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ExpTODIM-VIKOR Framework for Quality Evaluation of University Educational Management Using Linguistic Neutrosophic Numbers

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Abstract: University educational management quality evaluation is a systematic assessment of various elements involved in the educational management process of higher education institutions. Its goal is to analyze aspects such as management systems, resource allocation, faculty quality, student services, and curriculum design, measuring the impact of management practices on teaching outcomes to ensure educational objectives are met. This evaluation system helps improve the operational efficiency and teaching quality of universities, enhancing their reputation and aligning talent cultivation with societal needs. The quality evaluation of university educational management is a task well-suited for multi-attribute group decision-making (MAGDM). Recently, the Exponential TODIM (ExpTODIM) and VIKOR methods have been introduced to address MAGDM challenges. For handling uncertain data during this evaluation, the 2-tuple linguistic neutrosophic sets (2TLNSs) have been introduced as an effective tool. In this research, the 2-tuple linguistic neutrosophic number ExpTODIM-VIKOR (2TLNN-ExpTODIM-VIKOR) method is introduced to tackle MAGDM challenges using 2TLNSs. Furthermore, a numerical study focusing on the quality evaluation of university educational management is conducted to validate the effectiveness of the 2TLNN-ExpTODIM-VIKOR approach.

Keywords: MAGDM; 2TLNSs; ExpTODIM approach; VIKOR approach; quality evaluation of university educational management

1. Introduction

1.1. Research background

Educational management is a service-oriented support function rooted in university educational activities. It serves as the backbone for improving educational quality and effectiveness at the management level, thereby promoting the long-term development of various educational undertakings within the institution. Particularly in the context of the new era, only by aligning with societal progress can university educational management effectively meet the demands of contemporary development, enabling faster and better growth of higher education. A quality assurance system, which is based on the content, form, and objectives of educational management, provides a comprehensive evaluation. It promotes the smooth completion of educational management tasks through scientific and reasonable methods, ensuring that it plays its supportive educational role under the premise of high quality and high efficiency. In the context of the massification of education, this system enhances the efficiency and quality of both the management framework and the teaching mechanism, gradually making universities an integral part of the rapid development of the socio-economic landscape. As early as 2001, Wang and Zhou [1] explored the design of university educational management information systems oriented towards quality evaluation. They proposed that the system's design should cover a wide range of information points and meet the needs of network users while ensuring cost-effectiveness and generalization. This laid the foundation for subsequent research on university educational management systems. In 2007, Zhu and Yan [2] emphasized the importance of educational management in improving university teaching quality. They argued that teaching quality is the lifeline of universities and that effective educational management is the fundamental guarantee for improving teaching quality. The study explored how to enhance teaching quality through faculty management, teaching management, and student management. Then, in 2009, Lan [3] discussed the application of total quality management theory in university educational management. Based on experiences from corporate total quality management, he suggested that this theory could significantly enhance the quality of university management, particularly in coping with the challenges posed by the massification of higher education, ensuring sustainable university development. With the further development of higher education, Gao [4] studied changes in the quality of university educational management in the context of higher education massification. He noted a decline in teaching quality as higher education became more accessible, which affected the quality of talent cultivation. The study highlighted the importance of researching educational management quality in the context of China's "12th Five-Year Plan" for national talent development. In 2019, Gao [5] proposed that educational supervision is key to improving the quality of university educational management. He argued that a well-developed educational supervision system could significantly enhance university management quality, particularly in ensuring the quality of educational management. In the same year, Liu [6] focused on issues related to university entrepreneurship education management models and quality evaluation. He analyzed various problems in the development of entrepreneurship education, particularly in terms of management model innovation and quality evaluation systems, and proposed strategies to improve students' entrepreneurial and employability skills. In 2021, Liu [7] researched the quality assurance path for university educational management. He argued that educational management plays a crucial role in university curriculum reform and proposed a quality assurance mechanism that integrates educational management with talent cultivation to ensure the long-term development of universities. In 2022, Guo [8] analyzed issues in university educational management from the perspective of innovative talent cultivation. She emphasized that cultivating innovative talent is key to societal progress and argued that universities should adjust traditional talent cultivation models and promote industry-university-research cooperation to optimize educational management systems. In 2023, Lin [9] further explored university entrepreneurship education management models and quality evaluation. She analyzed the development of entrepreneurship education management models in Chinese universities and proposed methods for constructing management and evaluation systems to improve the effectiveness of entrepreneurship education. Finally, in 2024, Fang [10] proposed an optimization strategy for university educational management aimed at improving employment service quality. He analyzed the current state of university educational management and emphasized the importance of providing high-quality employment services to students. He proposed relevant optimization measures to enhance students' competitiveness in the job market and promote economic growth.

MAGDM involves a decision-making process with multiple decision-makers and multiple evaluation attributes [11-14]. This mode of decision-making is especially effective in addressing issues with multiple objectives and complex informational backgrounds. MAGDM provides significant decision support in policy-making, resource allocation, and public project management. For instance, in urban planning and environmental assessment, decision-makers need to evaluate multiple impact factors of various schemes [15, 16]. Businesses can optimize decision processes using MAGDM methods in areas such as supply chain management, project management, and strategic planning[17-21]. For example, selecting the best supplier by evaluating multiple performance indicators. MAGDM methods are used to evaluate and select investment portfolios, helping investors make better decisions by analyzing the risks and returns of multiple investment options. In medical decision-making, MAGDM helps healthcare institutions evaluate multiple indicators of different treatment options, such as cost, effectiveness, and risk, to offer personalized treatment plans for patients[22-25]. In environmental resource management and conservation decisions, MAGDM is used to evaluate the effectiveness of different environmental measures, helping decision-makers find a balance between economic benefits and environmental protection. In summary, MAGDM has made significant progress in both theory and application and will continue to expand its applications across various industries. With technological advancements, future MAGDM research will focus more on algorithm innovation, improving decision quality, and addressing ethical and sustainability issues in decision-making.

1.2. Research Motivation

The quality evaluation of university educational management involves MAGDM. Recently, the ExpTODIM [26-33] and VIKOR approaches [34, 35] have been applied to address these MAGDM challenges. The 2TLNSs [36] are utilized as a robust tool for representing uncertain data during the quality evaluation process in this context. In this research, the 2TLNN-ExpTODIM-VIKOR method is introduced to manage MAGDM using 2TLNSs. Additionally, a numerical study is conducted to validate the 2TLNN-ExpTODIM-VIKOR approach in the quality evaluation of university educational management as part of rural revitalization efforts. The major research goal and motivations are illustrated: (1) ExpTODIM and VIKOR approach are extended to the 2TLNNs; (2) entropy approach is described to obtain the weight under 2TLNNs; (3) 2TLNN-ExpTODIM-VIKOR approach is described forward MAGDM under 2TLNNs; (4) Finally, numerical example for quality evaluation for quality evaluation of university educational management and comparative analysis are described to validate the 2TLNN-ExpTODIM-VIKOR approach.

1.3. Structure of this paper

The structure of this research is organized. Section 2 introduces the concept of 2TLNSs. In Section 3, the 2TLNN-ExpTODIM-VIKOR approach is presented, integrating 2TLNSs with entropy. Section 4 offers an illustrative example focused on the quality evaluation of university educational management, accompanied by a comparative analysis. Section 5 offers a comparative analysis. Finally, Section 6 concludes with closing remarks.

2. Preliminaries

Wang et al. [36] described the 2TLNSs.

Definition 1 [36]. Let $z\vartheta$ be linguistic term sets (LTSs):

$$\begin{aligned} z\vartheta = \{ & z\vartheta_0 = exceedingly\ terrible, z\vartheta_1 = very\ terrible, z\vartheta_2 = terrible, \\ & z\vartheta_3 = medium, z\vartheta_4 = well, z\vartheta_5 = very\ well, z\vartheta_6 = exceedingly\ well \}, \end{aligned}$$

The 2TLNSs are described:

$$z\xi = \left\langle \left(z\vartheta_t, zx,\right), \left(z\vartheta_i, zy\right), \left(z\vartheta_f, zz\right) \right\rangle \quad (1)$$

where 2-tuple linguistic values $\left(z\vartheta_t, zx,\right), \left(z\vartheta_i, zy\right), \left(z\vartheta_f, zz\right)$ are membership, indeterminacy, and non-membership $0 \le \Delta^{-1}\left(z\vartheta_t, zx,\right) + \Delta^{-1}\left(z\vartheta_i, zy\right) + \Delta^{-1}\left(z\vartheta_f, zz\right) \le 3z\pi$.

Wang et al. [36] described the linguistic score function (LSF) and linguistic accuracy function (LAF) for 2TLNNs.

Definition 2[36]. Let $z\xi_1 = \left\langle \left(z\vartheta_{t_1}, zx_1,\right), \left(z\vartheta_{i_1}, zy_1\right), \left(z\vartheta_{f_1}, zz_1\right) \right\rangle$, $z\xi_2 = \left\langle \left(z\vartheta_{t_2}, zx_2,\right), \left(z\vartheta_{i_2}, sy_2\right), \left(z\vartheta_{f_2}, zz_2\right) \right\rangle$, the SF and AF are described:

$$LSF\left(z\xi_1\right) = \frac{\begin{pmatrix} 2z\pi + \Delta^{-1}\left(z\vartheta_{t_1}, zx_1,\right) \\ -\Delta^{-1}\left(z\vartheta_{i_1}, zy_1\right) - \Delta^{-1}\left(z\vartheta_{f_1}, zz_1\right) \end{pmatrix}}{3z\pi}, \quad LSF\left(z\xi_1\right) \in [0,1] \quad (2)$$

$$LSF\left(z\xi_2\right) = \frac{\begin{pmatrix} 2z\pi + \Delta^{-1}\left(z\vartheta_{t_2}, zx_2\right) \\ -\Delta^{-1}\left(z\vartheta_{i_2}, zy_2\right) - \Delta^{-1}\left(z\vartheta_{f_2}, zz_2\right) \end{pmatrix}}{3z\pi}, \quad LSF\left(z\xi_2\right) \in [0,1] \quad (3)$$

$$LAF\left(z\xi_1\right) = \frac{1}{2z\pi}\left(z\pi + \Delta^{-1}\left(z\vartheta_{t_1}, zx_1,\right) - \Delta^{-1}\left(z\vartheta_{f_1}, zz_1\right)\right), \quad LAF\left(z\xi_1\right) \in [0,1] \quad (4)$$

$$LAF\left(z\xi_2\right)=\frac{1}{2z\pi}\left(z\pi+\Delta^{-1}\left(z\vartheta_{t_2},zx_2\right)-\Delta^{-1}\left(z\vartheta_{f_2},zz_2\right)\right),\quad LAF\left(z\xi_2\right)\in[0,1] \tag{5}$$

For two $z\xi_1=\left\langle\left(z\vartheta_{t_1},zx_1,\right),\left(z\vartheta_{i_1},zy_1\right),\left(z\vartheta_{f_1},zz_1\right)\right\rangle$, $z\xi_2=\left\langle\left(z\vartheta_{t_2},zx_2,\right),\left(z\vartheta_{i_2},sy_2\right),\left(z\vartheta_{f_2},zz_2\right)\right\rangle$, the order is described: (1) $if\ LSF\left(z\xi_1\right)\prec LSF\left(z\xi_2\right),\ z\xi_1\prec z\xi_2;$ (2) $if\ LSF\left(z\xi_1\right)=LSF\left(z\xi_2\right), LAF\left(z\xi_1\right)\prec LAF\left(z\xi_2\right),\quad z\xi_1\prec z\xi_2;\quad if\ LSF\left(z\xi_1\right)=LSF\left(z\xi_2\right),$ $LAF\left(z\xi_1\right)=LAF\left(z\xi_2\right),\ z\xi_1=z\xi_2.$

Definition 3[27]. Let $z\xi_1=\left\langle\left(z\vartheta_{t_1},zx_1,\right),\left(z\vartheta_{i_1},zy_1\right),\left(z\vartheta_{f_1},zz_1\right)\right\rangle$, $z\xi_2=\left\langle\left(z\vartheta_{t_2},zx_2,\right),\left(z\vartheta_{i_2},sy_2\right),\left(z\vartheta_{f_2},zz_2\right)\right\rangle$ and $z\xi=\left\langle\left(z\vartheta_t,zx,\right),\left(z\vartheta_i,zy\right),\left(z\vartheta_f,zz\right)\right\rangle$ be 2TLNNs, then

$$(1)\ z\xi_1\oplus z\xi_2=\left\{\begin{array}{l}\Delta\left(z\pi\left(\frac{\Delta^{-1}\left(z\vartheta_{t_1},zx_1,\right)}{z\pi}+\frac{\Delta^{-1}\left(z\vartheta_{t_2},zx_2,\right)}{z\pi}-\frac{\Delta^{-1}\left(z\vartheta_{t_1},zx_1,\right)}{z\pi}\cdot\frac{\Delta^{-1}\left(z\vartheta_{t_2},zx_2,\right)}{z\pi}\right)\right),\\ \Delta\left(z\pi\left(\frac{\Delta^{-1}\left(z\vartheta_{i_1},zy_1\right)}{z\pi}\cdot\frac{\Delta^{-1}\left(z\vartheta_{i_2},zy_2\right)}{z\pi}\right)\right),\Delta\left(z\pi\left(\frac{\Delta^{-1}\left(z\vartheta_{f_1},zz_1\right)}{z\pi}\cdot\frac{\Delta^{-1}\left(z\vartheta_{f_2},zz_2\right)}{z\pi}\right)\right)\end{array}\right\};$$

$$(2)\ \ z\xi_1\otimes z\xi_2=\left\{\begin{array}{l}\Delta\left(z\pi\frac{\Delta^{-1}\left(z\vartheta_{t_1},zx_1,\right)}{z\pi}\cdot\frac{\Delta^{-1}\left(z\vartheta_{t_2},zx_2,\right)}{z\pi}\right),\\ \Delta\left(z\pi\left(\frac{\Delta^{-1}\left(z\vartheta_{i_1},zy_1\right)}{z\pi}+\frac{\Delta^{-1}\left(z\vartheta_{i_2},zy_2\right)}{z\pi}-\frac{\Delta^{-1}\left(z\vartheta_{i_1},zy_1\right)}{z\pi}\cdot\frac{\Delta^{-1}\left(z\vartheta_{i_2},zy_2\right)}{z\pi}\right)\right),\\ \Delta\left(z\pi\left(\frac{\Delta^{-1}\left(z\vartheta_{f_1},zz_1\right)}{z\pi}+\frac{\Delta^{-1}\left(z\vartheta_{f_2},zz_2\right)}{z\pi}-\frac{\Delta^{-1}\left(z\vartheta_{f_1},zz_1\right)}{z\pi}\cdot\frac{\Delta^{-1}\left(z\vartheta_{f_2},zz_2\right)}{z\pi}\right)\right)\end{array}\right\};$$

$$(3)\ \ \lambda z\xi_1=\left\{\begin{array}{l}\Delta\left(z\pi\left(1-\left(1-\frac{\Delta^{-1}\left(z\vartheta_{t_1},zx_1,\right)}{z\pi}\right)^{\lambda}\right)\right),\\ \Delta\left(z\pi\left(\frac{\Delta^{-1}\left(z\vartheta_{i_1},zy_1\right)}{z\pi}\right)^{\lambda}\right),\left(z\pi\left(\frac{\Delta^{-1}\left(z\vartheta_{f_1},zz_1\right)}{z\pi}\right)^{\lambda}\right)\end{array}\right\};$$

$$(4)\left(z\xi_1\right)^{\lambda}=\left\{\begin{array}{l}\Delta\left(z\pi\left(\frac{\Delta^{-1}\left(z\vartheta_{t_1},zx_1,\right)}{z\pi}\right)^{\lambda}\right),\Delta\left(z\pi\left(1-\left(1-\frac{\Delta^{-1}\left(z\vartheta_{i_1},zy_1\right)}{z\pi}\right)^{\lambda}\right)\right),\\ \Delta\left(z\pi\left(1-\left(1-\frac{\Delta^{-1}\left(z\vartheta_{f_1},zz_1\right)}{z\pi}\right)^{\lambda}\right)\right)\end{array}\right\}.$$

The 2TLNN Hamming distance (2TLNNHD) and 2TLNN Euclidean distance (2TLNNED) [37] is described.

Definition 4[37]. Let $z\xi_1=\left\langle\left(z\vartheta_{t_1},zx_1,\right),\left(z\vartheta_{i_1},zy_1\right),\left(z\vartheta_{f_1},zz_1\right)\right\rangle$, $z\xi_2=\left\langle\left(z\vartheta_{t_2},zx_2,\right),\left(z\vartheta_{i_2},sy_2\right),\left(z\vartheta_{f_2},zz_2\right)\right\rangle$, the 2TLNNHD are described:

$$2TLNNHD\left(z\xi_1,z\xi_2\right)=\frac{1}{3}\left(\begin{array}{l}\left|\frac{\Delta^{-1}\left(z\vartheta_{t_1},zx_1\right)-\Delta^{-1}\left(z\vartheta_{t_2},zx_2\right)}{z\pi}\right|\\+\left|\frac{\Delta^{-1}\left(z\vartheta_{i_1},zy_1\right)-\Delta^{-1}\left(z\vartheta_{i_2},zy_2\right)}{z\pi}\right|\\+\left|\frac{\Delta^{-1}\left(z\vartheta_{f_1},zz_1\right)-\Delta^{-1}\left(z\vartheta_{f_2},zz_2\right)}{z\pi}\right|\end{array}\right) \tag{6}$$

Definition 5[37]. Let $z\xi_1=\left\langle\left(z\vartheta_{t_1},zx_1,\right),\left(z\vartheta_{i_1},zy_1\right),\left(z\vartheta_{f_1},zz_1\right)\right\rangle$, $z\xi_2=\left\langle\left(z\vartheta_{t_2},zx_2,\right),\left(z\vartheta_{i_2},sy_2\right),\left(z\vartheta_{f_2},zz_2\right)\right\rangle$, the 2TLNNED is described:

$$2TLNNED\left(z\xi_1,z\xi_2\right)=\sqrt{\frac{1}{3}\left(\begin{array}{l}\left|\frac{\Delta^{-1}\left(z\vartheta_{t_1},zx_1\right)-\Delta^{-1}\left(z\vartheta_{t_2},zx_2\right)}{z\pi}\right|^2\\+\left|\frac{\Delta^{-1}\left(z\vartheta_{i_1},zy_1\right)-\Delta^{-1}\left(z\vartheta_{i_2},zy_2\right)}{z\pi}\right|^2\\+\left|\frac{\Delta^{-1}\left(z\vartheta_{f_1},zz_1\right)-\Delta^{-1}\left(z\vartheta_{f_2},zz_2\right)}{z\pi}\right|^2\end{array}\right)} \tag{7}$$

Then, the 2TLNNWG approach [36] is described.

Definition 6[36]. Let $z\xi_j=\left\langle\left(z\vartheta_{t_j},zx_j,\right),\left(z\vartheta_{i_j},zy_j\right),\left(z\vartheta_{f_j},zz_j\right)\right\rangle$ be 2TLNNs, the 2TLNNWG approach is described:

$$\begin{aligned}&2\text{TLNNWG}\left(z\xi_1, z\xi_2, \ldots, z\xi_n\right)\\&=\left(z\xi_1\right)^{zw_1} \oplus \left(z\xi_2\right)^{zw_2} \otimes \ldots \otimes \left(z\xi_n\right)^{zw_n} = \underset{j=1}{\overset{n}{\otimes}}\left(z\xi_j\right)^{zw_j}\\&=\left(\begin{array}{l}\Delta\left(z\pi\prod_{j=1}^{n}\left(\frac{\Delta^{-1}\left(z\vartheta_{t_j}, zx_j,\right)}{z\pi}\right)^{zw_j}\right),\\\Delta\left(z\pi\left(1-\prod_{j=1}^{n}\left(1-\frac{\Delta^{-1}\left(z\vartheta_{i_j}, zy_j\right)}{z\pi}\right)^{zw_j}\right)\right),\\\Delta\left(z\pi\left(1-\prod_{j=1}^{n}\left(1-\frac{\Delta^{-1}\left(z\vartheta_{i_j}, zy_j\right)}{z\pi}\right)^{zw_j}\right)\right)\end{array}\right)\end{aligned} \tag{8}$$

with zw_j is the weight value of $z\xi_j, \sum_{j=1}^{n} zw_j = 1.$

3. Method

3.1. 2TLN-MAGDM

The 2TLNN-ExpTODIM-VIKOR is described as the MAGDM. Let $ZX = \left(ZX_1, ZX_2, \ldots, ZX_m\right)$ be alternatives and $ZY = \left(ZY_1, ZY_2, \ldots, ZY_m\right)$ be attributes with weight values $zw = \left(zw_1, zw_2, \cdots, zw_n\right)$ and experts $ZZ = \left(ZZ_1, ZZ_2, \ldots, ZZ_m\right)$ with weight $z\omega = \left(z\omega_1, z\omega_2, \cdots, z\omega_q\right)$, the 2TLNN-ExpTODIM-VIKOR approach is described as the MAGDM.

Step 1. Describe the 2TLNN-matrix $ZR^{(t)} = \left[ZR_{ij}^{(t)}\right]_{m\times n}$:

$$ZR^{(t)} = \left[ZR_{ij}^{(t)}\right]_{m\times n} = \begin{array}{c} \\ ZX_1 \\ ZX_2 \\ \vdots \\ ZX_m \end{array}\begin{array}{c}\begin{array}{cccc} ZY_1 & ZY_2 & \ldots & ZY_n \end{array}\\ \begin{bmatrix} ZR_{11}^{(t)} & ZR_{12}^{(t)} & \ldots & ZR_{1n}^{(t)} \\ ZR_{21}^{(t)} & ZR_{22}^{(t)} & \ldots & ZR_{2n}^{(t)} \\ \vdots & \vdots & \vdots & \vdots \\ ZR_{m1}^{(t)} & ZR_{m2}^{(t)} & \ldots & ZR_{mn}^{(t)} \end{bmatrix}\end{array} \tag{9}$$

where $ZR_{ij}^{(t)} = \left(\left(z\vartheta_{t_{ij}}^{(t)}, zx_{ij}^{(t)},\right),\left(z\vartheta_{i_{ij}}^{(t)}, zy_{ij}^{(t)},\right),\left(z\vartheta_{f_{ij}}^{(t)}, zz_{ij}^{(t)},\right)\right)$ is 2TLNNs.

Step 2. Describe the 2TLNN-matrix $ZR = \left[ZR_{ij}\right]_{m\times n}$:

$$ZR = \left[ZR_{ij} \right]_{m\times n} = \begin{matrix} & ZY_1 & ZY_2 & \dots & ZY_n \\ ZX_1 & ZR_{11} & ZR_{12} & \dots & ZR_{1n} \\ ZX_2 & ZR_{21} & ZR_{22} & \dots & ZR_{2n} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ ZX_m & ZR_{m1} & ZR_{m2} & \dots & ZR_{mn} \end{matrix} \quad (10)$$

In light with 2TLNNWG, the $ZR = \left[ZR_{ij} \right]_{m\times n}$ is described:

$$\begin{aligned} ZR_{ij} &= \left(\left(z\vartheta_{t_{ij}}, zx_{ij} \right), \left(z\vartheta_{i_{ij}}, zy_{ij} \right), \left(z\vartheta_{f_{ij}}, zz_{ij} \right) \right) \\ &= \left(ZR_{ij}^{(1)} \right)^{zw_1} \oplus \left(ZR_{ij}^{(2)} \right)^{zw_2} \otimes \ldots \otimes \left(ZR_{ij}^{(q)} \right)^{zw_q} \\ &= \underset{t=1}{\overset{n}{\otimes}} \left(ZR_{ij}^{(t)} \right)^{zw_t} = \left(\begin{array}{l} \Delta\left(z\pi \prod_{t=1}^{q} \left(\dfrac{\Delta^{-1}\left(z\vartheta_{t_{ij}}^{(t)}, zx_{ij}^{(t)} \right)}{z\pi} \right)^{zw_j} \right), \\ \Delta\left(z\pi \left(1 - \prod_{t=1}^{q} \left(1 - \dfrac{\Delta^{-1}\left(z\vartheta_{i_{ij}}^{(t)}, zy_{ij}^{(t)} \right)}{z\pi} \right)^{uw_j} \right) \right), \\ \Delta\left(z\pi \left(1 - \prod_{t=1}^{q} \left(1 - \dfrac{\Delta^{-1}\left(z\vartheta_{f_{ij}}^{(t)}, zz_{ij}^{(t)} \right)}{z\pi} \right)^{zw_j} \right) \right) \end{array} \right) \end{aligned} \quad (11)$$

Step 3. Describe the 2TLNN normalized matrix $NZR = \left[NZR_{ij} \right]_{m\times n}$ [38].

For benefit attributes:

$$\begin{aligned} NZR_{ij} = ZR_{ij} &= \left(\left(z\vartheta_{t_{ij}}^{N}, zx_{ij}^{N} \right), \left(z\vartheta_{i_{ij}}^{N}, zy_{ij}^{N} \right), \left(z\vartheta_{f_{ij}}^{N}, zz_{ij}^{N} \right) \right) \\ &= \left(\left(z\vartheta_{t_{ij}}, zx_{ij} \right), \left(z\vartheta_{i_{ij}}, zy_{ij} \right), \left(z\vartheta_{f_{ij}}, zz_{ij} \right) \right) \end{aligned} \quad (12)$$

For cost attributes:

$$\begin{aligned} NZR_{ij} &= \left(\left(z\vartheta_{t_{ij}}^{N}, zx_{ij}^{N} \right), \left(z\vartheta_{i_{ij}}^{N}, zy_{ij}^{N} \right), \left(z\vartheta_{f_{ij}}^{N}, zz_{ij}^{N} \right) \right) \\ &= \left(\Delta\left(z\pi - \Delta^{-1}\left(z\vartheta_{t_{ij}}, zx_{ij} \right) \right), \Delta\left(z\pi - \Delta^{-1}\left(z\vartheta_{i_{ij}}, zy_{ij} \right) \right), \Delta\left(z\pi - \Delta^{-1}\left(z\vartheta_{f_{ij}}, zz_{ij} \right) \right) \right) \end{aligned} \quad (13)$$

3.2. Describe the attributes' weight with entropy.

Entropy [39] is utilized to construct weight. The normalized matrix is described:

$$LZZ_{ij}=\frac{1}{2}\left(\frac{\left(SF\left(\left(z\vartheta^{N}_{t_{ij}},zx^{N}_{ij}\right),\left(z\vartheta^{N}_{i_{ij}},zy^{N}_{ij}\right),\left(z\vartheta^{N}_{f_{ij}},zz^{N}_{ij}\right)\right)\right)}{\sum_{i=1}^{m}\left(AF\left(\left(z\vartheta^{N}_{t_{ij}},zx^{N}_{ij}\right),\left(z\vartheta^{N}_{i_{ij}},zy^{N}_{ij}\right),\left(z\vartheta^{N}_{f_{ij}},zz^{N}_{ij}\right)\right)\right)}+\frac{\left(AF\left(\left(z\vartheta^{N}_{t_{ij}},zx^{N}_{ij}\right),\left(z\vartheta^{N}_{i_{ij}},zy^{N}_{ij}\right),\left(z\vartheta^{N}_{f_{ij}},zz^{N}_{ij}\right)\right)+1\right)}{\sum_{i=1}^{m}\left(SF\left(\left(z\vartheta^{N}_{t_{ij}},zx^{N}_{ij}\right),\left(z\vartheta^{N}_{i_{ij}},zy^{N}_{ij}\right),\left(z\vartheta^{N}_{f_{ij}},zz^{N}_{ij}\right)\right)+1\right)}\right) \tag{14}$$

The linguistic Shannon entropy (LSE) is described:

$$LSE_{j}=-\frac{1}{\ln m}\sum_{i=1}^{m}LZZ_{ij}\ln LZZ_{ij} \tag{15}$$

and $LZZ_{ij}\ln LZZ_{ij}=0$ if $LZZ_{ij}=0$.

Then, the weights $zw=\left(zw_{1},zw_{2},\cdots,zw_{n}\right)$ is described:

$$zw_{j}=\frac{1-LSE_{j}}{\sum_{j=1}^{n}\left(1-LSE_{j}\right)},\quad j=1,2,\cdots,n. \tag{16}$$

3.3. 2TLNN-ExpTODIM-VIKOR approach for MAGDM

The 2TLNN-ExpTODIM-VIKOR approach is described to put forward the MAGDM.

(1) Describe relative decision weight:

$$rzw_{j}=zw_{j}\Big/\max_{j}zw_{j}, \tag{17}$$

(2) The linguistic information dominance degree (LIDD) $LIDD_{j}\left(ZA_{i},ZA_{t}\right)$ of ZX_{i} over ZX_{t} for ZY_{j} is described.

$$LIDD_{j}\left(ZX_{i},ZX_{t}\right)=\begin{cases}\dfrac{rzw_{j}\times\left(1-10^{-\rho 2TLNNHD\left(NZR_{ij},NZR_{tj}\right)}\right)}{\sum_{j=1}^{n}rzw_{j}} & \text{if } SF\left(NZR_{ij}\right)>SF\left(NZR_{tj}\right)\\ 0 & \text{if } SF\left(NZR_{ij}\right)=SF\left(NZR_{tj}\right)\\ -\dfrac{1}{\theta}\dfrac{\sum_{j=1}^{n}rzw_{j}\times\left(1-10^{-\rho 2TLNNHD\left(NZR_{ij},NZR_{tj}\right)}\right)}{rzw_{j}} & \text{if } SF\left(NZR_{ij}\right)<SF\left(NZR_{tj}\right)\end{cases} \tag{18}$$

where θ is from Tversky and Kahneman [40] and $\rho\in\left[1,5\right]$ [26].

The $LIDD_j(ZX_i)$ is described:

$$LIDD_j(ZX_i) = \left[LIDD_j(ZX_i, ZX_t)\right]_{m\times m} = \begin{array}{c} \\ ZX_1 \\ ZX_2 \\ \vdots \\ ZX_m \end{array} \begin{array}{c} \begin{array}{cccc} ZX_1 & ZX_2 & \cdots & ZX_m \end{array} \\ \begin{bmatrix} 0 & LIDD_j(ZX_1, ZX_2) & \cdots & LIDD_j(ZX_1, ZX_m) \\ LIDD_j(ZX_2, ZX_1) & 0 & \cdots & LIDD_j(ZX_2, ZX_m) \\ \vdots & \vdots & \cdots & \vdots \\ LIDD_j(ZX_m, ZX_1) & LIDD_j(ZX_m, ZX_2) & \cdots & 0 \end{bmatrix} \end{array}$$

(3) Describe the LIDD of ZX_i for other choices under ZY_j:

$$LIDD_j(ZX_i) = \sum_{t=1}^{m} LIDD_j(ZX_i, ZX_t) \tag{19}$$

The overall LIDD matrix is described:

$$LIDD = \left(LIDD_{ij}\right)_{m\times n} = \begin{array}{c} \\ ZX_1 \\ ZX_2 \\ \vdots \\ ZX_m \end{array} \begin{array}{c} \begin{array}{cccc} ZX_1 & ZX_2 & \cdots & ZX_n \end{array} \\ \begin{bmatrix} \sum_{t=1}^{m} LIDD_1(ZX_1, ZX_t) & \sum_{t=1}^{m} LIDD_2(ZX_1, ZX_t) & \dots & \sum_{t=1}^{m} LIDD_n(ZX_1, ZX_t) \\ \sum_{t=1}^{m} LIDD_1(ZX_2, ZX_t) & \sum_{t=1}^{m} LIDD_2(ZX_2, ZX_t) & \dots & \sum_{t=1}^{m} LIDD_n(ZX_2, ZX_t) \\ \vdots & \vdots & \vdots & \vdots \\ \sum_{t=1}^{m} LIDD_1(ZX_m, ZX_t) & \sum_{t=1}^{m} LIDD_2(ZX_m, ZX_t) & \dots & \sum_{t=1}^{m} LIDD_n(ZX_m, ZX_t) \end{bmatrix} \end{array}$$

(4) Describe the VIKOR approach through maximum group utility $ZTLNS_i$, minimum individual regret information $ZTLNR_i$ and relationship degree $ZTLNQ_i$ between $ZTLNS_i$ and $ZTLNR_i$.

$$ZTLNS_i = \sum_{j=1}^{n} zw_j \frac{d(LIDD_j^+, LIDD_{ij})}{d(LIDD_j^+, LIDD_j^-)} \tag{20}$$

$$ZTLNR_i = \max_{j=1}^{n} zw_j \frac{d(LIDD_j^+, LIDD_{ij})}{d(LIDD_j^+, LIDD_j^-)} \tag{21}$$

$$ZTLNQ_i = v \times \frac{ZTLNS_i - ZTLNS_i^-}{ZTLNS_i^+ - ZTLNS_i^-} + (1-v) \times \frac{ZTLNR_i - ZTLNR_i^-}{ZTLNR_i^+ - ZTLNR_i^-} \tag{22}$$

where $ZTLNS_i^{+} = \max_{i=1}^{m} ZTLNS_i$, $ZTLNS_i^{-} = \min_{i=1}^{m} ZTLNS_i$, $ZTLNR_i^{+} = \max_{i=1}^{m} ZTLNR_i$ and $ZTLNR_i^{-} = \min_{i=1}^{m} ZTLNR_i$. $v \in [0,1]$, in general, $v = 0.5$. $d(LIDD_j^{+}, LIDD_j^{-})$ is distance between $LIDD_j^{+} = \max_{i=1}^{m} LIDD_{ij}$ and $LIDD_{ij}$, $d(LIDD_j^{+}, LIDD_j^{-})$ is distance between $LIDD_j^{+} = \max_{i=1}^{m} LIDD_{ij}$ and $LIDD_j^{-} = \min_{i=1}^{m} LIDD_{ij}$.

(5) Three sequences are described by $ZTLNS_i$, $ZTLNR_i$ and $ZTLNQ_i$ through ascending order.

4. Case Study and Analysis

The evaluation of university educational management quality is a systematic and comprehensive process aimed at assessing the effectiveness and efficiency of various aspects of university management to ensure that management practices support high-quality teaching and research activities. As higher education rapidly develops, society demands higher standards for university performance and talent cultivation, making a scientifically sound management evaluation system an essential tool for continuously improving university management levels. In evaluating the quality of university educational management, the evaluation typically covers multiple dimensions. The first is the soundness of the management system, assessing the scientific and rational nature of institutional structures, organizational frameworks, and decision-making processes. An effective management system not only improves management efficiency but also enhances the overall operational capacity of the institution. The second dimension focuses on the allocation and utilization of teaching resources, evaluating whether faculty, teaching equipment, and educational funding are allocated rationally and whether these resources sufficiently support educational goals. Additionally, the evaluation emphasizes the quality of student management and services, including the organization of student activities, academic support, and mental health services, ensuring that students receive comprehensive support and development during their time at the university. Related to this is the evaluation of teaching management quality, which examines the design and implementation of teaching plans, the rationality of course offerings, the innovativeness of teaching methods, and the achievement of teaching outcomes. Through a comprehensive review of the teaching process, it is possible to understand the specific impact of management practices on teaching quality. Furthermore, research management is another important area of evaluation. Universities should foster research productivity and the transfer of research results through effective research management systems, encouraging faculty to engage in academic research and innovation activities. In terms of evaluation methods, university educational management quality evaluations typically use a combination of quantitative and qualitative approaches. For instance, quantitative methods like surveys and data analysis offer objective insights into management effectiveness, while qualitative approaches, such as expert interviews and case studies, delve into underlying issues and areas for improvement. These evaluations not only pinpoint existing management deficiencies but also serve as a foundation and guide for future management practices. Moreover, the ultimate goal of university educational management quality evaluation is to drive continuous optimization of management systems, achieve efficient allocation of educational resources, and improve the quality of talent cultivation, thereby enhancing the university's overall competitiveness. In the context of globalization, the construction and improvement of the evaluation system must align with international standards to ensure that universities remain competitive and influential in the global education market. This evaluation process is not only a crucial tool for universities' self-improvement but also an important means for the public and government to monitor and provide feedback on university performance. The quality evaluation of university educational management is MAGDM. Five potential regional comprehensive universities $ZX_i\left(i=1,2,3,4,5\right)$ are evaluated with four attributes: ZY_1 is to **Soundness of Management System**: Evaluates the organizational structure, decision-making processes, and institutional frameworks, assessing their scientific rigor and ability to support both day-to-day operations and long-term development; ZY_2 is **Teaching Resource Allocation and Utilization**: Assesses whether the allocation of faculty, teaching equipment, and funding is reasonable and sufficient to meet academic needs and improve teaching quality; ZY_3 is **Student Management and Service Quality**: Evaluates the comprehensiveness of student management and services, including academic support, mental health services, and career development guidance, ensuring students' holistic development; ZY_4 is **Research Management and Innovation Support**: Measures the effectiveness of research management, the support provided for research resources, and the output and commercialization of research results, encouraging faculty engagement in academic and innovative activities. Five regional comprehensive universities are evaluated with 2TLNNs with four criteria through three experts $ZZ_t\left(t=1,2,3\right)$ with expert weight $z\omega=\left(1/3,1/3,1/3\right)$. (Table 1 see appendix)

The 2TLNN-ExpTODIM-VIKOR approach is described to solve the quality evaluation of university educational management.

Step 1. Describe the 2TLNN matrix $ZR^{(t)}=\left[ZR_{ij}^{(t)}\right]_{5\times 4}\left(t=1,2,3\right)$ (Table 2-4).

Table 2. Evaluation data from ZZ_1

	ZY_1	ZY_2	ZY_3	ZY_4
ZX_1	ZW	ZM	ZT	ZVW
ZX_2	ZM	ZW	ZVW	ZVT
ZX_3	ZVT	ZVT	ZVW	ZM
ZX_4	ZT	ZVW	ZVT	ZM
ZX_5	ZVW	ZW	ZM	ZVT

Table 3. Evaluation data from ZZ_2

	ZY_1	ZY_2	ZY_3	ZY_4
ZX_1	ZVT	ZM	ZVW	ZT
ZX_2	ZT	ZW	ZM	ZVW
ZX_3	ZVW	ZW	ZVT	ZM
ZX_4	ZM	ZW	ZVT	ZVW
ZX_5	ZM	ZT	ZVW	ZW

Table 4. Evaluation data from ZZ_3

	ZY_1	ZY_2	ZY_3	ZY_4
ZX_1	ZM	ZT	ZVW	ZW
ZX_2	ZW	ZVW	ZVT	ZT
ZX_3	ZM	ZW	ZT	ZM
ZX_4	ZW	ZVW	ZT	ZM
ZX_5	ZVT	ZVT	ZM	ZW

Then according to 2TLNNWG, the $ZR = \left[ZR_{ij}\right]_{5\times4}$ is described (Table 5).

Table 5. The $ZR = \left[ZR_{ij}\right]_{5\times4}$

	ZY_1
ZX_1	$\{(z\vartheta_2, -0.2547), (z\vartheta_3, 0.2492), (z\vartheta_4, 0.2553)\}$
ZX_2	$\{(z\vartheta_4,\ 0.0213), (z\vartheta_3,\ 0.0125), (z\vartheta_2,\ 0.0435)\}$
ZX_3	$\{(z\vartheta_4, -0.2309), (z\vartheta_3, -0.3265), (z\vartheta_2, 0.3276)\}$
ZX_4	$\{(z\vartheta_5, -0.2973), (z\vartheta_2, 0.2302), (z\vartheta_1, 0.2975)\}$
ZX_5	$\{(z\vartheta_4, 0.1654), (z\vartheta_3, -0.3436), (z\vartheta_2, -0.1763)\}$
	ZY_2
ZX_1	$\{(z\vartheta_4, -0.2495), (z\vartheta_3, -0.4271), (z\vartheta_2, 0.1287)\}$
ZX_2	$\{(z\vartheta_4, -0.1576), (z\vartheta_3, -0.3438), (z\vartheta_2, 0.1572)\}$
ZX_3	$\{(z\vartheta_3, 0.3673), (z\vartheta_3, 0.2714), (z\vartheta_3, -0.3765)\}$
ZX_4	$\{(z\vartheta_3, 0.1296), (z\vartheta_3, 0.2145), (z\vartheta_3, -0.1394)\}$
ZX_5	$\{(z\vartheta_4, -0.4128), (z\vartheta_3, -0.2072), (z\vartheta_2, 0.4236)\}$

ZY_3

ZX1	$\{(z\vartheta_3,-0.3746),(z\vartheta_3,0.2543),(z\vartheta_3,0.4734)\}$
ZX2	$\{(z\vartheta_5,-0.3914),(z\vartheta_2,0.2589),(z\vartheta_1,0.3816)\}$
ZX3	$\{(z\vartheta_3,-0.2364),(z\vartheta_3,0.3437),(z\vartheta_3,0.2364)\}$
ZX4	$\{(z\vartheta_3,-0.4743),(z\vartheta_3,0.2825),(z\vartheta_3,0.4746)\}$
ZX5	$\{(z\vartheta_4,0.4843),(z\vartheta_3,-0.4492),(z\vartheta_2,-0.4675)\}$
	ZY4
ZX1	$\{(z\vartheta_2,-0.1546),(z\vartheta_3,0.3659),(z\vartheta_4,0.2362)\}$
ZX2	$\{(z\vartheta_1,0.3458),(z\vartheta_4,-0.3529),(z\vartheta_5,-0.3437)\}$
ZX3	$\{(z\vartheta_4,-0.1576),(z\vartheta_3,-0.3438),(z\vartheta_2,0.1576)\}$
ZX4	$\{(z\vartheta_4,0.3794),(z\vartheta_2,0.4623),(z\vartheta_2,-0.3795)\}$
ZX5	$\{(z\vartheta_3,-0.4968),(z\vartheta_3,0.2714),(z\vartheta_3,0.4975)\}$

Step 2. Normalize the $ZR=\left[ZR_{ij}\right]_{5\times4}$ into $NZR=\left[NZR_{ij}\right]_{5\times4}$ (See Table 6).

Table 6. The $NZR=\left[NZR_{ij}\right]_{5\times4}$

	ZY1
ZX1	$\{(z\vartheta_2,-0.2547),(z\vartheta_3,0.2492),(z\vartheta_4,0.2553)\}$
ZX2	$\{(z\vartheta_4,\ 0.0213),(z\vartheta_3,\ 0.0125),(z\vartheta_2,\ 0.0435)\}$
ZX3	$\{(z\vartheta_4,-0.2309),(z\vartheta_3,-0.3265),(z\vartheta_2,0.3276)\}$
ZX4	$\{(z\vartheta_5,-0.2973),(z\vartheta_2,0.2302),(z\vartheta_1,0.2975)\}$
ZX5	$\{(z\vartheta_4,0.1654),(z\vartheta_3,-0.3436),(z\vartheta_2,-0.1763)\}$
	ZY2

ZX1	$\{(z\vartheta_4, -0.2495),(z\vartheta_3,-0.4271),(z\vartheta_2,0.1287)\}$
ZX2	$\{(z\vartheta_4, -0.1576),(z\vartheta_3,-0.3438),(z\vartheta_2,0.1572)\}$
ZX3	$\{(z\vartheta_3, 0.3673),(z\vartheta_3,0.2714),(z\vartheta_3,-0.3765)\}$
ZX4	$\{(z\vartheta_3, 0.1296),(z\vartheta_3,0.2145),(z\vartheta_3,-0.1394)\}$
ZX5	$\{(z\vartheta_4, -0.4128),(z\vartheta_3,-0.2072),(z\vartheta_2,0.4236)\}$

	ZY3
ZX1	$\{(z\vartheta_3, -0.3746),(z\vartheta_3,0.2543),(z\vartheta_3,0.4734)\}$
ZX2	$\{(z\vartheta_5, -0.3914),(z\vartheta_2,0.2589),(z\vartheta_1,0.3816)\}$
ZX3	$\{(z\vartheta_3, -0.2364),(z\vartheta_3,0.3437),(z\vartheta_3,0.2364)\}$
ZX4	$\{(z\vartheta_3, -0.4743),(z\vartheta_3,0.2825),(z\vartheta_3,0.4746)\}$
ZX5	$\{(z\vartheta_4, 0.4843),(z\vartheta_3,-0.4492),(z\vartheta_2,-0.4675)\}$
	ZY4
ZX1	$\{(z\vartheta_2, -0.1546),(z\vartheta_3,0.3659),(z\vartheta_4,0.2362)\}$
ZX2	$\{(z\vartheta_1, 0.3458),(z\vartheta_4,-0.3529),(z\vartheta_5,-0.3437)\}$
ZX3	$\{(z\vartheta_4, -0.1576),(z\vartheta_3,-0.3438),(z\vartheta_2,0.1576)\}$
ZX4	$\{(z\vartheta_4, 0.3794),(z\vartheta_2,0.4623),(z\vartheta_2,-0.3795)\}$
ZX5	$\{(z\vartheta_3, -0.4968),(z\vartheta_3,0.2714),(z\vartheta_3,0.4975)\}$

Step 3. Describe the weight: $zw_1 = 0.2803, zw_2 = 0.3624, zw_3 = 0.1908, zw_4 = 0.1665$.

Step 4. Describe the relative weight: $rzw = (0.7735, 1.0000, 0.5265, 0.4594)$

Step 5. Describe the $LIDD = (LIDD_{ij})_{5\times4}$ (Table 7):

Table 7. The $LIDD = \left(LIDD_{ij}\right)_{5\times4}$

	ZY1	ZY2	ZY3	ZY4
ZX1	-0.2707	1.0729	0.3317	-0.5862
ZX2	0.2600	0.3591	-1.8541	0.4491
ZX3	-1.2130	-0.8965	0.8285	-1.2623
ZX4	0.8229	-0.5033	-0.4939	1.0014
ZX5	-1.1008	-1.4236	-0.5887	-0.0616

Step 6. Describe the $ZTLNS_i$, $ZTLNR_i$ and $ZTLNQ_i$ (See Table 8).

Table 8. The $ZTLNS_i$, $ZTLNR_i$ and $ZTLNQ_i$

	ZX1	ZX2	ZX3	ZX4	ZX5
$ZTLNS_i$	0.3847	0.3610	0.7166	0.2230	0.6620
$ZTLNR_i$	0.2255	0.1755	0.3332	0.1536	0.2403
$ZTLNQ_i$	0.3277	0.2177	1.0000	0.0000	0.7331

Step 7. Sort these alternatives through the $ZTLNS_i$, $ZTLNR_i$ and $ZTLNQ_i$.

$$ZTLNS_4 < ZTLNS_2 < ZTLNS_1 < ZTLNS_5 < ZTLNS_3$$
$$ZTLNR_4 < ZTLNR_2 < ZTLNR_1 < ZTLNR_5 < ZTLNR_3$$
$$ZTLNQ_4 < ZTLNQ_2 < ZTLNQ_1 < ZTLNQ_5 < ZTLNQ_3$$

The best regional comprehensive university is ZX_4.

5. Comparative analysis

The 2TLNN-ExpTODIM-VIKOR approach is compared with 2TLNNWA operator[36], and 2TLNNWG approach[36], 2TLNN-MABAC approach [41], 2TLNN-GRA approach [38], 2TLNN-CODAS approach [42], and 2TLNN-TODIM approach [37]. The corresponding results are constructed in Table 9.

Table 9. Order for different approaches

Methods	Order
2TLNNWA approach [36]	$ZX_4 > ZX_2 > ZX_1 > ZX_5 > ZX_3$
2TLNNWG approach [36]	$ZX_4 > ZX_2 > ZX_5 > ZX_1 > ZX_3$
2TLNN-MABAC approach [41]	$ZX_4 > ZX_2 > ZX_1 > ZX_5 > ZX_3$
2TLNN-GRA approach [38]	$ZX_4 > ZX_2 > ZX_1 > ZX_5 > ZX_3$
2TLNN-CODAS approach [42]	$ZX_4 > ZX_2 > ZX_1 > ZX_5 > ZX_3$
2TLNN-TODIM approach [37]	$ZX_4 > ZX_2 > ZX_1 > ZX_5 > ZX_3$
2TLNN-ExpTODIM-VIKOR approach	$ZX_4 > ZX_2 > ZX_1 > ZX_5 > ZX_3$

The comparative analysis shows that while there are minor differences in the rankings across the models, all decision models and algorithms consistently identify the same best and worst regional comprehensive universities. This validates the reasonableness and effectiveness of the 2TLNN-ExpTODIM-VIKOR approach. Furthermore, the 2TLNN-ExpTODIM-VIKOR method developed in this study provides a more accurate and reliable decision analysis compared to other decision-making techniques. A key strength of this research is that the 2TLNN-ExpTODIM-VIKOR approach takes into account the bounded rationality of decision-makers and effectively handles MAGDM problems involving conflicting or incomparable attributes.

6. Conclusion

The evaluation of university educational management quality is a comprehensive mechanism that assesses the effectiveness and efficiency of various aspects of the management process. It covers the implementation of educational policies, the rationality of management structure, the optimization of resource allocation, the quality of student services, and the support for teaching and research. Through systematic analysis and feedback on these elements, the evaluation mechanism identifies problems and areas for improvement, helping universities enhance their management, and optimize the efficiency of their educational resources. Additionally, it ensures that universities' goals align with societal needs and development trends, promoting the sustainable development of higher education. The quality evaluation of university educational management, within the framework of rural revitalization, epitomizes a MAGDM challenge. Recently, the TODIM-VIKOR method has been introduced to address such MAGDM problems. In this context, 2TLNSs have been introduced as a means to handle uncertain data during the evaluation process. This study introduces the 2TLNN-ExpTODIM-VIKOR model, specifically designed to manage MAGDM scenarios utilizing 2TLNSs. To demonstrate the effectiveness of the 2TLNN-ExpTODIM-VIKOR model, a numerical study focusing on the quality evaluation of university educational management is presented. The major contributions are illustrated: (1) ExpTODIM and VIKOR approaches are extended to the 2TLNNs; (2) entropy approach is described to obtain the weight under 2TLNNs; (3) 2TLNN-ExpTODIM-VIKOR approach is described forward MAGDM with 2TLNNs; (4) Finally, numerical example for quality evaluation of university educational management and comparative analysis are described to validate the 2TLNN-ExpTODIM-VIKOR approach.

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Appendix

Table 1. Linguistic scale and 2TLNNs

Linguistic Terms	2TLNNs
Exceedingly Terrible-ZET	$\{(z\vartheta_0,0),\ (z\vartheta_5,0),\ (z\vartheta_6,0)\}$
Very Terrible-ZVT	$\{(z\vartheta_1,0),\ (z\vartheta_4,0),\ (z\vartheta_5,0)\}$
Terrible-ZT	$\{(z\vartheta_2,0),\ (z\vartheta_3,0),\ (z\vartheta_4,0)\}$
Medium-ZM	$\{(z\vartheta_3,0),\ (z\vartheta_3,0),\ (z\vartheta_3,0)\}$
Well-ZW	$\{(z\vartheta_4,0),\ (z\vartheta_3,0),\ (z\vartheta_2,0)\}$
Very Well-ZVW	$\{(z\vartheta_5,0),\ (z\vartheta_2,0),\ (z\vartheta_1,0)\}$
Exceedingly Well-ZEW	$\{(z\vartheta_6,0),\ (z\vartheta_1,0),\ (z\vartheta_0,0)\}$

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