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Type-2 Neutrosophic Numbers for Impact Evaluation of Sports on the Psychological and Emotional Regulation of Rural Children

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Abstract: The role of sports in the psychological and emotional development of children has gained increasing attention, particularly in rural areas where social and educational opportunities may be limited. This study examines the impact of structured and unstructured sports activities on the emotional regulation, cognitive development, and overall well-being of rural children. By analyzing key psychological factors such as self-confidence, stress reduction, and social interaction, the research highlights how engagement in sports contributes to emotional stability and mental resilience. The study employs a comprehensive evaluation framework based on multi-criteria decision-making (MCDM) methods to assess the effectiveness of different sports programs. Two MCDM methods are used, such as LBWA method to compute the criteria weights and the TOPSIS method to rank the alternatives. These methods are used under the Type-2 Neutrosophic Set to deal with uncertainty information. Application is employed to show the validation of the proposed approach. Alos, comparative analysis is conducted. This study provides valuable guidance for policymakers, educators, and community leaders in designing sports initiatives that effectively support the psychological well-being of rural children.

Keywords: Type-2 Neutrosophic Set; Psychological and Emotional Regulation; Rural Children; Uncertainty.

1. Introduction

The psychological and emotional well-being of children is a critical component of their overall development, particularly for those in rural areas who may face socioeconomic challenges, limited educational resources, and reduced access to extracurricular activities. In this context, sports serve as an essential medium for fostering mental resilience and emotional stability. Unlike conventional classroom learning, sports encourage active engagement, teamwork, and self-expression, all of which contribute to emotional regulation. However, the extent to which different types of sports influence psychological well-being remains a topic of growing interest among educators and researchers[1], [2].

Sports participation has been linked to improvements in emotional stability, stress management, and social adaptability among children. Engaging in physical activities provides an outlet for emotional expression and stress relief, helping children cope with anxiety, frustration, and other psychological burdens. Furthermore, sports cultivate a structured environment where discipline, goal setting, and perseverance are reinforced, all of which contribute to a child's ability to handle emotional challenges in other aspects of life. Rural children, who often have fewer recreational outlets, can particularly benefit from the emotional support and stability provided by well-organized sports programs[3], [4].

One of the significant aspects of sports participation is the development of self-confidence and self-esteem. By achieving small milestones, mastering new skills, and receiving encouragement from peers and mentors, children build a stronger self-image. This, in turn, enhances their ability to confront difficulties with a positive mindset. In rural settings, where children may have limited exposure to external validation, sports become an important avenue for personal growth and self-empowerment.

Additionally, social integration is a fundamental outcome of sports activities. Engaging in team-based exercises enhances children's ability to communicate effectively, cooperate with peers, and resolve conflicts constructively. Many rural children experience social isolation due to geographical and economic constraints, playing sports is a valuable platform for interaction and community engagement. Structured sports programs enable children to forge friendships, learn the importance of teamwork, and develop a sense of belonging within their communities[5], [6].

Apart from social and emotional benefits, participation in sports plays a key role in behavioral and cognitive development. Studies have shown that regular physical activity contributes to improved focus, better decision-making skills, and enhanced cognitive flexibility. These attributes extend beyond the sports field and translate into academic improvement and better adaptability to real-life situations. Rural children engaged in sports activities are more likely to develop disciplined habits, manage their time effectively, and display proactive problem-solving skills[7], [8].

Despite the clear advantages, the implementation of sports programs in rural areas faces several challenges, including inadequate infrastructure, lack of trained coaches, and limited community support. In many cases, the absence of well-structured programs results in inconsistent participation, reducing the overall benefits of sports engagement. Addressing these barriers requires targeted efforts from policymakers, educators, and local organizations to ensure that children receive sustained and meaningful opportunities to participate in sports.

This study employs a multi-criteria decision-making (MCDM) approach to evaluate the effectiveness of various sports programs in supporting psychological and emotional well-being among rural children. By assessing factors such as emotional stability, self-confidence, stress reduction, and social interaction, this research aims to provide a comprehensive understanding of how different sports models contribute to childhood development. The findings will serve as a foundation for designing more effective interventions and policies aimed at promoting holistic well-being through sports.

Understanding the impact of sports on the psychological and emotional regulation of rural children is crucial for designing programs that maximize their developmental potential. With proper implementation, sports can act as a transformative tool, equipping children with essential life skills, emotional resilience, and a strong sense of community. By integrating sports more effectively into rural education and community programs, society can create a more inclusive and supportive environment for children's mental and emotional well-being[9], [10].

For MCDM, fuzzy systems (FSs) [11]and intuitionistic fuzzy systems (IFSs) [12]were suggested; nevertheless, they are ineffective when there is a large amount of fuzzy data. It was suggested that fuzzy information be handled using the neutrosophic set (NS)[13]. Because these two sets may hold more information, the single-valued neutrosophic set (SVNS) and interval-valued neutrosophic set (IVNS) were established for practical decision-making to expand the scope of NS's applicability. The type-2 neutrosophic number (T2NN) set is suggested as a form of NS based on earlier research on NS[14].

Truth-membership, indeterminacy-membership, and falsity-membership are the three components that make up T2NN. The three T2NN memberships are triangular fuzzy numbers, which is the distinction. To completely convey his own judgment, the decision-maker might have more fuzzy information while providing the evaluation matrix of the options thanks to the usage of triangular fuzzy numbers. Higher degrees of fuzzy judgments can be handled using T2NN[15].

2. Type-2 Neutrosophic Model

This section shows the steps of the proposed approach. Alos, we show some definitions of the Type-2 Neutrosophic Numbers.

Definitions [15]

$$X_1 = \begin{pmatrix} \left(T_{T_{X_1}}(R), T_{I_{X_1}}(R), T_{F_{X_1}}(R)\right), \\ \left(I_{T_{X_1}}(R), I_{I_{X_1}}(R), I_{F_{X_1}}(R)\right), \\ \left(F_{T_{X_1}}(R), F_{I_{X_1}}(R), F_{F_{X_1}}(R)\right) \end{pmatrix} \text{ and} \tag{1}$$

$$X_2 = \begin{pmatrix} \left(T_{T_{X_2}}(R), T_{I_{X_2}}(R), T_{F_{X_2}}(R)\right), \\ \left(I_{T_{X_2}}(R), I_{I_{X_2}}(R), I_{F_{X_2}}(R)\right), \\ \left(F_{T_{X_2}}(R), F_{I_{X_2}}(R), F_{F_{X_2}}(R)\right) \end{pmatrix} \tag{2}$$

Where X_2 and X_1 are two Type-2 Neutrosophic Numbers. Then we show their operations such as:

$$X_1 \oplus X_2 = \begin{pmatrix} \begin{pmatrix} T_{T_{X_1}}(R) + T_{T_{X_2}}(R) - T_{T_{X_1}}(R) T_{T_{X_2}}(R), T_{I_{X_1}}(R) + T_{I_{X_2}}(R) - T_{I_{X_1}}(R) T_{I_{X_2}}(R), \\ T_{F_{X_1}}(R) + T_{F_{X_2}}(R) - T_{F_{X_1}}(R) T_{F_{X_2}}(R) \end{pmatrix}, \\ \left(I_{T_{X_1}}(R) I_{T_{X_2}}(R), I_{I_{X_1}}(R) I_{I_{X_2}}(R), I_{F_{X_1}}(R) I_{F_{X_2}}(R)\right), \\ \left(F_{T_{X_1}}(R) F_{T_{X_2}}(R), F_{I_{X_1}}(R) F_{I_{X_2}}(R), F_{F_{X_1}}(R) F_{F_{X_2}}(R)\right) \end{pmatrix} \tag{3}$$

$$X_1 \otimes X_2 = \begin{pmatrix} \left(T_{T_{X_1}}(R) T_{T_{X_2}}(R), T_{I_{X_1}}(R) T_{I_{X_2}}(R), T_{F_{X_1}}(R) T_{F_{X_2}}(R)\right), \\ \begin{pmatrix} I_{T_{X_1}}(R) + I_{T_{X_2}}(R) - I_{T_{X_1}}(R) I_{T_{X_2}}(R), I_{I_{X_1}}(R) + I_{I_{X_2}}(R) - I_{I_{X_1}}(R) I_{I_{X_2}}(R), \\ I_{F_{X_1}}(R) + I_{F_{X_2}}(R) - I_{F_{X_1}}(R) I_{F_{X_2}}(R) \end{pmatrix}, \\ \begin{pmatrix} F_{T_{X_1}}(R) + F_{T_{X_2}}(R) - F_{T_{X_1}}(R) F_{T_{X_2}}(R), F_{I_{X_1}}(R) + F_{I_{X_2}}(R) - F_{I_{X_1}}(R) F_{I_{X_2}}(R), \\ F_{F_{X_1}}(R) + F_{F_{X_2}}(R) - F_{F_{X_1}}(R) F_{F_{X_2}}(R) \end{pmatrix} \end{pmatrix} \tag{4}$$

$$\beta X_1 = \begin{pmatrix} \left(\left(1 - \left(1 - T_{T_{X_1}}(R)\right)^{\beta}\right), \left(1 - \left(1 - T_{I_{X_1}}(R)\right)^{\beta}\right), \left(1 - \left(1 - T_{F_{X_1}}(R)\right)^{\beta}\right)\right), \\ \left(\left(I_{T_{X_1}}(R)\right)^{\beta}, \left(I_{I_{X_1}}(R)\right)^{\beta}, \left(I_{F_{X_1}}(R)\right)^{\beta}\right), \\ \left(\left(F_{T_{X_1}}(R)\right)^{\beta}, \left(F_{I_{X_1}}(R)\right)^{\beta}, \left(F_{F_{X_1}}(R)\right)^{\beta}\right) \end{pmatrix} \tag{5}$$

$$X_1^{\beta} = \begin{pmatrix} \left(\left(T_{T_{X_1}}(R)\right)^{\beta}, \left(T_{I_{X_1}}(R)\right)^{\beta}, \left(T_{F_{X_1}}(R)\right)^{\beta}\right), \\ \left(\left(1 - \left(1 - I_{T_{X_1}}(R)\right)^{\beta}\right), \left(1 - \left(1 - I_{I_{X_1}}(R)\right)^{\beta}\right), \left(1 - \left(1 - I_{F_{X_1}}(R)\right)^{\beta}\right)\right), \\ \left(\left(1 - \left(1 - F_{T_{X_1}}(R)\right)^{\beta}\right), \left(1 - \left(1 - F_{I_{X_1}}(R)\right)^{\beta}\right), \left(1 - \left(1 - F_{F_{X_1}}(R)\right)^{\beta}\right)\right) \end{pmatrix} \tag{6}$$

Then we show the steps of the LBWA method to obtain the criteria weights.

We can define the significance of the criteria by the opinions of experts. We put the different criteria on different levels based on their significance. We put the criteria are superior twice significance or equal to other criteria in the first level. We put the criteria lower twice significance or three times to other criteria in the second level. In the third level, we put the criteria are x or x+1 times fewer than the highest significance.

$$Y = Y_1 \cup Y_2 \dots \cap Y_x \tag{7}$$

Where Y refers to the number of levels.

Every criterion can put into integral value

$$D = \max\{|Y_1|, |Y_2|, \dots, |Y_x|\};\ D_0 < D \tag{8}$$

The influence function is obtained as:

$$V(G_{ip}) = \frac{D_0}{i(D_0) + I_{ip}} \tag{9}$$

I refers to the number of levels.

The criteria weights are computed

$$W_j = \frac{1}{1 + V(G_j) + \dots + V(G_n)} \tag{10}$$

Then we apply the steps of the TOPSIS method.

Create the decision matrix.

Four experts use the Type-2 Neutrosophic numbers to evaluate the criteria and alternatives. Then these numbers are converted into crisp value. Then these values are combined into one decision matrix

The decision matrix is normalized such as:

$$h_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} (x_{ij})^2}} \tag{11}$$

The weighted decision matrix is computed such as:

$$Z_{ij} = W_j h_{ij} \tag{12}$$

The positive and negative ideal solutions are obtained for positive and negative criteria such as:

$$S^+ = \{Z_1^+, \dots, Z_n^+\} = \left\{\left(\max_i Z_{ij}, j \in J\right)\left(\min_i Z_{ij}, j \in B\right)\right\} \tag{13}$$

$$S^- = \{Z_1^-, \dots, Z_n^-\} = \left\{\left(\min_i Z_{ij}, j \in J\right)\left(\max_i Z_{ij}, j \in C\right)\right\} \tag{14}$$

Compute the separation measures

$$V_i^+ = \left\{\sum_{j=1}^{n} \left(Z_{ij} - Z_j^+\right)^2\right\}^{\frac{1}{2}} \tag{15}$$

$$V_i^- = \left\{\sum_{j=1}^{n} \left(Z_{ij} - Z_j^-\right)^2\right\}^{\frac{1}{2}} \tag{16}$$

The relative closeness is computed such as:

$$E_i = \frac{V_i^-}{V_i^- + V_i^+} \tag{17}$$

Rank the alternatives.

3. Results

Four experts and decision makers are evaluating the criteria and alternatives to obtain the weights of criteria and ranking the alternatives. This study uses eight criteria and seven alternatives as shown in Fig 1.

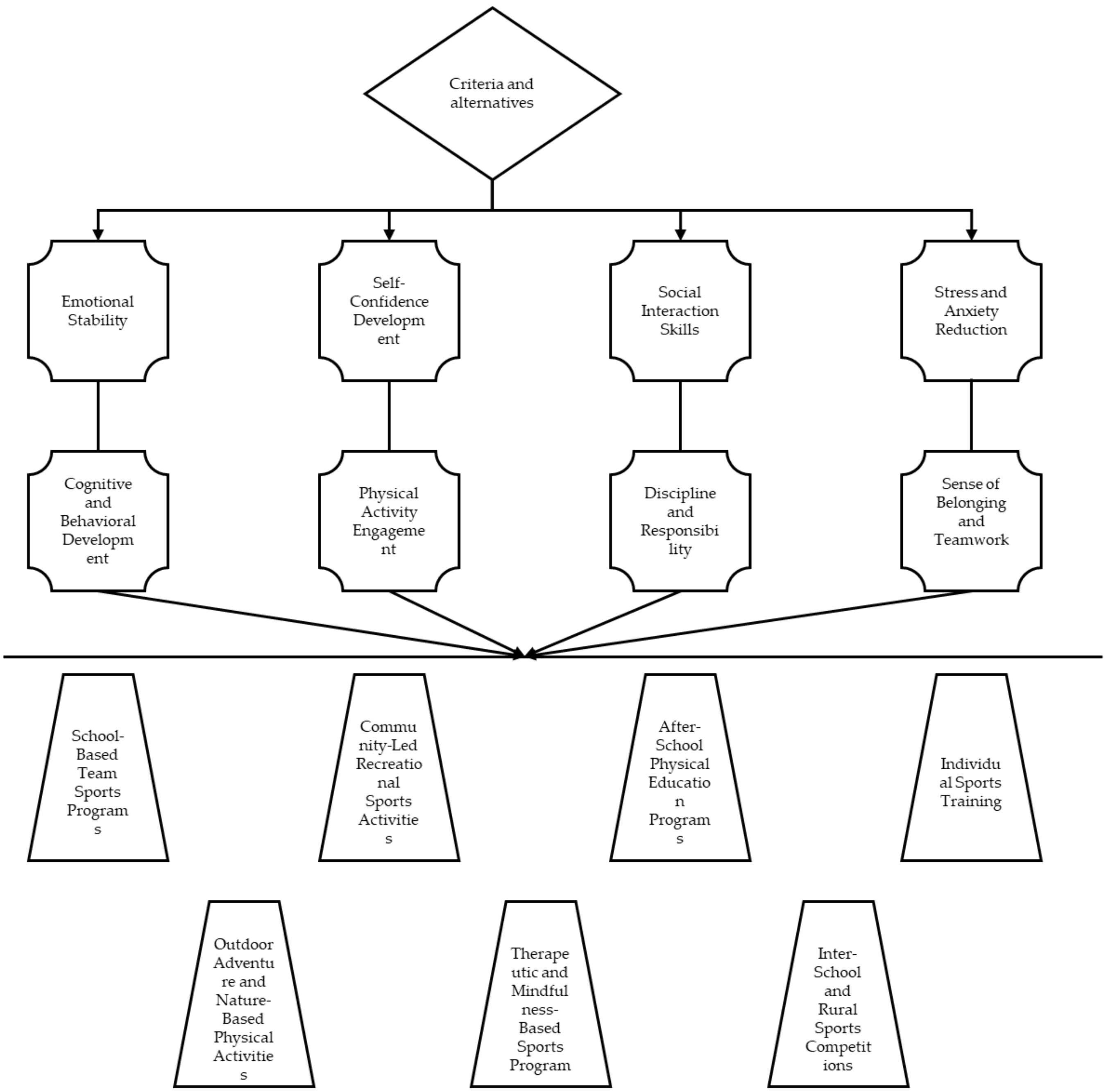

Fig 1. The criteria and alternatives.

We show the results of the LBWA method. Experts are defined the highest importance criterion and put the criteria into different levels.

Then every criterion can put into integral value using eq. (8).

Then the influence function is obtained eq. (9).

Then we compute the criteria weights using eq. (10) as shown in Fig 2.

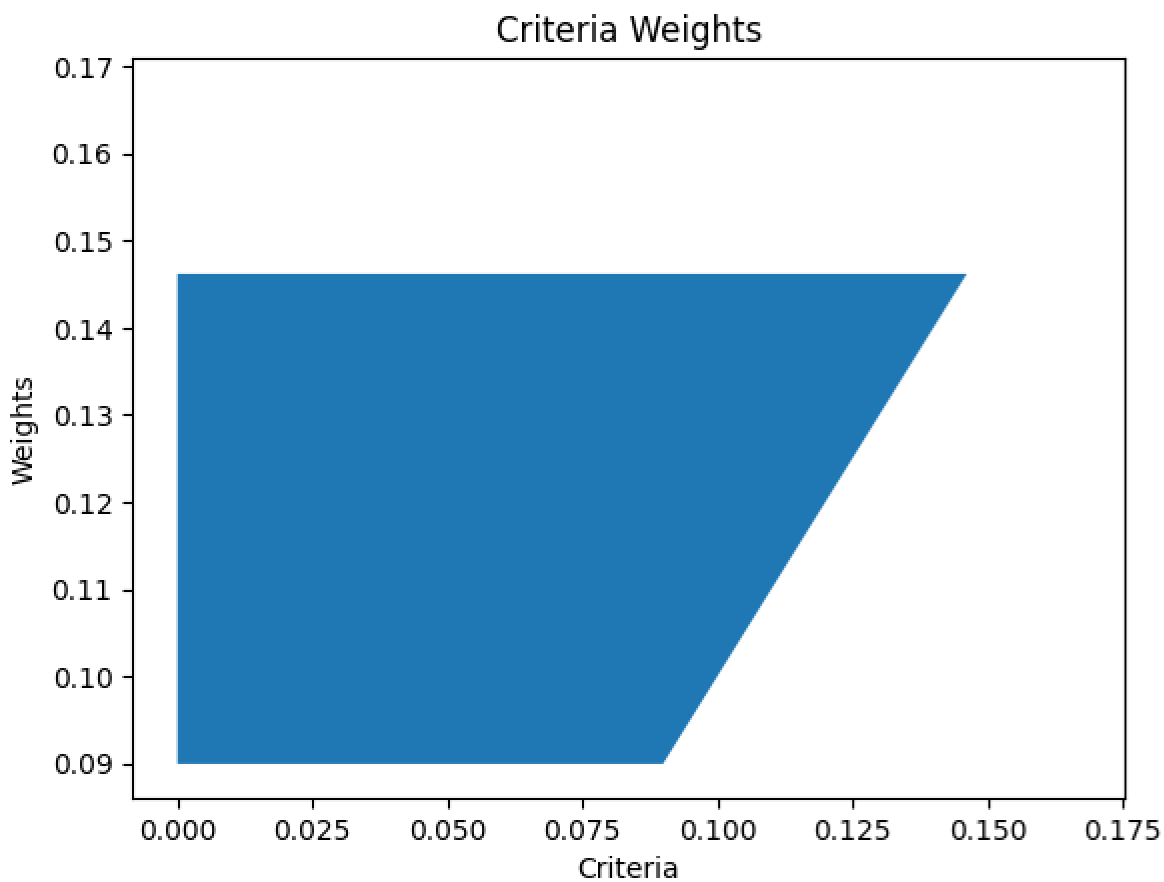

Fig 2. The significance of the criteria.

Then we show the results of the TOPSIS methodology. Four experts have created the decision matrix using the Type-2 Neutrosophic numbers as shown in Tables 1-4. Then we obtain crisp values. Then we combine it into a single matrix.

Then we normalize the decision matrix using eq. (11) as shown in table 5.

Then we obtained the weighted decision matrix using Eq. (12) as shown in Table 6.

The positive and negative ideal solutions are obtained using eqs. (13 and 14).

Then we compute the separation measures using eqs. (15 and 16) as shown in Tables 7 and 8.

Then we obtained relative closeness is computed using eq. (17) as shown in Fig 3.

Then we rank the alternatives as shown in Fig 4.

Table 1. The first Type-2 Neutrosophic Numbers.

	TNC_1	TNC_2	TNC_3	TNC_4	TNC_5	TNC_6	TNC_7	TNC_8
TNA_1	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
TNA_2	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))
TNA_3	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
TNA_4	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
TNA_5	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
TNA_6	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
TNA_7	((0.20,0.20,0.10), (0.65,0.8	((0.50,0.30,0.50), (0.50,0.3	((0.40,0.45,0.50), (0.40,0.4	((0.60,0.45,0.50), (0.20,0.1	((0.40,0.45,0.50), (0.40,0.4	((0.60,0.45,0.50), (0.20,0.1	((0.35,0.35,0.10), (0.50,0.7	((0.95,0.90,0.95), (0.10,0.1

	0,0.85),(0.45,0.80,0.70))	5,0.45),(0.45,0.30,0.60))	5,0.50),(0.35,0.40,0.45))	5,0.25),(0.10,0.25,0.15))	5,0.50),(0.35,0.40,0.45))	5,0.25),(0.10,0.25,0.15))	5,0.80),(0.50,0.75,0.65))	0,0.05),(0.05,0.05,0.05))

Table 2. The second Type-2 Neutrosophic Numbers.

	TNC$_1$	**TNC$_2$**	**TNC$_3$**	**TNC$_4$**	**TNC$_5$**	**TNC$_6$**	**TNC$_7$**	**TNC$_8$**
TNA$_1$	((0.20,0.20,0.10),(0.65,0.80,0.85),(0.45,0.80,0.70))	((0.35,0.35,0.10),(0.50,0.75,0.80),(0.50,0.75,0.65))	((0.50,0.30,0.50),(0.50,0.35,0.45),(0.45,0.30,0.60))	((0.40,0.45,0.50),(0.40,0.45,0.50),(0.35,0.40,0.45))	((0.60,0.45,0.50),(0.20,0.15,0.25),(0.10,0.25,0.15))	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))	((0.50,0.30,0.50),(0.50,0.35,0.45),(0.45,0.30,0.60))
TNA$_2$	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))	((0.60,0.45,0.50),(0.20,0.15,0.25),(0.10,0.25,0.15))	((0.40,0.45,0.50),(0.40,0.45,0.50),(0.35,0.40,0.45))	((0.50,0.30,0.50),(0.50,0.35,0.45),(0.45,0.30,0.60))	((0.20,0.20,0.10),(0.65,0.80,0.85),(0.45,0.80,0.70))	((0.40,0.45,0.50),(0.40,0.45,0.50),(0.35,0.40,0.45))
TNA$_3$	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))	((0.20,0.20,0.10),(0.65,0.80,0.85),(0.45,0.80,0.70))	((0.40,0.45,0.50),(0.40,0.45,0.50),(0.35,0.40,0.45))	((0.60,0.45,0.50),(0.20,0.15,0.25),(0.10,0.25,0.15))	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))	((0.35,0.35,0.10),(0.50,0.75,0.80),(0.50,0.75,0.65))	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))	((0.60,0.45,0.50),(0.20,0.15,0.25),(0.10,0.25,0.15))
TNA$_4$	((0.60,0.45,0.50),(0.20,0.15,0.25),(0.10,0.25,0.15))	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))	((0.20,0.20,0.10),(0.65,0.80,0.85),(0.45,0.80,0.70))	((0.20,0.20,0.10),(0.65,0.80,0.85),(0.45,0.80,0.70))	((0.20,0.20,0.10),(0.65,0.80,0.85),(0.45,0.80,0.70))	((0.20,0.20,0.10),(0.65,0.80,0.85),(0.45,0.80,0.70))	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))
TNA$_5$	((0.40,0.45,0.50),(0.40,0.45,0.50),(0.35,0.40,0.45))	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))	((0.20,0.20,0.10),(0.65,0.80,0.85),(0.45,0.80,0.70))	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))	((0.20,0.20,0.10),(0.65,0.80,0.85),(0.45,0.80,0.70))	((0.60,0.45,0.50),(0.20,0.15,0.25),(0.10,0.25,0.15))	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))
TNA$_6$	((0.50,0.30,0.50),(0.50,0.35,0.45),(0.45,0.30,0.60))	((0.60,0.45,0.50),(0.20,0.15,0.25),(0.10,0.25,0.15))	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))	((0.95,0.90,0.95),(0.10,0.10,0.05),(0.05,0.05,0.05))	((0.40,0.45,0.50),(0.40,0.45,0.50),(0.35,0.40,0.45))	((0.70,0.75,0.80),(0.15,0.20,0.25),(0.10,0.15,0.20))
TNA$_7$	((0.35,0.35,0.10),(0.50,0.75,0.80),	((0.40,0.45,0.50),(0.40,0.45,0.50),	((0.60,0.45,0.50),(0.20,0.15,0.25),	((0.70,0.75,0.80),(0.15,0.20,0.25),	((0.60,0.45,0.50),(0.20,0.15,0.25),	((0.70,0.75,0.80),(0.15,0.20,0.25),	((0.50,0.30,0.50),(0.50,0.35,0.45),	((0.60,0.45,0.50),(0.20,0.15,0.25),

	(0.50,0.75,0.65))	(0.35,0.40,0.45))	(0.10,0.25,0.15))	(0.10,0.15,0.20))	(0.10,0.25,0.15))	(0.10,0.15,0.20))	(0.45,0.30,0.60))	(0.10,0.25,0.15))

Table 3. The third Type-2 Neutrosophic Numbers.

	TNC$_1$	**TNC$_2$**	**TNC$_3$**	**TNC$_4$**	**TNC$_5$**	**TNC$_6$**	**TNC$_7$**	**TNC$_8$**
TNA$_1$	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
TNA$_2$	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
TNA$_3$	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
TNA$_4$	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
TNA$_5$	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
TNA$_6$	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
TNA$_7$	((0.50,0.30,0.50), (0.50,0.35,0.45),	((0.50,0.30,0.50), (0.50,0.35,0.45),	((0.50,0.30,0.50), (0.50,0.35,0.45),	((0.70,0.75,0.80), (0.15,0.20,0.25),	((0.40,0.45,0.50), (0.40,0.45,0.50),	((0.50,0.30,0.50), (0.50,0.35,0.45),	((0.70,0.75,0.80), (0.15,0.20,0.25),	((0.60,0.45,0.50), (0.20,0.15,0.25),

	(0.45,0.30,0.60))	(0.45,0.30,0.60))	(0.45,0.30,0.60))	(0.10,0.15,0.20))	(0.35,0.40,0.45))	(0.45,0.30,0.60))	(0.10,0.15,0.20))	(0.10,0.25,0.15))

Table 4. The fourth Type-2 Neutrosophic Numbers.

	TNC_1	**TNC_2**	**TNC_3**	**TNC_4**	**TNC_5**	**TNC_6**	**TNC_7**	**TNC_8**
TNA_1	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
TNA_2	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
TNA_3	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
TNA_4	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
TNA_5	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))
TNA_6	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
TNA_7	((0.70,0.75,0.80), (0.15,0.20,0.25),	((0.70,0.75,0.80), (0.15,0.20,0.25),	((0.50,0.30,0.50), (0.50,0.35,0.45),	((0.70,0.75,0.80), (0.15,0.20,0.25),	((0.70,0.75,0.80), (0.15,0.20,0.25),	((0.60,0.45,0.50), (0.20,0.15,0.25),	((0.70,0.75,0.80), (0.15,0.20,0.25),	((0.60,0.45,0.50), (0.20,0.15,0.25),

	(0.10,0.15,0.20))	(0.10,0.15,0.20))	(0.45,0.30,0.60))	(0.10,0.15,0.20))	(0.10,0.15,0.20))	(0.10,0.25,0.15))	(0.10,0.15,0.20))	(0.10,0.25,0.15))

Table 5. The normalized decision matrix.

	TNC_1	TNC_2	TNC_3	TNC_4	TNC_5	TNC_6	TNC_7	TNC_8
TNA_1	0.303913	0.297802	0.312876	0.413348	0.452373	0.471371	0.5873	0.2633
TNA_2	0.440464	0.485852	0.438165	0.357509	0.34061	0.337458	0.1969	0.3536
TNA_3	0.394246	0.25631	0.420168	0.367723	0.424433	0.19819	0.3272	0.3705
TNA_4	0.300412	0.3674	0.193125	0.243787	0.353916	0.164042	0.37	0.4346
TNA_5	0.40475	0.337955	0.368252	0.166837	0.284729	0.374954	0.2824	0.3921
TNA_6	0.453068	0.462429	0.464469	0.469869	0.35192	0.512883	0.3805	0.3787
TNA_7	0.314417	0.382792	0.380712	0.508003	0.411127	0.440571	0.3845	0.427

Table 6. The weighted decision matrix.

	TNC_1	TNC_2	TNC_3	TNC_4	TNC_5	TNC_6	TNC_7	TNC_8
TNA_1	0.044425	0.04975	0.040653	0.048337	0.048092	0.068903	0.0572	0.0237
TNA_2	0.064385	0.081166	0.056933	0.041807	0.03621	0.049328	0.0192	0.0318
TNA_3	0.057629	0.042819	0.054594	0.043002	0.045121	0.028971	0.0319	0.0333
TNA_4	0.043913	0.061377	0.025094	0.028509	0.037625	0.023979	0.0361	0.0391
TNA_5	0.059165	0.056458	0.047849	0.01951	0.030269	0.054809	0.0275	0.0353
TNA_6	0.066228	0.077253	0.06035	0.054947	0.037413	0.074971	0.0371	0.0341
TNA_7	0.04596	0.063949	0.049467	0.059406	0.043707	0.064401	0.0375	0.0384

Table 7. The positive separation measures.

	TNC_1	TNC_2	TNC_3	TNC_4	TNC_5	TNC_6	TNC_7	TNC_8
TNA_1	0.000475	0.000987	0.000388	0.000123	0	3.68E-05	0	0.0002
TNA_2	3.39E-06	0	1.17E-05	0.00031	0.000141	0.000658	0.0014	5E-05
TNA_3	7.39E-05	0.00147	3.31E-05	0.000269	8.82E-06	0.002116	0.0006	3E-05
TNA_4	0.000498	0.000392	0.001243	0.000955	0.00011	0.0026	0.0004	0
TNA_5	4.99E-05	0.00061	0.000156	0.001592	0.000318	0.000407	0.0009	1E-05
TNA_6	0	1.53E-05	0	1.99E-05	0.000114	0	0.0004	3E-05
TNA_7	0.000411	0.000296	0.000118	0	1.92E-05	0.000112	0.0004	5E-07

Table 8. The negative separation measures.

	TNC_1	TNC_2	TNC_3	TNC_4	TNC_5	TNC_6	TNC_7	TNC_8
TNA_1	2.62E-07	4.8E-05	0.000242	0.000831	0.000318	0.002018	0.0014	0
TNA_2	0.000419	0.00147	0.001014	0.000497	3.53E-05	0.000643	0	7E-05

TNA_3	0.000188	0	0.00087	0.000552	0.000221	2.49E-05	0.0002	9E-05
TNA_4	0	0.000344	0	8.1E-05	5.41E-05	0	0.0003	0.0002
TNA_5	0.000233	0.000186	0.000518	0	0	0.000951	7E-05	0.0001
TNA_6	0.000498	0.001186	0.001243	0.001256	5.1E-05	0.0026	0.0003	0.0001
TNA_7	4.19E-06	0.000446	0.000594	0.001592	0.000181	0.001634	0.0003	0.0002

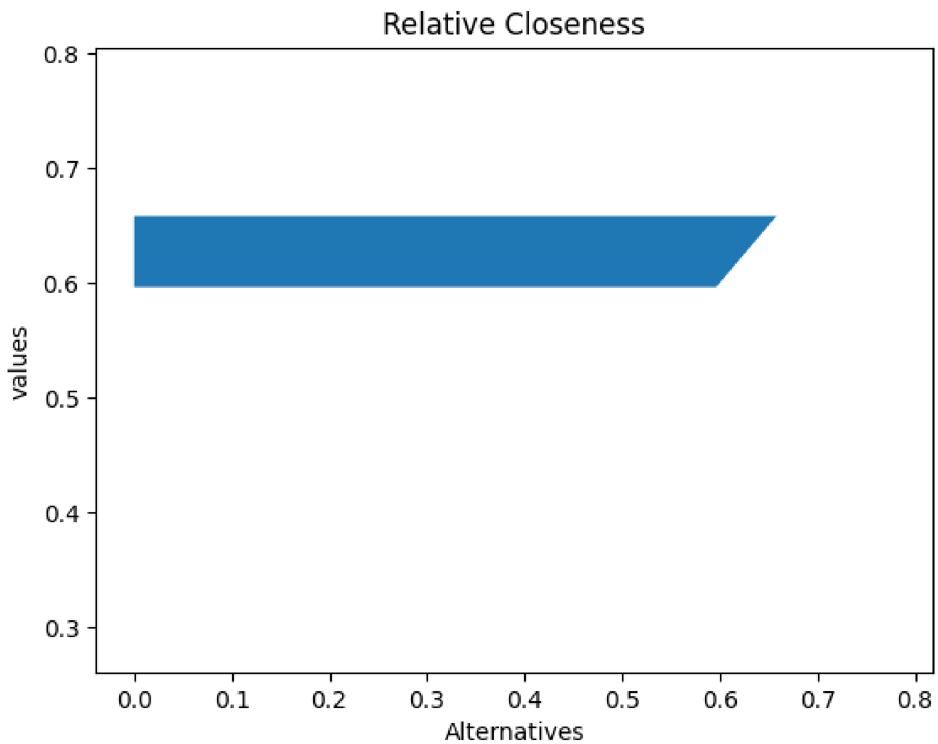

Fig 3. The values of relative closeness.

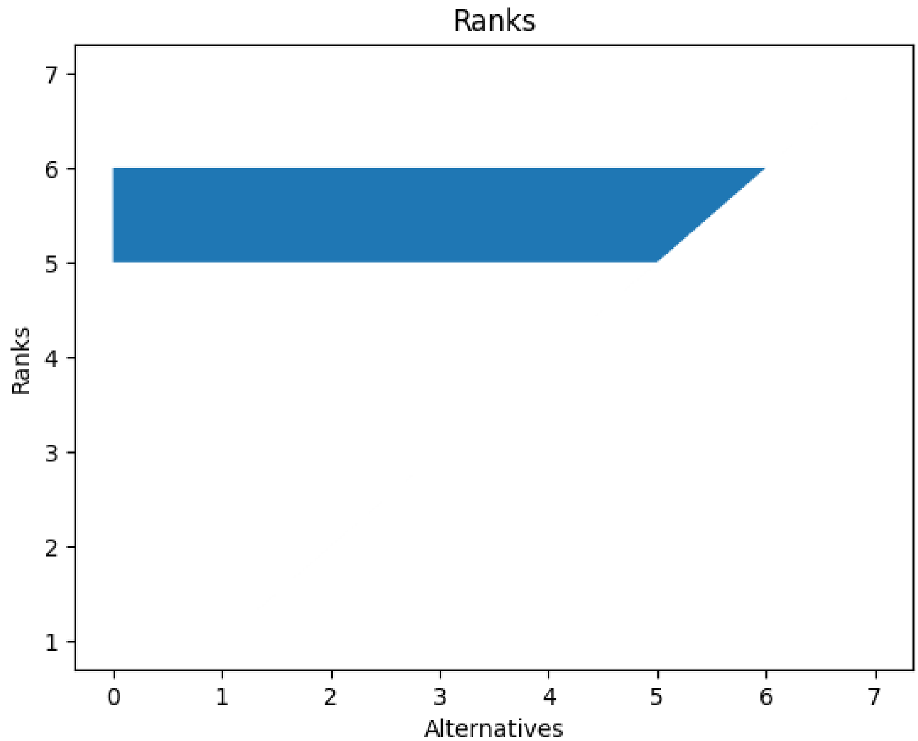

Fig 4. The rank of alternatives.

4. Analysis

This section shows the comparative analysis between the proposed approach and other methods to show the effectiveness of the proposed approach. We used the criteria weights by our method. Then we compared the rank of the alternatives by six methods such as MABAC, WASPAS, EDAS, COPRAS, MOORA, and MOOSRA methos. Fig 5 shows the results of the comparative analysis. We show the proposed approach is effective compared to other methods. We show that alternative 6 is the best and alternative 4 is the worst.

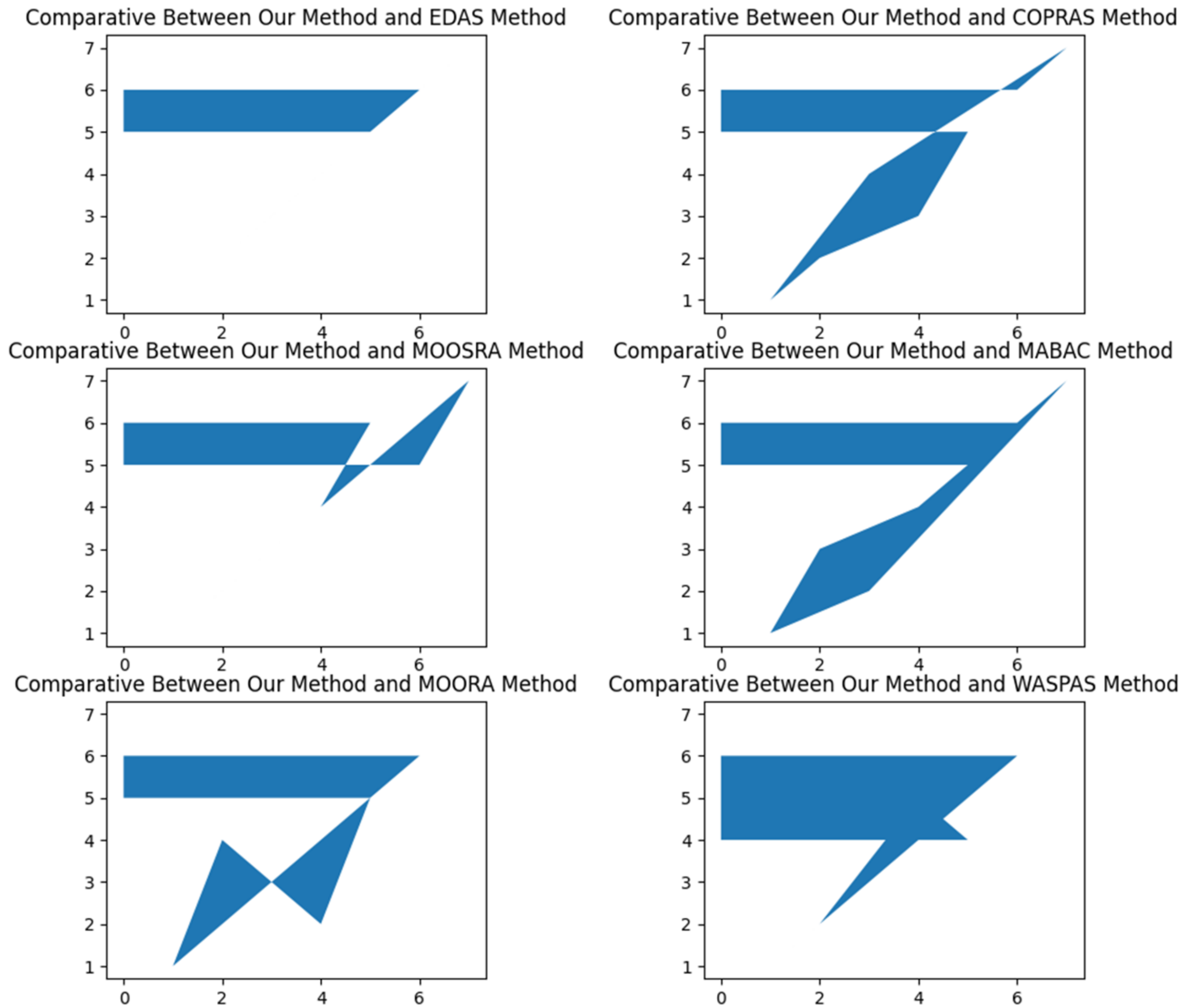

Fig 5. The results of comparative.

5. Conclusions

The findings of this study underscore the significance of sports as a vital contributor to the psychological and emotional well-being of rural children. Through enhanced self-confidence, improved stress management, and strengthened social skills, sports play an essential role in fostering emotional resilience. However, challenges such as limited infrastructure, lack of trained personnel, and inconsistent participation remain barriers to maximizing the benefits of sports programs.

This study used Type-2 Neutrosophic Set is used to deal with uncertainty and vague information. Then we used MCDM methods such as LBWA method to compute the criteria weights and the TOPSIS method to rank the alternatives. Then we obtained the best alternatives and best criterion from eight criteria and seven alternatives. Then we conducted comparative analysis between the proposed approach and other MCDM methods. The results showed that the proposed approach is effective compared to other MCDM methods.

Ultimately, sports provide an invaluable opportunity to empower rural children, equipping them with essential life skills that extend far beyond the playing field. With continued investment and strategic implementation, sports can serve as a powerful tool for nurturing resilience, social integration, and mental well-being among young individuals in rural communities.

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