Research on the Benefits of the Olympics

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Abstract: The International Olympic Committee (IOC) is facing a decline in the number of applicants for the Summer and Winter Olympics, with recent host cities/countries experiencing various short-term and long-term negative impacts. We have established a grey correlation TOPSIS benefit evaluation model to evaluate the benefits of hosting the Olympic Games in various countries, and to help countries wishing to host the Olympic Games assess their comprehensive benefits. Comprehensive benefit evaluation model for Olympic Games based on grey relevance-TOPSIS: The paper innovatively combines the grey relevance-TOPSIS model with Pearson correlation to establish a grey relevance-TOPSIS evaluation model. Taking the comprehensive benefit evaluation of the Olympic Games as the overall indicator, taking economic benefits, social benefits, cultural benefits, and political benefits as the first level indicators, and taking the subdivision factors of the first level indicators as the second level indicators, a comprehensive benefit evaluation model for the Olympic Games based on grey correlation TOPSIS was established. The paper conducts normalization processing based on the collected data of various indicators, and then obtains the entropy weight of the benefits of hosting the Olympic Games in various countries from 1964 to 2020 to assess the comprehensive benefits of hosting the Olympic Games in various countries.

Keywords: System Analysis; Pearson; Grey Correlation - TOPSIS; PCA

1. Background

The International Olympic Committee (IOC) is facing a declining number of applicants for the Summer and Winter Olympics, and recent host cities/countries have experienced various short-term and long-term negative impacts. To solve these problems, we need to establish models to solve them. For example, both the Summer Olympics and the Winter Olympics should have a fixed location. Another idea is that hosting four smaller Olympic Games for Olympic events (such as winter, spring, summer, and autumn) may reduce the burden of hosting such a large event to some extent.

The International Olympic Committee (IOC) is facing a declining number of applicants for the Summer and Winter Olympics, and recent host cities/countries have experienced various short-term and long-term negative impacts. To solve these problems, we need to establish models to evaluate the comprehensive benefits of hosting the Olympic Games in various countries. In this paper, we have three parts: (1) The comprehensive evaluation index system for the hosting of the Olympic Games; (2) Comprehensive Benefit Evaluation Model for Olympic Games Based on Grey Correlation TOPSIS; (3) Model accuracy verification and applicability discussion.

2. Assumptions of the model

To simplify the problem, we make the following basic assumptions, each of which is properly justified: (1)Innovatively combine gray correlation and Pearson correlation coefficients, establish a comprehensive correlation evaluation model, conduct factor screening, and calculate more correlation effects; (2)Assume that a large number of factors considered are representative and can represent various indicators; (3)The impact of unexpected factors on the model, such as epidemic outbreaks and wars, is not considered; (4)By comparing the difference between the predicted value of entropy weight and the actual value, and conducting cross validation with the actual results, the constraints draw are more constraining.

3. Comprehensive Evaluation Model for the hosting of the Olympic Games

3.1 Comprehensive evaluation index system for the hosting of the Olympic Games

The first question requires us to determine a quantitative decision-making indicator that can define "the best", so that decision-makers have confidence in the hosting of the Olympic Games. This indicator should consider short-term and long-term benefits and costs.

After studying the relevant concepts and basic theories of the benefit evaluation of the Olympic Games, the evaluation indicators for the Olympic Games are divided into economic benefits (including various costs and benefits), personnel satisfaction, transportation facility impact Long-term impact benefits (including improving political status, economic benefits, and cultural benefits), and combining relevant research by many scholars[1-5], a universal comprehensive evaluation index evaluation system model for Olympic Games hosting has been established. The construction model of the evaluation indicator system is shown in the Table 3.1.

3.2 Comprehensive Benefit Evaluation Model for Olympic Games

To evaluate the comprehensive benefits of hosting the Olympic Games in various countries, a comprehensive evaluation must be conducted scientifically. This section introduces the grey relevance-TOPSIS model, which innovatively combines the grey relevance-TOPSIS model with Pearson correlation to establish a grey relevance-TOPSIS evaluation model. Taking the comprehensive benefit evaluation of the Olympic Games as the overall indicator, taking economic benefits, social benefits, cultural benefits, and political benefits as the first level indicators, and taking the subdivision factors of the first level indicators as the second level indicators, a comprehensive benefit evaluation model for the Olympic Games based on grey correlation TOPSIS was established.

3.2.1 Data standardization

The data mentioned above are in different dimensional units, so the size of the data varies greatly and the range of the data is also different. At the same time, it will have a greater impact on the prediction results of some variables. Turning all data into numbers between [0,1] can eliminate the deviation caused by different sizes of data.

In this paper, the maximum minimum method is introduced to normalize the data:

$$v_s = \frac{v - v_{min}}{v_{max} - v_{min}} \tag{3.1}$$

3.2.2 Gray correlation-Pearson correlation

Due to the large number of selected variables, it will be more difficult for the paper to directly calculate and analyze, and there will be related coupling problems between the variables. To refine the analysis, this article intends to use the method of correlation solving to select some representative variables from the large number of variables proposed in this article, and then calculate the weights below [6-8].

To calculate the correlation of the parameters introduced in this article, more traditional methods include Pearson's correlation coefficient solving, mutual information method and gray correlation algorithm. This article innovatively combines Pearson correlation coefficient and gray correlation method to obtain comprehensive correlation solution The specific model of the coefficient method is as follows [6-8]:

The following introduces the improved gray correlation degree correlation solving model:

Step 1: Sequence of system behavior [6-8]

$$\begin{aligned} X_0 &= (x_0(1), x_0(2), \cdots, x_0(m)) \\ X_1 &= (x_1(1), x_1(2), \cdots, x_1(m)) \\ &\cdots\cdots\cdots\cdots \\ X_i &= (x_i(1), x_i(2), \cdots, x_i(m)) \\ &\cdots\cdots\cdots\cdots \\ X_n &= (x_n(1), x_n(2), \cdots, x_n(m)) \end{aligned} \tag{3.2}$$

Step 2: Calculate the correlation coefficient [6-8]

$$\gamma_{0i}(k) = \frac{c}{c + \tan\left(\frac{\beta_{0i}(k)}{2}\right)} \tag{3.3}$$

Step 3: Calculate the weight

$$W_{0i}(k) = 1 - \frac{|x_i(k) - x_0(k)|}{\sum_{k=1}^{m} |x_i(k) - x_0(k)|} \quad (3.4)$$

Step 4: Correlation calculation

$$\gamma_{0i} = \frac{1}{m-1} \sum_{k=1}^{m-1} W_{0i}(k) \gamma_{0i}(k) \quad (3.5)$$

Step 5: Calculation of comprehensive correlation coefficient

$$p = \frac{|\gamma_{0i}| + |r|}{2} \quad (3.6)$$

3.2.3 Evaluation Model Based on Entropy Weight-TOPSIS

After obtaining the data of each indicator, to describe the quantitative trend of the target, this paper adopts the method of TOPSIS and entropy weight to calculate the comprehensive indicator parameters. First, the paper needs to use the entropy weight method to weight the indicators in the evaluation system to obtain the proportion of each indicator parameter in the evaluation system (100% overall). The entropy weight method is less subjective and can make full use of the characteristics of the data [9-10]. First, the entropy weight algorithm is used to calculate the weight of the indicator, and then the paper analyzes the attributes of the indicator system, the result is also shown in the Table 3.1.

Table 3.1 Comprehensive benefit evaluation and entropy weight of Olympic games

Overall indicators	Primary indicator	Secondary indicators	+/-	E-W
Comprehensive evaluation of the hosting of the Olympic Games 1.0000	Economic Benefits 0.3526	Increase in employment	+	0.0512
		Improvement in local living standards	+	0.0418
		Increase in tourism income	+	0.0638
		Investment costs	-	0.0821
		Increased taxes	+	0.0532
		Capital debt ratio	-	0.0605
	Social Benefits 0.2654	Infrastructure improvement	+	0.0524
		Traffic conditions	-	0.0548
		Population density	-	0.0519
		Facility utilization rate	+	0.0511
		Carbon emission increase rate	-	0.0552
	Humanistic Benefits 0.2782	Value transmission	+	0.0266
		Organizational ability of local government personnel	+	0.0281
		Permanent participation rate of Olympic related sports	+	0.0247
		Pride of local people	+	0.0276
		Perception of tourists	+	0.0355
		Number of athletes participating	+	0.0264
		Number of tourists	+	0.0432
		Quality of facilities	+	0.359
		Sense of personnel experience	+	0.302
	Political Benefits 0.1038	International visibility	+	0.0328
		Improvement of planners' capabilities	+	0.0284
		Continuation of cooperative relationships	+	0.0426

The paper performs normalization processing based on the collected data of various indicators, and then calculates the entropy weight values of the benefits of hosting Olympic Games in various countries from 1964 to 2020. The entropy weight values are visualized as heat maps for easy reading. It is evident that the comprehensive benefits of countries hosting the second Olympic Games have increased by more than 50%.

Table 3.2 Entropy Weights for Benefit Assessment of Olympic Games Hosting in Various

Year	Host country	E-W	Year	Host country	E-W
1964	Japan	0.01	**1996**	U.S.A	0.99
1968	Mexico	0	**2000**	Australia	0.62
1972	Germany	0.06	**2004**	Greece	0.08
1976	Canada	0.04	**2008**	China	0.66
1980	Soviet Union	0.14	**2012**	Britain	0.4
1984	U.S.A	0.5	**2016**	Brazil	0.32
1988	the republic of Korea	0.08	**2020**	Japan	0.84
1992	Spain	0.12			

By importing the calculated entropy weights of the comprehensive evaluation of previous Olympic Games into the software for visualizing the thermal diagram, it can be clearly found that the economic benefits of carrying out the Olympic Games in the United States, Australia, China, and Japan are high.

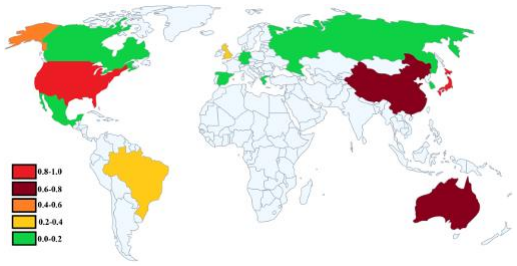

Figure 3.3 Heat Map of Benefit Assessment for Olympic Games Hosting in Various Countries

4. Summary and suggestions

To evaluate the comprehensive benefits of hosting the Olympic Games in various countries, a comprehensive evaluation must be conducted scientifically. This section introduces the grey correlation TOPSIS model, innovatively combining the grey correlation model with the Pearson correlation to establish a grey correlation TOPSIS evaluation model. Taking the comprehensive benefit evaluation of the Olympic Games as the overall indicator, taking economic benefits, social benefits, cultural benefits, and political benefits as the first level indicators, and taking the subdivision factors of the first level indicators as the second level indicators, a comprehensive benefit evaluation model for the Olympic Games based on grey correlation TOPSIS was established. Through entropy weight calculation, we can find that for countries hosting the first Olympic Games, their overall benefits are generally low, while for countries hosting the second Olympics, such as Japan and the United States, their overall benefits have significantly improved.

Therefore, we propose several suggestions:

(1) Countries should increase their investment in the Olympic Games to enhance the experience of their athletes and tourists, enhance their national self-confidence and international visibility.

(2) Vigorously develop the tourism industry and develop Olympic themed tourism as a local characteristic industry.

(3) Strengthen regional cooperation, coordinate the hosting of the Olympic Games by multiple countries, and increase the number of Spring and Autumn Olympics, increase GDP while extending athletes' participation opportunities, and enhance international solidarity.

(4) Strengthen environmental protection, improve citizens' awareness of environmental protection, and create a Lebensraum for sustainable development.

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