{ki})}^I = \begin{cases} 0 & u_{ki} \geq 0.6 \\ \frac{0.6 - u_{ki}}{0.2} & 0.4 \leq u_{ki} \leq 0.6 \\ 1 & 0 \leq u_{ki} \leq 0.4 \end{cases} \quad (4)$$

$$\delta_{(u_{ki})}^{II} = \begin{cases} 0 & u_{ki} \leq 0.5 \vee u_{ki} \geq 0.8 \\ \frac{u_{ki} - 0.5}{0.2} & 0.5 \leq u_{ki} \leq 0.7 \\ \frac{0.8 - u_{ki}}{0.1} & 0.7 \leq u_{ki} \leq 0.8 \\ 1 & x_{ij} = 0.7 \end{cases} \quad (5)$$

$$\delta_{(u_{ki})}^{III} = \begin{cases} 1 & u_{ki} \geq 0.9 \\ \frac{u_{ki} - 0.8}{0.1} & 0.8 \leq u_{ki} \leq 0.9 \\ 0 & u_{ki} \leq 0.8 \end{cases} \quad (6)$$

Ecological factor, environmental factor, economic factor and scientific factor are the second-class factors. The definitions of three grey categories are defined as the following with Figure.1-3 as the reference:

$$\delta_{(u_{ki})}^I = \begin{cases} 0 & u_{ki} \geq 0.5 \\ \frac{0.5 - u_{ki}}{0.1} & 0.4 \leq u_{ki} \leq 0.5 \\ 1 & 0 \leq u_{ki} \leq 0.4 \end{cases} \quad (7)$$

$$\delta_{(u_{ki})}^{II} = \begin{cases} 0 & u_{ki} \leq 0.5 \vee u_{ki} \geq 0.85 \\ \frac{u_{ki} - 0.6}{0.1} & 0.5 \leq u_{ki} \leq 0.6 \\ \frac{0.85 - u_{ki}}{0.25} & 0.6 \leq u_{ki} \leq 0.85 \\ 1 & x_{ij} = 0.6 \end{cases} \quad (8)$$

$$\delta_{(u_{ki})}^{III} = \begin{cases} 1 & u_{ki} \geq 0.95 \\ \frac{u_{ki} - 0.85}{0.1} & 0.85 \leq u_{ki} \leq 0.95 \\ 0 & u_{ki} \leq 0.8 \end{cases} \quad (9)$$

Cultural factor, civilizational factor and educational factor are the third-class factors. The definitions of three grey categories are defined as the following with Figure 1-3 as the reference:

$$\delta_{(u_{ki})}^I = \begin{cases} 0 & u_{ki} \geq 0.4 \\ \frac{0.4 - u_{ki}}{0.1} & 0.3 \leq u_{ki} \leq 0.4 \\ 1 & 0 \leq u_{ki} \leq 0.3 \end{cases} \quad (10)$$

$$\delta_{(u_{ki})}^{II} = \begin{cases} 0 & u_{ki} \leq 0.4 \vee u_{ki} \geq 0.8 \\ \frac{u_{ki} - 0.4}{0.2} & 0.4 \leq u_{ki} \leq 0.6 \\ \frac{0.8 - u_{ki}}{0.2} & 0.6 \leq u_{ki} \leq 0.8 \\ 1 & x_{ij} = 0.6 \end{cases} \quad (11)$$

$$\delta_{(u_{ki})}^{III} = \begin{cases} 1 & u_{ki} \geq 0.9 \\ \frac{u_{ki} - 0.8}{0.1} & 0.8 \leq u_{ki} \leq 0.9 \\ 0 & u_{ki} \leq 0.8 \end{cases} \quad (12)$$

3.4 Importance of Indicators of the Development Competitiveness of Tourism Cities

These 10 influence factors are different in terms of importance to the development competitiveness of tourism cities. Thus, the comprehensive evaluation method is adopted to analyze the importance of influence factors. Assume s experts are invited. A 0-1 ratio scale is used to score the importance and the judgment matrix B is obtained:

$$B = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1l} \\ b_{21} & b_{22} & \cdots & b_{2l} \\ \vdots & \vdots & \vdots & \vdots \\ b_{s1} & b_{s2} & \cdots & b_{sl} \end{bmatrix} \quad (13)$$

Then the weight w_j of indicator j of the development competitiveness of tourism cities is:

$$w_j = \frac{\sum_{k=1}^s a_{kh}}{\sum_{h=1}^l \sum_{k=1}^s a_{kh}} \quad (14)$$

3.5 Multi-attribute Evaluation Model of the Development Competitiveness of Tourism Cities

The value of indicator j of object p is $u^j(p)$, the grey clustering analysis functions $\delta_{(u_{ki})}^I - \delta_{(u_{ki})}^{III}$ are established. The matrix $\delta(p)$ of grey clustering analysis functions belonging to grey category $I - III$ of indicator j of object P is obtained:

$$\delta(p) = \begin{bmatrix} \delta_{1I}^p & \delta_{1II}^p & \delta_{1III}^p \\ \delta_{2I}^p & \delta_{2II}^p & \delta_{2III}^p \\ \vdots & \vdots & \vdots \\ \delta_{10I}^p & \delta_{10II}^p & \delta_{10III}^p \end{bmatrix} \quad (15)$$

Assume the weight of indicator j is w_j , so the weighed matrix of grey clustering analysis function belonging to grey category $I - III$ of indicator j of object P is:

$$\pi(p) = [\pi_I^p, \pi_{II}^p, \pi_{III}^p] = W^T * \delta(p) = [w_1, w_2, \dots, w_{10}] * \begin{bmatrix} \delta_{1I}^p & \delta_{1II}^p & \delta_{1III}^p \\ \delta_{2I}^p & \delta_{2II}^p & \delta_{2III}^p \\ \vdots & \vdots & \vdots \\ \delta_{10I}^p & \delta_{10II}^p & \delta_{10III}^p \end{bmatrix} \quad (16)$$

According to the optimal principle, if it satisfies:

$$\pi_o^p = \max_{I \leq g \leq III} (\pi(p)) = \max_{I \leq g \leq III} ([\pi_I^p, \pi_{II}^p, \pi_{III}^p]) = \pi_e^p \quad (17)$$

Then it indicates object p is in the grey category e . If there are several objects under evaluation, similar analysis can be taken to obtain different grey categories.

4. Case Study

City A is a popular tourism city in a province and one of the cities on the list of key zones for development by the provincial government. Thus, it is necessary to evaluate the development competitiveness of city A so as to provide guidance for future planning.

Experts and leaders in relevant fields are invited to score the development competitiveness of city A . The score are shown in Table 1.

Table 1. Evaluation Score of the Development Competitiveness of Tourism Cities

Influence factor	Weight	Evaluation score
Ecological factor	0.104	0.75
Environmental factor	0.095	0.88
Cultural factor	0.068	0.68
Educational factor	0.052	0.92
Scientific factor	0.083	0.87
Civilizational factor	0.085	0.65
Brand factor	0.146	0.78
Economic factor	0.102	0.75
Market factor	0.137	0.87
Development potential factor	0.128	0.93

According to the grey clustering analysis function of grey categories of influence factors, the value of function can be obtained and the weighted value of grey clustering analysis function are computed, as shown in Table 2.

Table 2. Value of Grey Clustering Analysis Function

Influence factor	Value of grey clustering analysis function		
	Grey category <i>I</i>	Grey category <i>II</i>	Grey category <i>III</i>
0.104	0	0.0416	0
0.095	0	0	0.0285
0.068	0	0.0408	0
0.052	0	0	0.052
0.083	0	0	0.0166
0.085	0	0.0638	0
0.146	0	0.0292	0
0.102	0	0.0408	0
0.137	0	0	0.0959
0.128	0	0	0.128
Weighed value of grey clustering analysis function	0	0.2162	0.3210

From Table 2, it is seen that the development competitiveness of tourism city A is in category III . It indicates that city A has high competitiveness but there is still much room for improvement.

5. Conclusion

This paper studies the development competitiveness of tourism cities from ten dimensions, namely ecological factor, environmental factor, cultural factor, educational factor, scientific factor, civilizational factor, brand factor, economic factor, market factor and development potential factor. Multiple dimensions make the study more objective and thus, convincing. According to the grey system theory, a multi-attribute evaluation model of the development competitiveness of tourism cities is established based on grey clustering analysis. The grey category to which the development competitiveness belongs is judged according to the value of grey clustering analysis function. Consequently, the model serves as a measurement of development competitiveness of tourism cities and supports for decision-makings about the sustainable development.

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