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Fuzzy comprehensive evaluation method-based regional sports industry layout optimization research

Fugao Jiang[1]*, Tie Wang[2]

[1]Department of Physical Education, QuFu Normal University, Rizhao 276826, Shandong, (CHINA)

[2]College of Geography and Tourism, QuFu Normal University, Rizhao 276826, Shandong, (CHINA)

ABSTRACT

Sports industry includes material and intangible service two aspects. From some extents, sports industry development status represents people's living standard. Nowadays, China lies in economic adjustment hard time, which propels to sports industry development to conform to economic adjustment direction. Just because the two aspects causes, nation puts emphasis on sports industry development. The paper utilizes fuzzy comprehensive evaluation method, takes Beijing, Seoul and Sydney as research objects, and regards China and America as weights' reference objects. Seoul and Sydney are developed countries' cities, the paper aims to look for Chinese sports industry internal structure and developed countries' sports industry internal structure differences, whether Chinese sports industry backward development is caused by regional development unevenness. By data analysis, it gets conclusion that Beijing is the most reasonable city from the three cities in sports industry internal structure. Though Seoul and Sydney lie in developed countries, Beijing industry structure is better than the other two, which shows Chinese sports industry development backward is caused by regional uneven development.

KEYWORDS

Sports industry;
Internal structure;
Fuzzy integration;
Weight analysis;
Mathematical model;
Regional sports.

INTRODUCTION

In 2013, sports blue book press conference just ended. It was an important academic research report in the industry. In 2008, China succeeded in hosting Beijing Olympic Games. In recent years, Chinese economy has been rapidly developed, peoples' living standard constantly increased. People promote fitness awareness while it also drives Chinese sports industry development. Sports industry not only refers to international competitions' medals ranking, but also contains sports product sales status, manufacturing status and sports service industry and others multiple aspects. However, in real life, Chinese sports industry development status compares with developed countries sports industry status, China is still in the backward level.

In 2003, Wang Liang-Ju in the article "Our country modern sports industry development research", made comparative analysis of present Chinese sports industry status and sports industry developed countries status, the paper pointed out that developed countries sports industry gross product has already arrived

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at 3% – 6% of *GDP*, and our country sports industry gross product hasn't arrived at 1% of *GDP*. In 2010, Yang Cang-Nan in the article "Our country sports industry development status and future development countermeasure research", took foreign sports industry development status as reference standard, from multiple perspectives of cultivating market, adjusting structures, system reforming, made reasonable suggestions on our country sports industry development problems. In 2011, Yang Qian in the article "Our country sports industry structure optimal upgrade research", used Lagrange's interpolation, Delphi method, grey relational analysis method and others multiple methods, researched on sports industry structure upgrade problems, the obtained conclusion was that current sports industry structure was unreasonable. Our country now was in the stage of economic structure adjustment, developing sports industry economy conformed to economic development adjustment orientation. In 2013, Su Ning in the article "Chinese sports industry development temporary dynamics and spatial pattern, analyzed our country sports industry development time, constructed sports industry development index dynamic prediction model. The paper pointed out that our country's eastern, middle and western parts' sports industry development was gradient development.

The paper works on analyzing Chinese sports industry backward causes from sports industry internal structure perspective. Select China Beijing, South Korea Seoul and Australia Sydney three cities as research objects, utilize mathematical models to define optimal development city. Look for Beijing and other cities' differences. If Beijing is the optimal developed cities of the three cities, then it shows Chinese sports industry backward causes are caused by regional development unevenness.

MODEL ESTABLISHMENT

The model is establishing according to fuzzy comprehensive evaluation method. Fuzzy comprehensive evaluation is making comprehensive evaluation according to multiple aspects' factors, it can effective make comprehensive evaluation on events that suffer multiple factors influences. The paper establishes models to evaluate whether sports industry is good or not from sports industry internal structure directions. By analyzing the model, it can get sports industry optimal city so that deduce Chinese sports industry backward causes.

Data processing

TABLE 1 quotes data in the article "Our country sports industry structure and its optimization research". It contains Beijing, Seoul, Sydney, China and America. Beijing data is from Beijing the second time economic census statistical information. Foreign cities and countries' data are from relative research institution.

Original data

By TABLE 1 data, it is clear column data sum is not equal to 100% . Sports product sale, sports fitness and recreational activities, other sports services, sports organizational management percentage represents proportion that occupies in sports industry added value. Normalize data and get TABLE 2.

Data result

List out TABLE 2 data is to easier compare and analyze each city and each country sports industry in-

TABLE 1 : Sports industry internal structure status(unit:%)

Major type name	Beijing	Seoul	Sydney	China	America
Sports organizational management activities	22	15.9	25.3	6.83	14.2
Sports fitness and recreational activities	13.4	33.7	38.6	6.87	35.7
Sports intermediary activities	3.1	7.8	6.1	0.79	5.5
Other sports service activities	11.7	12.8	15	4.45	14.9
Sports service industry	50.2	70.2	85	18.94	70.3
Sports product manufacturing	8.2	7.6	4.5	61.55	16.2
Sports product sales	34.8	13.7	4.9	16.53	103
Stadium architecture activities	7	8.5	5.6	2.99	3.2

TABLE 2 : Sports industry internal structure status after normalization

Major type name	Beijing	China	Seoul	America	Sydney
Sports organizational management activities	0.15	0.06	0.09	0.05	0.14
Sports fitness and recreational activities	0.09	0.06	0.20	0.14	0.21
Sports intermediary activities	0.02	0.01	0.05	0.02	0.03
Other sports service activities	0.08	0.04	0.08	0.06	0.08
Sports service industry	0.33	0.16	0.41	0.27	0.46
Sports product manufacturing	0.05	0.52	0.04	0.06	0.02
Sports product sales	0.23	0.14	0.08	0.39	0.03
Stadium architecture activities	0.05	0.03	0.05	0.01	0.03
Total sum	1.00	1.00	1.00	1.00	1.00

ternal structure status.

Figure 1 is three cities and two countries' sports internal structure distribution chart; it can see from the figure Beijing sports internal structure distribution is relative even.

Fuzzy comprehensive evaluation

In general, fuzzy comprehensive evaluation involves three quantities. Set that there are n pieces of evaluated objects correlation factors, it records as $U=\{u_1,u_2,\cdots,u_n\}$, and calls it as factor set. And set all possible occurred remarks have m pieces, it records as $V=\{v_1,v_2,\cdots,v_m\}$, and calls it as evaluation set. Because every factor position is different, its function is also different, so it appears measurement criterion that is weight, and it records $A=\{a_1,a_2,\cdots,a_n\}$.

Fuzzy comprehensive evaluation steps are proceeding as following methods:

(1) Define factor set $U=\{u_1,u_2,\cdots,u_n\}$.

(2) Define evaluation set $V=\{v_1,v_2,\cdots,v_m\}$.

(3) Carry out single factor evaluation and get $r_i=\{v_{i1},v_{i2},\cdots,v_{im}\}$.

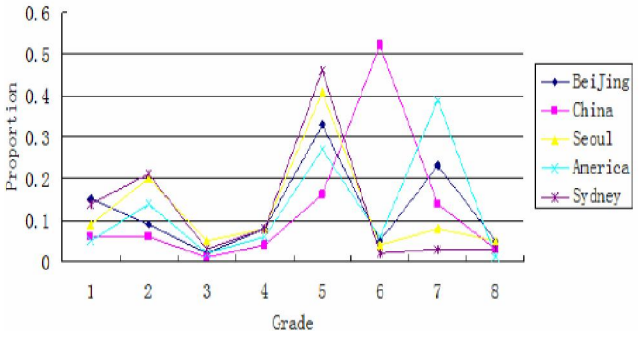

Figure 1 : All objects comparison chart

(4) Construct comprehensive evaluation matrix:

$$\mathbf{R}=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \quad (1)$$

(5) Comprehensive evaluation: to weight $A=\{a_1,a_2,\cdots,a_n\}$, calculate $B=A\circ R$, and need to make evaluation according to maximum membership principle.

When make comprehensive evaluation, according to operator $\circ$ different definitions, it has different models.

(1) Model I : $M(\wedge,\vee)$—— Principal divisor decisive type

Computing method is

$$b_j=\max\{(a_i\wedge r_{ij}),i=1,2,\cdots,n\}(j=1,2,\cdots,m) \quad (2)$$

The model evaluation result is up to factors that play main effects on total evaluation, other factors will not impact on evaluation, relatively, the model is fit for the case that comprehensive evaluation is thought to be optimal when single evaluation is optimal.

(2) Model II: $M(\bullet,\vee)$—— Principal divisor prominent type

Computing method is

$$b_j=\max\{(a_i\bullet r_{ij}),i=1,2,\cdots,n\}(j=1,2,\cdots,m) \quad (3)$$

The model has some similarities with'& model, but it is more refining than '&model. It not only highlights

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main factors, but also gives considerations to other factors. The model is fit for the range that model '& is inapplicable, which is also in case that each factor cannot be distinguished but needed to be refined.

(3) Model III: $M(\bullet,+)$—— Weighted average type

Computing method is

$$b_j = \sum_{i=1}^{n} a_i \bullet r_{ij} (j = 1,2,\cdots,m) \quad (4)$$

The model according to each factor importance, take all influence factors into consideration, relatively it is fit for the case that requires comprehensive optimization.

(4) Model IV: $M(\wedge,\oplus)$—— Taking sum of small upper bound type

Computing method is

$$b_j = \min\left\{\left(1, \sum_{i=1}^{n}(a_i \wedge r_{ij})\right)\right\}(j = 1,2,\cdots,m) \quad (5)$$

When use the model, it should pay special attention to: every a_i cannot take excessive big value, otherwise it may appear the case that b_j is1; every a_i cannot take excessive small value, otherwise it will appear the case that b_j is equal to the sum of each a_i, which will lead to single factor evaluation relative information lose.

(5) Model V: $M(\wedge,+)$—— Balanced average type

Computing method is

$$b_j = \sum_{i=1}^{n}\left(a_i \wedge \frac{r_{ij}}{r_0}\right)(j = 1,2,\cdots,m) \quad (6)$$

Among them, $r_0 = \sum_{k=1}^{n} r_{kj}$. The model is fit for comprehensive evaluation matrix R element is excessive big or small cases.

The paper established model uses principal divisor decisive type's operator.

Establishment process

The paper looks for Chinese sports industry backward causes through considering three cities (Beijing, Seoul, Sydney) sports industry structure status evaluation problems. Thereupon, it establishes factor set $U = \{u_1, u_2, u_3, u_4, u_5, u_6, u_7, u_8\}$, from which u_1 represents sports organizational management activities, u_2 represents sports fitness and recreational activities, u_3 represents sports intermediary activities, u_4 represents other sports service activities, u_5 represents sports service industry, u_6 represents sports product manufacturing, u_7 represents sports product sales, u_8 represents stadium architecture activities. Due to it needs to make comparison of three cities; it should make horizontal standardization on TABLE 2 data.

In TABLE 3, Beijing, Seoul, Sydney three cities are regarded as evaluation objects, it should make standardization on three cities' horizontal data that add three cities' horizontal values sum as 1. China and America are regarded as reference objects, it should carry out standardization processing with the two countries' horizontal data that the two cities' horizontal values adding sum is 1. Data in TABLE 3 is factor set U composition.

In following diagram, mark number "1" represents sports organizational management activities, "2" repre-

TABLE 3 : Status table after horizontal standardization

Major type name	Beijing	Seoul	Sydney	China	America
Sports organizational management activities	0.39	0.25	0.36	0.52	0.48
Sports fitness and recreational activities	0.18	0.4	0.42	0.3	0.7
Sports intermediary activities	0.21	0.46	0.33	0.24	0.76
Other sports service activities	0.33	0.32	0.35	0.4	0.6
Sports service industry	0.28	0.34	0.38	0.37	0.63
Sports product manufacturing	0.44	0.36	0.2	0.89	0.11
Sports product sales	0.68	0.24	0.08	0.26	0.74
Stadium architecture activities	0.37	0.39	0.24	0.67	0.63

sents sports fitness and recreational activities, "3" represents sports intermediary activities, "4" represents other sports service activities, "5" represents sports service industry, "6" represents sports product manufacturing, "7" represents sports product sales, "8" represents stadium architecture activities.

By referencing lots of document, China is undeveloped country in sports industry, however American sports industry is relative developed. According to TABLE 3 data, make comparison of America and China two countries' sports industry internal structure status, it gets Figure 2.

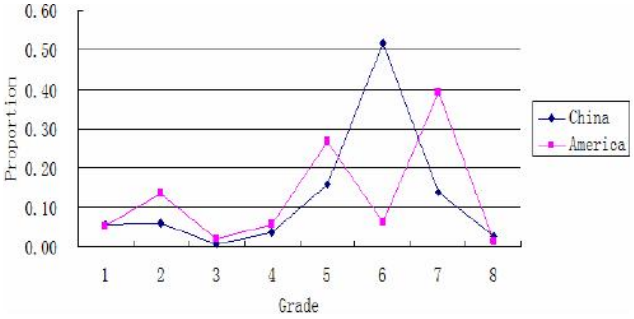

Figure 2 : The comparison chart of China and the United States case

From Figure 2, it is clear that the maximum difference between America and China's sports internal structure is whether distribution is even or not. American sports industry internal structure is relative even, however Chinese sports industry internal structure is not stable. Therefore, according to two countries' sports industry structure data as evaluation indicators' different weights' evidence that are respectively:

$A_1 = (0.52,0.30,0.24,0.40,0.37,0.89,0.26,0.67)$

$A_2 = (0.48,0.70,0.76,0.60,0.63,0.11,0.74,0.63)$

According to TABLE 3 data, establish comprehensive evaluation matrix:

$$\mathbf{R} = \begin{bmatrix} 0.39 & 0.25 & 0.36 \\ 0.18 & 0.40 & 0.42 \\ 0.21 & 0.46 & 0.33 \\ 0.33 & 0.32 & 0.35 \\ 0.28 & 0.34 & 0.38 \\ 0.44 & 0.36 & 0.20 \\ 0.68 & 0.24 & 0.08 \\ 0.37 & 0.39 & 0.24 \end{bmatrix} \quad (7)$$

Take model I—— $M(\wedge,\vee)$ as evident, for two weights, respective calculate and get:

$$\mathbf{B_1 = A_1 \circ R = (0.44,0.39,0.37)}$$
$$\mathbf{B_2 = A_2 \circ R = (0.68,0.46,0.42)} \quad (8)$$

Because it needs to calculate percentage, make normalization on above result, result is as following:

$$\mathbf{B_1 = A_1 \circ R = (0.37,0.33,0.31)}$$
$$\mathbf{B_2 = A_2 \circ R = (0.44,0.29,0.27)} \quad (9)$$

By (9), it is clear in case two different weights, Beijing sports industry structure is better.

From Figure 3, it is clear that compares to other two cities, Beijing sports industry internal structure is more stable, distribution is more even. By above analysis, it is clear that a city sports industry internal structure each part distribution is even then the city sports industry development will be better. Due to each city sports industry internal structure distribution exists significant difference that causes Chinese sports industry development backward situation. Therefore, our country each city sports industry internal structure distribution should take Beijing sports industry internal structure as refer-

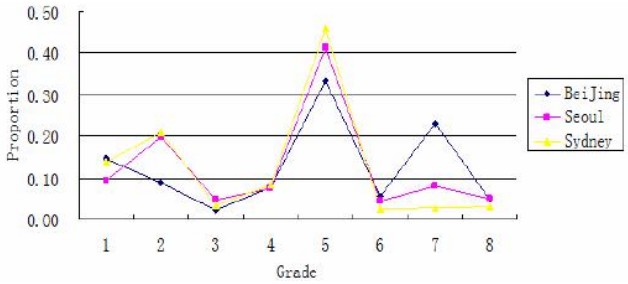

Figure 3 : The comparison chart of three cities case

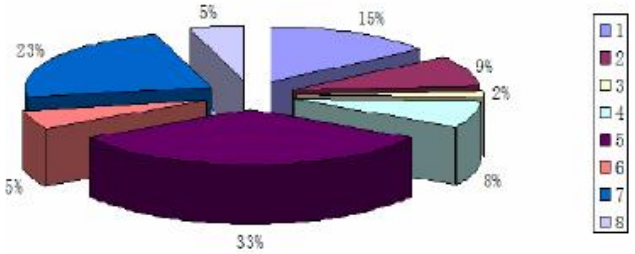

Figure 4 : Distribution of the internal structure of the sports industry in Beijing

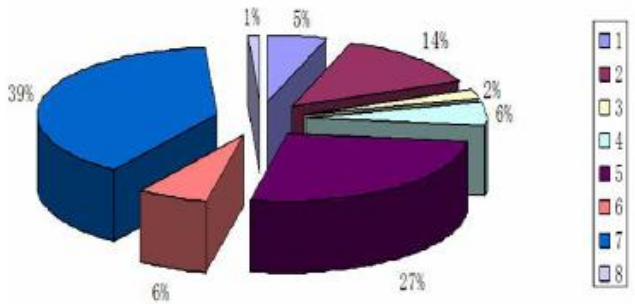

Figure 5 : Distribution of the internal structure of the sports industry in America

ences. Beijing sports industry internal structure distribution is as Figure 4.

China as maximum developing country in the world, it lists in the world sports powers. Nowadays, China lies in economic structure adjustment important transformation period, China will work on developing the tertiary industry. Sports industry as the tertiary industry, is one of industries that nation focuses on supporting and constructing. Sports industry development status represents people's spiritual life and material life development level. Chinese sports industry internal structure adjustment can take American sports industry internal structure as references. American sports industry internal structure distribution is as Figure 5.

CONCLUSION

The paper used fuzzy comprehensive evaluation method generally will solve a kind of difficulties in arrangement and selection. The key in whole process is establishing fuzzy comprehensive evaluation matrix. The matrix composition is single element evaluation result. Reader can provide weights according one's experiences or reference other documents' data. But, one data is unreasonable; it will lead to wrong model and affect evaluation result. By the paper established model, analyze Chinese sports industry development backward causes that are due to Chinese each region sports internal structure existing significant differences, which causes sports industry backward situation. Compares to developed countries, Chinese contacting time with sports is obvious not short. Such as, as early as Song Dynasty, China prevailed Chuk-guk. But time for Chinese opening-up and walking into world is not long. In 1936 Berlin Olympic Games, China got no medals. Therefore, Chinese sports industry backwardness still exists certain historical causes.

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