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Original Paper

The Development of the Olympic Games Based on TOPSIS-EWM and LSTM Models

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Abstract

Facing the declining interest in hosting the Olympic Games, this study proposes two innovative solutions and develops evaluation models to assess their feasibility.

The first solution suggests replacing the traditional format with four smaller, seasonal events. Analysis identifies Canada as most suitable for winter, Great Britain for summer, and China and Spain for spring and autumn editions. The second solution recommends establishing two permanent host sites. Evaluation of candidate countries—China, France, and Canada—through predictive modeling shows China with the strongest potential for long-term hosting. Further research forecasts the multidimensional impact on host cities and outlines strategic implementation steps. The findings are summarized in a policy memorandum submitted to the International Olympic Committee to support the sustainable future of the Games.

Keywords

Olympic Games, TOPSIS-EWM, IMOG, K-means cluster analysis, principal component analysis, LSTM predict

1. Introduction

1.1 Problem Background and Motivation

The Frenchman Coubertin proposed the modern Olympic Games at the end of the 19th century. The Olympic Committee was established in 1894, the first Olympic Games were held in 1896, and the first Winter Olympic Games were held in 1924 (From fanaticism to apathy-cold thinking about the decline in the popularity of the Olympic bid, n.d.). The Winter Olympics were originally scheduled to be held every 4 years as the same

as the Summer Olympics. Beginning with the second Winter Olympics in 1928, the Winter Olympic Games and the Summer Olympic Games were held in different countries. Since 1994, the Winter

Olympics and the Summer Olympics have been held two years apart (The Olympic Games portfolio is interpreted in a variety of regions, n.d.). In order to stagger the timing of the Winter Olympics and the Summer Olympics. As of June 2022, 23 countries and 41 cities have hosted the Summer and Winter Olympics including Pyeongchang, South Korea, which failed to bid twice and did not win the right to host the 2018 Winter Olympics until the third bid (Look at the economic benefits of the Olympics from the perspective of scarcity, n.d.).

In the past, holding the Olympic Games has many benefits, but all the cities that can host the Olympic Games have an international level and organizational ability, which is of extraordinary significance for improving urban construction management and ecological level, followed by holding the Olympic Games can drive a lot of investment, consumption and economic development, increase a lot of employment opportunities, and finally hold the Olympic Games can improve the comprehensive quality of urban citizens and promote the construction of spiritual civilization, whether from ideological or economic construction, the benefits are considerable (How big the impact of the Olympic Games is based on the model and measurement from the perspective of industry linkage, n.d.). However, the negative impact increased, and the net tourist number fell sharply, the "white elephant" problem of infrastructure, the increasing cost of hosting the Olympic Games and significant overruns in estimated expenditures. Issues such as fierce competitive bidding cycles make it extremely difficult to find willing and capable Olympic organizers (The impact of the Olympics on the host country's economy, n.d.).

1.2 Research Objectives

Considering the face of a dwindling number of bids due to the various negative impacts experienced by the host city/country, we need to write a memorandum with strategic and policy recommendations and solve the following problems:

In recent years, the number of countries bidding for the Olympic Games has been decreasing gradually.

If the Olympics are to be held in four seasons, how to build metrics for the impacts of the hosting city?

If choose a long-term host city for the Winter and Summer Olympic Games how to build metrics for the impacts of the hosting city？

Consider the feasibility of the solution, the schedule of implementation, and the impact of the potential strategy on the measurement.

1.3 Our Work and Paper Structure

To tackle these problems, we undertake a systematic, multi-stage analytical process. First, we design a hierarchical indicator system. Second, for the Seasonal Model, we apply the objective EWM-TOPSIS framework for comparative evaluation. Third, for the Permanent Host Model, we employ PCA for data simplification, K-means for candidate screening, and a novel LSTM-based IMOG for causal impact analysis and final selection. Finally, we conduct predictive forecasting, strategic planning, sensitivity testing, and synthesize findings into actionable recommendations.

The paper is structured accordingly: Section 2 details the composite impact indicator system. Section 3 presents the EWM-TOPSIS model and results for the Seasonal Games. Section 4 explains the PCA, K-means, and IMOG (LSTM) framework for Permanent Host selection. Section 5 provides predictive analysis, strategic implementation guidelines, feasibility assessment, and sensitivity analysis. Section 6 concludes with a summary and policy memorandum.

2. Construction of an Index System

In order to determine the factors that influence countries' bid for the Olympic Games globally, a secondary evaluation index has been developed. We categorize these indexes into four broad categories: economic, environmental, humanistic, and prestige (REN, 2008). Form these four categories into a system composed of four aspects: economy, land use, people's satisfaction and prestige. Among them, there are 2 main indicators (per capita GDP and happiness index) and 12 secondary indicators (life service, transportation trip, native income, health and catering input, international tourism revenue, total import, export of service trade, foreign investment, land use area, construction of competition facilities, land area, national security factor, international status), the index system is shown in Figure 1.

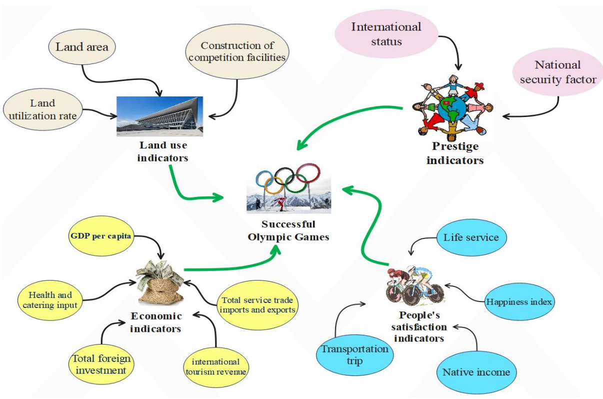


Figure 1. Impact Indicator System Diagram

Countries that have hosted the Olympics will see a significant increase in international visitors compared to those that did before the Games, thus increasing international tourism revenues. Let the increased number of international passengers be a , The per capita consumption of tourists is b . The increase in international tourism income can be obtained V :

$$V = a \bullet b \tag{1}$$

To host the Olympic Games, in order to provide athletes and spectators with good participation and viewing experience, the host place will increase the investment in the service industry, including medical treatment, accommodation, tour guide, catering, transportation, etc., which is likely to improve people's satisfaction. Set the total investment in services during the Olympic Games as c .

Let's say the increase in income of the local people is Δy .

We think of $z(q)$ is the satisfaction of the public. The higher the economic benefit q is, the greater the $z(q)$ is, and the satisfaction of citizens is higher. The value of this function can be used to quantitatively describe the satisfaction degree of the public to host the Olympic Games:

$$z(q) = 1 - e^{-q^2}, q = c, \Delta y \tag{2}$$

In the above equation, c represents the total investment in service industry during the Games and Δy represents the increased income of local residents. That is, the total investment in services measures the satisfaction of athletes and spectators respectively, and the increased income of local people measures their satisfaction.

The Happiness Index is an index that reflects the quality of life and happiness of the people. The happiness index can be calculated by the following formula:

$$GNH = \frac{y}{\eta} \tag{3}$$

In the above equation, y is people's income and η is the survival cost.

The human development index, which can be directly reflected by hosting the Olympic Games, calculated by the following formulas:

The income index INC:

$$INC = \frac{\ln(GNIpc) - \ln(163)}{\ln(108211) - \ln(163)} \tag{4}$$

Average number of years of schooling index:

$$MYSI = \frac{(MYS - 0)}{13.2 - 0} \tag{5}$$

Index of expected years of schooling:

$$EYSI = \frac{(EYS - 0)}{20.6 - 0} \tag{6}$$

The HDI is the geometric average of the three basic indices:

$$HDI = \sqrt{INC \bullet MYSI \bullet EYSI} \tag{7}$$

Suppose the number of new railways or roads built for the Games is Δl.

During the Olympic Games, mascots, souvenirs and surrounding areas are much loved by the public, and sales will increase significantly compared to normal. The increment of export value of trade in services is set as d.

During the Olympic Games, the broadcast of advertisements will bring huge profits, and the construction and publicity of related chain industries will bring wealth, so foreign enterprises will invest in projects appropriately. Assume that the amount of foreign investment is e.

In the following formula, s_i refers to the area of land used to host the Olympic Games, ΔW_i refers to the GDP output value that this area is used for other production, the total value W of the land used to host the Olympic Games can be calculated as follow:

$$W = \sum_{i=1}^{n} s_i \bullet \Delta W_i \tag{8}$$

The average investment per square meter of construction is A , the investment amount for the establishment of the competition facilities is X :

$$X = A\sum_{i=1}^{n} s_i \tag{9}$$

Suppose the land area of the country hosting the Olympic Games is S .

$$S = \sum_{i=1}^{n} s_i \tag{10}$$

The climate condition is considered as the average annual temperature T of the region, The hydrological situation is considered as the average annual precipitation R of the region and the number N of nearby rivers, lakes and seas. Here climatic and hydrological conditions determine whether the region has the prerequisite conditions to host the Games in different seasons. (At the same time, we assume that each country does not have the capacity to spend significant financial resources to forcibly change or provide living conditions that do not belong to the region in which it operates).

A country's reputation is usually reflected by its international standing and its level of security**,** The safety factor f is the number n_I of conflicts occurring in that country/the average number $n_{average}$ of conflicts occurring in countries around the world:

$$f = \frac{n_I}{n_{average}} \tag{11}$$

2. The Establishment of TOPSIS - EWM Model

EWM-TOPSIS is an effective method to evaluate the status of score, and it is applicable to any index. Entropy originated from thermodynamics and was introduced into information theory by C.E.Shannon. The entropy weight method is an objective weighting method. In the specific use process, the entropy weight method uses the information entropy to calculate the entropy weight of each index according to the variation degree of each index, so as to obtain a more objective index weight. Therefore, the weight of indicators affecting the score can be determined by calculating EWM value. The TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) method was first proposed by C.L.Hwang and K.Yoon in 1981. TOPSIS is a method of sorting according to the closeness of a limited number of evaluation objects to an idealized goal. It is an existing The relative merits and demerits of the objects are evaluated. The TOPSIS method is a commonly used and effective method in multi-objective decision analysis, also known as the superior-inferior solution distance method. This paper adopts the combined method of EWM-TOPSIS to combine the advantages of the two methods, so as to improve the objectivity of the data and the scope of application of the method.

The specific steps of model establishment are as follows:

3.1 EWM Weight Calculation

EWM is an objective weighting method to determine the weight of indicators based on the difference in the degree of order of the information contained in each indicator, and it only depends on the degree of dispersion of the data itself.

Entropy is used to measure uncertainty. The greater the dispersion of the index (the greater the uncertainty), the greater the entropy value, indicating that the more information the index value provides, the greater the weight of the index should be. The main calculation steps are as follows:

1) Assuming n evaluation objects and m evaluation indicators, the value of the i evaluation object with respect to the j index variable is a_{ij} (i =1,2,…, n ; j =1,2,…, m), and a data matrix $A=(a_{ij})_{n\times m}$ is constructed.

2) Perform standard 0-1 normalization on the original data matrix by column.

In order to make the best value of each attribute after transformation is 1 and the worst value is 0, a standard 0-1 transformation can be performed. For the benefit attribute x_j , let

$$b_{ij}=\frac{a_{ij}-a_j^{\min}}{a_j^{\max}-a_j^{\min}} \tag{12}$$

For the cost attribute x_j , let

$$b_{ij}=\frac{a_j^{\max}-a_{ij}}{a_j^{\max}-a_j^{\min}} \tag{13}$$

3) Use the obtained data matrix $A=(a_{ij})_{n\times m}$ to calculate p_{ij} (i =1,2,…, n ; j =1,2,…, m), that is, the proportion of the i evaluation object to the j index value:

$$p_{ij}=\frac{a_{ij}}{\sum_{i=1}^{n}a_{ij}}, i=1,2,\cdots,n, j=1,2,\cdots,m \tag{14}$$

4) Calculate the entropy value of the j index:

$$e_j=-\frac{1}{\ln n}\sum_{i=1}^{n}p_{ij}\ln p_{ij}, j=1,2,\cdots,m \tag{15}$$

5) Calculate the coefficient of variation of the j index:

$$g_j=1-e_j, j=1,2,\cdots,m. \tag{16}$$

For the j indicator, the larger e_j is, the smaller the variation of the indicator value is

6) Calculate the weight of the j indicator:617

$$w_j = \frac{g_j}{\sum_{j=1}^{m} g_j}, j = 1, 2, \cdots, m \tag{17}$$

The weight calculated from this is the weight of each index in the next TOPSIS method.

3.2 TOPSIS Comprehensive Evaluation

1) Convergence processing of indicator attributes. The original data form is $a_{n\times m} = \left[a_{ij}\right]$ (i =1,2,…, n ; j =1,2,…, m); each index attribute is different. But the TOPSIS evaluation method requires that all indicators have the same attributes. We adopt positive processing. the positive indicators do not change; the negative indicators take the following changes: Normalize the original data matrix. The method we adopted is to convert low performance indicators into high performance indicators. The specific methods are as follows:

2)
$$a_{ij}^{**} = \begin{cases} a_{ij} & \text{High-quality index} \\ 1/a_{ij} & \text{Low-quality index} \end{cases} . \tag{18}$$

3) The canonical decision matrix is obtained by vector normalization. Let the decision matrix of the multi-attribute decision-making problem be $A = (a_{ij})_{n\times m}$, and the normalized decision matrix $B = (Z_{ij})_{n\times m}$:

$$Z_{ij} = a_{ij}^{**} / \sqrt{\sum_{i=1}^{n} (a_{ij}^{**})^2}, i = 1, 2, \cdots, n; j = 1, 2, \cdots, m \tag{19}$$

3) Determine the best and worst solutions. The optimal solution Z^+ is composed of the maximum value of each column in Z : Z^+ = ($\max Z_{i1}$, $\max Z_{i2}$, …, $\max Z_{im}$). The worst plan Z^- consists of the minimum value of each column in Z : Z^- = ($\min Z_{i1}$, $\min Z_{i2}$, …, $\min Z_{im}$). Calculate the distance of each scheme to the positive ideal solution and the negative ideal solution. The distance from the Z_{i1} to the positive and negative ideal solution is:

$$N_i^+ = \sqrt{\sum_{j=1}^{m} w_j \left(\max Z_{ij} - Z_{ij}\right)^2} \tag{20}$$

$$N_i^- = \sqrt{\sum_{j=1}^{m} w_j \left(\min Z_{ij} - Z_{ij}\right)^2} \tag{21}$$

4) Calculate the ranking index value (comprehensive evaluation index) of each scheme:

$$M_i = \frac{N_i^-}{N_i^+ + N_i^-} \quad 0 \le M_i \le 1 \tag{22}$$

5) Arrange the pros and cons of the schemes according to M_i from large to small.

3.3 The Processing Results of the Model

Since we propose to subdivide the Olympic Games into four seasons, considering the climate change in different seasons and the particularity of some events, it is necessary to conduct a separate analysis of the cities selected for the Olympic Games. After the above modeling calculation and referring to the countries that have hosted and applied for the Olympic Games in the past, which are shown in the figure 2 the appropriate cities for the four seasons are divided.

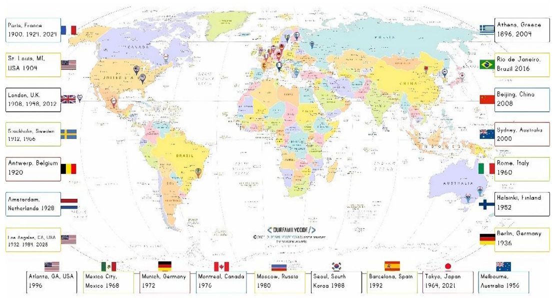
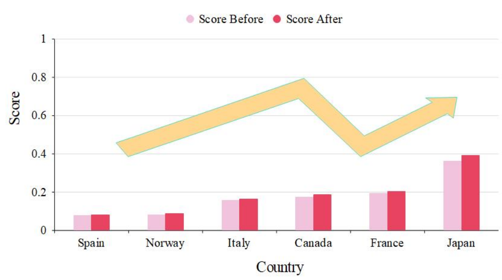


Figure 2. The Map of Olympic Host Cities

The Winter Olympic Games are mainly outdoor events, such as skiing, skating, sleigh, etc., the hardware requirements are strict; At the same time, the venue needs plenty of ice and snow, so the climate of the venue is extremely demanding. A look at the cities that have hosted the Winter Olympics in the past shows that they are all in the northern Hemisphere, along with North America, Northern Europe and Russia, the Alps, and East Asia. The comprehensive national strength, geographical location and previous application list, although the comprehensive national strength of Russia is the third in the world, the climatic conditions and other factors are very suitable for hosting the Winter Olympic Games, due to its recent war behavior, we will not take it into consideration, so we finally choose six countries (France, Canada, Norway, Italy Japan and Spain) to host the Winter Olympics. The score of country before and after they host the Winter Olympics as shown in the Figure 3 and Figure 4.



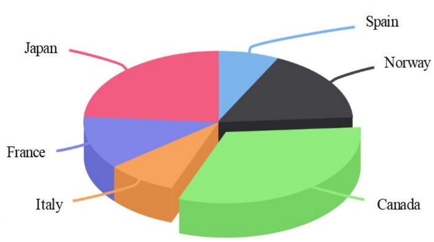
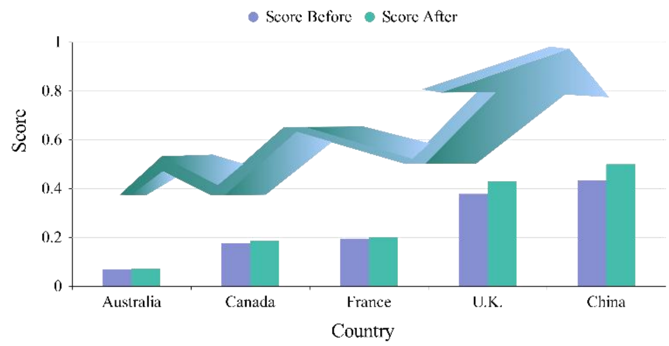


Figure 3. Winter Olympic Candidates Scores Figure 4: Fraction Growth Rate

From the picture above, it is clear that Canada is the best choice to host the Winter Olympic Games.

The Summer Olympics include many water-related events such as swimming, diving, water polo, so the temperature requirements are high and the water surface may freeze if held in a cooler season or region. And since the 11th Olympic Games, lighting the Olympic flame is one of the indispensable ceremonies in the opening ceremony of every Olympic Games, so there are certain requirements on the weather. There are more events in the Summer Olympic Games, which attracts more attention from the international community. Therefore, whether the host country has the national capacity and land area is also an important indicator to measure. Based on the above considerations, we finally selected China, France, the United States and Australia as the shortlist. As shown in the Figure 6 and Figure 7.



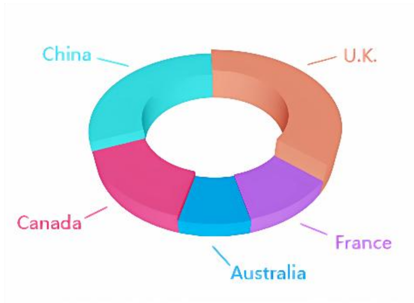
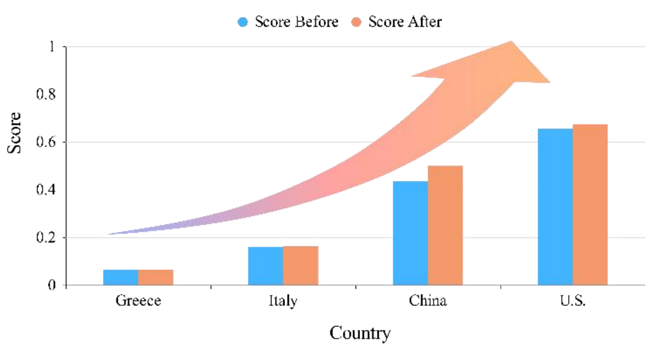


Figure 6. Summer Olympic Candidates Scores **Figure 7. Rate of Increase in Scores**

From the growth rate graph, it is clear that Britain is the best choice to host the Summer Olympics.

Faced with fewer and fewer countries bidding for the Olympic Games, we cannot help but think that the huge cost is prohibitive for many countries. The huge cost is due to the huge demand for venues for many sports. Therefore, we propose that some summer Olympic sports, such as rowing, sailing, canoeing and cycling, be moved to the spring and autumn. Taking into account the size of the river, ocean and climatic conditions, we finally selected China, Japan, Australia, Sweden and Brazil as candidates for the spring and autumn Games, which was shown in Figure 7 and Figure 8.



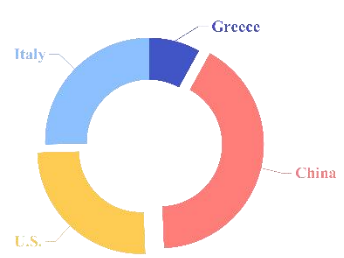


Figure 7. Spring and Autumn Olympic Candidate Scores Figure 8. Score Growth Rate

As can be seen from Figure 8, China and the United States not only score high, but also have high score growth rates. Because the United States and China have a rich four-season climate, the two countries can cross the Spring and Autumn Olympic Games.

On the whole, the basis for the above selection is sufficient and convincing. A possible disadvantage is that we did not properly assess the impact of the cost reduction on the host country, as split seasons may reduce some Olympic sports.

4. Selection of the Permanent Location for Olympic Games

If only countries that have hosted the Olympic Games before are considered, national strength, transportation convenience, development potential and other factors should be taken into account to determine whether they have the conditions to host each Olympic Games (Analysis of the correlation effect between the Olympic Games and surrounding industries, n.d.). We have carried out a series of operations to select the most suitable country, which was shown in the Figure 9.

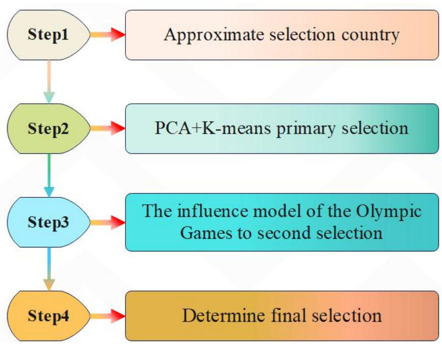


Figure 9. Steps for Selecting the Permanent Location for Olympic Games

4.1 PCA to Reduce Dimension Processing

PCA (Principal Component Analysis) is a good way to reduce the dimensionality of the data set while maintaining most of the information in the original data set (The research on the prediction model of LSTM network for economic indicators of time validity was improved, n.d.). Prior to the data downscaling process, the original data first need to be normalized and the covariance matrix calculated.

$$R = \frac{\sum_{k=1}^{n}(x_{ki}-\overline{x}_i)(x_{kj}-\overline{x}_j)}{\sqrt{\sum_{k=1}^{n}(x_{ki}-\overline{x}_i)\sum_{k=1}^{n}(x_{kj}-\overline{x}_j)}} \tag{23}$$

Afterwards, the eigenvalues $\lambda_1 \geq \lambda_2 \geq \ldots \geq \lambda_p \geq 0$ and eigenvectors of R are calculated.

$$d_1=\begin{bmatrix} d_{11} \\ d_{21} \\ \dots \\ d_{p1} \end{bmatrix}, d_2=\begin{bmatrix} d_{12} \\ d_{22} \\ \dots \\ d_{p2} \end{bmatrix}, \dots, d_p=\begin{bmatrix} d_{1p} \\ d_{2p} \\ \dots \\ d_{pp} \end{bmatrix} \quad (24)$$

Finally, the cumulative contribution of the number of attempts is calculated.

$$CCR=\frac{\sum_{k=1}^{i}\lambda_K}{\sum_{k=1}^{p}\lambda_K}, (i=1,2,\dots,p) \quad (25)$$

The top m principal components corresponding to the eigenvalues with a general cumulative contribution of more than 80%.

After analysis, we found that two principal components are relatively important. Thirteen specific indicators were reduced to two principal components by PCA.

4.2 K-means Primary Screening

The following 19 countries have hosted the Olympics: Greece, France, the United States, the United Kingdom, Sweden, Germany, Belgium, the Netherlands, Japan, Finland, Australia, Italy, Mexico, Canada, Russia, Korea, Spain, China, Brazil. We analyze the above countries through K-means.

After dimensionality reduction we have a two-dimensional vector, after which K clustering prime points are randomly selected $\mu_1, \mu_2, \dots, \mu_{\mathrm{k}} \in R^n$.

For each sample, calculate the class to which it should belong.

$$c^{(i)} := \arg\min \| x^{(i)} - \mu_j \|^2 \quad (26)$$

For each class, recalculate the center of mass of this class.

$$\mu_j := \frac{\sum_{i=1}^{m}\{c^{(i)}=j\}x^{(i)}}{\sum_{i=1}^{m}\{c^{(i)}=j\}} \quad (27)$$

We eventually manipulated the above steps through SPSS and found that the samples could be divided into 3 categories. In the explanation of the three categories, it is easy to see that they can be divided into three categories: Weaker, average and stronger.

Bringing the above-mentioned countries that have hosted the Olympic Games into the cluster analysis, it is easy to see that the stronger categories in figure 10. In this figure, China, France and Canada belong to the stronger categories.

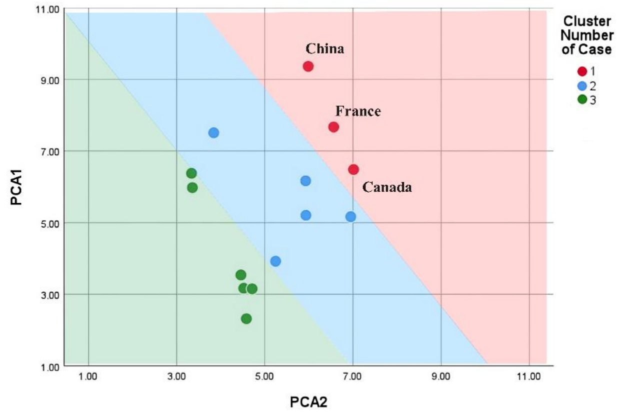


Figure 10. PCA and K-means Clustering Results Graph

4.3 Construction of the Influence Model of the Olympic Games (IMOG)

We have established an impact model for the Olympic Games, using LTSM to predict the numerical values of relevant indicators for each country assuming they did not host the Olympics. Then we compare the changes in each indicator between not hosting the Olympics and hosting the Olympics Games to measure the impact of the Olympic Games.

4.4 Quantitative Calculation the Influence of Olympic Games

The LSTM prediction model is established by selecting four direct impact indicators including GDP, tourism income, international passenger volume (traffic volume) and GNI. Using data for many years prior to the hosting of the Olympic Games, the index background values for each of the five years after the hosting of the Olympic Games are projected and then compared with the actual statistics after the hosting of the Olympic Games. The ratio of the difference between the actual statistic and the background value predicted by the LSTM model (the " background values ") and the actual statistic is the quantified value of the influence of the Olympic Games on each factor indicator. The $x_i(k)$ represents the actual statistic of each indicator, the $p_i(k)$ represents the background value predicted by the LSTM, so the influence of the Olympic Games on each factor indicator can be calculated by the following formula:

$$\gamma_i = \frac{\sum_{k=k_{ty}}^{k_{ty}+5} (x_i(k) - p_i(k))}{\sum_{k=k_{ty}}^{k_{ty}+5} x_i(k)} \quad (28)$$

In the equation for γ_i , k_{ty} refers to the year when the Olympic Games were held and

$k_{ty}+5$ represents the five years after the Olympic Games. The reason why we use the relevant data of the first five years after hosting the Olympic Games is that the time when hosting the Olympic Games has a significant effect on the development of each country. According to statistics, some countries have a rapid rise in national strength in one or two years, while others have not changed significantly in the past ten years. Therefore, we consider the development of the five years as a unified standard.

The impact of this factor on the Games is reflected in the ratio of the total net growth rate (the sum of the four main indicators) to the total real value five years after the successful hosting of the Games, that is, the impact of the Games on the host country is quantified. We use the following formula to score the rate of increase in influence.

The influence of the Olympic Games on each factor indicator (4 indicators in total) is reflected in γ_i.

We take the average value of γ_i as the influence of the Olympic Games:

$$S_{total}=\frac{\sum_{i=1}^{4}\gamma_i}{4}, i=1,2,3,4 \tag{29}$$

4.5 The Establishment of LSTM Model

In order to predict the relevant index changes after holding the Olympic Games, we modeled the change patterns of these indicators using the long and short term memory (LSTM).

LSTM model is a variant of recurrent neural network (RNN). It is well-suited to classifying, processing and making predictions based on time series data. A common LSTM unit is composed of a cell, an input gate, an output gate, a memory gate and a forget gate. The cell remembers values over arbitrary time intervals and the four gates regulate the flow of information into and out of the cell. The structure of our nested two-layer LSTM. The model can be divided into three separate modules: input module, LSTM module and output module. As shown in the Figure 11.

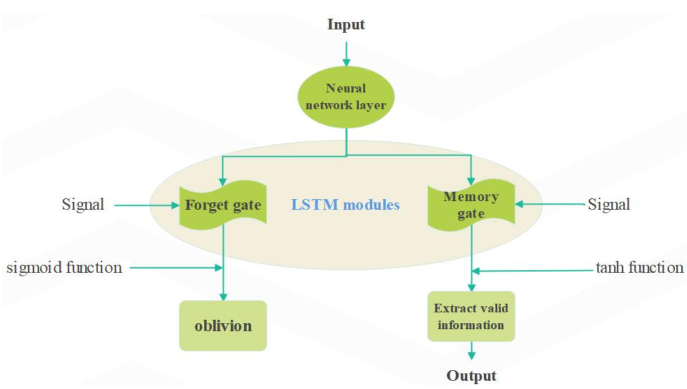


Figure 11. LSTM Schematic Diagram

1) The forget gate uses sigmoid function to read the information of the previous moment h_{t-1} and the current moment x_t . According to the weight w_{hf} and w_{xf} of the information of the two moments in the whole process, a value of 0 to 1 is output to each cell to determine how much information should be discarded, The result is represented by f_t , where 1 means "completely retained" and 0 means "completely abandoned". By the following formula.

2) $$f_t = \sigma(w_{xf}x + w_{hf}h_{t-1} + b_f) \tag{30}$$

3) The input gate processes the current information to determine how much new information to add to the cell. There are two steps in this process, one is the sigmoid function called the "input gate layer" to determine the update of the information, the other is that the tanh layer of the relationship between the cell and the input element determines the retention of some information. Calculated by the following formula.

$$f_i = \sigma(w_{xi}x + w_{hi}h_{t-1} + b_i) \tag{31}$$

$$C_t = \tanh(w_{xc}x + w_{hc}h_{t-1} + b_c) \tag{32}$$

4) The sigmoid layer of the output gate filters the information to be output and processes it with tanh. As shown in the following formula.

$$O_t = \sigma(w_{xo}x + w_{ho}h_{t-1} + b_o) \tag{33}$$

$$h_t = O_t \bullet \tanh(C_t) \tag{34}$$

4.6 Influence Model Solving

We first collected the relevant information of China, France and Canada before the Olympic Games, used LSTM to predict the development trend of relevant indicators if they do not hold the Olympic Games, and then obtained the net growth rate according to the actual data. The influence model was used to calculate the influence of each indicator, and the TOPSIS was used to score the results as shown in the figure12.

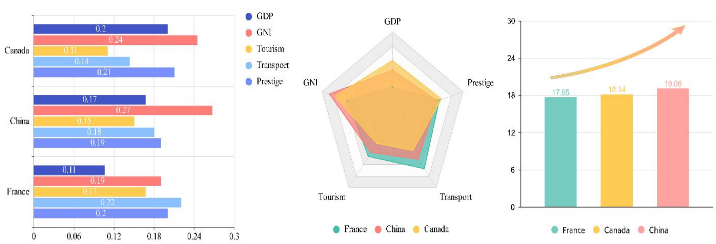


Figure 12. Influence Model Indicator Changes and Scores

From the above exponential growth scores, it can be intuitively seen that China and Canada have higher scores, and the Winter and Summer Olympics will be held in these two countries. Considering that Canada is located at a high altitude in the northern hemisphere and has cold and long winters, while China has a distinct and relatively suitable climate throughout the year, tourists experience better in winter. As a result, China was chosen as the long-term host of the Winter Olympics and Canada as the long-term host of the Summer Olympics.

5. Implementation Strategies and Recommendations

5.1 Strategies

In order to better host the Olympic Games in different seasons and select specific regions to host the Olympic Games, we have developed relevant implementation strategies, which was shown in Figure 13.

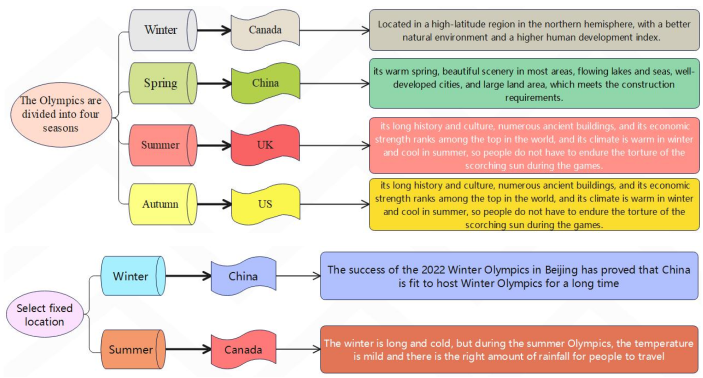


Figure 13. The Implementation Strategies for Olympic Games

5.2 Recommendations for Better Hosting the Olympic Games

Considering the impact of hosting the Olympic Games from the perspectives of economy, land use, people's satisfaction, travel, future improvement opportunities, and the prestige of the host city/country, we chose to hold the Olympic Games in four seasons or in a fixed location. To this end, we put forward the following suggestions to better host the Olympic Games:

1) Develop a comprehensive impact assessment system: The IOC should work with host cities/countries to develop a comprehensive system to assess the impact of hosting the Olympic Games. The system should adopt consistent tracking and evaluation indicators across all host cities, and commit to certain safeguard support policies for cities with high impact and limited capacity.

2) Prioritize land reuse planning: The IOC should prioritize sustainable and inclusive development when selecting host cities. This will help ensure that the Games have a positive impact on the local economy, environment and society.

3) Improve the experience for all involved in the Games: Countries hosting the Olympic Games should appropriately increase investment in high-quality facilities, transportation infrastructure, and other amenities in order to provide a better experience for participating athletes, spectators, and staff. At the

same time, it should be ensured that it does not have a great impact on the daily life of the local residents of the host city.

4) Improve the civilization construction of the host city: Countries hosting the Olympic Games should show the local open and inclusive civilization construction in order to have a good sense of experience for foreigners, in addition, the countries should also spread the city's open and inclusive culture in order to drive the development of local tourism.

5.3 Feasibility Assessment and Timeline to Implement

Feasibility assessment:

Preparation for the Olympic Games for the choice of countries, generally speaking, the comprehensive national strength of the strong country is not too big problems, if the comprehensive national strength is weak, raw materials are insufficient, need to consider the import of raw materials ordering, early planning, the time line is appropriate to extend. In addition, if you encounter some unexpected situations, such as economic crisis, inflation, revolution, etc., you need to be prepared and adjust the corresponding time line.

Timeline:

From the time axis of the above strategy, the whole preparatory process of the Olympic Games can be divided into five parts: The time to bid for the Olympic Games, the time it takes to solicit design proposals from around the world, the time to finalize plans and order equipment and other raw materials after winning the bid, the time to build new venues, and the time to conduct test events for Olympic venues. The time required above can be calculated as follows:

The time to bid for the Olympic Games: t_1 .

The time it takes to solicit design proposals from around the world: t_2 .

The time for ordering raw materials such as equipment after the successful bid:

$$t_3 = L_1 / v_1 + L_2 / v_2 + L_3 / v_3 \tag{35}$$

Among them, the average speed of air freight is v_1 , the average speed of land transport is v_2 , and the average speed of water transport is v_3 , and the corresponding distance from the place where raw materials are produced to the Olympic venue is L_1 , L_2 , L_3 .

The time for building a new sports venue:

$$t_4 = S_1 / s_1 \tag{36}$$

Among them, S_1 refers to the total area that needs to be expanded, and s_1 refers to the area that can be newly built every day. Since the standard model calculates the area of each floor based on the area of the building axis, it is considered that the building area is calculated by the actual building contour lines such as structure, exterior wall, thermal insulation and curtain wall in the process of building design and construction. Therefore, 5% is used as the upper limit of the building area adjustment factor α_1 (exterior wall area factor).

Since the standard model is based on a square plan, considering that the actual architectural design scheme may appear circular, oval and other special-shaped planes, the shape of the external wall of the building may also be inclined and exterior. Therefore, 10% is used as the upper limit of the floor area adjustment factor α_2 (body shape change coefficient).

$$S_1 = A(1+\beta)(1+\alpha_1+\alpha_2) \tag{37}$$

where S_1 is the calculated area of the standard model, A is the area of the standard model, and the β is the adjustment factor of the area of the computer room of 10%.

The amount of time it takes for Olympic venues to host test events: t_5.

Construction needs to leave some time margin: Δt.

So the time from bidding for the Olympic Games to successfully holding the Olympic Games is:

$$t = t_1 + t_2 + t_3 + t_4 + t_5 + \Delta t \tag{37}$$

The timeline to implement for Olympic Games is shown in Figure 14:

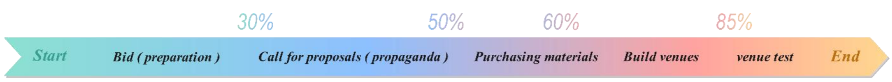


Figure 14. The Timeline to Implement for Olympic Games

6. Sensitivity Analysis

In figure 14, in the solving process of Chapter 6, a relational model of the degree of change of relevant parameters before and after holding the Olympic Games is established. We use the influence factors extracted from the influence model established in Chapter 5 and the results predicted by the LSTM model for comprehensive analysis to obtain the changes of GNI parameters after hosting the Olympic Games. Next, the sensitivity of favorable conditions (GNI-Better Cases) and unfavorable conditions (GNI-Worse Cases) to GNI parameters in the influence model is analyzed.

In case of major natural disaster, major security accident or negative impact on the Olympic Games, we can get the data of the Worse Cases of GNI in figure 18 after reasonable analysis and calculation and appropriate reduction of the total amount of production and transactions. In the case of huge investment by foreign companies, good environment or positive influence on the Olympic Games, relevant data of GNI-Better Cases in Figure15 can be obtained after reasonable analysis, calculation and appropriate increase of total production and transaction amount.

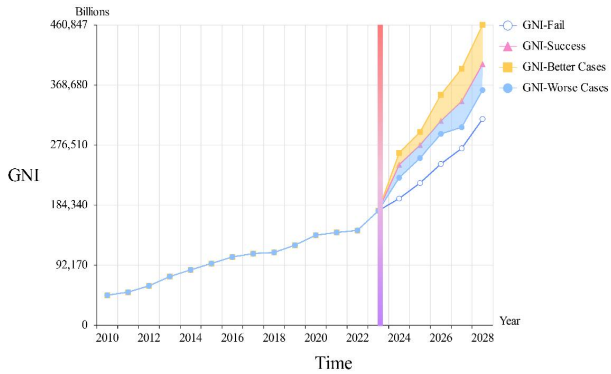


Figure 15. Sensitivity Analysis Chart

It can be intuitively obtained from the data and images. Both negative and positive influences have low sensitivity to GNI parameters, and the system results are stable. It indicates that the GNI value of the predicted years is within a reasonable range.

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