Fuzzy Comprehensive Evaluation of Research on China’s Sports Industry Development in Leisure Era

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Abstract: In the leisure era, the sports industry has attracted more and more people’s attention, and fitness centers became the main places of citizens’ relaxation and entertainment in the city, which not only played roles in relaxation but also let sports fitness to gain well development. The paper utilizes fuzzy comprehensive evaluation to evaluate China’s sports industrial development. The values obtain from comprehensive evaluation show that China’s sports industrial contribution is good and shows an excellent development trend.

Keywords: Fuzzy evaluation, Leisure era, Physical health, Sports industry.

1. INTRODUCTION

Sports industry is China’s important affiliated enterprise, and also an indispensable industry contributing to the state economy. China’s sports industry’s current situation is not going well, so in this paper we carried out status conditions analysis targeting at China’s sports industry and conducted strategic researches on future development [1]. China’s sports industry surely has many drawbacks, for example low starting points, imbalanced development and so on [2]. But the overall trend is increasing by year; economically developed cities have higher requirements on sports industry [3].

By Table 1, it is clear that rapidly economically developed cities also have very developed sports industry, which indicates that the sports industry can be regarded as the important pillar of economy, and also an important state industry [4]. Table 2 shows Hubei province sports industry’s forms of ownership, which is dominated both by state-owned holding and private holding, and meanwhile Hubei province introduces proactive industries from Hong Kong, Macao and Taiwan, which not only introduces advanced enterprises, but also brings in rational management system and lets Hubei province sports industry to enter into a brand new developmental height [5].

Table 3 summarizes Hubei province’s sports and relative industries investigation data.

Sports manufacturing industry occupies considerably large proportions in Hubei province sports industry, and it can be called as pillar industry. The sports manufacturing industry introduced gross value of production, covering sports sales, sports construction industry, and sports service industry. However, from Table 3, it is shown that Hubei province sports service industry development is not very impressive. However, if the sports industry gets rid of sports manufacturing industry, as shown in Fig. (1), it is established that sports sales and sports service industry will be increasing year by year, whereas the future of sports construction industry is surely uncertain so that it may have some connections with its attributes.

2. FUZZY EVALUATION MODEL ESTABLISHMENTS

2.1. Fuzzy Comprehensive Evaluation Model

Fuzzy comprehensive evaluation model is suitable for fuzzy calculation of multiple factors that are uncertain. The paper utilizes fuzzy comprehensive evaluation with the following steps:

1. At first, the paper establishes a factor set \( U \):
   \[ U = \{ U_1, U_2, \ldots, U_n \} \]

2. Second, it establishes a judgment set \( V \) (evaluation set).

3. By establishing a fuzzy mapping from judgment matrix \( U \) to judgment matrix \( V \), it gets a fuzzy relation as the following matrix shows:
   \[ R = \begin{bmatrix}
   r_{11} & r_{12} & \cdots & r_{1n} \\
   r_{21} & r_{22} & \cdots & r_{2n} \\
   \vdots & \vdots & \ddots & \vdots \\
   r_{m1} & r_{m2} & \cdots & r_{mn}
   \end{bmatrix} \]

4. By establishing a weight set, \( A = (a_1, a_2, \cdots, a_n) \), the condition that should be met is:
   \[ \sum_{i=1}^{n} a_i = 1 \quad a_i \geq 0 \]

5. In fuzzy relation \( R \), every line reflects the line influencing factors to judgment-object extent, and
Meanwhile, \( R \) in every column reflects the column influencing factors to judgment-object extent.

\[
\sum_{i=1}^{n} r_{ij} = 1, 2, 3, \cdots, m
\]

Secondly, carry out following calculation:

\[
B = A \cdot R
\]

\[
= (a_1, a_2, a_3, \cdots, a_n) \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}
\]

\[
= (b_1, b_2, b_3, \cdots, b_n)
\]

In \( V \), evaluation of fuzzy set \( B \) describes the combination. Based on the above described facts, a simple modified model that is obtained by fuzzy comprehensive evaluation is shown as Fig. (1):

According to Fig. (1), the modified fuzzy comprehensive evaluation model is established which corresponds to every factor of the grade evaluation transformation function, so that evaluation factors \( u_1, u_2, u_3, u_4, u_5 \) membership functions can be expressed as the following formulas (1), (2), (3), (4) respectively:

\[
u_{i1}(u_i) = \begin{cases} 
0.5(1 - \frac{u_i - k_1}{k_2 - k_1}), & u_i \geq k_1 \\
0.5(1 - \frac{k_2 - u_i}{k_2 - k_1}), & k_2 \leq u_i < k_1 \\
0, & u_i < k_2
\end{cases}
\]

(1)

\[
u_{i2}(u_i) = \begin{cases} 
0.5(1 - \frac{u_i - k_1}{u_i - k_2}), & u_i \geq k_1 \\
0.5(1 - \frac{k_2 - u_i}{k_2 - k_1}), & k_2 \leq u_i < k_1 \\
0.5(1 - \frac{k_1 - u_i}{k_1 - k_2}), & k_1 \leq u_i < k_2 \\
0.5(1 - \frac{k_3 - u_i}{k_3 - k_2}), & u_i < k_3
\end{cases}
\]

(2)
Table 4. China’s sports undertaking evaluation indicator system.

<table>
<thead>
<tr>
<th>Sports construction industry $U_1$</th>
<th>Sports personnel cultivation $U_2$</th>
<th>Sports organizations cultivation $U_3$</th>
<th>Sports undertaking revitalization $U_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports facilities introduction $u_{11}$</td>
<td>Professional coaches cultivation $u_{21}$</td>
<td>Sports events $u_{31}$</td>
<td>International sports undertaking introduction $u_{41}$</td>
</tr>
<tr>
<td>Sports facilities maintenance $u_{12}$</td>
<td>Universities faculty cultivation $u_{22}$</td>
<td>Sports activities $u_{32}$</td>
<td>Sports public undertaking development $u_{42}$</td>
</tr>
<tr>
<td>Stadium construction $u_{13}$</td>
<td>Sports foreign teachers introduction $u_{23}$</td>
<td>Sports lecturing $u_{33}$</td>
<td>Revitalization of sports traditional undertaking $u_{43}$</td>
</tr>
<tr>
<td>Daily sports facilities construction $u_{14}$</td>
<td>Training strength $u_{24}$</td>
<td>Sports overseas tour $u_{34}$</td>
<td></td>
</tr>
<tr>
<td>Sports equipment maintenance and changing $u_{15}$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Four kinds of factors statistics ranking based on importance degree.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Rank 1</th>
<th>Rank 2</th>
<th>Rank 3</th>
<th>Rank 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports construction industry $U_1$</td>
<td>33</td>
<td>7</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Sports personnel cultivation $U_2$</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>28</td>
</tr>
<tr>
<td>Sports organizations cultivation $U_3$</td>
<td>0</td>
<td>9</td>
<td>23</td>
<td>12</td>
</tr>
<tr>
<td>Sports undertaking revitalization $U_4$</td>
<td>3</td>
<td>3</td>
<td>19</td>
<td>21</td>
</tr>
</tbody>
</table>

$$u_i(u_1) = \begin{cases} 
0, & u_i \geq k_2 \\
0.5(1 - \frac{k_1 - u_i}{k_2 - k_3}), & k_1 \leq u_i < k_2 \\
0.5(1 + \frac{k_3 - u_i}{k_2 - u_i}), & u_i < k_3 
\end{cases} \quad (3)$$

2.2. Combine with Fuzzy Evaluation Models to Evaluate China’s Sports Undertaking System

By the above model principles, a factor set $U$ has been established, from which $U = (U_1, U_2, U_3, U_4)$ is obtained. Among them, sports construction industry is $U_1$, sports personnel cultivation is $U_2$, sports organizations cultivation is $U_3$, and sports undertaking revitalization is $U_4$, see Table 4. The paper establishes a small factor set out of four important factors sets.

Table 4 listed factors helped get an evaluation set.

$$U_1 = \{u_{11}, u_{12}, u_{14}, u_{14}\}$$

$$U_2 = \{u_{21}, u_{22}, u_{23}, u_{24}, u_{25}\}$$

$$U_3 = \{u_{31}, u_{32}, u_{33}\}$$

$$U_4 = \{u_{41}, u_{42}, u_{43}, u_{44}\}$$

By collecting and analyzing data, statistics of four kinds of factors ranked based on importance, has been obtained, see Table 5.

In Table 5, a four-column rank of a matrix has been established in which: sports construction industry is $U_1$, sports personnel cultivation is $U_2$, sports organizations cultivation is $U_3$, sports undertaking revitalization is $U_4$.

$$U_2 = \{33, 7, 4, 0\}$$

$$U_3 = \{7, 18, 18.0\}$$

$$U_4 = \{0, 9, 23, 12\}$$

$$U_4 = \{3, 0, 19, 21\}$$

Weighted vector is obtained from rank 1 to rank 2

$$\beta = \{\beta_1, \beta_2, \beta_3, \beta_4\} = \{0.4, 0.3, 0.2, 0.1\}$$
Table 6. Remarks membership.

<table>
<thead>
<tr>
<th>Evaluation Way</th>
<th>0-60</th>
<th>60-80</th>
<th>80-90</th>
<th>90-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>0</td>
<td>0</td>
<td>0.05</td>
<td>0.95</td>
</tr>
<tr>
<td>Good</td>
<td>0</td>
<td>0.05</td>
<td>0.9</td>
<td>0.05</td>
</tr>
<tr>
<td>Normal</td>
<td>0.05</td>
<td>0.9</td>
<td>0.05</td>
<td>0</td>
</tr>
<tr>
<td>Bad</td>
<td>0.95</td>
<td>0.05</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 7. China’s sports undertaking’s evaluation obtained values for all indicators.

<table>
<thead>
<tr>
<th>Each Layer Indicator</th>
<th>Evaluation Value</th>
<th>Each Layer Indicator</th>
<th>Evaluation Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports facilities introduction $U_{i1}$</td>
<td>Excellent</td>
<td>Sports events $U_{31}$</td>
<td>Excellent</td>
</tr>
<tr>
<td>Sports facilities maintenance $U_{i2}$</td>
<td>Excellent</td>
<td>Sports activities $U_{i2}$</td>
<td>Good</td>
</tr>
<tr>
<td>Stadium construction $U_{i3}$</td>
<td>Normal</td>
<td>Sports lecturing $U_{i3}$</td>
<td>Good</td>
</tr>
<tr>
<td>Daily sports facilities construction $U_{i4}$</td>
<td>Normal</td>
<td>Sports overseas tour $U_{i4}$</td>
<td>Normal</td>
</tr>
<tr>
<td>Sports equipment maintenance and changing $U_{i5}$</td>
<td>Normal</td>
<td>International sports undertaking introduction $U_{i6}$</td>
<td>Good</td>
</tr>
<tr>
<td>Professional coaches cultivation $U_{i6}$</td>
<td>Excellent</td>
<td>Sports public undertaking development $U_{i6}$</td>
<td>Excellent</td>
</tr>
<tr>
<td>Universities faculty cultivation $U_{i7}$</td>
<td>Excellent</td>
<td>Revitalization of sports traditional undertaking $U_{i7}$</td>
<td>Normal</td>
</tr>
<tr>
<td>Sports foreign teachers introduction $U_{i8}$</td>
<td>Excellent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training strength $U_{i9}$</td>
<td>Good</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$U_i^* = U_i \cdot \beta^T$

$U_i^* = 14, U_i^* = 9.4, U_i^* = 4, U_i^* = 5.6$

The paper takes normalization processing

$U_i^* = 0.35, U_i^* = 0.3, U_i^* = 0.2, U_i^* = 0.15$

It gets

$A = (0.35, 0.3, 0.2, 0.15)$

The paper establishes remarks membership, as shown in Table 6.

China’s sport undertaking’s evaluation results obtained in sports construction industry, sports personnel cultivation, sports organizations cultivation, and sports undertaking revitalization, are given in Table 7.

By the above model, a single-layer indicator factor fuzzy weight set is:

$U_i^* = \{U_{i1}, U_{i2}, U_{i3}, U_{i4}, U_{i5}\} = \{0.26, 0.25, 0.24, 0.12, 0.17\}$

$U_i^* = \{U_{i1}, U_{i2}, U_{i3}, U_{i4}, U_{i5}\} = \{0.53, 0.11, 0.24, 0.15\}$

$U_i^* = \{U_{i31}, U_{i32}, U_{i33}, U_{i34}\} = \{0.38, 0.31, 0.11, 0.24\}$

$U_i^* = \{U_{i41}, U_{i42}, U_{i43}\} = \{0.30, 0.4, 0.3\}$

By analyzing Table 5 and Table 3, an evaluation set for each column has been established in which: sports construction industry is $U_i$, sports personnel cultivation is $U_2$, sports organizations cultivation is $U_3$, and sports undertaking revitalization is $U_4$:

**Sports construction industry**

$U_i = \begin{bmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.95 & 0.05 \\ 0.05 & 0.95 & 0.05 \\ 0 & 0.05 & 0.95 & 0.05 \end{bmatrix}$

**Sports personnel cultivation**

$U_2 = \begin{bmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.95 & 0.05 \\ 0.05 & 0.95 & 0.05 \\ 0 & 0.05 & 0.95 & 0.05 \end{bmatrix}$
Sports organizations cultivation

\[ U_3 = \begin{bmatrix}
0 & 0 & 0.05 & 0.95 \\
0 & 0.05 & 0.9 & 0.05 \\
0.05 & 0.9 & 0.05 & 0
\end{bmatrix} \]

Sports undertaking revitalization

\[ U_4 = \begin{bmatrix}
0 & 0 & 0.05 & 0.95 \\
0 & 0.05 & 0.9 & 0.05 \\
0.05 & 0.9 & 0.05 & 0
\end{bmatrix} \]

The above evaluation sets are calculated according to following formula:

\[ B_i = A_i \cdot R_i \]

The normalization processing is carried out using the obtained \( B_i \), and thus a fuzzy evaluation matrix is obtained:

\[ \bar{B} = \begin{bmatrix}
B_1 \\
B_2 \\
B_3 \\
B_4
\end{bmatrix} = \begin{bmatrix}
0.07 & 0.27 & 0.23 & 0.43 \\
0 & 0.1 & 0.07 & 0.5 \\
0.08 & 0.16 & 0.28 & 0.28 \\
0.14 & 0.2 & 0.3 & 0.36
\end{bmatrix} \]

Thus, comprehensive evaluation value is as follows:

\[ Z = U^* \cdot \bar{B} = (0.40 \ 0.05 \ 0.34 \ 0.18) \]

**CONCLUSION**

Sports industry is an industry indispensable for China’s economy. This paper conducted status analysis of China’s sports industry, and carried out strategic researches on its future development. The paper utilized fuzzy mathematics to analyze recognition of human resources by the outer world, due to suffering from numerous factors, which are fuzzy. The fuzzy mathematics has been used to analyze China government’s promotions of sports industry development.

**CONFLICT OF INTEREST**

The author confirms that this article content has no conflict of interest.

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**REFERENCES**


