CoCoSo Framework for Management Performance Evaluation of Teaching Services in Sports Colleges and Universities with Euclidean Distance and Logarithmic Distance

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***Abstract*—Sports colleges are the highest educational level in China's higher education system to cultivate sports professionals. They shoulder the arduous task of cultivating sports talents with innovative spirit and practical ability, and contribute to the country's sports and education undertakings. Through the study of the service performance of the teaching management departments in sports colleges, it is beneficial for teaching management workers to establish the central position of teaching work more firmly in their thoughts and actions, transform their work style, enhance their ideological awareness of serving teaching work, serve teaching, teachers, and students, closely focus on teaching work to provide various services, strive to improve the level of management services, and make improving service levels and optimizing service quality an important part of improving the teaching management level in sports colleges. The management performance evaluation of teaching services in sports colleges and universities is regarded as the defined multiple-attribute decision-making (MADM). Recently, the CoCoSo and entropy technique was utilized to cope with MADM. The double-valued neutrosophic sets (DVNSs) are utilized as a technique for characterizing fuzzy information during the management performance evaluation of teaching services in sports colleges and universities. In this study, double-valued neutrosophic number CoCoSo (DVNN-CoCoSo) technique is administrated for MADM in light with DVNN Euclidean distance (DVNNED) and DVNN Logarithmic distance (DVNNLD). Finally, numerical example for management performance evaluation of teaching services in sports colleges and universities is put forward to show the DVNN-CoCoSo technique. The major contribution of this study is administrated: (1) DVNN-CoCoSo technique is administrated for MADM in light with DVNNED and DVNNLD; (2) The objective weights are considered through entropy technique; (3) numerical example for management performance evaluation of teaching services in sports colleges and universities and some comparative analysis are administrated to verify the DVNN-CoCoSo technique.**

Keywords*—Multiple-Attribute Decision-Making (MADM); Double-Valued Neutrosophic Sets (DVNSs); CoCoSo technique; management performance evaluation of teaching services

I. INTRODUCTION

Cultivating talents is the basic function and fundamental task of higher education institutions in China, and the central task of schools is often teaching work. Therefore, teaching management plays a particularly important role [1]. Sports colleges and universities have an important mission in developing the national sports industry, advancing China towards a sports powerhouse, building an innovative country, and enhancing the country's competitiveness in development [2-4]. Sports colleges have various functions such as cultivating senior specialized sports talents for national construction, conducting sports scientific research, and engaging in social services [5-7]. They actively adapt to the development needs of the national sports industry with sports as their characteristics [8-10]. Teaching management is the core function of the teaching management department, which has unique characteristics of complexity, complexity, and repetition. In the process of development, sports colleges have gradually shown a trend of expanding their scale, comprehensive professional settings, and diversified educational levels [11, 12]. The difficulty and complexity of teaching management are increasing, and with the continuous deepening of information technology in teaching management, the requirements for the quality and information acquisition ability of managers are becoming higher and higher [13, 14]. With the continuous deepening of the implementation of the credit system, the transition from the academic year system to academic year credit system, and the transformation to the credit system, the original teaching management work methods, management methods, and systems seem somewhat inadequate and difficult to adapt to. The number of disciplines and majors in sports colleges is increasing, and the number of students on campus is also increasing [15-18]. The unified management by the school appears to have a huge coverage, and it is also difficult to achieve effective management after implementing secondary college management. In the practice of teaching management, we may encounter such phenomena: the school's decision-making and work ideas cannot be well implemented. There are more discussions on teaching work than practical ones, and the problems raised during the meetings are often not solved [19, 20]. The same problems are raised year by year and occur year by year. The school's rules and regulations lack a certain degree of constraint ability; Inadequate work arrangement; The execution process is sloppy, etc. Although schools have attempted to link the implementation of their respective departments with performance, the results have been minimal.

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Low efficiency in handling affairs, unreasonable management structure, low overall business quality of management personnel, poor channels for uploading and issuing information, and emphasis on form over connotation in goal management and management performance evaluation [21-24]. The management methods are not entirely scientific, the hierarchical and categorical distinctions in management are insufficient, the system is rigid, the response to new things is slow, and the phenomenon of habitual defense is obvious [25, 26]. Political management is too broad, administrative intervention in teaching management is too strong, the official centric ideology is severe, there are too many checkpoints, work transparency is poor, coordination is insufficient, the tendency towards government is obvious, and the rule of man is greater than the rule of law. These phenomena have been troubling many workers engaged in teaching management [27]. Sports colleges are the highest educational level in China's higher education system to cultivate sports professionals. They shoulder the arduous task of cultivating sports talents with innovative spirit and practical ability, and contribute to the country's sports and education undertakings [28-30]. The construction of teaching management performance is achieved by adopting scientific management methods, mobilizing the enthusiasm, initiative, and creativity of the majority of teaching staff in their work, correcting their service attitude, enhancing their consciousness of actively serving teaching work, thereby improving work efficiency and ability, and better implementing the school's policies and guidelines [31-33].

The management performance evaluation of teaching services in sports colleges and universities is regarded as the defined MADM. Recently, the CoCoSo [34] and entropy [35] has been used to cope with MADM. The DVNSs [36] are used as a technique for characterizing fuzzy information during the management performance evaluation of teaching services in sports colleges and universities. Furthermore, many techniques employed CoCoSo technique [34] and entropy [35] separately to manage the MADM. Until now, no or few techniques have been administrated on entropy technique [35] and CoCoSo [34] under DVNSs. Therefore, the DVNN-CoCoSo model is founded to manage the MADM. Finally, numerical example for management performance evaluation of teaching services in sports colleges and universities and comparative analysis is administrated to validate the DVNN-CoCoSo model. The major research motivation of this work is managed: (1) the novel MADM is put forward based on CoCoSo and entropy technique under DVNSs. (2) The objective weights are considered through entropy technique. (3) The new MADM technique based on DVNN-CoCoSo technique is proposed for management performance evaluation of teaching services in sports colleges and universities. (4) numerical example for management performance evaluation of teaching services in sports colleges and universities and comparative analysis are employed to prove the DVNN-CoCoSo model.

The framework of this study is administrated. Section II introduces the DVNSs. In Section III, the DVNN-CoCoSo technique is administrated for MADM. In Section IV, numerical example for blended teaching quality decision evaluation is administrated and comparative analysis is conducted. The final study ends in Section V.

II. PRELIMINARIES

Kandasamy [36] administrated the DVNSs.

Definition 1 [36]. The DVNSs RA in Θ is put forward:

$$RA=\left\{\left(\begin{matrix}\theta,RT_A(\theta),RIT_A(\theta),\\ RIF_A(\theta),RF_A(\theta)\end{matrix}\right)\middle|\theta\in\Theta\right\}. \tag{1}$$

where $RT_A(\theta)$ is truth-membership, $RIT_A(\theta)$ is indeterminacy leaning towards $RT_A(\theta)$, $RIF_A(\theta)$ is indeterminacy leaning towards $RF_A(\theta)$, $RF_A(\theta)$ is falsity-membership,

$RT_A(\theta),RIT_A(\theta),RIF_A(\theta),RF_A(\theta)\in[0,1]$,

$0\le RT_A(\theta)+RIT_A(\theta)+RIF_A(\theta)+RF_A(\theta)\le 4$.

The DVNN is expressed as $RA=(RT_A,RT_A,RIF_A,RF_A)$, where

$RT_A,RIT_A,RIF_A,RF_A\in[0,1]$

$0\le RT_A+RIT_A+RIF_A+RF_A\le 4$.

Definition 2 [36]. Let $RA=(RT_A,RT_A,RIF_A,RF_A)$ be the DVNN, the score value is administrated:

$$SV(RA)=\frac{(2+RT_A+RIT_A-RIF_A-RF_A)}{4},$$

$$SV(RA)\in[0,1] \tag{2}$$

Definition 3 [36]. Let $RA=(RT_A,RT_A,RIF_A,RF_A)$ be the DVNN, the accuracy value is administrated:

$$AV(RA)=\frac{(RT_A+RIT_A+RIF_A+RF_A)}{4},$$

$$AV(RA)\in[0,1] \tag{3}$$

The order for DVNNs is administrated.

Definition 4[36]. Let $RA=(RT_A,RT_A,RIF_A,RF_A)$ and $RB=(RT_B,RT_B,RIF_B,RF_B)$,

$$SV(RA)=\frac{(2+RT_A+RIT_A-RIF_A-RF_A)}{4},$$

$$SV(RB)=\frac{(2+RT_B+RIT_B-RIF_B-RF_B)}{4},$$

$AV\left(RA\right)=\frac{\left(RT_A+RIT_A+RIF_A+RF_A\right)}{4}$,

$AV\left(RB\right)=\frac{\left(RT_B+RIT_B+RIF_B+RF_B\right)}{4}$, if $SV\left(RA\right)<SV\left(RB\right)$, $RA<RB$; if $SV\left(RA\right)=SV\left(RB\right)$, (1)if $AV\left(RA\right)=AV\left(RB\right)$, $RA=RB$; (2) if $AV\left(RA\right)<AV\left(RB\right)$, $RA<RB$.

Definition 5 [36]. Let $RA=\left(RT_A,RT_A,RIF_A,RF_A\right)$ and $RB=\left(RT_B,RT_B,RIF_B,RF_B\right)$ be two DVNNs, the operations are administrated:

$$(1)\ RA\oplus RB=\left(RT_A+RT_B-RT_ART_B,RIT_A+RIT_B-RIT_ARIT_B,RIF_ARIF_B,RF_ARF_B\right);$$
$$(2)\ RA\otimes RB=\left(RT_ART_B,RIT_ARIT_B,RIF_A+RIF_B-RIF_ARIF_B,RF_A+RF_B-RF_ARF_B\right);$$
$$(3)\ \lambda RA=\left(1-\left(1-RT_A\right)^{\lambda},1-\left(1-RIT_A\right)^{\lambda},\left(RIF_A\right)^{\lambda},\left(RF_A\right)^{\lambda}\right),\lambda>0;$$
$$(4)\left(RA\right)^{\lambda}=\left(\left(RT_A\right)^{\lambda},\left(RIT_A\right)^{\lambda},1-\left(1-RIF_A\right)^{\lambda},1-\left(1-RF_A\right)^{\lambda}\right),\lambda>0.$$

Definition 6[36]. Let $RA=\left(RT_A,RT_A,RIF_A,RF_A\right)$ and $RB=\left(RT_B,RT_B,RIF_B,RF_B\right)$, the DVNN Euclidean distance (DVNNED) between $RA=\left(RT_A,RT_A,RIF_A,RF_A\right)$ and $RA=\left(RT_A,RT_A,RIF_A,RF_A\right)$ is:

$$ED\left(RA,RB\right)=\sqrt{\frac{1}{4}\left(\begin{array}{l}\left|RT_A-RT_B\right|^2+\left|RIT_A-RIT_B\right|^2\\+\left|RIF_A-RIF_B\right|^2+\left|RF_A-RF_B\right|^2\end{array}\right)} \quad (4)$$

Definition 7. Let $RA=\left(RT_A,RT_A,RIF_A,RF_A\right)$ and $RB=\left(RT_B,RT_B,RIF_B,RF_B\right)$, the DVNN Logarithmic distance (DVNNLD) between $RA=\left(RT_A,RT_A,RIF_A,RF_A\right)$ and $RB=\left(RT_B,RT_B,RIF_B,RF_B\right)$ is administrated:

$$DVNNLD\left(RA,RB\right)=\frac{1}{4}\left(\begin{array}{l}RT_A\log\frac{2RT_A}{RT_A+RT_B}+RT_B\log\frac{2RT_B}{RT_A+RT_B}\\+RIT_A\log\frac{2RIT_A}{RIT_A+RIT_B}+RIT_B\log\frac{2RIT_B}{RIT_A+RIT_B}\\+RIF_A\log\frac{2RIF_A}{RIF_A+RIF_B}+RIF_B\log\frac{2RIF_B}{RIF_A+RIF_B}\\+RF_A\log\frac{2RF_A}{RF_A+RF_B}+RF_B\log\frac{2RF_B}{RF_A+RF_B}\end{array}\right) \quad (5)$$

III. DVNN-CoCoSo Approach for MADM with Entropy Weight

The DVNN-CoCoSo technique is administrated for MADM. Let $RA=\left\{RA_1,RA_2,\cdots,RA_m\right\}$ be alternatives, $RG=\left\{RG_1,RG_2,\cdots,RG_n\right\}$ be attributes with weight rw, where $rw_j\in\left[0,1\right]$, $\sum_{j=1}^{n}rw_j=1$. Suppose that assessed information are DVNNs $RM=\left(RM_{ij}\right)_{m\times n}=\left(RT_{ij},RIT_{ij},RIF_{ij},RF_{ij}\right)_{m\times n}$.

Then, DVNN-CoCoSo technique is put forward MADM (see Fig. 1).

Step 1. Put forward the DVNN-matrix $RM=\left(RM_{ij}\right)_{m\times n}=\left(RT_{ij},RIT_{ij},RIF_{ij},RF_{ij}\right)_{m\times n}$

$$RM=\left[RM_{ij}\right]_{m\times n}=\begin{bmatrix}RM_{11}&RM_{12}&\cdots&RM_{1n}\\RM_{21}&RM_{22}&\cdots&RM_{2n}\\\vdots&\vdots&\vdots&\vdots\\RM_{m1}&RM_{m2}&\cdots&RM_{mn}\end{bmatrix} \quad (6)$$

$$RM_{ij}=\left(RT_{ij},RIT_{ij},RIT_{ij},RF_{ij}\right) \quad (7)$$

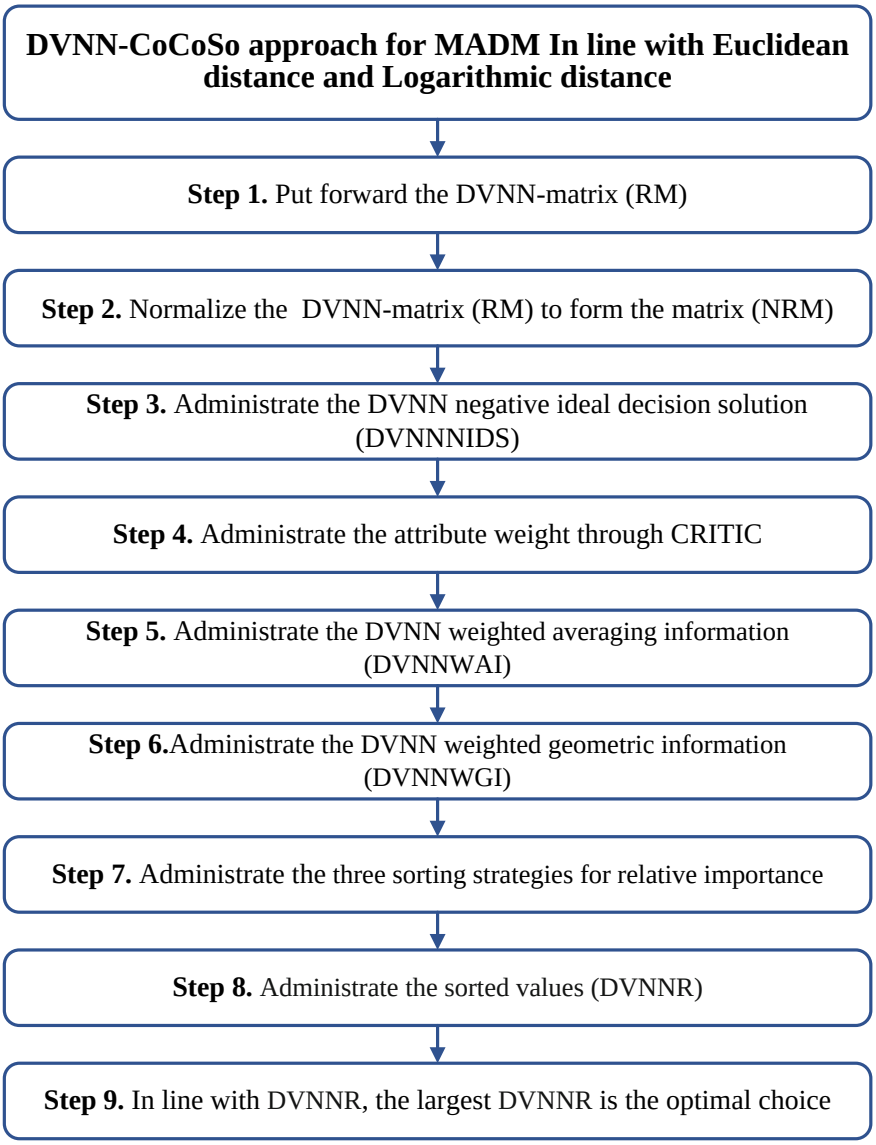

Fig. 1. DVNN-CoCoSo technique for MADM in line with Euclidean distance and Logarithmic distance.

Step 2. Normalize the

$$UR = \left(UR_{ij}\right)_{m\times n} = \left(UT_{ij}, UIT_{ij}, UIF_{ij}, UF_{ij}\right)_{m\times n}$$

into

$$NRM = \left(NRM_{ij}\right)_{m\times n} = \left(RT_{ij}^{N}, RIT_{ij}^{N}, RIF_{ij}^{N}, RF_{ij}^{N}\right)_{m\times n}$$

$$NRM_{ij} = \left(RT_{ij}^{N}, RIT_{ij}^{N}, RIF_{ij}^{N}, RF_{ij}^{N}\right) = \begin{cases} \left(RT_{ij}, RIT_{ij}, RIF_{ij}, RF_{ij}\right), & RG_j \text{ is benefit attribute} \\ \left(RF_{ij}, RIF_{ij}, RIT_{ij}, RT_{ij}\right), & RG_j \text{ is cost attribute} \end{cases} \quad (8)$$

Step 3. Administrate the DVNN negative ideal decision solution (DVNNNIDS):

$$DVNNNIDS = \begin{pmatrix} DVNNNIDS_1, DVNNNIDS_2, \\ \cdots, DVNNNIDS_n \end{pmatrix} \quad (9)$$

$$DVNNNIDS_j = \left(RT_j^{N-}, RIT_j^{N-}, RIF_j^{N-}, RF_j^{N-}\right) \quad (10)$$

$$DVNNSV\left(DVNNNIDS_j\right) = \min_i DVNNSV\left(RT_{ij}^{N}, RIT_{ij}^{N}, RIF_{ij}^{N}, RF_{ij}^{N}\right) \quad (11)$$

Step 4. Administrate the attribute weight through CRITIC.

The CRITIC [37] is administrated to obtain the objective weight.

1) Administrate the DVNNED and DVNNLD of RA_i from DVNNNIDS.

$$DVNNED\left(NRM_{ij}, DVNNNIDS_j\right) = \sqrt{\frac{1}{4}\left(\begin{array}{l}\left|RT_{ij}^{N} - RT_{j}^{N-}\right|^2 + \left|RIT_{ij}^{N} - RIT_{j}^{N-}\right|^2 \\ + \left|RIF_{ij}^{N} - RIF_{j}^{N-}\right|^2 + \left|RF_{ij}^{N} - RF_{j}^{N-}\right|^2\end{array}\right)} \quad (12)$$

$$DVNNLD\left(NRM_{ij}, DVNNNIDS_j\right) = \frac{1}{4}\left(\begin{array}{l} RT_{ij}^{N}\log\frac{2RT_{ij}^{N}}{RT_{ij}^{N}+RT_{j}^{N-}} + RT_{j}^{N-}\log\frac{2RT_{j}^{N-}}{RT_{ij}^{N}+RT_{j}^{N-}} \\ + RIT_{ij}^{N}\log\frac{2RIT_{ij}^{N}}{RIT_{ij}^{N}+RIT_{j}^{N-}} + RIT_{j}^{N-}\log\frac{2RIT_{j}^{N-}}{RIT_{ij}^{N}+RIT_{j}^{N-}} \\ + RIF_{ij}^{N}\log\frac{2RIF_{ij}^{N}}{RIF_{ij}^{N}+RIF_{j}^{N-}} + RIF_{j}^{N-}\log\frac{2RIF_{j}^{N-}}{RIF_{ij}^{N}+RIF_{j}^{N-}} \\ + RF_{ij}^{N}\log\frac{2RF_{ij}^{N}}{RF_{ij}^{N}+RF_{j}^{N-}} + RF_{j}^{N-}\log\frac{2RF_{j}^{N-}}{RF_{ij}^{N}+RF_{j}^{N-}}\end{array}\right) \quad (13)$$

$$NRMRA_j = \frac{1}{m}\sum_{i=1}^{m}\left(\frac{\left(\begin{array}{l}DVNNED\left(NRM_{ij}, DVNNNIS_j\right) \\ + DVNNLD\left(NRM_{ij}, DVNNNIDS_j\right)\end{array}\right)}{2}\right), j = 1, 2, \cdots, n. \quad (14)$$

$$NHHOA_{ij} = \frac{\left(\begin{array}{l}DVNNED\left(NRM_{ij}, DVNNNIS_j\right) \\ + DVNNLD\left(NRM_{ij}, DVNNNIDS_j\right)\end{array}\right)}{2} \quad (15)$$

2) Administrate the DVNN correlation decision coefficient (DVNNCDC):

$$DVNNCDC_{jk} = \frac{\sum_{i=1}^{m}\left(NRMRA_{ij} - NRMRA_j\right)\left(NRMRA_{ik} - NRMRA_k\right)}{\sqrt{\sum_{i=1}^{m}\left(NRMRA_{ij} - NRMRA_j\right)^2\sum_{i=1}^{m}\left(NRMRA_{ik} - NRMRA_k\right)^2}} \quad (16)$$

3) Administrate the DVNN standard deviation ($DVNNSD_j$):

$$DVNNSD_j = \sqrt{\frac{1}{m-1}\sum_{i=1}^{m}\left(NRMRA_{ij} - NRMRA_j\right)^2}, \quad (17)$$

(4) Administrate the weight numbers:

$$rw_j = \frac{DVNNSD_j\left(1 - DVNNCDC_{jk}\right)}{\sum_{k=1}^{n} DVNNSD_j\left(1 - DVNNCDC_{jk}\right)} \quad (18)$$

Step 5. Administrate the DVNN weighted averaging information (DVNNWAI).

$$DVNNWAI_i = \left(\sum_{j=1}^{n} \left(rw_j \times \begin{pmatrix} DVNNED\left(NHH_{ij}, DVNNNIS_j\right) \\ +DVNNLD\left(NRM_{ij}, DVNNNIDS_j\right) \end{pmatrix} \right) \Big/ 2 \right). \tag{19}$$

Step 6. Administrate the DVNN weighted geometric information (DVNNWGI).

$$DVNNWGI_i = \prod_{j=1}^{n} \left(\left(\begin{pmatrix} DVNNED\left(NHH_{ij}, DVNNNIS_j\right) \\ +DVNNLD\left(NRM_{ij}, DVNNNIDS_j\right) \end{pmatrix} \right) \Big/ 2 \right)^{rw_j}. \tag{20}$$

Step 7. Administrate the three sorting strategies for relative importance.

$$DVNNR_{ia} = \frac{DVNNWGI_i + DVNNWAI_i}{\sum_{i=1}^{m} \left(DVNNWGI_i + DVNNWAI_i \right)}. \tag{21}$$

$$DVNNR_{ib} = \frac{DVNNWAI_i}{\min\limits_i DVNNWAI_i} + \frac{DVNNWGI_i}{\min\limits_i DVNNWGI_i}. \tag{22}$$

$$DVNNR_{ic} = \frac{DVNNWAI_i + (1-\lambda) DVNNWGI_i}{\lambda \max\limits_i DVNNWAI_i + (1-\lambda) \max\limits_i DVNNWGI_i}, 0 \le \lambda \le 1. \tag{23}$$

where $DVNNR_{ia}$ is arithmetic average of $DVNNWAI_i, DVNNWGI$, $DVNNR_{ib}$ is relative scores of $DVNNWAI_i, DVNNWGI$, and $DVNNR_{ic}$ is balanced compromise of $DVNNWAI_i, DVNNWGI$.

Step 8. Administrate the sorted values $DVNNR_i$.

$$DVNNR_i = \begin{pmatrix} \sqrt[3]{DVNNR_{ia} DVNNR_{ib} DVNNR_{ic}} \\ +\dfrac{DVNNR_{ia} + DVNNR_{ib} + DVNNR_{ic}}{3} \end{pmatrix} \tag{24}$$

Step 9. Administrate the alternatives with $DVNNR_i \left(i = 1, 2, \cdots, m\right)$, and higher $DVNNR_i$ is better alternative.

IV. Example Study and Comparative Analysis

A. Example Study for Management Performance Evaluation of Teaching Services in Sports Colleges and Universities

The current teaching management in universities is becoming increasingly complex, and some teaching management personnel have deficiencies in concepts, professional qualities, knowledge, and mentality, which leads to a certain degree of insufficient human resources in the actual operation process of teaching management [38-40]. Collaboration and teamwork between teaching management departments are beneficial for members to overcome their own knowledge limitations, which can be achieved through rotation of teaching management positions or team work based on the time period of teaching management work. The reasonable flow of teaching management personnel within the department is an effective way for personal knowledge to be shared within the organization, which is conducive to knowledge transfer among members [41, 42]. The teaching management work of schools is mainly focused on supporting teaching work, and the nature of services is very obvious. In the practice of teaching management, teaching managers should establish the ideological consciousness of serving teaching work, serving grassroots, teaching, teachers, and students, and closely focus on providing various services around teaching work, striving to improve the level of management services [43-46]. To some extent, the process of service is the process of knowledge transfer. Teaching managers can openly express their opinions, maintain efficient communication with other managers, teachers, and students, promote the integration of various information in business relationships, and improve the behavioral paradigm of teaching managers. Continuously learning in the management process, emphasizing the learning process, summarizing the problems or advantages discovered in practice, and internalizing the correct experiences of these learning outcomes into organizational memory [47-49]. By establishing a long-term learning mechanism, a common communication channel is created for explicit and implicit knowledge within the organization, forming a shared learning system and accelerating the flow of knowledge within the organization [17, 50, 51]. We will adhere to the methods of development and reform to solve the problems in progress,

vigorously promote innovation in the teaching management system and mechanism, further improve the level of teaching management, enhance the awareness and quality of teaching management services, and achieve the goal of cultivating high-quality composite applied talents with innovative spirit and practical ability [52-55]. Education, scientific research, and training will develop comprehensively, coordinated, and sustainably. People use defensive reasoning for thinking and action in their daily lives and work because they have developed this habit for a long time in such an environment. Habitual defense is an important protective factor that prevents people from bravely facing and correcting mistakes, and hinders organizations from continuously learning and developing. In the process of teaching management reform in schools, we often encounter such problems. In the face of either new and old systems or innovation, we both face the dilemma of autonomy and control [56-58]. So, self-protection emerged, with a vague and unclear attitude towards new things, fearing that change would harm one's own interests. Establishing a creative learning environment in teaching management practice, improving the reflective learning ability of management personnel, and promoting the continuous development of teaching management [59]. The management performance evaluation of teaching services in sports colleges and universities is MADM. There are five possible sports colleges and universities $RA_i\ (i=1,2,3,4,5)$ are assessed in light with four attributes: ①RG_1 is the student feedback results; ②RG_2 is the blended teaching management costs; ③RG_3 is the blended teaching attitude; ④RG_4 is the invited peer review recognition. RG_2 is the cost. Then, the DVNN-CoCoSo model is administrated for management performance evaluation of teaching services in sports colleges and universities.

Step 1. Put forward the DVNN-matrix $RM=\left(UR_{ij}\right)_{5\times4}$ as in Table I.

TABLE I. DVNN INFORMATION

	RG_1	RG_2
RA_1	(0.35,0.64, 0.13, 0.46)	(0.42, 0.36, 0.45, 0.38)
RA_2	(0.53, 0.42,0.35, 0.54)	(0.63, 0.56, 0.37, 0.42)
RA_3	(0.46, 0.35, 0.49,0.43)	(0.29, 0.35, 0.46, 0.24)
RA_4	(0.43, 0.34, 0.37, 0.42)	(0.34, 0.53, 0.42, 0.46)
RA_5	(0.35, 0.46,0.39, 0.37)	(0.37, 0.59, 0.36, 0.29)
	RG_3	RG_4
RA_1	(0.49, 0.26, 0.58, 0.45)	(0.36, 0.38, 0.23, 0.43)
RA_2	(0.42, 0.31,0.52, 0.43)	(0.42, 0.57,0.16, 0.45)
RA_3	(0.25, 0.39,0.37, 0.46)	(0.49, 0.54,0.32, 0.41)
RA_4	(0.32, 0.46, 0.45, 0.39)	(0.35, 0.51,0.39, 0.42)
RA_5	(0.34, 0.48,0.42, 0.37)	(0.37, 0.64,0.15, 0.48)

Step 2. Normalize the DVNN matrix $RM=\left(UR_{ij}\right)_{5\times4}$ to $NRM=\left(NRM_{ij}\right)_{5\times4}$ (see Table II).

TABLE II. THE NORMALIZED DVNNS

	RG_1	RG_2
RA_1	(0.25, 0.39,0.37, 0.46)	(0.41, 0.32,0.54, 0.49)
RA_2	(0.32, 0.46, 0.45, 0.39)	(0.42, 0.39,0.51, 0.35)
RA_3	(0.34, 0.48,0.42, 0.37)	(0.48, 0.15,0.64, 0.37)
RA_4	(0.49, 0.26, 0.58, 0.45)	(0.43, 0.23, 0.38, 0.36)
RA_5	(0.42, 0.31,0.52, 0.43)	(0.45, 0.16,0.57, 0.42)
	RG_3	RG_4
RA_1	(0.43, 0.34, 0.37, 0.42)	(0.34, 0.53, 0.42, 0.46)
RA_2	(0.35, 0.46,0.39, 0.37)	(0.37, 0.59, 0.36, 0.29)
RA_3	(0.35,0.64, 0.13, 0.46)	(0.42, 0.36, 0.45, 0.38)
RA_4	(0.53, 0.42,0.35, 0.54)	(0.63, 0.56, 0.37, 0.42)
RA_5	(0.46, 0.35, 0.49,0.43)	(0.29, 0.35, 0.46, 0.24)

Step 3. Administrate the weight numbers (Table III).

TABLE III. THE WEIGHT NUMBERS

	RG_1	RG_2	RG_3	RG_4
weight	0.2207	0.3028	0.2504	0.2261

Step 4. Put forward the DVNNWAI (Table IV).

TABLE IV. THE DVNNWAI

	RA_1	RA_2	RA_3	RA_4	RA_5
DVNNWAI	0.8145	0.5597	0.6728	0.6984	0.4652

Step 5. Administrate the DVNNWGI (Table V).

TABLE V. THE DVNNWGI

	RA_1	RA_2	RA_3	RA_4	RA_5
DVNNWGI	0.7378	0.4613	0.5736	0.5879	0.3657

Step 6. Administrate the $DVNNR_{ia}, DVNNR_{ib}, DVNNR_{ic}$ (see Table VI).

TABLE VI. THREE DECISION STRATEGIES

	$DVNNR_{ia}$	$DVNNR_{ib}$	$DVNNR_{ic}$
RA_1	0.2615	3.7684	1.0000
RA_2	0.1720	2.4646	0.6577
RA_3	0.2099	3.0148	0.8029
RA_4	0.2167	3.1089	0.8286
RA_5	0.1400	2.0000	0.5353

Step 7. Administrate the DVNNR (see Table VII).

TABLE VII. THE DVNNR

	RA_1	RA_2	RA_3	RA_4	RA_5
DVNNR	2.6717	1.7513	2.1406	2.2081	1.4229

Step 8. According to $DVNNR_i\left(i=1,2,3,4,5\right)$, the order is $RA_1 > RA_4 > RA_3 > RA_2 > RA_5$ and the optimal sports college and university is RA_1.

B. Comparative Analysis

The DVNN-CoCoSo technique is compared with generalized double-valued neutrosophic weighted distance [36] and weighted Dice similarity measures $WD_{\mathrm{DVNS}_1}\left(RA_i, DVNNPIS\right)$, $WD_{\mathrm{DVNS}_2}\left(RA_i, DVNNPIS\right)$ and weighted generalized Dice similarity measures $WGD_{\mathrm{DVNS}_1}\left(RA_i, DVNNPIS\right)$, $WGD_{\mathrm{DVNS}_2}\left(RA_i, DVNNPIS\right)$ [60], DVNN-TODIM-VIKOR technique [61] and DVNN-ExpTODIM-GRA technique [62]. The comparative results are administrated in Table VIII.

TABLE VIII. ORDER FOR DIFFERENT TECHNIQUES

	Order
DVNN weighted Hamming distance[36]	$RA_1 > RA_4 > RA_3 > RA_2 > RA_5$
DVNN weighted Euclidean distance[36]	$RA_1 > RA_4 > RA_3 > RA_2 > RA_5$
$WD_{\mathrm{DVNS}_1}\left(RA_i, DVNNPIS\right)$ [60]	$RA_1 > RA_4 > RA_3 > RA_2 > RA_5$
$WD_{\mathrm{DVNS}_2}\left(RA_i, DVNNPIS\right)$ [60]	$RA_1 > RA_4 > RA_3 > RA_2 > RA_5$
$WGD_{\mathrm{DVNS}_1}\left(RA_i, DVNNPIS\right)$ [60]	$RA_1 > RA_4 > RA_3 > RA_2 > RA_5$
$WGD_{\mathrm{DVNS}_2}\left(RA_i, DVNNPIS\right)$ [60]	$RA_1 > RA_4 > RA_3 > RA_2 > RA_5$
DVNN-TODIM-VIKOR technique [61]	$RA_1 > RA_4 > RA_2 > RA_3 > RA_5$
DVNN-ExpTODIM-GRA technique [62]	$RA_1 > RA_4 > RA_2 > RA_3 > RA_5$
DVNN-CoCoSo technique	$RA_1 > RA_4 > RA_3 > RA_2 > RA_5$

From the above comparative analysis, the order of generalized double-valued neutrosophic weighted distance [36] and weighted Dice similarity measures $WD_{\mathrm{DVNS}_1}\left(RA_i, DVNNPIS\right)$, $WD_{\mathrm{DVNS}_2}\left(RA_i, DVNNPIS\right)$ and weighted generalized Dice similarity measures $WGD_{\mathrm{DVNS}_1}\left(RA_i, DVNNPIS\right)$, $WGD_{\mathrm{DVNS}_2}\left(RA_i, DVNNPIS\right)$ [60] is same to order of DVNN-CoCoSo technique; while order of DVNN-TODIM-VIKOR technique [61] and DVNN-ExpTODIM-GRA technique [62] is slightly different from order of DVNN-CoCoSo technique, however, several techniques have same optimal sports college and university and worst sports college and university. This verifies the effectiveness of DVNN-CoCoSo technique. Thus, the main advantages of DVNN-CoCoSo are managed: (1) DVNN-CoCoSo technique not only manages the uncertainty for MADM, but also manages three fused strategies. (2) DVNN-CoCoSo manages different behavior of CoCoSo and entropy as MADM when they are combined.

V. CONCLUSION

The service performance of the teaching management department is an important basis for measuring and evaluating the quality and operational efficiency of teaching management in higher education institutions, and is a comprehensive reflection of the school's management capabilities. Sports colleges and universities are the highest level of education in China's higher education system to cultivate sports professionals, shouldering the arduous task of cultivating sports talents with innovative spirit and practical ability, and contributing to the country's sports and education undertakings. The service performance construction of the teaching management department is achieved by adopting a scientific management approach, stimulating the enthusiasm, initiative, and creativity of teaching staff, correcting service attitudes, enhancing the consciousness of actively serving teaching work, thereby improving work efficiency and ability, and better implementing the school's policies and guidelines. The management performance evaluation of teaching services in sports colleges and universities is regarded as MADM. Consequently, the DVNN-CoCoSo technique is administrated to put forward MADM for management performance evaluation of teaching services in sports colleges and universities. The major contribution of this paper is administrated: 1) DVNN-CoCoSo technique is administrated for MADM in light with DVNNED and DVNNLD; 2) the objective weights are considered through entropy technique; 3) numerical example for management performance evaluation of teaching services in sports colleges and universities and some comparative analysis are administrated to verify the DVNN-CoCoSo technique.

There may be some possible limitations for management performance evaluation of teaching services in sports colleges and universities, which could be conducted through our future research: 1) It is a worthwhile research work to manage consensus [63-66] for management performance evaluation of teaching services in sports colleges and universities under DVNSs. 2) It is also worthwhile research to manage regret theory for management performance evaluation of teaching services in sports colleges and universities under DVNSs [67-70].

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