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Research Article

An Integrated Taxonomy Method Using Single-Valued Neutrosophic Number MAGDM for Evaluating the Physical Education Teaching Quality in Colleges and Universities

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Before the advent of the new era, my country has completed the popularization of higher education, and the country has gradually begun to pay attention to the quality of higher education. Under the background of Healthy China, the quality of physical education teaching in colleges and universities has become a hot topic of social concern. The quality of physical education teaching in colleges and universities directly determines the quality of physical education talents. A reasonable, complete, and scientific evaluation system of physical education teaching quality in colleges and universities is an effective measure to improve the quality of physical education teaching and the training of physical education talents. The physical education teaching quality evaluation in colleges and universities is frequently viewed as the multiple attribute group decision-making (MAGDM) issue. In such paper, taxonomy method is designed for solving the MAGDM under single-valued neutrosophic sets (SVNSs). First, the score function of SVNSs and criteria importance through intercriteria correlation (CRITIC) method is used to derive the attribute weights. Second, then, the optimal choice is obtained through calculating the smallest single-valued neutrosophic number development attribute values from the single-valued neutrosophic number positive ideal solution (SVNNPIS). Finally, a numerical example for physical education teaching quality evaluation in colleges and universities is given to illustrate the built method.

1. Introduction

Decision-making is a very common phenomenon which ranges from personal clothing, housing, and transportation to national policy formulation and is closely related to people's lives [1–5]. Among them, multi-attribute decision-making (MADM) means that under many different requirements and criteria, the plan to be selected needs to be evaluated by decision-makers or corresponding experts and scholars, and the most suitable decision-making plan is finally selected through scientific methods [6–10]. As an important part of modern decision science, multi-attribute decision-making has been favored by many scholars and experts and its methods and theories have been applied to many practical fields such as politics, business, environment, and energy [11–14]. The multi-attribute group decision-making problem (MAGDM) is based on the MADM, which comprehensively considers the evaluation of alternatives with multiple attributes by different decision-makers [15–20]. In the actual MAGDM process, due to the complexity and uncertainty of objective things, the limitations of human cognition, and the ambiguity of thinking, it is difficult to use quantitative and accurate information to describe decision objects [21–25]. To represent uncertainty and inconsistency in information, Smarandache [26] built the neutrosophic sets (NS) as an useful alternative to IFSs and IVIFSs. In order to practical application, the SVNS [27] and INS [28] were devised as subclasses of NS, and then Ye [29] studied the SNS, SVNS, and INS. The SVNNWBM operator was proposed by Liu and Wang [30] using the Bonferroni mean, the WBM, and the normalized WBM. Liu et al. [31] combined Hamacher operator and generalized operator into

NS and proposed the GNNHWA operator, GNNHOWA operator, and GNNHHA operator. Sahin and Kucuk [32] gave the introduction of entropy measure of SVNSs. Li et al. [33] proposed some Heronian mean operators with SVNSs. Ye [34–38] introduced a similarity measure between SVNSs and INSs. Furthermore, Ye [39] examined interval-neutrosophic MADM methods based on probability degree sequencing and ordered weighted aggregate operators. Broumi and Smarandache [40] built the correlation coefficients of INSs. Zhang et al. [41] developed INNWA operator and INNWG operator. Ye [42] proposed INWEA operator and DUNWEA operator based on exponential algorithm. Liu and Wang [43] further proposed INPOWA operator. Aiwu et al. [44] extended the GWA operator to work in line with the IVNS data. Ye [45] proposes an interval-neutral MADM with confidence information. Furthermore, Wu et al. [46] devised the SVN 2-tuple linguistic sets (SVN2TLSs) and built some novel Hamacher aggregation operators. Ju et al. [47] extended the SVN2TLSs to interval-valued setting.

The taxonomy method was introduced by Adanson in 1763 and extended through some mathematicians from Poland in 1950. In 1968, Hellwig [48] introduced such method as a means of classifying and determining the degree of development. Compared with the first two decision models, its calculation process is more complicated, but this cannot be regarded as a defect of the model, because the model has a high degree of variability. Because it categorizes and compares various activities based on the attributes studied to understand their strengths and utility, its ranking results are more accurate. Xiao et al. [49] designed the taxonomy algorithms for MAGDM under IVIFSs. He et al. [50] devised the taxonomy for PUL-MAGDM. Liu and Wang [51] defined the taxonomy for t-spherical fuzzy MADM.

The document issued by the Ministry of Education in September 2019 clearly pointed out "Deepen the reform of undergraduate education and teaching, cultivate successors with all-round development of socialist morality, knowledge, art, and labor, and continue to accelerate the pace of review and evaluation and qualification evaluation of undergraduate teaching work [52–54]. The results serve as the basis for supervising and managing teaching" and emphasized "To fully implement the advanced concepts of student-centered, output-oriented, and continuous improvement, and accelerate the formation of schools as the main body, education departments as the leading, industry departments, academic organizations and social institutions [55–57]. A quality assurance system with Chinese characteristics and world-class participation." Physical education teaching in colleges and universities is an important part of teaching in colleges and universities. The fundamental task of physical education teaching is to cultivate high-quality sports talents. The quality of physical education teaching directly affects the level of training sports talents. In order to meet the demand for applied sports talents in the new era, the physical education work in colleges and universities must implement the "China Education Modernization 2035," comprehensively promote the quality and cultural construction of physical education, highlight the core position of sports talents training, and take the training of comprehensive sports talents as the starting point. Establish a correct oriented, objective, effective, concise, and clear evaluation system. It can not only improve the quality of physical education in colleges and universities, but also produce correct guidance and incentives. At present, the cultivation of physical education professionals in colleges and universities has entered a period of quality enhancement. Facing the requirements of the new era, the existing physical education quality evaluation system has the phenomenon of modularized evaluation content, inflexible evaluation tools, and fixed evaluation methods. The current physical education teaching quality evaluation system in colleges and universities is no longer in line with the development law of the new era, and the reform of the physical education teaching quality evaluation system in colleges and universities is imperative [58–60]. The physical education teaching quality evaluation in colleges and universities is viewed as the MAGDM. The main goal of such paper is to extend taxonomy to solve the MAGDM under SVNSs.

The remainder of this built paper is set out as follows. Section 2 lists basic concepts of SVNSs. In Sect. 3, the SVNN-taxonomy method is built for MAGDM along with CRITIC weight. In Sect. 4, a case study for physical education teaching quality evaluation in colleges and universities is given and some comparative algorithms are fully conducted. The defined study ends with some useful conclusions in Sect. 5.

2. Preliminaries

Wang et al. [27] built the SVNSs.

Definition 1 (see [27]). Let X be a space of objects along with a generic element in fixed set X, denoted by x. A SVNS A in X is characterized:

$$A = \{(x, TT_A(x), II_A(x), FF_A(x)) | x \in X\}, \tag{1}$$

where the truth-membership $TT_A(x)$, indeterminacy-membership $II_A(x)$, and falsity-membership $FF_A(x)$ are single subset along with $[0,1]$, that is, $TT_A(x)$: $X \longrightarrow [0,1]$, $I_A(x)$: $X \longrightarrow [0,1]$ and $FT_A(x)$: $X \longrightarrow [0,1]$. And the sum of $TT_A(x)$, $II_A(x)$, and $FF_A(x)$ satisfies $0 \leq TT_A(x) + II_A(x) + FF_A(x) \leq 3$.

The single-valued neutrosophic number (SVNN) is expressed as $A = (TT_A, II_A, FF_A)$, where $TT_A \in [0,1]$, $II_A \in [0,1]$, $FF_A \in [0,1]$, and $0 \leq TT_A + II_A + FF_A \leq 3$.

Definition 2 (see [61]). Let $A = (TT_A, II_A, FF_A)$ be a SVNN, and a score value is represented:

$$\begin{aligned} SV(A) &= \frac{(2 + TT_A - II_A - FF_A)}{3}, \\ S(A) &\in [0,1], \end{aligned} \tag{2}$$

Definition 3 (see [61]). Let $A = (TT_A, II_A, FF_A)$ be a SVNN, and an accuracy value is represented:

$$HV(A) = TT_A - FF_A,$$
$$H(A) \in [-1, 1]. \tag{3}$$

The larger the value of $H(A)$ is, the more the accuracy value of $A = (TT_A, II_A, FF_A)$.

Definition 4 (see [62]). Let $A = (TT_A, II_A, FF_A)$ be a SVNN, and a certainty value is represented:

$$CV(A) = TT_A, H(A) \in [-1, 1]. \tag{4}$$

The larger the value of $CV(A)$ is, the more the accuracy value of $A = (TT_A, II_A, FF_A)$.

Smarandache [62] defined the order relation between two SVNNs.

Definition 5 (see [62]). Let $A = (TT_A, II_A, FF_A)$ and $B = (TT_B, II_B, FF_B)$ be two given SVNNs, let $SV(A) = (2 + TT_A - II_A - FF_A)/3$ and $SV(B) = (2 + TT_B - II_B - FF_B)/3$, and let $HV(A) = TT_A - FF_A$ and $HV(B) = TT_B - FF_B$, and $CV(A) = TT_A$ and $CV(B) = TT_B$, respectively; then if $SV(A) < SV(B)$, then $A < B$; if $SV(A) = SV(B)$, then if $HV(A) < HV(B)$, then $A < B$; if $HV(A) = HV(B)$, then if $CV(A) < CV(B)$, then $A < B$.

Definition 6 (see [27]). Let $A = (TT_A, II_A, FF_A)$ and $B = (TT_B, II_B, FF_B)$ be two SVNNs, and the basic operations are defined:

$$\begin{aligned}
&(1)\ A \oplus B = (TT_A + TT_B - TT_A TT_B, II_A II_B, FF_A FF_B);\\
&(2)\ A \otimes B = (TT_A TT_B, II_A + II_B - II_A II_B, FF_A + FF_B - FF_A FF_B);\\
&(3)\ \lambda A = \left(1 - (1 - TT_A)^{\lambda}, (II_A)^{\lambda}, (FF_A)^{\lambda}\right), \lambda > 0;\\
&(4)\ (A)^{\lambda} = \left((TT_A)^{\lambda}, (II_A)^{\lambda}, 1 - (1 - FF_A)^{\lambda}\right), \lambda > 0.
\end{aligned} \tag{5}$$

Definition 7 (see [63]). Let $A = (TT_A, II_A, FF_A)$ and $B = (TT_B, II_B, FF_B)$, then the normalized Euclidean distance between $A = (TT_A, II_A, FF_A)$ and $B = (TT_B, II_B, FF_B)$ is defined:

$$ED(A, B) = \sqrt{\frac{1}{3}\left(|TT_A - TT_B|^2 + |II_A - II_B|^2 + |FF_A - FF_B|^2\right)}. \tag{6}$$

3. SVNN-Taxonomy Method for MAGDM with CRITIC Weight

In this section, SVNN-taxonomy method is built for MAGDM. Let $AA = \{AA_1, AA_2, \cdots, AA_m\}$ be a set of given alternatives, and the chosen attributes set $GG = \{GG_1, GG_2, \cdots, GG_n\}$ with weight CW, where $CW_j \in [0, 1]$, $\sum_{j=1}^{n} CW_j = 1$ and a set of invited experts $EE = \{EE_1, EE_2, \cdots, EE_q\}$ with expert weight EW, where $EW_j \in [0, 1]$, $\sum_{j=1}^{n} EW_j = 1$. Suppose that there are n given attributes for m alternatives and their values are always assessed by q experts and always depicted with SVNNs $QQ^{(k)} = (qq_{ij}^{k})_{m \times n} = (TT_{ij}^{k}, II_{ij}^{k}, FF_{ij}^{k})_{m \times n}$ $(i = 1, 2, \cdots, m, j = 1, 2, \cdots, n, k = 1, 2, \cdots, q)$.

Then, SVNN-taxonomy method is employed to solve the MAGDM. The given calculating steps are depicted.

Step 1. Set up each DM's SVNN matrix $QQ^{(k)} = (qq_{ij}^{k})_{m \times n}$ and derive the overall SVNN matrix $QQ = (qq_{ij})_{m \times n}$ through SVNNWA operator.

$$QQ^{(k)} = \left[qq_{ij}^{k}\right]_{m \times n} = \begin{bmatrix} qq_{11}^{k} & qq_{12}^{k} & \cdots & qq_{1n}^{k} \\ qq_{21}^{k} & qq_{22}^{k} & \cdots & qq_{2n}^{k} \\ \vdots & \vdots & \vdots & \vdots \\ qq_{m1}^{k} & qq_{m2}^{k} & \cdots & qq_{mn}^{k} \end{bmatrix},$$

$$QQ = \left[qq_{ij}\right]_{m \times n} = \begin{bmatrix} qq_{11} & qq_{12} & \cdots & qq_{1n} \\ qq_{21} & qq_{22} & \cdots & qq_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ qq_{m1} & qq_{m2} & \cdots & qq_{mn} \end{bmatrix},$$

$$\begin{aligned} q_{ij} &= \left(TT_{ij}, II_{ij}, FF_{ij}\right),\\ &= \left(1 - \prod_{k=1}^{l}\left(1 - TT_{ij}^{k}\right)^{EW_k}, \prod_{k=1}^{l}\left(II_{ij}^{k}\right)^{EW_k}, \prod_{k=1}^{l}\left(FF_{ij}^{k}\right)^{EW_k}\right), \end{aligned} \tag{7}$$

where $qq_{ij}^{k} = (TT_{ij}^{k}, II_{ij}^{k}, FF_{ij}^{k})$ means the information value of chosen alternative AA_i regarding the given attribute GG_j through EE_k.

Step 2. Normalize the overall SVNN matrix $QQ = (qq_{ij})_{m \times n}$ to $NQQ = [nq_q^{ij}]_{m \times n}$.

$$\begin{aligned} \mathrm{nqq}_{ij} &= \left(\mathrm{NTT}_{ij}, NII_{ij}, NFF_{ij}\right)\\ &= \begin{cases} \left(TT_{ij}, II_{ij}, FF_{ij}\right), GG_j \text{ is a benefit criterion},\\ \left(FF_{ij}, II_{ij}, TT_{ij}\right), GG_j \text{ is a cost criterion}. \end{cases} \end{aligned} \tag{8}$$

Step 3. Utilize CRITIC method to determine the weight.

The CRITIC method is an objective weighting method proposed by Diakoulaki et al. [64]. The CRITIC has been used in different settings and connected with methods [65, 66]. The compute procedures of the CRITIC method are designed.

(1) Depending on the normalized overall SVNN matrix $NQQ = (nqq_{ij})_{m \times n}$, the SVNN correlation coefficient (SVNNCC) between given attributes is calculated.

$$\%\ \mathrm{SVNNCC}_{jt} = \frac{\sum_{i=1}^{m}\left(SV\left(nqq_{ij}\right) - SV\left(nqq_j\right)\right)\left(SV\left(nqq_{it}\right) - SV\left(nqq_t\right)\right)}{\sqrt{\sum_{i=1}^{m}\left(SV\left(nqq_{ij}\right) - SV\left(nqq_j\right)\right)^2}\sqrt{\sum_{i=1}^{m}\left(SV\left(nqq_{it}\right) - SV\left(nqq_t\right)\right)^2}}, \quad j, t = 1, 2, \ldots, n. \tag{9}$$

where $SV(\text{nqq}_j) = (1/m)\sum_{i=1}^{m} SV(nqq_j)$ and $SV(\text{nqq}_t) = (1/m)\sum_{i=1}^{m} SV(\text{nqq}_{\text{it}})$.

(2) Calculate attributes' SVNN standard deviation (SVNNSD).

$$SVNNSD_j = \sqrt{\frac{1}{m-1}\sum_{i=1}^{m}\left(SV\left(nqq_{ij}\right) - SV\left(nqq_j\right)\right)^2},\quad j = 1, 2, \ldots, n, \tag{10}$$

where $SV(nqq_j) = (1/m)\sum_{i=1}^{m} SV(nqq_{ij})$.

(3) Calculate the attributes' weight.

$$CW_j = \frac{SVNNSD_j \sum_{t=1}^{n}\left(1 - SVNNCC_{jt}\right)}{\sum_{j=1}^{n}\left(SVNNSD_j \sum_{t=1}^{n}\left(1 - SVNNCC_{jt}\right)\right)},\quad j = 1, 2 \ldots, n, \tag{11}$$

where $CW_j \in [0,1]$ and $\sum_{j=1}^{n} CW_j = 1$.

Step 5. Calculate the SVNN composite distance matrix (SVNNCDM):

Firstly, the distance of each alternative from other given alternatives is obtained through (9):

$$SVNNCDM_{ik} = \sqrt{\sum_{j=1}^{n}\frac{1}{3}CW_j\left(\left|NTT_{ij} - NTT_{kj}\right|^2 + \left|NII_{ij} - NII_{kj}\right|^2 + \left|NFF_{ij} - NFF_{kj}\right|^2\right)}. \tag{12}$$

Then, the SVNNCDM between alternatives is depicted as follows.

$$SVNNCDM = \begin{bmatrix} SVNNCDM_{11} & SVNNCDM_{12} & \cdots & SVNNCDM_{1m} \\ SVNNCDM_{21} & SVNNCDM_{22} & \cdots & SVNNCDM_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ SVNNCDM_{m1} & SVNNCDM_{m2} & \cdots & SVNNCDM_{mm} \end{bmatrix}. \tag{13}$$

Step 6. Homogenizing the given alternatives:

In such step, firstly, the minimum distance value of each given row of SVNNCDM is determined between alternatives. Then, the mean and standard deviation of the minimum distance of each defined row are calculated according to (11), respectively.

$$SVNN\overline{O} = \frac{1}{m}\sum_{i=1}^{m} SVNNO_i,\qquad S_{SVNNO} = \sqrt{\frac{1}{m}\sum_{i=1}^{m}\left(SVNNO_i - SVNN\overline{O}\right)^2}, \tag{14}$$

where $SVNNO_i$ is the minimum distance of ith row in SVNNCDM matrix. (12) is utilized to determine the homogeneity range of SVNNCDM.

$$SVNNO = SVNN\overline{O} \pm 2S_{SVNNO}. \tag{15}$$

If the minimum distance of each row is not situated in the given interval (8), they are inhomogeneous and eliminated, and again the given mean and standard deviation of these values are calculated.

Step 7. Define the SVNNPIS:

$$SVNNPIS = \left(SVNNPIS_1, SVNNPIS_2, \cdots, SVNNPIS_n\right), \tag{16}$$

where

$$SVNNPIS_j = \left(NTT_j, NII_j, NFF_j\right) = \left\{\max_i SV\left(NTT_{ij}, NII_{ij}, NFF_{ij}\right)\right\}. \tag{17}$$

Step 8. Calculate the SVNN development pattern (SVNNDP) for each given alternative: by homogenizing the alternatives, the SVNNDP is determined through equations (20) and (21) using the normalized SVNN matrix obtained in the second step.

$$SVNN\ DP\left(SVNNA_i, SVNNPIS\right) = \sqrt{\sum_{j=1}^{n} CW_j\left(ED\left(SVNNA_{ij}, SVNNPIS_j\right)\right)^2},$$

$$ED\left(SVNNA_{ij}, SVNNPIS_j\right) = \sqrt{\frac{1}{3}\left(\left|NTT_{ij} - NTT_j\right|^2 + \left|NII_{ij} - NII_j\right|^2 + \left|NFF_{ij} - NFF_j\right|^2\right)}, \tag{18}$$

where $SVNNDP(SVNNA_i, SVNNPIS)$ illustrates the SVNNDP for ith alternative.

Step 9. Calculate the SCVV high limit of development $SVNNHLD_0$ and the SVNN development pattern values $SVNN\ DP\ V_i\,(i = 1, 2, \cdots, m)$ as follows:

At such step, the $SVNNHLD_0$ is initially calculated according to equations (22)–(24)

$$SVNNHLD_0 = \overline{SVNNDP(SVNNA_i, SVNNPIS)} + 2S_{SVNN\ DP(SVNNA_i,SVNNPIS)},$$

$$\overline{SCVV\ DP(SVNNA_i, SVNNPIS)} = \frac{1}{m}\sum_{i=1}^{m} SVNN\ DP(SVNNA_i, SVNNPIS),$$

$$S_{SVNN\ DP(SVNNA_i,SVNNPIS)} = \sqrt{\frac{1}{m}\sum_{i=1}^{m}\begin{pmatrix} SVNNDP(SVNNA_i, SVNNPIS) \\ -\overline{SVNNDP(SVNNA_i, SVNNPIS)} \end{pmatrix}^2}. \tag{19}$$

Then, the alternatives are ranked by the $SVNNDP\ V_i\,(i = 1, 2, \cdots, m)$, which is for ith alternative and is obtained from

$$SVNNDPV_i = \frac{SVNNDP(SVNNA_i, SVNNPIS)}{SVNNHLD_0} \quad vi = 1, 2, \cdots, m. \tag{20}$$

Step 10. According to the $SVNNDPV_i$ $(i = 1, 2, \cdots, m)$, the ranking order of all given alternatives is determined.

4. A Case Study and Comparative Analysis

4.1. A Case Study. In the information age, survival by quality and development by quality have become a consensus in the development of domestic higher education institutions. Higher education is the most important part of national education. The quality of higher education has a direct impact on the quality of higher education personnel in our country and the development level of national economic construction. At present, the competition in higher education is becoming more and more intense, and the competition is first and foremost in terms of quality. For higher education to develop sustainably and healthily, it must be supported by high quality and comprehensively improve the quality of teaching. In recent years, the development of China's higher education has entered a fast lane, which is an inevitable requirement for the sustained and rapid development of my country's economy, and it is also an inevitable road for my country to become a powerful country in the era of knowledge economy and economic globalization. In the new stage of socialist modernization, meeting the challenges of the new century with high-quality higher education and cultivating tens of millions of specialized talents is an important guarantee for enhancing my country's comprehensive national strength and accomplishing the goals of the "Eleventh Five-Year Plan." To build socialist modernization, we must rely on education and talents under the leadership of the party. While putting forward the goal of a well-off society, the report of the 16th National Congress of the Communist Party of China made a comprehensive discussion on education, fully expressed the party's educational policy, and proposed the construction of a relatively complete modern national education system and lifelong education system and the construction of national learning and lifelong learning. The requirements of a learning-oriented society have clarified the task of creating hundreds of millions of high-quality workers, tens of millions of specialized talents, and a large number of top-notch innovative talents. Since the reform and opening up, my country has basically popularized nine-year compulsory education and realized the popularization of higher education. This is a new milestone in the history of education and even the history of the nation. The report of the 16th National Congress of the Communist Party of China clearly stated that it is necessary to "improve the quality of education," and the government work report also called for "focusing on improving the quality of higher education." The national plan is education-oriented; the education plan is teacher-oriented. Since 1999, my country's colleges and universities have expanded enrollment year after year. Zhou Ji mentioned in his "Speech at the National College Enrollment Work Teleconference in 2005": in recent years, my country's higher education has achieved a great historic leap, and the gross enrollment rate of higher education has increased from 9.8% in 1998 to 2004. 19% of the total, it will exceed 8 million in 2005 and reach 10 million in 2006. This shows that my country's higher education is in the stage of transformation to mass education. With the rapid expansion of the scale of undergraduate education, the improvement of the socialist market economic system, and the strategic adjustment of the economic structure, all aspects of society are concerned about the quality of higher education personnel training. New and higher requirements are put forward. The increase in the gross enrollment rate has brought about a decline in the quality of students and insufficient resources for running schools, which in turn leads to a decline in the quality of training, which poses a potential challenge to the quality of higher education. In the process of transforming higher education from elite education to mass education, we must attach great importance to the quality construction of higher education and put the strengthening of undergraduate teaching in the important work agenda. Educational administrative departments at all levels should take the quality of education, especially the quality of undergraduate education, as an important basis for evaluating and measuring the work of colleges and universities, and how to correctly monitor and evaluate the teaching quality of colleges and universities is an important topic before us. "Educational quality" is the most basic and most important requirement of society for schools, especially in the 1980s. Since then, the concepts of "quality first" and "quality is the soul and life of higher education" have been increasingly recognized worldwide. My country's education authorities also attach great importance to the improvement of education quality. In September 2001, the Ministry of Education issued a notice on "Several Opinions on Strengthening Undergraduate Teaching in Colleges and Universities and Improving Teaching Quality," which put forward suggestions for effectively strengthening the undergraduate teaching work and improving the teaching quality in colleges and universities. In March 2003, the Ministry of Education launched the "Quality Project," which mainly includes four aspects: the reform of the talent training model of the entire higher education, the change of teaching content, the change of the teaching system, and how to improve the quality of college students. Combined with the actual situation of education in my country, the "Quality Engineering" project was launched in batches. Among the four projects launched in the early stage, teaching quality evaluation is one of them. The inspection and evaluation of teaching quality is one of the core contents of the entire teaching quality, an important basis for measuring the teaching level of teachers, and also a way to improve teaching quality. It is the key to the teaching work of colleges and universities to pay full attention to and effectively grasp the teaching quality of teachers. The monitoring and evaluation of teachers' teaching quality has become one of the important topics in the teaching reform and teaching management of colleges and universities. For a long time, the monitoring and evaluation of the teaching quality of general physical education has been a weak link, and there is almost no complete evaluation system, which is very unfavorable to the monitoring and improvement of education quality. In particular, the new curriculum plan has made great efforts to reform the curriculum system and curriculum standards. How to monitor and evaluate the implementation of the new curriculum plan needs to develop a monitoring and evaluation system that is both comprehensive and suitable for new requirements. Therefore, researching and improving the teaching quality monitoring and evaluation system of physical education teachers is one of the hotspots and key issues in the current teaching reform in colleges and universities, and has very important practical significance. The physical education teaching quality evaluation in colleges and universities is frequently viewed as the MADM issue. Therefore, it is of great significance to start with the physical education teaching quality evaluation in colleges and universities. Thus, in such section a useful numerical example is given for physical education teaching quality evaluation in colleges and universities to illustrate the built method. There are five possible physical education teachers $PET_i\,(i = 1, 2, 3, 4, 5)$ to select. The expert group selects four defined attributes to assess five possible physical education teachers: ① GG_1 is the teaching attitude; ② GG_2 is the teaching costs; ③ GG_3 is the student feedback; ④ GG_4 is the peer recognition. Evidently, GG_2 is the cost attribute. In the following, the SVNN-taxonomy is built for physical education teaching quality evaluation in colleges and universities..

Step 1. Set up each DM's SVNN matrix $QQ^{(k)} = (qq_{ij}^{k})_{m\times n}\,(i = 1, 2, \ldots, 5, j = 1, 2, 3, 4, k = 1, 2, \ldots, 5)$ as in Table 1. From these tables, the overall Table 2 SVNN matrix is calculated. Table 3 results are depicted in Table 4.

Step 2. Normalize the SVNN matrix $QQ = [q_q^{ij}]_{m\times n}$ to $NQQ = [nq_q^{ij}]_{m\times n}$ (see Table 5).

Step 3. Decide the attribute weights CW_j $(j = 1, 2, \ldots, n)$ through the CRITIC method (Table 6).

Step 4. Calculate the SVNNCDM (Table 7).

Step 5. Homogenization of the alternatives:

First, the SVNN shortest distance of each row of the SVNNCDM is derived as follows:

$$\begin{aligned} &SVNNO_1 = 0.0363, SVNNO_2 = 0.0253,\\ &SVNNO_3 = 0.0417,\\ &SVNNO_4 = 0.0286, SVNNO_5 = 0.0253. \end{aligned} \tag{21}$$

Then, by calculating the mean and standard deviation of the probabilistic linguistic shortest distance of each row, the homogeneity range of composite distance matrix is as follows:

$$\begin{aligned} &SVNN\overline{O} = 0.0312, S_{SVNNO} = 0.0072,\\ &SVNNO = SVNN\overline{O} \pm 2S_{SVNNO} = 0.0312 \pm 2 * 0.0072. \end{aligned} \tag{22}$$

Therefore, all the SVNN shortest distance of each row of SVNNCDM is in this range, and the given alternatives are homogeneous.

Step 7. Obtain the SVNNPIS of SVNSs (Table 8).

Step 8. Calculate the given SVNNDP for each alternative:

$$\begin{aligned} &SVNN\ DP(SVNNA_1, SVNNPIS) = 0.1942,\\ &SVNN\ DP(SVNNA_2, SVNNPIS) = 0.2856,\\ &SVNN\ DP(SVNNA_3, SVNNPIS) = 0.1493,\\ &SVNN\ DP(SVNNA_4, SVNNPIS) = 0.2396,\\ &SVNN\ DP(SVNNA_5, SVNNPIS) = 0.2332. \end{aligned} \tag{23}$$

Step 9. Calculate the $SVNNLD_0$ and the $SVNNPV_i\,(i = 1, 2, 3, 4, 5)$ as follows:

$$\begin{aligned} &SVNNHLD_0 = 0.2976, SVNN\ DP\ V_1 = 0.6373,\\ &SVNN\ DP\ V_2 = 0.9234,\\ &SVNN\ DP\ V_3 = 0.5032, SVNNPV_4 = 0.7785,\\ &SVNN\ DP\ V_5 = 0.7654. \end{aligned} \tag{24}$$

Table 1: SVNN evaluation information by EE_1.

	GG_1	GG_2	GG_3	GG_4
PET_1	(0.22, 0.41, 0.22)	(0.24, 0.11, 0.28)	(0.42, 0.17, 0.22)	(0.22, 0.02, 0.22)
PET_2	(0.29, 0.14, 0.21)	(0.22, 0.42, 0.43)	(0.22, 0.09, 0.42)	(0.21, 0.05, 0.29)
PET_3	(0.20, 0.14, 0.20)	(0.22, 0.12, 0.26)	(0.22, 0.15, 0.22)	(0.48, 0.15, 0.24)
PET_4	(0.34, 0.15, 0.42)	(0.16, 0.15, 0.11)	(0.30, 0.23, 0.30)	(0.14, 0.42, 0.43)
PET_5	(0.41, 0.04, 0.43)	(0.21, 0.11, 0.11)	(0.33, 0.41, 0.15)	(0.36, 0.04, 0.45)

Table 2: SVNN evaluation information by EE_2.

	GG_1	GG_2	GG_3	GG_4
PET_1	(0.20, 0.32, 0.20)	(0.44, 0.34, 0.32)	(0.23, 0.35, 0.37)	(0.16, 0.15, 0.11)
PET_2	(0.21, 0.07, 0.29)	(0.22, 0.14, 0.22)	(0.22, 0.15, 0.22)	(0.28, 0.24, 0.14)
PET_3	(0.24, 0.07, 0.28)	(0.24, 0.19, 0.28)	(0.42, 0.07, 0.22)	(0.24, 0.41, 0.48)
PET_4	(0.22, 0.23, 0.22)	(0.44, 0.33, 0.36)	(0.33, 0.33, 0.33)	(0.21, 0.01, 0.11)
PET_5	(0.29, 0.32, 0.23)	(0.44, 0.44, 0.34)	(0.35, 0.09, 0.32)	(0.31, 0.05, 0.19)

Table 3: SVNN evaluation information by EE_3.

	GG_1	GG_2	GG_3	GG_4
PET_1	(0.31, 0.03, 0.42)	(0.11, 0.11, 0.11)	(0.22, 0.35, 0.22)	(0.26, 0.44, 0.34)
PET_2	(0.33, 0.03, 0.46)	(0.11, 0.19, 0.16)	(0.22, 0.03, 0.22)	(0.44, 0.33, 0.36)
PET_3	(0.43, 0.04, 0.46)	(0.31, 0.19, 0.16)	(0.36, 0.04, 0.33)	(0.24, 0.28, 0.36)
PET_4	(0.47, 0.47, 0.04)	(0.31, 0.01, 0.17)	(0.33, 0.34, 0.21)	(0.31, 0.47, 0.26)
PET_5	(0.45, 0.09, 0.43)	(0.41, 0.05, 0.19)	(0.39, 0.13, 0.32)	(0.42, 0.04, 0.42)

Table 4: Overall SVNN evaluation information.

	GG_1	GG_2	GG_3	GG_4
PET_1	(0.3353, 0.2145, 0.5625)	(0.2681, 0.1243, 0.5016)	(0.4944, 0.004, 0.4244)	(0.3942, 0.1254, 0.4246)
PET_2	(0.5601, 0.3498, 0.3066)	(0.6300, 0.3214, 0.3500)	(0.4346, 0.1008, 0.3644)	(0.4432, 0.18907, 0.3366)
PET_3	(0.4234, 0.2198, 0.3264)	(0.3606, 0.2109, 0.4192)	(0.4324, 0.2122, 0.2696)	(0.4030, 0.1067, 0.2990)
PET_4	(0.3166, 0.1078, 0.4632)	(0.4923, 0.3217, 0.4099)	(0.2613, 0.2199, 0.5085)	(0.5665, 0.3287, 0.3333)
PET_5	(0.3361, 0.4209, 0.5636)	(0.3268, 0.4326, 0.5502)	(0.3355, 0.2165, 0.5523)	(0.3532, 0.4367, 0.5268)

Table 5: The normalized SVNN evaluation information.

	GG_1	GG_2	GG_3	GG_4
PET_1	(0.3353, 0.2145, 0.5625)	(0.5016, 0.1243, 0.2681)	(0.4944, 0.004, 0.4244)	(0.3942, 0.1254, 0.4246)
PET_2	(0.5601, 0.3498, 0.3066)	(0.3500, 0.3214, 0.6300)	(0.4346, 0.1008, 0.3644)	(0.4432, 0.18907, 0.3366)
PET_3	(0.4234, 0.2198, 0.3264)	(0.4192, 0.2109, 0.3606)	(0.4324, 0.2122, 0.2696)	(0.4030, 0.1067, 0.2990)
PET_4	(0.3166, 0.1078, 0.4632)	(0.4099, 0.3217, 0.4923)	(0.2613, 0.2199, 0.5085)	(0.5665, 0.3287, 0.3333)
PET_5	(0.3361, 0.4209, 0.5636)	(0.5502, 0.4326, 0.3268)	(0.3355, 0.2165, 0.5523)	(0.3532, 0.4367, 0.5268)

Table 6: The attribute weights.

	GG_1	GG_2	GG_3	GG_4
Weight	0.1212	0.3435	0.3095	0.2258

Table 7: The SVNNCDM.

	PET_1	PET_2	PET_3	PET_4	PET_5
PET_1	—	0.4497	0.4132	0.4600	0.4616
PET_2	0.4497	—	0.4605	0.3747	0.3672
PET_3	0.4132	0.4605	—	0.4490	0.4795
PET_4	0.4600	0.3747	0.4490	—	0.3966
PET_5	0.4616	0.3672	0.4795	0.3966	—

Step 10. According to $SVNN\ DP\ V_i\,(i = 1, 2, 3, 4, 5)$, the order is $PET_2 > PET_4 > PET_5 > PET_1 > PET_3$ and the best college students are PET_2.

4.2. Comparative Analysis. Firstly, SVNN-taxonomy is compared with existed SVNNWA and SVNNWG operators [61]. For SVNWA operator, the given calculating values are $EV\,(\mathrm{PET}_1) = 0.2776$, $EV\,(\mathrm{PET}_2) = 0.6546$, $EV\,(\mathrm{PET}_3) = 0.2048$, $EV\,(\mathrm{PET}_4) = 0.5465$, $EV\,(\mathrm{PET}_5) = 0.4654$. Thus, the ranking order is $\mathrm{PET}_2 > \mathrm{PET}_4 > \mathrm{PET}_5 > \mathrm{PET}_1 > \mathrm{PET}_3$. For SVNWG operator, the obtained calculating values are $EV\,(PET_1) = 0.2687, EV\,(PET_2) = 0.6253, EV\,(PE$

Table 8: SVNNPIS of SVNSs.

	GG_1	GG_2	GG_3	GG_4
SVNNPIS	(0.5601, 0.3498, 0.3066)	(0.5502, 0.4326, 0.3268)	(0.4944, 0.004, 0.4244)	(0.5665, 0.3287, 0.3333)

Table 9: Evaluation obtained results of these selected methods.

Methods	Order	The best choice	The worst choice
SVNNWA operators [61]	$PET_2 > PET_4 > PET_5 > PET_1 > PET_3$	PET_2	PET_3
SVNNWG operators [61]	$PET_2 > PET_4 > PET_5 > PET_1 > PET_3$	PET_2	PET_3
SVNN-CODAS [67]	$PET_2 > PET_4 > PET_5 > PET_1 > PET_3$	PET_2	PET_3
SVNN-EDAS [68]	$PET_2 > PET_4 > PET_5 > PET_1 > PET_3$	PET_2	PET_3
The developed model	$PET_2 > PET_4 > PET_5 > PET_1 > PET_3$	PET_2	PET_3

$T_3) = 0.2438, EV(PET_4) = 0.5133, EV(PET_5) = 0.4658$. So, the ranking order is $PET_2 > PET_4 > PET_5 > PET_1 > PET_3$.

Then, SVNN-taxonomy is compared with SVNN-CODAS method [67], and the given calculating assessment values are $SVNNAV(PET_1) = -0.2354$, $SVNNAV(PET_2) = 0.3659, SVNNAV(PET_3) = -0.3128, SVNNAV(PET_4) = 0.2437, SVNNAV(PET_5) = 0.1265$. Thus, the ranking order is $PET_2 > PET_4 > PET_5 > PET_1 > PET_3$.

Then, SVNN-taxonomy is compared with SVNN-EDAS method [68], and the given calculating appraisal score is $SVNNAS(PET_1) = 0.2126, SVNNAV(PET_2) = 0.6694$, $SVNNAS(PET_3) = 0.1658$, $SVNNAS(PET_4) = 0.5622$, $SVNNAS(PET_5) = 0.3317$. Thus, the ranking order is $PET_2 > PET_4 > PET_5 > PET_1 > PET_3$.

From the above detailed analysis in Table 9, it could be seen that these three given models have the same optimal choice CS_2 and these five methods' order is slightly different. This verifies the SVNN-taxonomy is reasonable and effective. These five given models have their given advantages: (1) SVNNWA operator emphasis group decision influences; (2) SVNNWG operator emphasis individual decision influences; (3) the advantage of the SVNN-CODAS model lies in the use of two distance measures; it combines the Euclidean distance and the Hamming distance to select the optimal solution; (4) the SVNN-EDAS evaluation model measures the degree to which the alternative is far from the average solution through two indicators; (5) the SVNN-taxonomy evaluation model uses the Euclidean distance to compare the alternatives in pairs to obtain a composite distance matrix, then homogenize the alternatives according to the composite distance matrix, and finally measure the difference between the positive ideal solution and the alternatives.

5. Conclusion

Physical education in colleges and universities changes with the changes of society and students' needs, and the teaching quality evaluation system that conforms to it should also be constantly improved and innovated, and insist on keeping pace with the times. The teaching concept of the new era requires colleges and universities to establish the concept of training sports talents in the new era of comprehensive development. It is necessary to evaluate not only the effect of physical education teaching, but also the process of physical education classroom teaching. "Developmental teaching quality evaluation" attaches great importance to the professional quality development of physical education teachers and the level of professional teaching skills, encourages physical education teachers to actively participate in physical education quality evaluation, and integrates into the whole process of evaluating physical education quality in the form of communication, negotiation, and discussion In the end, a high-quality sports teacher team will be formed. When universities establish the purpose of physical education quality evaluation, they need to fully combine the concept of teaching concept in the new era with the concept of development of teaching evaluation. Although the role of the reward and punishment system is not excluded, its fundamental purpose should be to improve the quality of physical education teaching and constantly promote physical education teachers and teachers. Universities should gradually abandon the system of rewards and punishments, in line with the evaluation concept of the new era, center on the professional development of physical education teachers, and promote the overall improvement of physical education teachers' professional ability and teaching quality through the implementation of the physical education quality evaluation system. Universities need to continuously improve and perfect the evaluation system before they can drive the development of physical education teaching quality and improve the quality of training physical education talents. The physical education teaching quality evaluation in colleges and universities is frequently viewed as the MADM issue. In such paper, SVNN-taxonomy method is built for MAGDM with CRITIC weight. Firstly, the Euclidean distance of SVNSs is reviewed. Then, the expected values and the CRITIC method are then utilized to derive the weights. Then, the optimal choice is obtained through calculating the smallest SVNNDPV from SVNNPIS. Finally, a practical example for physical education teaching quality evaluation in colleges and universities is given to elaborate the built method and some good comparative algorithms are also employed to proof the applicability for MAGDM. In the future, the extension and application of the built methods under SVNSs shall be investigated into other fuzzy MAGDM [69–75] and other uncertain settings [76–78]. At the same time, further research should expand the proposed framework to relevant social and economic, for instance, sustainable development-level evaluation and innovative development ability evaluation and others.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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