Model of Evaluation on Sports Scientific Research Performance Based on Grey Correlation Analysis in Universities

Shiliang Ding, Jing Lv

Shijiazhuang Railway University Sports, Shijiazhuang050043, China

Abstract

Evaluation on the sports scientific research performance, as the way to judge the scientific research ability of sports teachers for universities and colleges, is of great significance to improve the overall sports scientific research quality. This paper studied on the evaluation on the sports scientific research performance from the following perspectives. Firstly, the fundamental methods of evaluating the sports scientific research performance was given; the second was to present the indices for the performance evaluation and analyze specifically the indices; thirdly, the gray ideal domain of the evaluation indices was established as well as the gray correlation coefficients of the evaluated objects and the gray ideal domain; the fourth was to obtain the weight of indices via the comprehensive analysis method and to build the weighted gray correlation analysis model for the sports scientific research performance evaluation to get the gray correlation degree of the evaluated objects which served to judge the sports scientific research ability and level of objects. For the last part, this paper conducted the case study which verified the simple calculation and operation of the model.

Keywords: Grey Correlation Analysis, Sports Scientific Research Performance, Evaluation Model

1. INTRODUCTION

Scientific, reasonable and effective evaluation on the scientific research performance of sports teacher in universities and colleges can not only quantify the teachers’ scientific research workload that provides evidence for rewards and bonus, but also stimulate the teachers in teaching and scientific research that helps enhance their scientific research ability, thus increasingly improving the general proficiency in sports scientific research and teaching of universities (Zhang, 2015; Luo, 2008; Xu, 2010). Such evaluation, as a complicated multi-attribute problem requiring decision and analysis, should take several factors into consideration, including the specific situation of universities in this regard (Li, 2005; Lu, 2014). For recent years, many scholars have made relevant researches from several perspectives and achieved results of theories and applications in the incentive function (Tang, 2011; Zhang, 2014) and the evaluation system (Sheng, 2010; Hou, 2012; Hong, 2010) and method (Li, 2008, Lu, 2014) of sports scientific research performance, helpful to increase the sports scientific research level. However, several factors need to be considered in the performance analysis based on practical situation of universities, which means the evaluation system and method still require future research. On the basis of the existing researches, this paper, to address the gray information (Coskun, 14; Qiao, 2011) in the scientific research performance analysis, presented a model for sports scientific research performance evaluation based on gray correlation analysis (Basar, 2014; Singh, 2016; Jayaraman, 2014).

2. THE SYSTEM OF SPORTS SCIENTIFIC RESEARCH PERFORMANCE EVALUATION INDICES

2.1 The analysis method of sports scientific research performance evaluation

(1) Literature review

This method is to obtain thesis, books, teaching materials and online information by keyword searching in the literature bank and sort them out for reference.

(2) Questionnaires
Questionnaires are delivered to PE teachers and leaders in physical education school to get the status quo, problems and developing trend of PE scientific research performance in universities.

(3) Experts Consulting

Experts are consulted to know their opinions and suggestions on the analysis of sports scientific research performance in universities.

(4) Statistical analysis

Statistical analysis is used to process the materials and data collected and conduct the logic analysis to obtain exact and reliable evaluation.

2.2 The system of sports scientific research performance evaluation indices

The system of sports scientific research performance evaluation indices, guided by the above analysis methods, was established in the principle of science, objectivity and comprehensiveness. Details are as follows:

(1) The number of scientific research projects $X_1$: Scientific research projects are divided into three levels: national level (10 grades for each), provincial level (5 grades for each) and other level (3 grades for each).

(2) The number of theses, patents and books $X_2$: 10 grades for each book, 5 grades for each SCI/EI paper, 2 grades for each patent or paper in core journals and 1 grade for each paper in other journals.

(3) The number of graduates $X_3$: It mainly refers to the number of graduates that the teacher has mentored.

(4) The number of academic conferences attended $X_4$: 10 grades for at least 3 international or domestic academic conferences in one year, 2 grades for 2 conferences, 3 grades for 1 conference and 0 grade for none.

(5) Project funds $X_5$: It mainly means the project funds in the account.

(6) The times of wining prizes $X_6$: 5 grades for prize as the first winner, 3 grades for prize as the second winner and 1 grades for other prizes.

(7) The ability to transform the scientific research results $X_7$: Qualitative description is adopted with the 0-1 ratio scale. The higher value means stronger ability to transform the scientific research results.

(8) The competence of subject and team building $X_8$: Qualitative description is adopted with the 0-1 ratio scale. Higher value refers to higher competence of subject and team building.

(9) Integration of teaching and scientific research $X_9$: Qualitative description is adopted with the 0-1 ratio scale. Higher value represents better ability to integrate scientific research, practice and teaching.

(10) The capability of social service $X_{10}$: Qualitative description is adopted with the 0-1 ratio scale. Higher value stands for stronger capability of social service.

3. THE SPORTS SCIENTIFIC RESEARCH PERFORMANCE EVALUATION MODEL BASED ON GRAY CORRELATION ANALYSIS

3.1 Set of evaluation indices

Based on the elaboration in 2.2, indices in the evaluation system are used for the analysis of the scientific research performance. And the set of the indices $X$ can be written as:

$$X = \{X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}\} \quad (1)$$
3.2 Gray ideal domain

If M PE teachers are to be evaluated concerning their scientific research performance, the gray sequence $Y_i$ formed by the evaluation value $y_{ij}$ of the index $j$ of the teacher $i$ can be obtained.

$$Y_i = \{y_{i1}, y_{i2}, \ldots, y_{ij}, \ldots, y_{i(N-1)}, y_{iN}\} \quad (2)$$

If the evaluation index $j$ is the profit index, the corresponding gray ideal domain $r_{ij}$ is:

$$r_{ij} = \max_{1 \leq i \leq m} \{y_{ij}\} \quad (3)$$

If the evaluation index $j$ is the cost index, the corresponding gray ideal domain $r_{ij}$ is:

$$r_{ij} = \min_{1 \leq i \leq m} \{y_{ij}\} \quad (4)$$

Then the consensus sequence $R$ of gray ideal domain is got as follows:

$$R = \{r_{i1}, y_{i2}, \ldots, y_{ij}, \ldots, y_{i(N-1)}, y_{iN}\} \quad (5)$$

3.3 Gray correlation analysis

After obtaining the evaluation value $y_{ij}$ of the evaluation index $j$ of teacher $i$, the distance $d_{ij}$ between $j$ and the corresponding gray ideal domain is:

$$d_{ij} = y_{ij} - r_{ij} \quad (6)$$

If the double maximum value of $d_{ij}$ is set, then

$$\Delta_y = \max_i \max_j |d_{ij}| = \max_i \max_j |y_{ij} - r_{ij}| \quad (7)$$

If the double minimum value of $d_{ij}$ is set, then

$$\nabla_y = \min_i \min_j |d_{ij}| = \min_i \min_j |y_{ij} - r_{ij}| \quad (8)$$

Then the gray correlation coefficient $\rho_{ij}$ between $j$ and the corresponding gray ideal domain is:

$$\rho_{ij} = \frac{\nabla_y + \beta \cdot \Delta_y}{\Delta_y + \beta \cdot \Delta_y} \quad (9)$$

$\beta \in [0,1]$ refers to identification coefficient with the usual value as 0.5.

3.4 Standardization of evaluation indices

Owing to different dimensions of sports scientific research evaluation indices and its classification of profit index and cost index, the indices need to be standardized.

If the evaluation index $j$ is the profit index, the standardized value $\bar{y}_{ij}$ of PE teacher $i$ is:
\[ \tilde{y}_{ij} = \frac{y_{ij} - \min_{k \in \mathbb{K}} y_{ik}}{\max_{k \in \mathbb{K}} (y_{ij} - \min_{k \in \mathbb{K}} y_{ik})} \] (10)

If the evaluation index \( j \) is the cost index, the standardized value \( \tilde{y}_{ij} \) of PE teacher \( i \) is:

\[ y_{ij} = \frac{\max_{k \in \mathbb{K}} y_{ij} - y_{ij}}{\max_{k \in \mathbb{K}} (y_{ij} - \min_{k \in \mathbb{K}} y_{ij})} \] (11)

Based on Formula (3) and (4), the corresponding gray ideal domain of index \( j \) is \( \tilde{r}_0 \) as shown in Formula (6):

\[ d_j = \tilde{y}_{ij} - \tilde{r}_0 \] (12)

### 3.5 Weight of evaluation indices

Considering various weights of sports scientific research evaluation indices, the comprehensive evaluation method was adopted in this paper. Expert \( k \) graded the importance of the evaluation index \( j \), leading to the initial evaluation matrix \( P \):

\[
P = \begin{bmatrix}
p_{11} & \cdots & p_{1j} & \cdots & p_{1N} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
p_{kj} & \cdots & p_{kj} & \cdots & p_{kN} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
p_{k1} & \cdots & p_{k1} & \cdots & p_{kN}
\end{bmatrix} \] (13)

\( k \) is the number of experts and \( N \) is the number of evaluation indices.

And the weight \( w_j \) of the index \( j \) is:

\[ w_j = \frac{1}{K_j} \sum_{i=1}^{K_j} p_{ij} \] (14)

### 3.6 The sports scientific research performance evaluation model

Based on the gray correlation coefficient \( \rho_{ij} \) and the weight \( w_j \) of the evaluation index \( j \) of PE teacher \( i \), then the weighted gray correlation degree \( \zeta_i \) of the gray ideal domain consensus sequence \( R \) and all evaluation indices of teacher \( i \) is:

\[ \zeta_i = \sum_{j=1}^{N} (w_j \cdot \rho_{ij}) \] (15)

According to the optimum principle, if

\[ \zeta_s = \max_{1 \leq i \leq M} (\zeta_i) \] (16)

then PE teacher \( s \) represents the best scientific research performance.

If

\[ \zeta_s = \min_{1 \leq i \leq M} (\zeta_i) \] (17)
then PE teacher s ives the worst scientific research performance.

4. MODEL VERIFICATION

The assessment on the scientific research performance of PE teachers in universities and colleges, as well as that on the teaching performance, is a key component of the annual performance assessment on PE teachers and imposes essential influence on their comprehensive evaluation. In order to effectively evaluate the scientific research performance, the verification and explanation of the model’s validity and feasibility are necessary. This paper, taking the annual scientific research performance evaluation on PE teachers in universities as an example, further analyzed and explained the evaluation model and method mentioned above. Data was obtained through statistical analysis of objects as shown in Table 1.

The standardized data can be seen in Table 2 through the above data processing with the model and method given.

Through the standardization, the gray ideal domain sequence can be obtained as R={1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0}. In line with the gray correlation analysis model proposed in the paper, the corresponding gray correlation coefficients can be seen in the following Table 3.

### Table 1 Data of the sports scientific research performance evaluation

<table>
<thead>
<tr>
<th>Indices</th>
<th>weight</th>
<th>Objects</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$</td>
<td>0.15</td>
<td>18</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>$X_2$</td>
<td>0.15</td>
<td>25</td>
<td>32</td>
<td>35</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>$X_3$</td>
<td>0.10</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>$X_4$</td>
<td>0.05</td>
<td>10</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>$X_5$</td>
<td>0.15</td>
<td>32</td>
<td>50</td>
<td>20</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>$X_6$</td>
<td>0.05</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>$X_7$</td>
<td>0.10</td>
<td>0.70</td>
<td>0.60</td>
<td>0.60</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>$X_8$</td>
<td>0.15</td>
<td>0.60</td>
<td>0.90</td>
<td>0.80</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>$X_9$</td>
<td>0.05</td>
<td>0.80</td>
<td>0.80</td>
<td>0.90</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>$X_{10}$</td>
<td>0.05</td>
<td>0.60</td>
<td>0.80</td>
<td>0.60</td>
<td>0.80</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2 Standardized data of the sports scientific research performance evaluation

<table>
<thead>
<tr>
<th>Indices</th>
<th>Objects</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$</td>
<td>0.833</td>
<td>1.000</td>
<td>0.167</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$X_2$</td>
<td>0</td>
<td>0.467</td>
<td>0.667</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>$X_3$</td>
<td>1.000</td>
<td>0.333</td>
<td>0.667</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$X_4$</td>
<td>1.000</td>
<td>0</td>
<td>1.000</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>$X_5$</td>
<td>0.400</td>
<td>1.000</td>
<td>0</td>
<td>0.833</td>
<td></td>
</tr>
<tr>
<td>$X_6$</td>
<td>0.500</td>
<td>1.000</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$X_7$</td>
<td>0.500</td>
<td>0</td>
<td>0</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>$X_8$</td>
<td>0</td>
<td>1.000</td>
<td>0.667</td>
<td>0.667</td>
<td></td>
</tr>
<tr>
<td>$X_9$</td>
<td>0</td>
<td>0</td>
<td>1.000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>$X_{10}$</td>
<td>0</td>
<td>1.000</td>
<td>0</td>
<td>1.000</td>
<td></td>
</tr>
</tbody>
</table>
Table 3 Gray correlation coefficients of the sports scientific research performance evaluation

<table>
<thead>
<tr>
<th>Indices</th>
<th>Objects</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$</td>
<td>0.750</td>
<td>1.000</td>
<td>0.375</td>
<td>0.333</td>
<td></td>
</tr>
<tr>
<td>$X_2$</td>
<td>0.333</td>
<td>0.484</td>
<td>0.600</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>$X_3$</td>
<td>1.000</td>
<td>0.428</td>
<td>0.600</td>
<td>0.333</td>
<td></td>
</tr>
<tr>
<td>$X_4$</td>
<td>1.000</td>
<td>0.333</td>
<td>1.000</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>$X_5$</td>
<td>0.455</td>
<td>1.000</td>
<td>0.333</td>
<td>0.750</td>
<td></td>
</tr>
<tr>
<td>$X_6$</td>
<td>0.500</td>
<td>1.000</td>
<td>0.333</td>
<td>0.333</td>
<td></td>
</tr>
<tr>
<td>$X_7$</td>
<td>0.500</td>
<td>0.333</td>
<td>0.333</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>$X_8$</td>
<td>0.333</td>
<td>1.000</td>
<td>0.600</td>
<td>0.600</td>
<td></td>
</tr>
<tr>
<td>$X_9$</td>
<td>0.333</td>
<td>0.333</td>
<td>1.000</td>
<td>0.333</td>
<td></td>
</tr>
<tr>
<td>$X_{10}$</td>
<td>0.333</td>
<td>1.000</td>
<td>0.333</td>
<td>1.000</td>
<td></td>
</tr>
</tbody>
</table>

Based on the above data and the calculation model given in this paper, the gray correlation degree sequence of the objects can be obtained as $\zeta=(0.539,0.732,0.513,0.669)$. It can be perceived that the PE teacher B shows the grayest correlation degree with the best evaluation result, while the PE teacher C shows the least gray correlation degree with the worst evaluation result.

5. CONCLUSION

In order to effectively evaluate and judge the sports scientific research performance in universities for enhanced ability and higher level in this regard, a new index system for the sports scientific research performance evaluation in universities is built as well as an evaluation model based on gray correlation analysis. This model has sound feasibility with easy calculating procedures and clear purpose, which shows great significance in its providing a new way to analyze the sports scientific research performance. And at last, the validity of this model is also verified through case analysis.

REFERENCES


