Research on Organizing Strategies for the Olympic Games Based on the TOPSIS Method

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Abstract. Fewer and fewer countries have bid to host the Olympic Games in recent years because of the negative short- and long-term impacts that bidding to host the Games has had on the country. A sustainable and healthy Olympic Games will have a huge positive impact on the country, so it is quite meaningful to assess the ability of an Olympic Games to be sustainable. In order to assess the success of the Olympic Games, we designed the Olympic Sustainability Index (OSI) as a primary indicator. Then, using McKinsey Logic Tree Analysis, we constructed a three-level evaluation index system, and we designed three secondary indicators and 10 tertiary indicators. The entropy weight method was used to determine the weights between the three-level indicators, and CRITIC weighting method was used to determine the weights between the second-level indicators, and finally an OSI evaluation model was built. After that, we collected the data of tertiary indicators from 1992 to 2020 Winter Olympics and Summer Olympics, and based on the above evaluation model, we got the OSI of each Olympic Games, among which the Vancouver Winter Olympics and Beijing Summer Olympics had the highest index. Since the OSI of the Olympic Games fluctuates greatly, in order to attenuate it, we propose the strategy of "fixed host city", i.e., selecting Vancouver and Beijing as the host cities of the Winter Olympic Games and the Summer Olympic Games, respectively.

Keywords: Olympic Games; OSI; TOPSIS; McKinsey Logic Tree Analysis.

1. Introduction

In recent years, as the Olympic Games have become more and more frequent, fewer and fewer countries are willing to assume the responsibility of hosting the Summer and Winter Olympic Games. Bidding to host the Olympic Games is a great opportunity for a country to showcase its image and promote economic development while at the same time enhancing its international status and attracting international investment. However, as the preparation and hosting of the Olympic Games require huge financial and human resources, many countries will weigh the pros and cons when considering bidding for the Games. Olympic bidding countries need to take on more economic and financial risks after being awarded the right to host the Games. They need to be responsible for upgrading and building new venues, upgrading transportation support and ensuring safety, all of which require huge financial support. As the benefits of the Olympics are not immediate and there is a possibility of financial deficits. This will put great economic and financial pressure on the country. Moreover, if the benefits are not as expected, the country may also lose a lot of financial and monetary resources as a result [1].

To address this challenge, the IOC has given two solutions. One idea is to consider having a fixed location for each of the Summer and Winter Olympics, while the other idea is to divide the Olympics into four seasons with four smaller Olympics (Winter, Spring, Summer and Fall). In this paper, decisions were made based on the evaluation model developed [2].

2. OSI Assessment Model

2.1. Selection of indicators

A successful Olympics is reflected in three main areas: the economy, people's satisfaction, and the prestige of the host city. In turn, there are many factors and indicators for these three aspects. In our model, we use McKinsey Logic Tree Analysis to select a few important indicators to estimate the benefits of a particular Olympic Games.

2.1.1 Economic indicator

On the economic side, regional GDP can visualize the economic development of a region over time, and based on the GDP before and after the Olympics can reflect the economic impact of the Games. Economic indicators can be reflected in five aspects: GDP, television broadcasting rights, commercial sponsorship, employment growth and ticket revenue [3].

(1) GDP

The growth in regional GDP before and after the Olympics can reflect to a large extent the impact of the Olympics on the economic growth of the region.

$$\Delta GDP = GDP_{during\ or\ after\ event} - GDP_{before\ event} \tag{1}$$

ΔGDP indicates the change in GDP; if this number is positive, then it can be interpreted as a positive economic impact of the event; if it is negative, it could be that the event had a negative impact on the economy or that there were other non-event factors that caused GDP to fall.

(2) Television broadcasting rights

Television broadcasting rights, mainly refers to the right to hold sports competitions and sports performances that allow others to televise the event, and the organizers will be paid for it. With the increase in commercial development of the Olympic Games, television broadcasting of the Olympic Games has brought in huge profits.

$$TBR = POR + AR - PARC \tag{2}$$

TBR is television broadcasting rights, POR is royalties, AR is advertising revenue, and PARC is production and broadcasting costs.

(3) Commercial Sponsorship

Enterprises or individuals will make commercial sponsorships to the organizers of the Olympic Games in order to gain positive benefits such as great exposure opportunities, positive brand connections, and unique marketing opportunities through the Olympic Games, and commercial sponsorships will also bring the driving force for economic growth.

$$CS = \sum_1^n CS_n \tag{3}$$

CS is commercial sponsorship, is the amount of commercial sponsorship by sponsors, and n is the sum of the number of sponsors.

(4) Employment growth

The Olympics require infrastructure development, event organization and management, service sector growth, volunteers and temporary jobs, so hosting the Olympics will continue to create jobs and drive the economy.

$$EG = (\frac{O}{S})^{\frac{1}{m}} - 1 \tag{4}$$

O is the number of people employed at the end of the Olympics, S is the number of people employed at the beginning of the Olympics, and m is the number of years

(5) Ticket Revenue

Tickets, usually by the organizer of a commercial event or the management of a tourist attraction is responsible for the issuance of production, sales and supervision of the use of a valuable ticket. The Olympic Games involves a variety of sports, and the collection of admission tickets by the competition venues is also an important part of the revenue of the Olympic Games.

$$GR = \sum_1^i (X_i * N_i) \quad (5)$$

GR is the ticket revenue, X_i denotes the ticket fare of a sport, N_i denotes the number of tickets provided by the organizing committee of a sport, and i denotes the number of the sport.

2.1.2 People's satisfaction

(1) Consumption

The most common indicator of people's satisfaction or happiness index is the local consumption situation. Consumption can be measured by dividing per capita expenditure by total income.

$$CS = \frac{PCE}{CI} \quad (6)$$

CS is consumption, PCE is per capita expenditure and CI is per capita income.

(2) Spectator participation rate

There is a certain correlation between the audience participation rate and people's satisfaction of the Olympic Games, they are not a direct causal relationship, but a high audience participation rate implies a high public interest and expectation, and a high audience participation rate indicates that the audience has a high expectation of the time.

$$APR = \frac{P}{N} \quad (7)$$

APR denotes the audience participation rate, P denotes the number of audience actually present, and N denotes the number of all tickets sold.

(3) Satisfaction Survey

Adopting the form of questionnaire survey to investigate the general public's satisfaction and happiness index of the Olympic Games can effectively obtain the degree of satisfaction of the masses in this Olympic Games, and all the questionnaires can be statistically organized to obtain the final value of satisfaction.

$$SS = \frac{\sum S_1}{S_2 * n} \quad (8)$$

SS is crowd satisfaction, $\sum S_1$ is the sum of satisfaction, S_2 defaults to 100, and n is the number of questionnaires distributed.

2.1.3 Prestige of the host city

(1) Media Coverage

Positive media reports can show the influence of the host city in the whole world, the better the image of the host city in the hearts of the people all over the world, and the higher the prestige of the host city will be [4].

$$MR = \frac{MR_1}{MR_2} \quad (9)$$

MR is the media coverage score, MR_1 is the number of positive media coverage, and MR_2 is the total number of media coverage.

(2) Traffic

Traffic, the number of vehicles or pedestrians passing through a designated point during a specified period of time, on the web refers to the number of popular visits to a website address that opens within a certain period of time, or the colloquial meaning of cell phone mobile data. The Olympic Games, as the world's largest sporting event, has a global effect on traffic. The number of users and clicks searching for the Olympics around the world will be huge, and the host city, as the venue for the Olympics, will also generate a very large amount of traffic. The size of the traffic can be portrayed using the number of likes over an average period of time.

$$I = \frac{\sum D}{T} \quad (10)$$

I is the flow rate, D is the number of likes, and T is the time.

2.2. TOPSIS-based cross-sectional comparison model of different cities

The determination of indicator weights plays an important role and directly affects the accuracy of the evaluation results.

For the three-level indicator weights, we adopted the entropy weight method. Entropy weight method is an objective weight method. We use it to determine the indicator weights. We selected a total of fourteen Olympic Games from 1992 to 2020 including the Summer and Winter Olympic Games, obtained data from relevant reports, and then used MATLAB to calculate the weight of each indicator.

For the weights of the secondary indicators, we adopted the CRITIC weight method, which is an objective weighting method. We use it to determine the weights of the secondary indicators. We extracted data from the reports of the National Sports Administration, municipal governments and other organizations, and then calculated the weights of each indicator in MATLAB. Table 1 shows the specific results.

Table 1. Weighting of indicators

Olympic Sustainability Index	Economics	0.345	GDP	0.512
			Television broadcasting right	0.161
			Commercial sponsorships	0.064
			Employment growth	0.123
			Ticket revenue	0.140
	People's satisfaction	0.324	Consumption	0.737
			Audience participation	0.188
			Satisfaction survey	0.075
	Prestige of the host city	0.331	Media report	0.421
			Flux	0.579

TOPSIS is a multi-criteria decision analysis method. The core idea is that for each alternative, it should be as close as possible to the positive ideal solution and as far as possible from the negative ideal solution. In order to evaluate the sustainability of each Olympic Games and obtain the sustainability index of the Olympic Games, we establish the TOPSIS model and select the data of 14 Olympic Games from 1992 to 2020 and calculate them to get the sustainability index of the Olympic Games, the larger the index, the larger the sustainability [5]. The specific process is as follows.

First need to standardize the index data, because the normalization has appeared above, here we directly use to indicate the score of the jth index of the ith country.

From the above calculations we can obtain a normalized Y matrix, and now we determine the best and worst scenarios for each indicator:

$$Y^+ = (max\{y_{11}, y_{21}, \cdots, y_{n1}\}, max\{y_{12}, y_{22}, \cdots, y_{n2}\}, \cdots max\{y_{1m}, y_{2m}, \cdots, y_{nm}\}) = (Y_1^+, Y_2^+, \cdots, Y_m^+) \quad (11)$$

$$Y^- = (min\{y_{11}, y_{21}, \cdots, y_{n1}\}, min\{y_{21}, y_{22}, \cdots, y_{n2}\}, \cdots, min\{y_{1m}, y_{2m}, \cdots, y_{nm}\}) = (Y_1^-, Y_2^-, \cdots, Y_m^-) \quad (12)$$

Calculate the proximity of each indicator to the best and worst case scenarios:

$$D_i^+ = \sqrt{\sum_{j=1}^{m} w_j\left(Y_j^+ - y_{ij}\right)^2}, D_i^- = \sqrt{\sum_{j=1}^{m} w_j(Z_j^- - z_{ij})^2}, OSI_i = C_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (13)$$

The higher the OSI_i-score, the greater the sustainability index of the Olympics and the more sustainable and sustainable it is.

3. Decision-making on the organization of the Olympic Games

3.1. Comparison of the Winter and Summer Olympics

Using the TOPSIS cross-sectional comparison model, we can obtain a line graph for the Summer and Winter Olympics as shown in Figures 1 and 2 below.

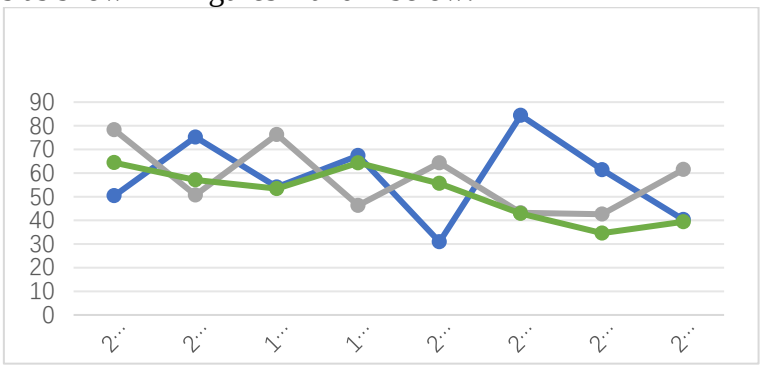

Fig. 1 Comparison of secondary indicators for the Summer Olympics

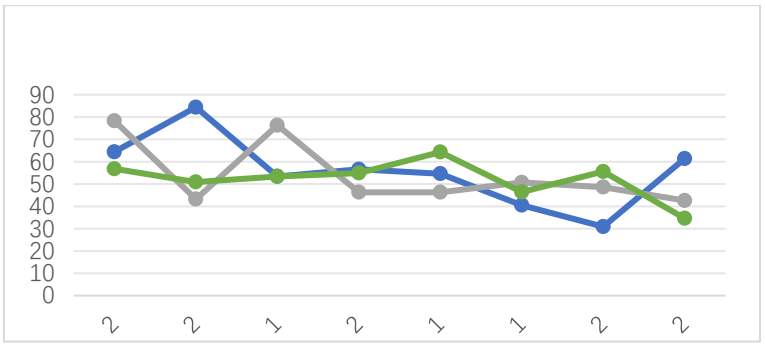

Fig. 2 Comparison of secondary indicators for the Winter Olympics

In the above figure, the blue folded line indicates the economy, the gray folded line indicates people's satisfaction, and the green folded line indicates the prestige of the host city. As shown in Figure 1, the sustainability indices of the Summer Olympic Games and the Winter Olympic Games are not in an average range, and there is a big gap between them, and none of the Olympic Games has a sustainability index of 350, which indicates that there is a lot of room for improvement in the sustainability index of the Olympic Games. In addition to that, the indices in the line graph in Figure 2 have very big differences in different cities, and these indices directly affect the OSI.

3.2. Strategic choice

As we can see from the line graph above, there is a great deal of ups and downs in any of the indicators for the Summer Olympics and the Winter Olympics for different time locations, which suggests that the indicators are strongly influenced by location, and to ensure that the OSIs for different time points can be evaluated by sharing the same model, we decided to adopt the strategy of holding the Olympics at a fixed location.

In the figure above, there is a very large difference in the size of the metrics that make up the OSI for the Olympics at different points in time. For example, there is a large difference between the average economic indicators for the Summer Olympics and the Winter Olympics. In order to make sure that our policy works for all the Olympics, we decided to discuss the Winter Olympics and the Summer Olympics separately, and give the corresponding policies for each.

In the end, we decided to adopt a "fixed host city" strategy.

4. Summary

In quantifying the sustainability of the Olympic Games, we use three secondary indicators and ten tertiary indicators, which is a very comprehensive consideration of the measurement elements of the sustainability of the Olympic Games. TOPSIS can accurately assess the sustainability of the Olympic Games.

A successful model needs good stability, and a stable model will not be changed due to the interference of some other factors. So the sensitivity of the model needs to be tested after the model is built. In order to test the sensitivity of our model, we chose to conduct a sensitivity analysis of the OSI assessment model. We increased and decreased the index of each three-level index of economic indicators by 1.0%, and input the changed data into the model we built.

Taking GDP as an example, when the index of GDP is increased or decreased by 1%, the trend of OSI does not change and the deviation is very small and within the reliable range. So it can be said that our model is stable and can solve real problems.

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