

An Evaluation System and Grey Clustering Evaluation Model of Sunshine Sports Overall Capacity of Colleges and Universities Based on Whitening Weight Functions

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Sunshine sport is one of the important contents of sports education in colleges and universities. Weaknesses and problems of sunshine sports of colleges and universities are studied and discussed in this paper. Firstly, evaluation indexes of sunshine sports are confirmed. And a comprehensive evaluation system is established. Secondly, under the evaluation system, different evaluation indexes are analyzed and the whitening weight functions corresponding to those indexes are constructed. Next, with the weight of index taken into account, a grey clustering evaluation model of sunshine sports for colleges and universities is taken shape and the overall sunshine sports capacity of colleges and universities are obtained based on weighted grey clustering coefficients. Results show that the model is reliable and can be applied to various cases. Last but not the least, the efficacy and the practicality of the model are verified through case study.

1. Introduction

In order to respond to national policies and plans on sports education, colleges and universities started to implement sunshine sports step by step and have yielded fruitful results [Wang (2007) and Shi (2014) reported]. However, some problems of sunshine sports of colleges and universities were identified, one of which was that quality and health of students didn't improve, even degraded in some institutions of higher education. Meanwhile, during the implementation of sunshine sports, the goal is far from clear and relevant measures have no precise target, which result in a lack of mechanism and planning for long-term development. Currently, some experts and scholars have studied the issue from different views and tried to interpret the policy on sunshine sports. They also analyzed the content of sunshine sports as well as planning and strategies on sunshine sports of colleges and universities [Xu (2009), Liang (2011), Zhang et al (2011), Chen (2011) and Cai et al (2014) reported]. However, current evaluation of the sunshine sports evaluation of colleges and universities fails to reach the underlying part of the issue. And it is significant to evaluate the implementation of sunshine sports in a direct and quantified way. Therefore, on the basis of previous research, this paper studies the comprehensive sunshine sports capacity and proposes an evaluation system and a grey clustering [A (2010), Mustansar et al (2014) and Wen et al (2014) reported] evaluation model based on whitening weight functions [Ker-Tah (2011) reported].

2. The Evaluation System of Sunshine Sports of Colleges and Universities

Based on the scientific principle, the systematic principle, the directing principle and the representative principle, this paper evaluates the implementation of sunshine sports of colleges and universities from three perspectives, namely hardware capacity, software capacity and implementation and execution capacity. The evaluation system of overall sunshine sports capacity of colleges and universities is constructed as Table 1.

Table 1: The evaluation system of overall sunshine sports capacity of colleges and universities

evaluation system	Evaluation criteria	Evaluation index
The evaluation system of overall sunshine sports capacity of colleges and universities U	Hardware capacity U_1	Venues and equipment u_{11}
		Capital investment u_{12}
		Institutional arrangement u_{13}
		Management organs u_{14}
		Teaching staff u_{15}
		Course design u_{16}
	Software capacity U_2	Teaching quality u_{21}
		Integration of production, academia and research u_{22}
		Establishment of key majors u_{23}
		Extracurricular activities u_{24}
		Sports training and competition u_{25}
	Implementation and execution capacity U_3	Policy implementation u_{31}
		Advertisement u_{32}
		Teaching reform u_{33}
		Improvement of students' talent u_{34}
		Social satisfaction u_{35}

3. Grey Cluster Evaluation Model Based on Whitening Weight Functions

3.1 Basic forms of whitening weight functions

Whitening weight functions is the core of the grey cluster analysis. When analyzing the object, evaluation indexes of different grey categories usually have distinct whitening weight functions. If the whitening weight function between the object and the i -th grey category about evaluation index j is marked as $f_i^j(u)$. The basic forms of whitening weight functions $f_i^j(u)$ can be summarized into the followings.

(1) Ladder-shape whitening weight functions $f_i^j(u)$

The basic structure of ladder-shape whitening weight functions $f_i^j(u)$ is shown in Figure 1.

Corresponding whitening weight functions $f_i^j(u)$ can be expressed as:

$$f_i^j(u) = \begin{cases} 0 & u \leq u_i^j(a) \text{ or } u \geq u_i^j(d) \\ \frac{u - u_i^j(a)}{u_i^j(b) - u_i^j(a)} & u_i^j(a) \leq u \leq u_i^j(b) \\ \frac{u_i^j(d) - u}{u_i^j(d) - u_i^j(c)} & u_i^j(c) \leq u \leq u_i^j(d) \\ 1 & u_i^j(b) \leq u \leq u_i^j(c) \end{cases} \quad (1)$$

(2) Left-half ladder-shape whitening weight functions $f_i^j(u)$

The basic structure of left-half ladder-shape whitening weight functions $f_i^j(u)$ is shown in Figure 2.

Corresponding whitening weight functions $f_i^j(u)$ can be expressed as:

$$f_i^j(u) = \begin{cases} 0 & u \geq u_i^j(b) \\ \frac{u_i^j(b) - u}{u_i^j(b) - u_i^j(a)} & u_i^j(a) \leq u \leq u_i^j(b) \\ 1 & u \leq u_i^j(a) \end{cases} \quad (2)$$

(3) Right-half ladder-shape whitening weight functions $f_i^j(u)$

The basic structure of right-half ladder-shape whitening weight functions $f_i^j(u)$ is shown in Figure 3.

Corresponding whitening weight functions $f_i^j(u)$ can be expressed as:

$$f_i^j(u) = \begin{cases} 0 & u \leq u_i^j(a) \\ \frac{u - u_i^j(a)}{u_i^j(b) - u_i^j(a)} & u_i^j(a) \leq u \leq u_i^j(b) \\ 1 & u \geq u_i^j(b) \end{cases} \quad (3)$$

(4) Triangle-shape whitening weight functions $f_i^j(u)$

The basic structure of triangle-shape whitening weight functions $f_i^j(u)$ is shown in Figure 4.

Corresponding whitening weight functions $f_i^j(u)$ can be expressed as:

$$f_i^j(u) = \begin{cases} 0 & u \leq u_i^j(a) \text{ or } u \geq u_i^j(c) \\ \frac{u - u_i^j(a)}{u_i^j(b) - u_i^j(a)} & u_i^j(a) \leq u \leq u_i^j(b) \\ \frac{u_i^j(b) - u}{u_i^j(c) - u_i^j(b)} & u_i^j(b) \leq u \leq u_i^j(c) \\ 1 & u = u_i^j(b) \end{cases} \quad (4)$$

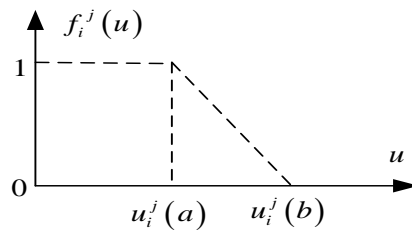
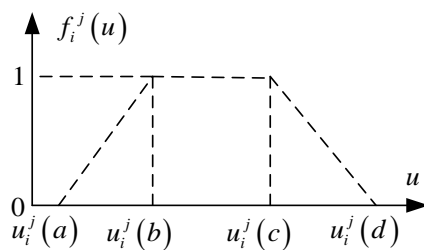


Figure 1: Ladder-shape whitening weight functions Figure 2: Left-half ladder-shape whitening weight functions

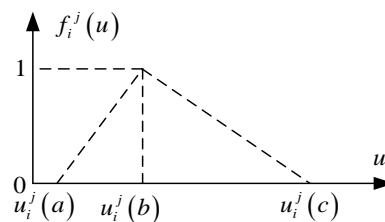
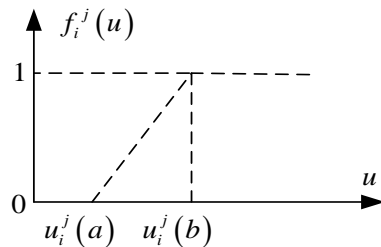


Figure 3: Right-half ladder-shape whitening weight functions

Figure 4: Triangle-shape whitening weight functions

3.2 Weight of indexes of overall sunshine sports capacity

In this paper, weights of indexes of overall sunshine sports capacity are allocated on the basis of Delphi Method. Assume m experts are invited to score n evaluation indexes. If the score of evaluation index j from expert i is v_{ij} , the judgment matrix V is:

$$V = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} \quad (5)$$

Thus, the column vector and its value w_j^* of evaluation index j is obtained:

$$w_j^* = \sum_{i=1}^m v_{ij} \tag{6}$$

Consequently, the weight of evaluation index j is:

$$w_j = w_j^* / \sum_{j=1}^n w_j^* \tag{7}$$

3.3 The grey cluster analysis of overall sunshine sports capacity

Based on actual implementation of sunshine sports of colleges and universities as well as the distribution of indexes values in the evaluation system, overall sunshine sports capacity is categorized into five levels, namely excellent (level 1), good (level 2), mediocre (level 3), qualified (level 4) and unqualified (level 5). The whitening weight functions corresponding to each level are shown in Figure 5.

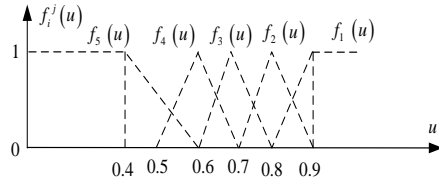


Figure 5: Whitening weight functions of overall sunshine sports capacity

According to the whitening weight functions in Figure 5, whitening weight functions of different evaluation levels can be expressed by the followings:

$$f_5(u) = \begin{cases} 0 & u \geq 0.6 \\ \frac{0.6-u}{0.2} & 0.4 \leq u \leq 0.6 \\ 1 & u \leq 0.4 \end{cases} \tag{8}$$

$$f_4(u) = \begin{cases} 0 & u \leq 0.5 \text{ or } u \geq 0.7 \\ \frac{u-0.5}{0.1} & 0.5 \leq u \leq 0.6 \\ \frac{0.7-u}{0.1} & 0.6 \leq u \leq 0.7 \\ 1 & u = 0.6 \end{cases} \tag{9}$$

$$f_3(u) = \begin{cases} 0 & u \leq 0.6 \text{ or } u \geq 0.8 \\ \frac{u-0.6}{0.1} & 0.6 \leq u \leq 0.7 \\ \frac{0.8-u}{0.1} & 0.7 \leq u \leq 0.8 \\ 1 & u = 0.7 \end{cases} \tag{10}$$

$$f_2(u) = \begin{cases} 0 & u \leq 0.7 \text{ or } u \geq 0.9 \\ \frac{u-0.7}{0.1} & 0.7 \leq u \leq 0.8 \\ \frac{0.9-u}{0.1} & 0.8 \leq u \leq 0.9 \\ 1 & u = 0.8 \end{cases} \tag{11}$$

$$f_1(u) = \begin{cases} 0 & u \leq 0.8 \\ \frac{u-0.8}{0.1} & 0.8 \leq u \leq 0.9 \\ 1 & u \geq 0.9 \end{cases} \tag{12}$$

Therefore, it can be obtained the grey clustering coefficient $f_i^{U_1}(u)$ of hardware capacity U_1 of sunshine sports evaluation of colleges and universities is:

$$f_i^{U_1}(u) = \sum_{j=1}^5 (w_{1j} * f_i^{u_{1j}}(u)) \tag{13}$$

The grey clustering coefficient $f_i^{U_2}(u)$ of software capacity U_2 of sunshine U_1 sports evaluation of colleges and universities is:

$$f_i^{U_1}(u) = \sum_{j=1}^6 (w_{1j} * f_i^{u_{1j}}(u)) \tag{14}$$

The grey clustering coefficient $f_i^{U_3}(u)$ of implementation and execution capacity U_3 of sunshine sports evaluation of colleges and universities is:

$$f_i^{U_3}(u) = \sum_{j=1}^5 (w_{3j} * f_i^{u_{3j}}(u)) \tag{15}$$

So the comprehensive grey clustering coefficient $f_i^{U_3}(u)$ of sunshine sports evaluation of colleges is:

$$f_i^U(u) = w_1 * f_i^{U_1}(u) + w_2 * f_i^{U_2}(u) + w_3 * f_i^{U_3}(u) \tag{16}$$

And the overall sunshine sports capacity of colleges and universities is at level p , and it satisfies:

$$f_p^U(u) = \max\{f_1^U(u), f_2^U(u), f_3^U(u), f_4^U(u), f_5^U(u)\} \tag{17}$$

4. Case Study

Based on the evaluation index system, the overall sunshine sports capacity of a key university in West China is studied and analyzed. Through questionnaire, consultation with experts and statistical analysis, index values of overall sunshine sports capacity of this university is known. And according to whitening weight functions and grey clustering model, grey clustering coefficients of indexes of different levels are obtained, as shown in Table 2.

Table 2: The grey clustering coefficient of sunshine sports evaluation

Evaluation criteria	Evaluation index	Weight	Value	Grey clustering coefficient				
				Level 1	Level 2	Level 3	Level 4	Level 5
U_1	u_{11}	0.20	0.85	0.500	0.500	0	0	0
	u_{12}	0.20	0.60	0	0	0	1.000	0
	u_{13}	0.15	0.70	0	0	1.000	0	0
	u_{14}	0.15	0.75	0	0.500	0.500	0	0
	u_{15}	0.15	0.70	0	0	1.000	0	0
	u_{16}	0.15	0.80	0	1.000	0	0	0
U_2	u_{21}	0.25	0.80	0	1.000	0	0	0
	u_{22}	0.10	0.50	0	0	0	0	0.500
	u_{23}	0.15	0.50	0	0	0	0	0.500
	u_{24}	0.25	0.80	0	1.000	0	0	0
	u_{25}	0.25	0.85	0.500	0.500	0	0	0
U_3	u_{31}	0.20	0.90	1.000	0	0	0	0
	u_{32}	0.15	0.95	1.000	0	0	0	0
	u_{33}	0.15	0.60	0	0	0	1.000	0
	u_{34}	0.25	0.75	0	0.500	0.500	0	0
	u_{35}	0.25	0.80	0	1.000	0	0	0

Similarly, the grey clustering coefficient and the comprehensive weighted grey clustering coefficient of indexes under different evaluation criteria of overall sunshine sports capacity are obtained, as shown in Table 3.

Table 3: The comprehensive weighted grey clustering coefficient of sunshine sports evaluation

Evaluation criteria	Weight	Grey clustering coefficient				
		Level 1	Level 2	Level 3	Level 4	Level 5
U_1	0.30	0.100	0.325	0.375	0.200	0
U_2	0.30	0.125	0.625	0	0	0.100
U_3	0.40	0.350	0.375	0.125	0.150	0
Comprehensive grey clustering coefficient		0.208	0.435	0.163	0.120	0.030

From Table 3, it is known that the overall sunshine sports capacity of this key university is at level 2 or defined as "good".

5. Conclusions

This paper analyzes evaluation indexes of sunshine sports of colleges and universities and proposes an improved evaluation index system, making the evaluation more reasonable and more reliable. At the same time, whitening weight functions corresponding to different levels of indexes are established on the basis of the grey system theory. And a grey clustering coefficient is put in place, making the result even more convincing. Last but not the least, the model is verified through case study. The study contributes to the evaluation of the implementation effect of sunshine sports with theoretical and practical values.

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