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Research on influence of large sports events on urban development based on fuzzy mathematics

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ABSTRACT

With the continuous of national strength, more and more large cities in China have participated in and held international sports events, it is obvious that the holding of sports events has advantages to the development of a city. Since the 2000 Olympic Games, the competitiveness of cities has gradually been highlighted, and the holding of sports events is significant to improve the urban image and enhance urban competitiveness. An index system is established and fuzzy mathematics are used to research the influence of sports events on the urban development and quantize the role of sports events to the urban development. It is concluded that the holding of sports events has a short and long-term comprehensive promotion role for the development of cities.

KEYWORDS

Sports events; Urban development; Fuzzy evaluation; Fuzzy mathematics.

INTRODUCTION

As an emerging economic form, sports industry has presented its strong activity worldwide. Sports industry is gradually developed and formed. The sports events play an immeasurable role for the formation of sports of a city, which does not only have a short-term economic benefit, but also has a great radiation effect to the development of a city, and even the whole country.

As the largest developing country, China has large cities growing prosperously, with more and more metropolitans. The country is the collection of cities, and the image and competitiveness of cities also reflect the status and international competitiveness of the country. The holding of sports events has a high requirement for the city, and post-sports events are also significant to the development of cities. Therefore, it is significant to research the influence of sports events on the urban development. The direction of this research is how to make full use of the optimal effect of sports events and promote the development of cities. In this paper, fuzzy mathematics are employed to analyze the connection between the sports events and cities, and a comprehensive fuzzy evaluation system is established to provide reference for the development of sports events and cities.

INDEX SYSTEM

The sports events have more influences on the development of cities, including the direct and indirect influences, and they have different influences on various aspects of urban development. The urban development is a complicated system, and establishing an appropriate index system is the necessary condition to research the influence of sports events on the urban development. In this paper, an index system is established for the influence of sports events from three aspects, namely urban environment, urban image and economic development.

TABLE 1 : Index system table

Objective	Rule layer	Index layer
Influence of large sports events on urban development (P)	Urban environment (B_1)	Improving of urban infrastructures (B_{11})
		Promotion of ecological civilization construction (B_{12})
		Improving people's living standards (B_{13})
	Economic development (B_2)	Adjusting structure of sports industry (B_{21})
		Promoting upgrading of sports industry (B_{22})
		Driving development of other industries (B_{23})
		Strengthening connection between industries (B_{24})
	Urban image (B_3)	Increasing urban cultural relics (B_{31})
		Improving people's quality (B_{32})
		Accelerating urban civilization construction (B_{33})
		Improving urban popularity (B_{34})

COMPREHENSIVE EVALUATION MODEL OF FUZZY MATHEMATICS

Fuzzy mathematics

The concept of fuzzy mathematics was proposed by Professor L. A. Zadeh in 1965. Corresponding to accurate mathematics, fuzzy mathematics are to find out the fuzzy relation between privacies through inaccurate calculation. Fuzzy comprehensive evaluation is a method of using fuzzy

theory to determine the evaluation result by establishing the degree of membership of the index evaluation. The steps of fuzzy evaluation are as follows:

1. Establishing the factor domain of discourse of evaluation target U,

$$U = (u_1, u_2 \cdots, u_n)$$

2. Determining the grade of qualitative evaluation of factors in the domain of discourse V,

$$V(v_1, v_2, \cdots, v_n)$$

The determination of evaluation is generally crucial, like good and bad, high and low, and importance. From the experts' perspective, the evaluation is set as 5 grades, respectively 10 scores, 8 scores, 6 scores, 4 scores and 2 scores.

3. Establishing the fuzzy relation matrix R through membership degree of evaluation domain of discourse corresponding to factors.

The index degree of membership under the three rules constitutes three membership function matrixes, and the matrix form is as follows:

$$R = \begin{pmatrix} r_{11} & \cdots & r_{1m} \\ \vdots & \ddots & \vdots \\ r_{n1} & & r_{nm} \end{pmatrix}$$

Where r_{ij} represents the degree of membership of indexes to the domain of discourse of evaluation grade, for example, the membership of improving urban infrastructures to 10 scores.

Establishing fuzzy matrix

After the indexes are subject to expert scoring, three fuzzy matrixes are obtained, respectively as follows:

R_1	10 scores	8 scores	6 scores	4 scores	2 scores
B_{11}	0.39	0.23	0.17	0.12	0.09
B_{12}	0.46	0.19	0.18	0.10	0.07
B_{13}	0.41	0.20	0.11	0.28	0

R_1	10分	8分	6分	4分	2分
(B_{21})	0.32	0.36	0.12	0.20	0
(B_{22})	0.51	0.21	0.28	0	0
(B_{23})	0.29	0.26	0.23	0.15	0.07
(B_{24})	0.19	0.41	0.17	0.21	0.03

R_1	10分	8分	6分	4分	2分
(B_{31})	0.33	0.28	0.13	0.17	0.09

(B_{32})	0.49	0.20	0.11	0.15	0.05
(B_{33})	0.30	0.18	0.20	0.19	0.13
(B_{34})	0.54	0.23	0.14	0.09	0

Determining the weight if factors in factor domain of discourse

Weight vectors A, $A=(a_1,a_2,\cdots a_n)$, where a_i represents the membership relation to the evaluated system, i.e. the distribution of importance of various factors in the evaluation system. Different importance degrees of factors in the system decide that factors have different weights, and the weights can be calculated through layered mathematical analysis method.

First, a judgment matrix is created, for example, B_i, B_j is taken for importance evaluation, and the result is represented with figures 1-9, and each figure represents the following:

TABLE 2 : Meaning of scales 1-9

Scale	Meaning
1	Two factors are of equal importance to the objective.
3	The first factor is slightly more important than the second one.
5	The first factor is more important than the second one.
7	The first factor is relatively more important than the second one.
9	The first factor is extremely more important than the second one
Even number	Represents that the important is between two odd numbers
Reciprocal	Represents the positive and negative comparison sequence of the factors

The judgment matrix created with the method above is as follow:

B_1	B_{11}	B_{12}	B_{13}
B_{11}	1	3	2
B_{12}	1/3	1	1
B_{13}	1/2	1	1

Similarly, a judgment matrix is established for the second-level indexes under the first-level indexes, and for the remaining second-level indexes, as follows:

B_2	B_{21}	B_{22}	B_{23}	B_{24}
B_{21}	1	3	2	5
B_{22}	1/3	1	1/2	2
B_{23}	1/2	2	1	4
B_{24}	1/5	½	1/4	1

B_3	B_{31}	B_{32}	B_{33}	B_{34}
B_{31}	1	3	3	1/2
B_{32}	1/3	1	1/2	1/3
B_{33}	1/3	2	1	1/3
B_{34}	2	3	3	1

Consistency check and weight vector

The calculation method of consistency index CI of judgment matrix and the consistency ratio CR of judgment matrix is expressed as follows:

$$CI = \frac{\lambda_{\max} - n}{n-1}$$

Where n represents the order of judgment matrix, i.e. the number of comparison factors:

$$CR = \frac{CI}{RI}$$

Where RI represents the value of Random Consistency Index, as shown in the table below:

TABLE 3 : List of RI values

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

When $CR \geq 0.1$, the inconsistency of the matrix is not acceptable, and the data of the judgment matrix should be slightly adjusted. When $CR < 0.1$, the judgment matrix can be considered to be a consistent matrix.

TABLE 4 : Consistency check and weight value

	B_1	B_2	B_3
w	0.548	0.476	0.309
	0.211	0.154	0.106
	0.241	0.288	0.150
		0.081	0.435
λ	3.018	4.021	4.122
CI	0.009	0.007	0.041
CR	0.016	0.008	0.045

Weight calculation ranking

Assume the weight vector of 3 indexes in the first layer is $A = (a_1, a_2, a_3)$, and that of the second-level index in the lower layer is $D = (d_1, d_2, \cdots d_n)$, then the overall weight of the second-level index is:

$$w_i = a_i d_{ij}$$

and the weight value of the indictor $A = (0.3 \quad 0.4 \quad 0.3)$, according to the formula, it is calculated that the weight of each index in the overall objective is as follows:

TABLE 5 : Weight result list

Rule layer	Weight value	Index layer	Weight value
Urban environment (B_1)	0.3	Improving urban infrastructures (B_{11})	0.1644
		Promoting ecological civilization construction (B_{12})	0.0633
		Improving people's living standards (B_{13})	0.0723
Economic development (B_2)	0.4	Adjusting structure of sports industry (B_{21})	0.1904
		Promoting upgrading of sports industry (B_{22})	0.0616

		Driving development of other industries (B_{23})	0.1152
		Strengthening connection between industries (B_{24})	0.0324
Urban image (B_3)	0.3	Increasing urban cultural relics (B_{31})	0.0927
		Improving people's quality (B_{32})	0.0318
		Accelerating urban civilization construction (B_{33})	0.045
		Improving urban popularity (B_{34})	0.1305

The result shows that according to the weight calculation result, large sports events are most important to adjust the structure of sports industry, followed by improving urban infrastructures, improving urban popularity, driving other industries and increasing cultural relics. According to these indexes with great weight, large sports events are very effective to develop the urban tourism. Improving urban infrastructures and promoting ecological civilization construction have slow and enduring influences, and will play role long time after the events, so these indicators have relatively small values in the weight calculation.

Calculation result

Through the above methods, vector A can be obtained, which is a fuzzy matrix. A and R are composed to get vector $B = (b_1, b_2, \cdots b_m)$ with composition operator $M(\bullet, \oplus)$.

$$B = AOR = (a_1 \quad a_2 \quad a_3) O \begin{pmatrix} D_1 OR_1 \\ D_2 OR_2 \\ D_3 OR_3 \end{pmatrix}$$

Where:

$$D_1 OR_1 = \begin{pmatrix} d_1 & d_2 & \cdots & d_n \end{pmatrix} O \begin{pmatrix} r_{11} & r_{12} & \cdots & \\ r13 & r_{22} & & \\ \vdots & & \ddots & \\ & & & r_{mn} \end{pmatrix}$$

$$d_j = (d_1 \underset{*}{\bullet} r_{1j}) + (d_2 \underset{*}{\bullet} r_{2j}) + \cdots + (d_n \underset{*}{\bullet} r_{nj}), \ (j = 1,2,\cdots m)$$

Upon calculation, the following vector is obtained:

$$B = (0.385 \quad 0.259 \quad 0.162 \quad 0.149 \quad 0.044)$$

The above results are the comprehensive evaluation results of influence of large sports events on the urban development, the results show that 38.5% of the people think that the influence of large sports events in urban development is 10 scores, 25.9% think it is 8 scores, 16.2% think it is 6 scores, 14.95 think it is 4 scores, and 4.4% thought it is 2 scores. Based on the principle of maximum membership degree, the evaluation result of influence of large sports events on urban development should be 10 scores, indicating that the holding of large sports events have an important role for the urban development, and that holding sports events is the propeller for urban development.

CONCLUSION

Based on the comprehensive evaluation of fuzzy mathematics, the influence of large sports events on urban development is evaluated. The result shows that the holding of large sports events is significant to the urban development, with influence result estimated to be 10 scores, 64.4% of the experts think that the holding of sports events has a result of above 8 scores for the development of cities, and according to the maximum membership principle of fuzzy mathematics, the results of influence of holding sports events on the urban image, urban image and economic development are all estimated to be 10 scores.

In combination with the research conclusion of this paper, it is concluded that the urban development is all-directional, and the influence of sports events on the urban development is also in different directions. The sports events should be significant to improve the urban environment and achieve sustainable growth. It is suggested to hold large international sports events in cities, which will play an active role to improve the urban popularity, competitiveness and influence.

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