Evaluation, Prediction, and Recommendations of Olympic SDEs——Based on TOPSIS and Grey Prediction Models

Xuanqi Liu[1], Kaiyang Liu[2], Haole Shen[1] , Rongduo Mu[3]

[1]Ningbo Foreign Language School, Ningbo 315100, China

[2] Shanghai United International School, Shanghai 201100, China

[3] IPSWICH School, IPSWICH, IP1 3RH, United Kingdom

Xuanqi Liu, Kaiyang Liu,Haole Shen, Rongduo Mu are co-first authors

Abstract. The IOC is planning the 2032 Summer Olympics in Brisbane. Throughout Olympic history, SDEs have been introduced, removed, or reintroduced to reflect the times. We created a mathematical model that evaluates SDEs to provide well-reasoned recommendations and make quantitatively informed decisions about which SDEs best fit the Olympics' evolving vision. In our model, we identified various factors crucial for SDE decisions. We build an indicator system based on the International Olympic Committee's (IOC) criteria. We subdivide them into 21 indicators. We systematically assess SDEs against IOC criteria, leveraging the factors identified earlier. We collected data on 72 SDEs from diverse sources like official committees and social media and established the TOPSIS Evaluation Model. We used the Entropy Weight Method and the CRITIC Method to weigh and calculate the combined weight. SDEs with higher scores are Athletics, Basketball, and Swimming. Then, our model is rigorously tested using a diverse selection of SDEs. For SDEs added or removed recently, like Karate, Squash, and Baseball, we analyze their historical and current status in the Olympics. Moreover, an analysis was conducted on six aspects, such as popularity and accessibility, and a bar chart of their TOPSIS scores was drawn. For long-standing SDEs such as Swimming, Weightlifting, and Artistic Gymnastics, we have drawn a line chart to analyze their hosting frequencies and trends from 1896 to the present. Also, we explore their continued relevance and value. Besides, we introduce a time factor and use the Grey Model to predict changes in SDEs as the Olympics progresses over the next 12 years after a scale test. Esports, Ultimate, and Breaking are singled out by analyzing various factors. We identify these three sports with high potential for the 2032 Brisbane Olympics and 2036 Olympics and subsequent Games, thus potentially shaping the future of the Olympic program. Furthermore, we carried out the sensitivity analysis of the model and found that the coefficients in our model are not highly sensitive, which proves that the model is robust.

Keywords: Olympic Games; Entropy Weight Method; CRITIC Method; TOPSIS; Gray Model.

1. Introduction

The International Olympic Committee is engaged in elaborate and meticulous preparations for the highly anticipated 2032 Summer Olympics, which will take place in the vibrant city of Brisbane, Australia. This grand event is paramount as it aspires to assemble a diverse congregation of athletes worldwide, uniting them in the spirit of sportsmanship and competition.

Reflecting on the historical evolution of the Olympics, it becomes clear that the sports events within this prestigious platform have been in a ceaseless and dynamic state of flux. To ensure that the Olympics endures and thrives in the contemporary era, the IOC has painstakingly crafted a comprehensive and all-encompassing set of criteria. Highlight the applicability of the model and discuss how the model confirms the current Olympic status of these SDEs. Determine three SDEs that can be newly added or reintroduced to the 2032 Brisbane Olympics and the order of their inclusion, and explore SDEs that have the potential to be included in the Olympics in 2036 and beyond. Conduct a sensitivity analysis to evaluate the robustness of the model, clarify the aspects that make SDEs score well, and discuss the advantages and disadvantages of these aspects for the model as a decision-making tool. Our work mainly evaluates and predicts Olympic Sports, Disciplines, or Events

(SDEs). Firstly, multiple influencing factors are considered, including Safety and Fair Play, Popularity and Accessibility, Gender Equity, Sustainability, Inclusivity, Relevance and Innovation, etc. We have constructed the Olympic SDE TOPSIS Model and evaluated different SDEs by collecting data. These data involve the SDEs that have been added or removed in recent Olympics (such as Karate, Squash, and Baseball) and those that have been present since 1988 or earlier (such as Swimming, Weightlifting, and Artistic Gymnastics). In addition, the Grey Model is used to predict new SDEs. Finally, we conduct in-depth research through Sensitivity Analysis, draw conclusions, and make suggestions.

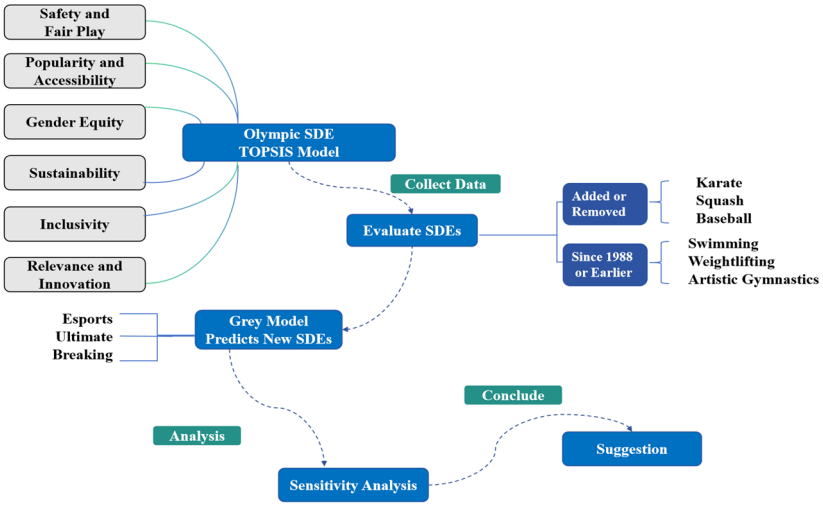

Fig. 1 Our Work

2. Factors to Consider in Addressing the IOC Criteria

Table 1 The Factors to Consider in Addressing the IOC Criteria

First-level Index	Second-level Index	Data Processing	Unit
Popularity and Accessibility	TV Ratings	Percentage of viewers tuning in to watch a particular sport during the Olympics	%
	Number of Sports Venues	Count of dedicated sports venues available for a specific sport	Number
	Audience Size	Total number of spectators attending the live events of a sport	Number
	Audience Ratings	Average score given by the audience to a sports event	%
Gender Equity	Ratio of Men's and Women's Medals	Proportion of medals won by male and female athletes in a specific sport	%
	Ratio of Men's and Women's Participation	Proportion of male and female athletes competing in a sports event	%
Sustainability	Financial Expenditure	Total amount of money spent on a sport about its operation, development, and participation in the Olympics	Number
	Usage Rate of Eco-friendly Materials	Percentage of materials used in a sport's equipment, venue construction, or environmentally friendly operations	%

	Green Certification	Whether a sport or its related facilities have obtained recognized environmental certifications	Yes/No
	Carbon Emissions	Amount of carbon dioxide and other greenhouse gases emitted during the sport's activities	ton
	Social Security Situation	Level of safety and stability in the areas related to the sport	Descriptive assessment
Inclusivity	Total Number of Athletes Participating in the Sport	The sum of all athletes participating in a particular sports event	Number
	Total Number of Medals in the Sport	Cumulative number of medals available and awarded in a sport	Number
	Number of Participating Countries	Count of different countries whose athletes participate in a sport	Number
	Age Variance	Statistical measure of the spread of ages among the athletes participating in a sport	Years
Relevance and Innovation	Social Media Heat	Level of activity and discussion on social media platforms about a sport	Number
	Introduction Rate of Advanced Equipment	The frequency at which new and advanced sports equipment or technologies are adopted in a sport	Number
Safety and Fair Play	Proportion of Injured Athletes	Percentage of athletes who suffer injuries during training or competition in a sport	%
	Number of Violations	Count of rule-breaking incidents by athletes, coaches, or teams in a sports event	Number
	Number of Doping Cases	Quantity of confirmed doping incidents in a sport	Number
	Referee Fairness	Perception of referee fairness	Descriptive assessment

3. Olympic SDEs Evaluation Model

3.1 Data Preprocessing

3.1.1 Missing Value Handling

Since the data collected involves multiple SDE and different time points, what seems difficult is to ensure the fully complete data in the collection process. However, the availability of the data is a crucial issue. Therefore, we must process the missing data properly to enhance the accuracy and validity of our model. The methods of this procession are shown as follows.

(1) Same-class Mean Interpolation Method: This is a single-value imputation method. A cluster analysis model predicts the type of missing value, and then the missing value is replaced with the mean for that category.

(2) Mean Interpolation Method: For interval data, impute using the mean of the type of missing value. For non-spaced data, use the mode for imputation.

(3) Maximum Likelihood Estimation Method: When the data is missing at random and the sample is large, the number of valid samples can ensure that the ML estimates follow an asymptotically unbiased normal distribution.

3.1.2 Data Normalization

For different types of metrics, there are different normalization methods. Cost-type indicators such as number of Violations and CO_2 emissions. Benefit-type indicators such as number of sports venues and audience size. It is worth noting that some indicators are not better if they are more or better if they are less. For example, in the ratio of men's and women's participation, we cannot achieve absolute participation equality, which is not a good situation, but such indicators become moderate-type indicators. The corresponding normalization methods for the above three types of indicators are as follows.

For cost-type indicators

$$x_i' = \frac{x_{max} - x_i}{x_{max} - x_{min}} \tag{1}$$

For benefit-type indicators:

$$x_i' = \frac{x_i - x_{min}}{x_{max} - x_{min}} \tag{2}$$

For moderate-type indicators:

$$x_i' = \begin{cases} 1 - \frac{a - x_i}{M}, & x_i < a \\ 1, & a \le x_i \le b \\ 1 - \frac{a - x_i}{M}, & x_i > b \end{cases} \tag{3}$$

where M = $max\{a - min\{x_i\}\ ,\ max\{x_i\} - b\}$.

3.2 Construction of Olympic SDEs Evaluation Model

3.2.1 Calculation of Weights

AHP method is a commonly used model to weigh the evaluation factors. While, the AHP method introduces strong subjectivity. To make the weight more objective, we use the entropy weight method and the CRITIC method to calculate the weight of each indicator and the weighted average method to obtain the combined weight of each indicator.

1. Entropy Weight Method: The entropy weight method has strong objectivity and has been widely used in social economy and engineering. We use the entropy weight method to obtain the indicator weights as follows. Assuming that the data corresponding to the i-th indicator is $\{x_{i1}, x_{i2}, \cdots, x_{in}\}$, its standardized value is $\{y_{i1}, y_{i2}, \cdots, y_{in}\}$, then the reorganization of the data information entropy is:

$$E_j = -\frac{1}{\ln n}\sum_{i=1}^{n} p_{ij} \ln p_{ij} \tag{4}$$

$$p_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}} \tag{5}$$

When $p_{ij} = 0$, there is:

$$\lim_{p_{ij} \to 0} p_{ij} \ln p_{ij} = 0 \tag{6}$$

The weight of each indicator calculated according to the information is:

$$W_j = \frac{1 - E_j}{k - \Sigma E_j} \tag{7}$$

The weight of each index can be obtained. For example, the weight of the audience size index is 0.059.

2. CRITIC Method: The CRITIC (Criteria Importance Through Intercriteria Correlation) method is an objective multi-attribute decision-making method used to determine the weights of evaluation indicators. This method takes into account both the variability of indicators and their conflict.

The standard deviation of indicator j is calculated as follows:

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{n}(x_{ij}-\bar{x}_j)^2}{n-1}} \quad (8)$$

The conflict among indicators is measured by calculating the correlation between them. For two indicators, j and k, their correlation coefficient r_{jk} is calculated using the Pearson correlation coefficient method. Then, the conflict of j-th indicator with other indicators can be expressed:

$$C_j = \sum_{k=1,k\neq j}^{m}(1 - r_{jk}) \quad (9)$$

The information content I_j of indicator j is a comprehensive manifestation of its variability and conflict and is calculated as follows:

$$I_j = \sigma_j \times C_j \quad (10)$$

Finally, the weight w_j of indicator j is determined as follows:

$$w_j = \frac{I_j}{\sum_{k=1}^{m} I_k} \quad (11)$$

3. Combination Weight Calculation: Sometimes, the index weight determined by the entropy weight method has the defect of equalization. To avoid this problem, we adopt the technique of combining entropy weight and CRITIC weight to obtain the index weight. Assuming that the preference coefficient of the weight is λ, the combined weight is:

$$\widehat{W_j} = \lambda W_j + (1-\lambda)W_{C_j} \;;\; \lambda \in (0,1) \quad (12)$$

We set the preference coefficient λ = 0.5, and then the comprehensive weight of each index is obtained, as shown in the figure below.

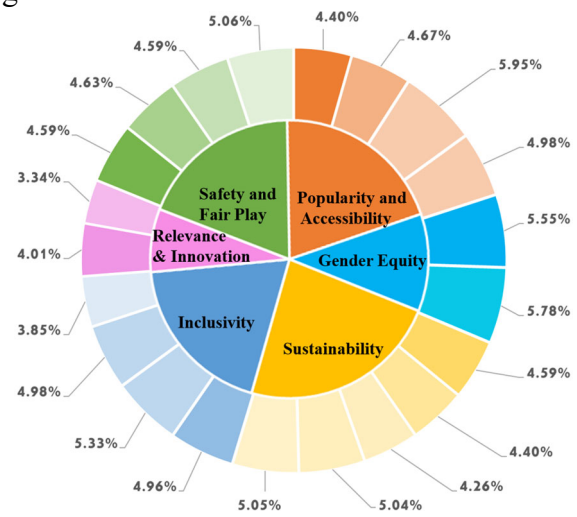

Fig. 2 Weights for each Indicator

3.2.2 Evaluation of the TOPSIS Model

C.L. Hwang and K. Yoony proposed the TOPSIS Model in the 1980s. It is a method of sorting according to the proximity of a limited number of evaluations to an idealized goal. In the weighting matrix, each index's maximum and minimum values are the optimal solution vector $\boldsymbol{X}^+$ and the worst solution vector $\boldsymbol{X}$. So, the close distances between each evaluation target and the optimal and worst solutions can be obtained, respectively.

$$D_i^+ = \sqrt{\sum_{j=1}^{m}\widehat{W_j}\left(\boldsymbol{X}_j^+ - x_{ij}\right)^2}, D_i^- = \sqrt{\sum_{j=1}^{m}\widehat{W_j}\left(X_j^- - x_{ij}\right)^2} \quad (13)$$

Then, the optimal degree of closeness, that is, how close countries are to the ideal level of equity, is:

$$C_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (14)$$

The positive perfect solution distance of each organization can be obtained:

D_i^+= {0.417, 0.443, 0.462, …, 0.697, 0.728, 0.705}

The negative ideal solution distance: D_i^- = {0.682, 0.698, 0.672, …, 0.491, 0.453, 0.406}. After calculating the degree of closeness, the following country scores and rankings can be calculated:

Table 2 Score and Rank of Each SDE

SDE	Score	Rank
Athletics	0.621	1
Basketball	0.612	2
Swimming	0.593	3
. . .	. . .	. . .
Jeu de Paume	0.413	70
Croquet	0.384	71
Roque	0.365	72

It can be seen from the table that three SDEs, including Athletics, Basketball, and Swimming, have relatively high scores and are ranked higher. Athletics is widely developed around the world and has high participation. In terms of education, almost all schools in every country, from primary to university, have incorporated athletics into their physical education curriculums, enabling students to engage in basic events like running, long - jump, and throwing from a young age and creating a large potential participant group. Socially, there are numerous professional and amateur athletes in national athletics teams, and the high participation can be seen from people jogging in city parks to those training in professional clubs. Besides, the basic athletics events have low equipment requirements. For example, running needs a flat surface, such as a playground or an outdoor path. Standing long jumps hardly require additional complex equipment, and some simple throwing events like sandbag throwing can be carried out in small venues, making them accessible worldwide.

However, croquet is not very popular globally. It is mainly recreational and has not developed into a large-scale competitive sport in many countries. It is seldom seen in school physical education courses and community sports activities. There are not many opportunities for the general public to participate, so its popularity and accessibility are rather poor. Consequently, its score is only 0.365.

4. Model Testing and Applicability Analysis Based on Olympic SDEs in Different Periods

The Olympic Games have witnessed various changes in sports disciplines and events. In this section, we aim to test our model using specific sports disciplines and events (SDEs) that have undergone different statuses in recent and past Olympics. We can evaluate our model's performance and general applicability by analyzing SDEs added or removed in the Olympic years 2020, 2024, and 2028 and those that have continuously been part of the Olympic program since 1988 or earlier.

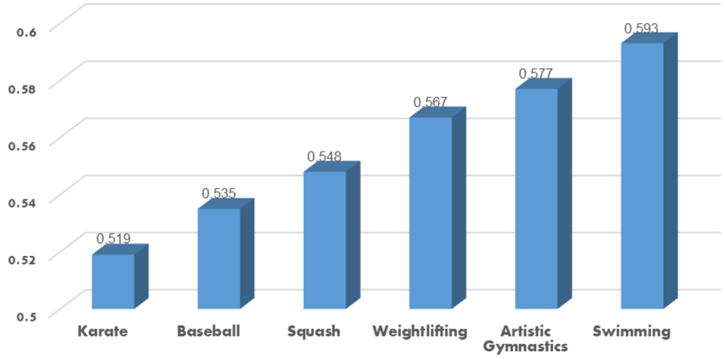

Fig. 3 Scores for SDEs

We have drawn a bar chart of the scores of the six SDEs in this chapter; as shown in Figure at, Karate has the lowest score, while Baseball and Squash have relatively higher scores, reaching 0.548.

Weightlifting, Artistic Gymnastics, and Swimming maintain relatively high scores, with the highest reaching 0.593. Next, we will conduct a specific analysis of these SDEs.

4.1 Added or Removed SDEs in Recent Olympics

In this section, we have selected Karate, Squash, and Baseball for analysis. These sports hold particular significance within the Olympic Games as they each have unique characteristics and histories related to Olympic participation. Their inclusion or exclusion in different Olympic years can provide valuable insights into the Olympic framework's decision-making processes and evaluation criteria. By examining these sports, we can better understand how they fit within the overall structure of the Olympics and how our model can assess and affirm their status within this prestigious sporting event.

Fig. 4 Karate, Squash, and Baseball

4.1.1 Karate

Karate's positive ideal solution distance D^+ is 0.557, and its negative ideal solution distance D^- is 0.602. Its score is 0.519, ranking 30th. Karate had never been an Olympic event before 2020. However, it was included in the Olympics in 2020 and then withdrawn from the Olympics later. For popularity and accessibility, Karate wasn't included in the Olympics in the early days because of its insufficient global popularity. It was little known in many countries and regions, and there were difficulties in obtaining training venues and professional equipment in some places, which limited public participation. Its inclusion in the Olympics in 2020 was because its international promotion in the previous period had increased the number of participants and enhanced its popularity. However, its subsequent withdrawal might be because after the increase in global events, some newly emerged issues regarding safety and fairness were not resolved promptly, such as disputes over judgments in emerging events and loopholes in safety protection, which affected its status in the Olympics.

4.1.2 Squash

Squash's positive ideal solution distance D^+ is 0.542, its negative ideal solution distance D^- is 0.656, and its score is 0.548, ranking 15th. It had never been an Olympic event before 2020. However, it was included in the Olympics in 2028. For sustainability, squash was not included in the Olympics previously because the sport faced challenges in sustainable development during its development process. On the one hand, the traditional squash operation model relied heavily on high-cost professional venues and specific social circles. On the other hand, there was a lack of adaptability to regions with different cultural backgrounds during global promotion. However, in recent years, squash has made many efforts in terms of sustainability. For example, more environmentally friendly and lower-cost portable squash equipment has been developed, making it easier to carry out in different environments. At the same time, the operation strategy has been adjusted to integrate into other cultures actively, enhancing the sustainability of its global development. Thus, in 2028, it meets the Olympics' expectations for sustainable development and is included.

4.1.3 Baseball

Baseball's positive ideal solution distance D^+ is 0.532, and its negative ideal solution distance D^- is 0.656. Its score is 0.535, ranking 20th. Baseball has been repeatedly added to and withdrawn from the Olympic events recently. The following will be an analysis of it. For gender equity in recent years, the international baseball community has been attaching increasing importance to the issue of gender

equality. Women's baseball has achieved certain development in some countries. Some countries and regions have begun to organize women's baseball leagues and hold international women's baseball events, making efforts towards gender equality in aspects such as the distribution of training resources and the provision of participation opportunities, gradually meeting the considerations of the Olympics regarding gender equality. However, on a global level, gender equality in baseball still faces challenges. In many traditional baseball powerhouses, the development level of women's baseball is far lower than that of men's baseball. Significant differences in event scale, commercial value, and social attention are still far from the comprehensive gender equality standards advocated by the Olympics and affect the stability of its status as an Olympic event.

In terms of inclusivity in baseball's development, increasing attention has been paid to inclusivity, providing diverse participation channels for people of different ages and skill levels. In addition, certain attempts and explorations have been made to involve disabled people in baseball, and some adaptive training and competition models have been developed. However, compared with other Olympic events, baseball still has obvious deficiencies in inclusivity. Especially in terms of the participation of disabled people, a widespread and mature system has not yet been formed, and the adaptive measures for people with different cultural backgrounds and body conditions on a global scale are not yet perfect, failing to meet the high requirements of the Olympics for inclusivity fully.

4.2 SDEs in the Olympic Program Since 1988 or Earlier

Since 1988 or even earlier, certain sports have maintained a stable presence in the Olympic Program. These long-established Olympic events have witnessed the development and transformation of the Olympic Games over the years. This chapter will conduct an in-depth analysis of these sports, exploring various aspects such as their historical significance, the evolution of competition rules, global popularity, cultural influence, and the challenges and opportunities they have faced during their long-term participation in the Olympics. By understanding these elements, we can gain a more comprehensive perspective on how these traditional Olympic sports have contributed to the overall charm and value of the Olympic Games.

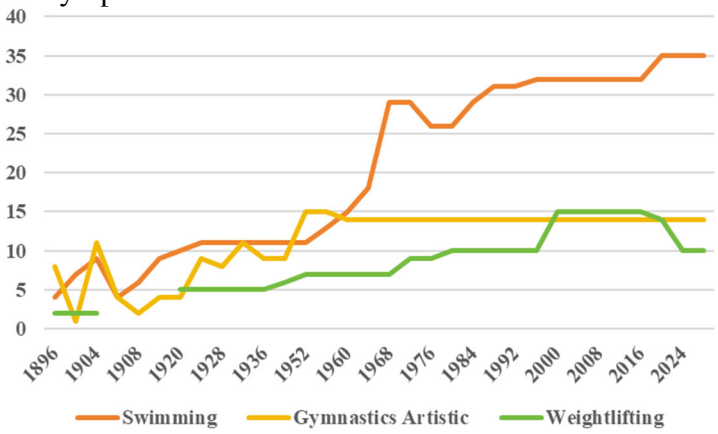

Fig. 5 The number of events for each sport contested at the respective Games

Fig. 6 Swimming, Weightlifting, and Artistic Gymnastics

4.2.1 Swimming

Swimming's positive ideal solution distance D^+ is 0.462, its negative ideal solution distance D^- is 0.672, and its score is 0.593, ranking 3rd. Baseball has been repeatedly added to and withdrawn from the Olympic events recently. The following will be an analysis of it.

For sustainability, swimming causes relatively less damage to the body. Compared with some highly confrontational athletics, swimming can be relatively longer. Moreover, swimming techniques and training methods have been continuously inherited and innovated. New training concepts and strategies can help athletes constantly improve their performance, ensuring the sustainable development of swimming in the competitive aspect. For gender equity, in swimming events, male and female athletes have had almost equal participation opportunities since the early days of the Olympics. Whether short-distance freestyle, butterfly stroke, backstroke, breaststroke, or relay events, there are separate competition settings for men and women. In terms of event organization, bonus distribution, and training resources, male and female athletes are treated relatively fairly, meeting the Olympics' strict requirements for gender equality. Moreover, in some countries, the achievements of female swimmers have even surpassed those of male swimmers. For example, some female swimming champions in Australia have inspired more women to participate in swimming with their success.

.4.2.2 Weightlifting

Weightlifting's positive ideal solution distance D^+ is 0.516, and its negative ideal solution distance D^- is 0.675. Its score is 0.567, ranking 7th. Baseball has been repeatedly added to and withdrawn from the Olympic events recently. The following will be an analysis of it.

For inclusivity, the weightlifting event is divided into different weight classes according to the athletes' body weights, which enables athletes of various weights to have the opportunity to compete. Whether they are small-built athletes or those with strong physiques, as long as they meet the requirements of the corresponding classes, they can give full play to their advantage in their classes. Meanwhile, for athletes with certain physical disabilities but good upper body strength, there are also special Paralympic weightlifting events, providing them with a platform to showcase themselves.

Weightlifting competitions have strict safety rules and protective measures for safety and fair play. At the competition site, some professionals accurately check the weight of the barbell to ensure that the athletes compete within a safe weight range. Meanwhile, athletes must wear necessary protective gear, such as weightlifting belts and wrist guards, to reduce the risk of injury. Regarding venue facilities, the design and quality of the weightlifting platform also meet safety standards and can effectively cushion the impact when the barbell is dropped.

4.2.3 Artistic Gymnastics

Artistic Gymnastics 's positive ideal solution distance D^+ is 0.480, its negative ideal solution distance D^- is 0.655, and its score is 0.577, ranking 5th. Baseball has been repeatedly added to and withdrawn from the Olympic events recently. The following will be an analysis of it.

For popularity and accessibility, artistic gymnasts showcase astonishing physical flexibility and coordination through highly difficult movement combinations, such as tumbling, spinning, and jumping, accompanied by beautiful music. The gymnasts are also highly creative in using apparatuses (such as ribbons, hula hoops, balls, etc.). Their movements are like dances, full of artistic charm, bringing the audience a dual enjoyment of sight and sound.

For relevance and innovation, artistic gymnastics constantly evolves regarding movement, apparatus, and competition format innovation. These innovative measures enable artistic gymnastics to keep up with the trend of modern sports development and add vitality to the Olympics.

5. Reintroduced or Identifying New SDEs for the 2032 Brisbane Olympics and Prospects for the 2036 Olympics

5.1 Construction of a Gray Prediction Model

The gray model can predict the development trend of things over some time.

$$x^{(0)} = \left(x^{(0)}(1), x^{(0)}(2), \ldots, x^{(0)}(n)\right) \tag{15}$$

If all level ratios $\lambda(k) = \frac{x^{(0)}(k-1)}{x^{(0)}} (k = 2,3, \ldots, n)$ fall in:

$$X = \left(e^{-\frac{2}{11}}, e^{\frac{2}{11}}\right) \tag{16}$$

Then, the original sequence can be set according to the original sequence:

$$x^{(0)}(k) + az^{(0)}(k) = b \tag{17}$$

The corresponding whitening model can be obtained by regression analysis:

$$\frac{dx^{(0)}(t)}{dt} + ax^{(0)}(t) = b \tag{18}$$

We can get:

$$x^{(0)}(t) = \left(x^{(0)}(1) - \frac{b}{a}\right) e^{-a(t-1)} + \frac{b}{a} \tag{19}$$

Finally, we can set k+1 = t to get the predicted value. We use data from 2004-2024 to predict what might happen in 2028-2036.

5.2 Solving and Analyzing the Model

We use the grey prediction model to analyze the Olympic events added or removed in recent years and other popular sports such as ultimate and esports. The predicted results are as in Table 3:

Table 3 Model Indicators

SDE	Developmental quotient a	Gray action b	The posterior difference ratio C
Ultimate	-0.075	0.404	0.034
Esports	-0.029	1.402	0.165
breaking	-0.046	0.491	0.234
Karate	-0.043	0.332	0.451
Baseball	-0.045	0.425	0.109
Softball	-0.018	0.483	0.145
Cricket	-0.02	0.488	0.291
Sixes	-0.027	0.496	0.206
Coastal	-0.018	0.534	0.000
Squash	-0.022	0.5	0.478

It can be seen that all of the posterior difference ratio C values are lower than 0.5, and the model accuracy is high, analyzing the model fitting results. At the same time, the model fitting prediction diagram is drawn as follows.

As can be seen from the graph, the evaluation scores of sports like softball and baseball have shown a gradual rise in recent years. Meanwhile, the three sports, Esports, Ultimate, and Breaking, have all ranked among the top three in terms of scores in both 2032 and 2036. Specifically, in 2036, their scores reached 0.786, 0.768, and 0.723, respectively. It indicates that, based on the evaluation and prediction of our model, these three sports are expected to become new events in the Olympics in the future.

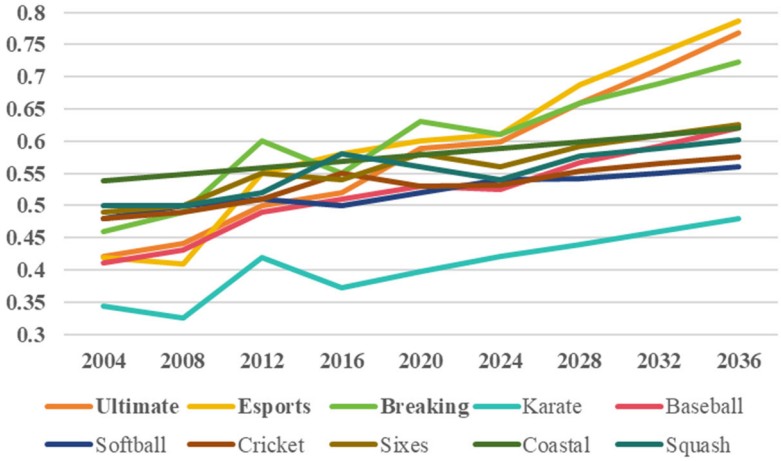

Fig. 7 Gray Prediction Results

6. Sensitivity Analysis

In calculating the combined weight, we use the parameter λ, which is obtained based on the weight obtained by the entropy weight and CRITIC methods. Therefore, a sensitivity analysis of the parameters is required. The study's results are as in Figure 8. As seen from the above figure, changes in the parameters λ of our model do not significantly impact the model results, with only minor changes in the score and rank. Therefore, it can be proved that our model is stable.

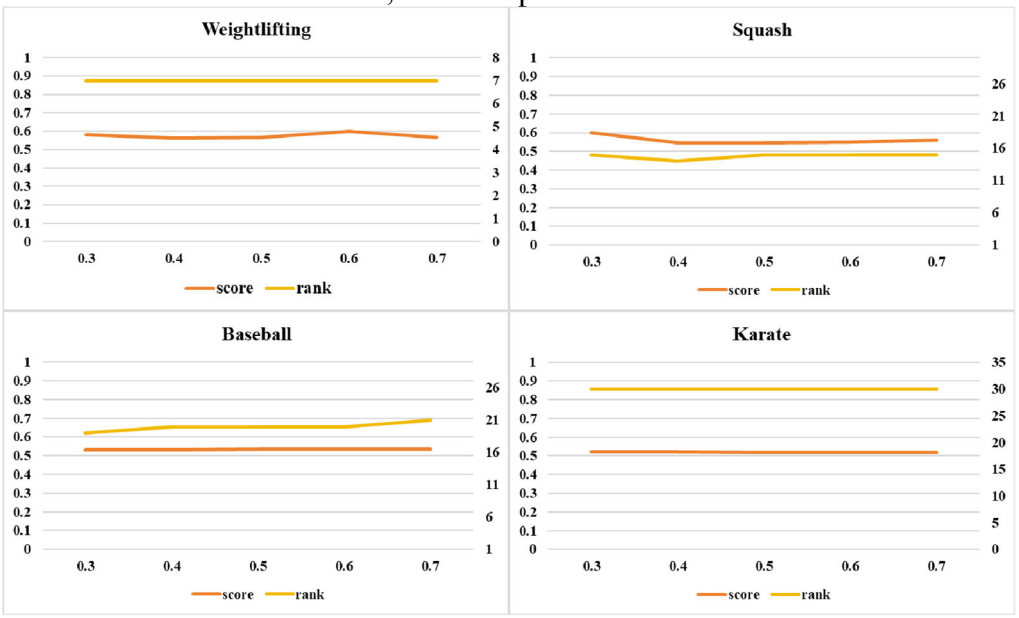

Fig. 8 Sensitivity Analysis

7. Evaluation of Strengths and Weaknesses

7.1 Strengths

When building an Olympic SDE Evaluation model, we start with Popularity and Accessibility, Gender Equity, Sustainability, Inclusivity, Relevance and Innovation, Safety, and Fair Play, covering various disciplines. In addition, we select data with sufficient representativeness. Each indicator we selected can be collected from authoritative data sources such as SPORTDiscus, Olympic Games, IOC Olympic Studies Centre, etc., and our dataset contains 21 indicators. Our model has adequate data support. We use the combined weight of the entropy weight method and the CRITIC method as the indicator's weight, which avoids possible equalization defects. Sensitivity test results show that

our combined weight preference coefficient has excellent stability. When we build and solve the model, we strictly conduct the level and time series tests, improving our model's rigor.

7.2 Weaknesses

We can further improve the indicator system by spending more time collecting and collating relevant data. We also can add consideration to the model's analysis, such as considering the interaction relationship between India and the impact of emergencies on the model.

7.3 Improvements

(1) Data and Indicator Aspects

- Broaden data collection channels. Incorporate data from more relevant international sports organizations to enrich data types and the existing authoritative data sources.
- (2) Regularly review and optimize the indicator system, updating indicator content based on the latest Olympic development trends and research findings.

(2) Model Analysis Aspects

- Employ advanced data analysis techniques to explore the potential inter-relationships among indicators and improve the model's accuracy.
- Establish an emergency mechanism and design corresponding model adjustment plans for possible unexpected events to enhance the model's adaptability.

References

[1] Vincent P. A Comparative Study on Suitability of AHP and TOPSIS for Identifying Optimal Conceptual Design of Bearing Puller[J]. Journal of Engineering Research and Reports,2023,25(12):194-205.

[2] Chappell J L, B. Kübler-Mabbott. The International Olympic Committee and the Olympic System[M].Routledge, 2008.

[3] Mackenzie I, Davies A. Lessons from the London 2012 Olympic and Paralympic Games construction program [J]. 2012.

[4] Chakraborty S.TOPSIS and Modified TOPSIS: A Comparative Analysis.

[5] Vr A, Nks A, Aa B. Integrated AHP-TOPSIS methods for optimization of epoxy composite filled with Kota stone dust ScienceDirect[J]. 2021.

[6] Xin-Sheng D L. Grey forecasting model of Olympic Games gold quantity[J]. Shandong Sports Science & Technology, 2005.