Octagonal Neutrosophic Number: Its Different Representations, Properties, Graphs and De-neutrosophication with the application of Personnel Selection

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Abstract

To deal with fluctations in decision-making, fuzzy / neutrosophic numbers are used. The problem having more fluctuations are difficult to sovle. Thus it is a dire need to define higher order number, also It is a very curious question by researchers all around the world that how octagonal neutrosophic number can be represented and how to be graphed? In this research article, the primarily focused on the representation and graphs of octagonal neutrosophic number. at last, a case study is done using VIKOR method based on octagonal neutrosophic number. These representations will be helpful in multi-criteria decision making problems in the case that there are large number of fluctuations. Finally, concluded the present work with future directions.

Keywords: Neutrosophic Number, Octagonal Number, VIKOR Method, MCDM, Uncertainty, Indeterminacy, Accuracy Function, De-neutrosophication.

1. Introduction

The theory of uncertainty plays a very important role to solve different issues like modelling in engineering domain. To deal with uncertainty the first concept was given by [1], extended by [2] named as intuitionistic fuzzy numbers. In year 1995, Smarandache proposed the idea of neutrosophic set, and the idea was published in 1998 [3], they have three distinct logic components i) truthfulness ii) indeterminacy iii) falsity. This idea also has a concept of hesitation component the research gets a high impact in different research domain. In neutrosophic, truth membership is noted by T, indeterminacy membership is noted by I, falsity membership is noted by F, These are all independent and their sum is between $0 \leq T + I + F \leq 3$. While when talking about intuitionistic fuzzy sets, uncertainty depends on the degree of membership and non-membership, but in neutrosophic sets then indeterminacy factor does not depend on the truth and falsity value. Neutrosophic fuzzy number can describe about the uncertainty, falsity and hesitation information of real-life problem.

Researchers from different fields developed triangular, trapezoidal and pentagonal neutrosophic numbers, and presented the notions, properties along with applications in different fields [4-6]. The de-neutrosophication technique of pentagonal number and its applications are presented by [7-10].

Scientists from different areas investigated the various properties and fluctuations of neutrosophic numbers and the properties of correlation between these numbers [6-7]. The applications in decision-making in different fields like phone selection [11-12], games prediction [13], supplier selection [14-16], medical [17], personnel selection [18-19].

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Octagonal neutrosophic number and its types are presented by [20] in his recent work. The graphical representation and properties are yet to be defined while dealing with the concept of octagonal neutrosophic number a decision-maker can solve more fluctuations because they have more edges as compare to pentagonal. Table:1 represents different numbers and their applicability.

Edge Parameter	Uncertainty Measurement	Hesitation Measurement	Vagueness Measurement	Fluctuations
Crisp number	*	*	*	*
Fuzzy number	determinable	*	*	*
Intuitionistic Fuzzy number	determinable	determinable	*	*
Neutrosophic number	determinable	determinable	determinable	determinable

Table 1: Fuzzy numbers, their extensions and applicability

1.1 Motivation

From the literature, it is found that octagonal neutrosophic numbers (ONN) their notations, graphs and properties are not yet defined. Since it is not yet defined so also it will be a question that how and where it can be applied? For this purpose, is de-neutrosophication important? How should we define membership, indeterminacy and non-membership functions? From this point of view ONN is a good choice for a decision maker in a practical scenario.

1.2 Novelties

The work contributed in this research is;

- Membership, Non-membership and Indeterminacy functions
- Graphical Representation of ONN.
- De-neutrosophication technique of ONN.
- Case study of personnel selection having octagonal fluctuations.

1.3 Structure of Paper

The article is structured as follows as shown in the Figure 1:

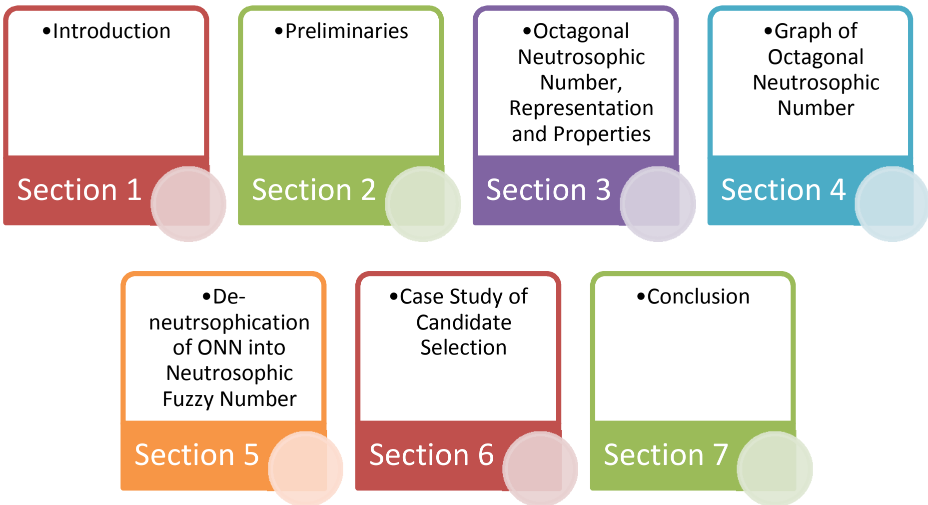

Figure 1: Pictorial view of the structure of the article

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2. Preliminaries

Definition 2.1: Fuzzy Number [1]

A fuzzy number is generalized form of a real number. It doesn't represent a single value, instead a group of values, where each entity has its membership value between $[0, 1]$. Fuzzy number $\bar{S}$ is a fuzzy set in R if it satisfies the given conditions.

- $\exists$ relatively one $y \in R$ with $\mu_{\bar{S}}$ (y) = 1.
- $\mu_{\bar{S}}$ (y) is piecewise continuous.
- $\bar{S}$ should be convex and normal.

Definition 2.2: Neutrosophic Fuzzy Number [3]

Let U be a universe of discourse then the neutrosophic set A is an object having the form
A = {< x: $T_A(x), I_A(x), F_A(x)$, >; x ∈ U}
where the functions T, I, F : U→ [0,1] define respectively the degree of membership, the degree of indeterminacy, and the degree of non-membership of the element x ∈ X to the set A with the condition. $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

Definition 2.3: Accuracy Function [21]

Accuracy function is used to convert neutrosophic number NFN into fuzzy number (De-neutrosophication using $\boldsymbol{A_F}$).
$A(F) = \{ x = \frac{[T_x+I_x+F_x]}{3} \}$

$\boldsymbol{A_F}$ represents the De-neutrosophication of neutrosophic number into fuzzy number.

Definition 2.4: Pentagonal Neutrosophic Number [6]

Pentagonal Neutrosophic Number PNN is defined as,

$$PNN = \langle [(\Omega, \square, ε, ȼ, \varepsilon): \Theta], [(\Omega^1, \square^1, ε^1, ȼ^1, \varepsilon^1): \Psi], [(\Omega^2, \square^2, ε^2, ȼ^2, \varepsilon^2): \quad] \rangle$$

Where Θ, Ψ , ∈ [0,1].

The truth membership function (Θ): ℝ → [0, б],

the indeterminacy membership function (Ψ):□ → [ȝ ,1],

and the falsity membership function ( ):ℝ→ [,1].

3. Octagonal Neutrosophic Number [ONN] Representation and Properties

In this section, we define ONN, representations and properties along with suitable examples.

Definition 3.1: Side Conditions of Octagonal Neutrosophic Number [ONN]

An Octagonal Neutrosophic Number denoted by;

$\hat{S}$ $\langle [(\Omega, \square, ε, ȼ, \varepsilon, \ , ó, з): \Theta], [(\Omega^1, \square^1, ε^1, ȼ^1, \varepsilon^1, \ ^1, ó^1, з^1): \Psi], [(\Omega^2, \square^2, ε^2, ȼ^2, \varepsilon^2, \ ^2, ó^2, з^2): \quad] \rangle$ should satisfy the following conditions:

Condition 1:

1. $\Theta_{\hat{s}}$: truth membership function ($\Theta_{\hat{s}}$): ℝ→ [0,1],
2. $\Psi_{\hat{s}}$: indeterminacy membership function ($\Psi_{\hat{s}}$):ℝ→ [ȝ ,1],
3. $_{\hat{s}}$: falsity membership function ($_{\hat{s}}$):ℝ→ [,1].

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Condition 2:

1. $\Theta_{\hat{s}}$: truth membership function is strictly non-decreasing continuous function on the intervals $[\Omega, \varepsilon]$.
2. $\Psi_{\hat{s}}$: indeterminacy membership function is strictly non-decreasing continuous function on the intervals $[\Omega^1, \varepsilon^1]$.
3. $_{\hat{s}}$: falsity membership function is strictly non-decreasing continuous function on the intervals $[\Omega^2, \varepsilon^2]$.

Condition 3:

1. $\Theta_{\hat{s}}$: truth membership function is strictly non-increasing continuous function on the intervals $[\varepsilon, з]$.
2. $\Psi_{\hat{s}}$: indeterminacy membership function is strictly non-increasing continuous function on the intervals $[\varepsilon^1, з^1]$.
3. $_{\hat{s}}$: falsity membership function is strictly non-increasing continuous function on the intervals $[\varepsilon^2, з^2]$.

Definition 3.2 : Octagonal Neutrosophic Number [ONN] A Neutrosophic Number denoted by $\hat{S}$ is defined as,

$\hat{S}$=⟨[(Ω, □, ꞓ, ѵ, ε, , ό, з): Θ], [(Ω¹, □¹, ꞓ¹, ѵ¹, ε¹, ¹, ό¹, з¹): Ψ], [(Ω², □², ꞓ², ѵ², ε², ², ό², з²):] ⟩

Where Θ, Ψ , ∈ [0,1].

The truth membership function ($\Theta_{\hat{s}}$): $\mathbb{R} \to$ [0,1],

the indeterminacy membership function ($\Psi_{\hat{s}}$):$\mathbb{R} \to$ [ƺ ,1],

and the falsity membership function ($_{\hat{s}}$):$\mathbb{R} \to$ [,1] are given as:

$$\Theta_{\hat{s}}(x)=\begin{cases} \Theta_{\hat{s}0}(x) & \Omega \le x < \square \\ \Theta_{\hat{s}1}(x) & \square \le x < ꞓ \\ \Theta_{\hat{s}2}(x) & ꞓ \le x < ѵ \\ \Theta_{\hat{s}3}(x) & ѵ \le x < \varepsilon \\ б & x = \varepsilon \\ \Theta_{\hat{s}3}(x) & \varepsilon \le x < \\ \Theta_{\hat{s}2}(x) & \le x < ό \\ \Theta_{\hat{s}1}(x) & ό \le x < з \\ 0 & otherwise \end{cases}$$

$$\Psi_{\hat{s}}(x)=\begin{cases} \Psi_{\hat{s}0}(x) & \Omega^1 \le x < \square^1 \\ \Psi_{\hat{s}1}(x) & \square^1 \le x < ꞓ^1 \\ \Psi_{\hat{s}2}(x) & ꞓ^1 \le x < ѵ^1 \\ \Psi_{\hat{s}3}(x) & ѵ^1 \le x < \varepsilon^1 \\ ƺ & x = \varepsilon^1 \\ \Psi_{\hat{s}3}(x) & \varepsilon^1 \le x < {}^1 \\ \Psi_{\hat{s}2}(x) & {}^1 \le x < ό^1 \\ \Psi_{\hat{s}1}(x) & ό^1 \le x < з^1 \\ 1 & otherwise \end{cases}$$

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$$
{}_{\hat{s}}(\mathrm{x}) = \begin{cases} {}_{\hat{s}0}(\mathrm{x}) & \Omega^2 \leq x < \square^2 \\ {}_{\hat{s}1}(\mathrm{x}) & \square^2 \leq x < ɛ^2 \\ {}_{\hat{s}2}(\mathrm{x}) & ɛ^2 \leq x < ɐ^2 \\ {}_{\hat{s}3}(\mathrm{x}) & ɐ^2 \leq x < \varepsilon^2 \\ & x = \varepsilon^2 \\ {}_{\hat{s}3}(\mathrm{x}) & \varepsilon^2 \leq x < {}^2 \\ {}_{\hat{s}2}(\mathrm{x}) & {}^2 \leq x < ó^2 \\ {}_{\hat{s}1}(\mathrm{x}) & ó^2 \leq x < ɜ^2 \\ 1 & otherwise \end{cases}
$$

Where $\widehat{S}=\langle[(\Omega < \square < ɛ < ɐ < \varepsilon < \ < ó < ɜ): \Theta], [(\Omega^1 < \square^1 < ɛ^1 < ɐ^1 < \varepsilon^1 < \ ^1 < ó^1 < ɜ^1): \Psi], [(\Omega^2 < \square^2 < ɛ^2 < ɐ^2 < \varepsilon^2 < \ ^2 < ó^2 < ɜ^2): \ ]\rangle$

4. Graphical Representation of Octagonal Neutrosophic Number [ONN]

In this section, graphs of truthiness, indeterminacy and falsity function are presented.

Definition 4.1: Octagonal Neutrosophic Number [ONN]

$$
\Theta_{\hat{s}}(\mathrm{x}) = \begin{cases} \Theta_{\hat{s}0}(0) & 0.1 \leq x < 0.2 \\ \Theta_{\hat{s}1}(0) & 0.2 \leq x < 0.3 \\ \Theta_{\hat{s}2}(0.1) & 0.3 \leq x < 0.4 \\ \Theta_{\hat{s}3}(0.1) & 0.4 \leq x < 0.5 \\ 1 & x = 0.5 \\ \Theta_{\hat{s}3}(1) & 0.5 \leq x < 0.6 \\ \Theta_{\hat{s}2}(0.1) & 0.6 \leq x < \mathrm{o}.7 \\ \Theta_{\hat{s}1}(0.1) & 0.7 \leq x < 0.8 \\ 0 & otherwise \end{cases}
$$

$$
\Psi_{\hat{s}}(\mathrm{x}) = \begin{cases} \Psi_{\hat{s}0}(1) & 0.1 \leq x < 0.2 \\ \Psi_{\hat{s}1}(1) & 0.2 \leq x < 0.3 \\ \Psi_{\hat{s}2}(0.9) & 0.3 \leq x < 0.4 \\ \Psi_{\hat{s}3}(0.9) & 0.4 \leq x < 0.5 \\ 0 & x = 0.5 \\ \Psi_{\hat{s}3}(0) & 0.5 \leq x < 0.6 \\ \Psi_{\hat{s}2}(0.9) & 0.6 \leq x < \mathrm{o}.7 \\ \Psi_{\hat{s}1}(0.9) & 0.7 \leq x < 0.8 \\ 1 & otherwise \end{cases}
$$

$$
{}_{\hat{s}}(\mathrm{x}) = \begin{cases} {}_{\hat{s}0}(1) & 0.1 \leq x < 0.2 \\ {}_{\hat{s}1}(1) & 0.2 \leq x < 0.3 \\ {}_{\hat{s}2}(0.9) & 0.3 \leq x < 0.4 \\ {}_{\hat{s}3}(0.9) & 0.4 \leq x < 0.5 \\ 0 & x = 0.5 \\ {}_{\hat{s}3}(0) & 0.5 \leq x < 0.6 \\ {}_{\hat{s}2}(0.9) & 0.6 \leq x < \mathrm{o}.7 \\ {}_{\hat{s}1}(0.9) & 0.7 \leq x < 0.8 \\ 1 & otherwise \end{cases}
$$

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4.1 Graphical Representation of Membership, Non-membership, Indeterminacy and ONN

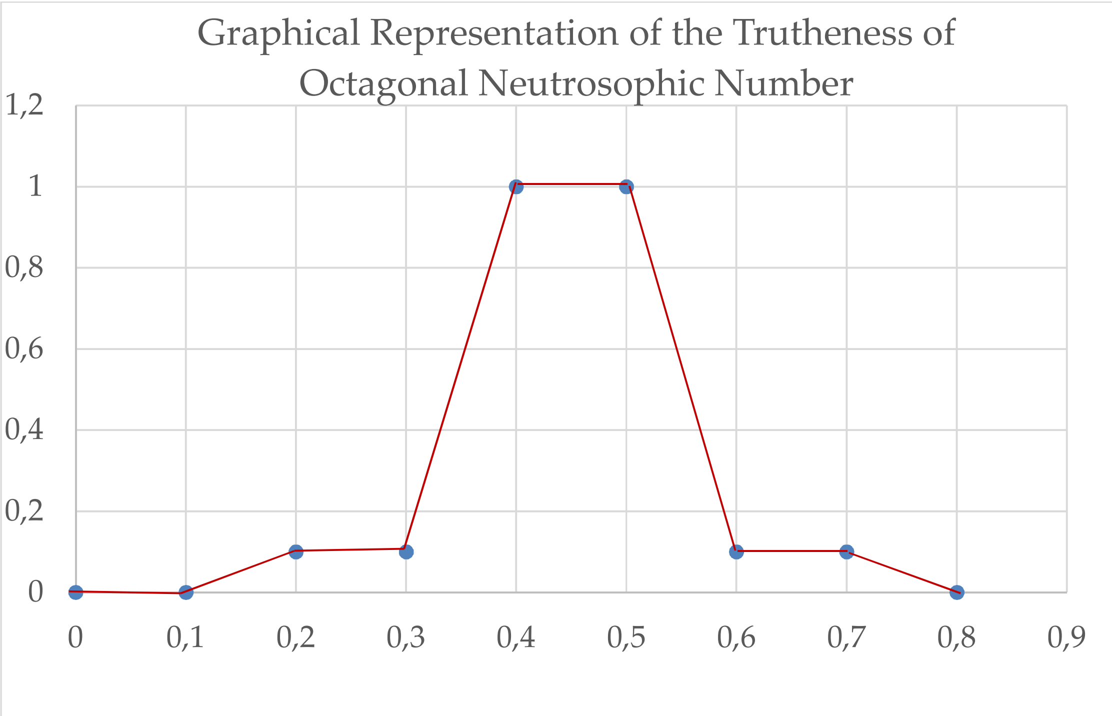

Figure 2: Graphical representation of the truthiness of ONN

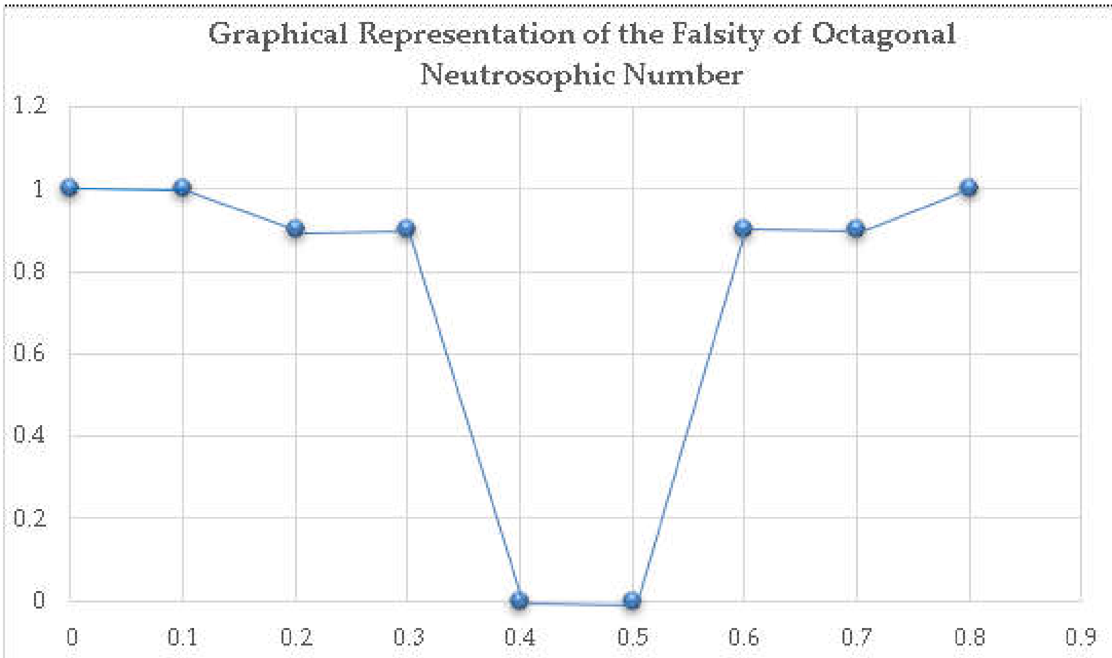

Figure 3: Graphical representation of the Falsity of ONN

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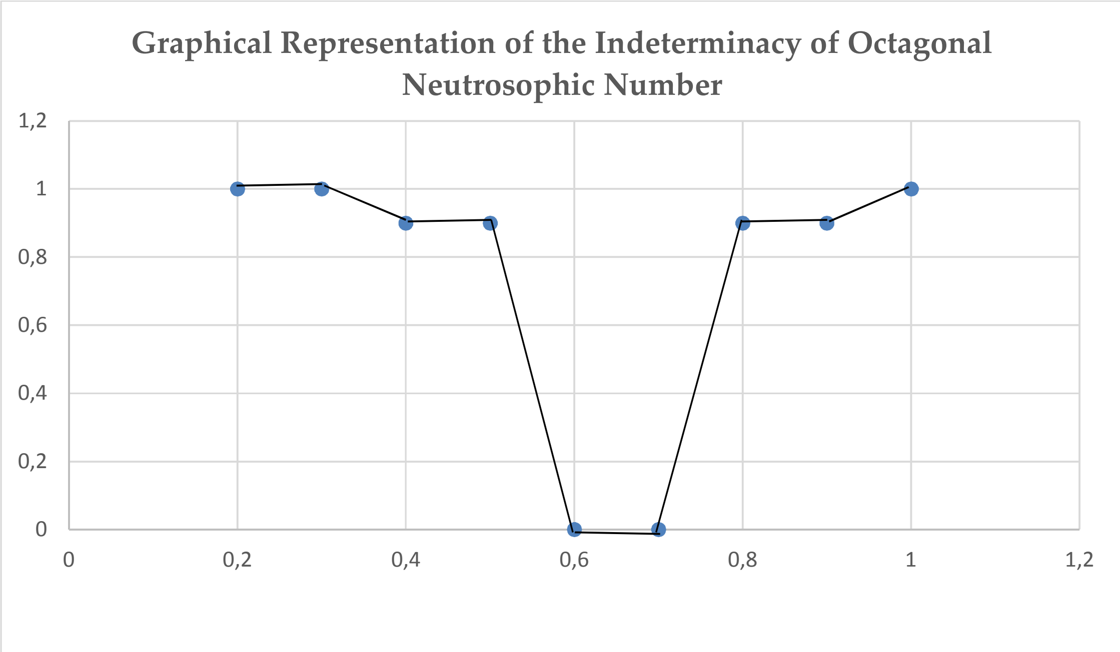

Figure 4: Graphical representation of the Indeterminacy of ONN

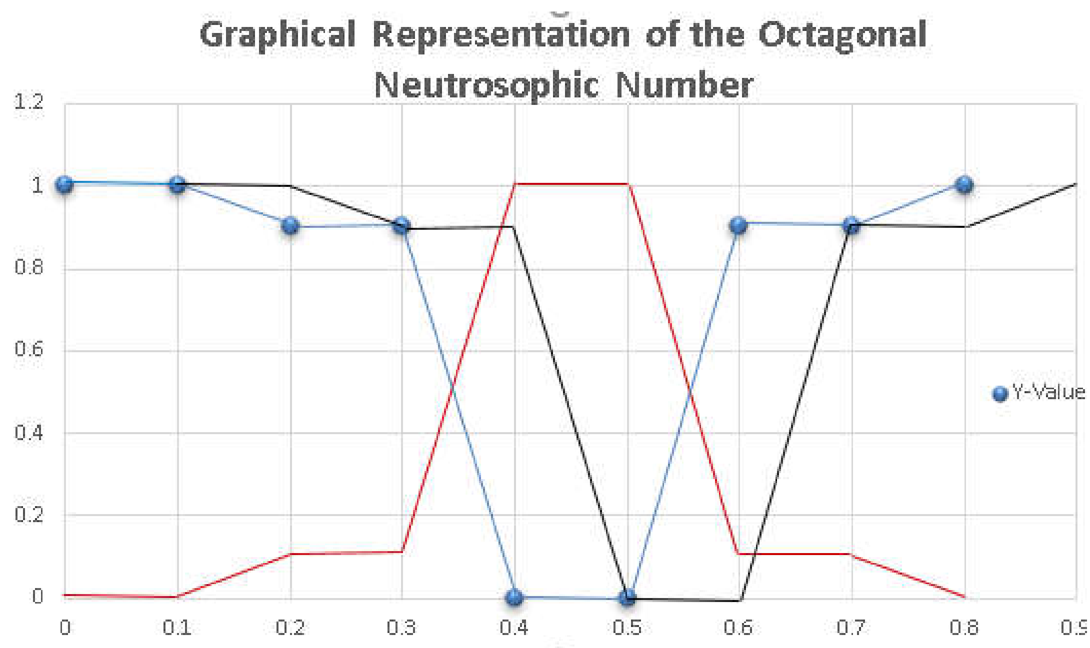

Figure 5: Graphical representation of the Octagonal Neutrosophic Number

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5. Accuracy Function for De-neutrosophication of Octagonal Neutrosophic Number (ONN)

5.1 De-neutrosophication of ONN into Neutrosophic Number

On the way of development of De-neutrosophication technique, we can generate results into neutrosophic number according to the result of octagonal neutrosophic number and its membership functions.

$$\boldsymbol{D^{T_{NO_N}}}=\left(\frac{\Omega+\square+\text{ɛ̡}+\text{ʋ̃}+\varepsilon+\quad+\text{ó}+\text{ɜ}}{\mathbf{8}}\right),$$

$$\boldsymbol{D^{I_{NO_N}}}=\left(\frac{\Omega^1+\square^1+\text{ɛ̡}^1+\text{ʋ̃}^1+\varepsilon^1+\quad{}^1+\text{ó}^1+\text{ɜ}^1}{\mathbf{8}}\right),$$

$$\boldsymbol{D^{F_{NO_N}}}=\left(\frac{\Omega^2+\square^2+\text{ɛ̡}^2+\text{ʋ̃}^2+\varepsilon^2+\quad{}^2+\text{ó}^2+\text{ɜ}^2}{\mathbf{8}}\right)$$

$$\boldsymbol{D_{NO_N}}=\left\{\frac{\Omega+\square+\text{ɛ̡}+\text{ʋ̃}+\varepsilon+\quad,\text{ó},\text{ɜ}}{\mathbf{8}},\frac{\Omega^1+\square^1+\text{ɛ̡}^1+\text{ʋ̃}^1+\varepsilon^1+\quad{}^1+\text{ó}^1+\text{ɜ}^1}{\mathbf{8}},\frac{\Omega^2+\square^2+\text{ɛ̡}^2+\text{ʋ̃}^2+\varepsilon^2+\quad{}^2+\text{ó}^2+\text{ɜ}^2}{\mathbf{8}}\right\}$$

$$\boldsymbol{D_{NO_F}}=\frac{\boldsymbol{D^{T_{NO_N}}}+\boldsymbol{D^{I_{NO_N}}}+\boldsymbol{D^{F_{NO_N}}}}{\mathbf{3}},$$

- $\boldsymbol{D^{T_{NO_N}}}$ represents the de-neutrosophication of trueness of neutrosophic octagonal number into neutrosophic.
- $\boldsymbol{D^{I_{NO_N}}}$ represents the de-neutrosophication of indeterminacy of neutrosophic octagonal number into neutrosophic.
- $\boldsymbol{D^{F_{NO_N}}}$ represents the de-neutrosophication of falsity of neutrosophic octagonal number into neutrosophic.
- $\boldsymbol{D_{NO_N}}$ represents the de-neutrosophication of octagonal number into neutrosophic number.

Example 1: In Table: 3 five octagonal neutrosophic numbers ONN are defuzzified into Neutrosophic Number.

	Octagonal Neutrosophic Number	$\boldsymbol{D_{NO_N}}$
1	(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8;0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9; 0.1,0.3,0.4,0.5,0.6,0.7,0.8,0.9)	(0.45,0.55,0.5375)
2	(0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9;0.1,0.3,0.4,0.5,0.6,0.7,0.8,0.9; 0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9)	(0.55,0.5375,0.55)
3	(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.9;0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8; 0.1,0.2,0.4,0.5,0.6,0.7,0.8,0.9)	(0.4625,0.45,0.525)
4	(0.1,0.2,0.4,0.5,0.6,0.7,0.8,0.9; 0.1,0.3,0.4,0.5,0.6,0.7,0.8,0.9; 0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9)	(0.45,0.5375,0.55)
5	(0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9; 0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8; 0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.9)	(0.55,0.45,0.4625)

Table 2: De-neutrosophication of ONN into Neutrosophic number using Accuracy Function.

5.2 De-neutrosophication of Neutrosophic Number

On the way of development of de-Neutrosophication technique, we can generate results into fuzzy number according to the result of neutrosophic number.

$$\boldsymbol{D_{NO_F}}=\frac{\boldsymbol{D^{T_{NO_N}}}+\boldsymbol{D^{I_{NO_N}}}+\boldsymbol{D^{F_{NO_N}}}}{\mathbf{3}},$$

$\boldsymbol{D_{NO_F}}$ represents the de-neutrosophication of octagonal number into fuzzy number.

Example 2: In Table: 3 five octagonal neutrosophic numbers are defuzzified into Fuzzy.

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	Octagonal Neutrosophic Number	D_{NO_N}	D_{NO_F}
1	(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8;0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9; 0.1,0.3,0.4,0.5,0.6,0.7,0.8,0.9)	(0.45,0.55,0.5375)	0.5125
2	(0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9;0.1,0.3,0.4,0.5,0.6,0.7,0.8,0.9; 0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9)	(0.55,0.5375,0.55)	0.54583
3	(0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.9;0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8; 0.1,0.2,0.4,0.5,0.6,0.7,0.8,0.9)	(0.4625,0.45,0.525)	0.47916
4	(0.1,0.2,0.4,0.5,0.6,0.7,0.8,0.9; 0.1,0.3,0.4,0.5,0.6,0.7,0.8,0.9; 0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9)	(0.45,0.5375,0.55)	0.5125
5	(0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9; 0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8; 0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.9)	(0.55,0.45,0.4625)	0.4875

Table 3: De-neutrosophication of ONN using Accuracy Function.

6. Case Study

To demonstrate the;

- Feasibility
- Productiveness

of the proposed method, here is the most useful real-life candidate selection problem is presented.

6.1 Problem Formulation

Suppose we have three candidates which have different degree, experience and number of publications, the thing which matter the most to select one which have more potential to deal with situation. The potential of person depends upon degree, experience and number of publications they have. To improve the competitiveness capability, the best selection plays an important role, and to select the best one. Due to octagonal we can deal with more fluctuations. The background of formal education comparison also necessary. Same case for experience because it illustrates the personality and also mention that person is capable to handle the circumstances. Same as publications is also important for selection. With the concept of octagonal we have more expanse to deal with more edges. Suppose we are talking about degree we can mention his all necessary degrees with grades.

6.2 Parameters

Selection is a complex issue, to resolve this problem criteria and alternative plays an important role. Following criteria and alternatives are considered in this problem formulation.

6.2.1 Alternatives

Candidates are considered as the set of alternatives represented with $\check{S} = < \zeta, \varpi, \upsilon >$

6.2.2. Criteria

Following three criteria are considered for the selection

- Degree
- Experience
- Publications

6.3 Assumptions

The decision makers $\{Ɗ_1, Ɗ_2, Ɗ_3, Ɗ_4, Ɗ_5, Ɗ_6, Ɗ_7, Ɗ_8\}$ will assign ONN, according to his own interest, knowledge and experience, to the above-mentioned criteria and alternatives.

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- Assigning Octagonal Neutrosophic Number ONN, by decision makers to the candidate ζ.

Sr # No	Criteria	Octagonal Neutrosophic Number (ONN)
1	Degree	< (0.72,0.35,0.71,0.77,0.41,0.73,0.77,0.81), (0.93,0.83,0.93,0.88 ,0.94,0.99,0.96,0.90), (0.86,0.95,0.99,0.97,0.94,0.93,0.95,0.91) >
2	Experience	< (0.75,0.65,0.96,0.54,0.73,0.65,0.83,0.56), (0.75,0.45,0.95,0.38,0.68,0.79,0.57,0.13), (0.36,0.59,0.68,0.79,0.47,0.36,0.47,0.95) >
3	Publications	< (0.74,0.73,0.64,0.75,0.96,0.34,0.85,0.89), (0..35,0.46,0.58,0.79,0.85,0.71,0.64,0.96), (0.84,0.73,0.85,0.75,0.98,0.84,0.66,0.94)>

Table 4(a): ONN by decision makers to each criterion to the candidate ζ.

- Assigning Octagonal Neutrosophic Number ONN, by decision makers to the candidate ϖ.

Sr # No	Criteria	Octagonal Neutrosophic Number (ONN)
1	Degree	< (0.73,0.73,0.94,0.85,0.96,0.74,0.95,0.89), (0.33,0.46,0.59,0.79 ,0.85,0.79,0.74,0.86), (0.48,0.33,0.55,0.75,0.68,0.64,0.36,0.70) >
2	Experience	< (0.75,0.55,0.96,0.54,0.93,0.65,0.73,0.56), (0.93,0.83,0.83,0.58,0.84,0.69,0.76,0.80), (0.66,0.59,0.68,0.99,0.47,0.46,0.87,0.95) >
3	Publications	< (0.94,0.93,0.74,0.95,0.96,0.94,0.85,0.99), (0.28,0.26,0.58,0.35,0.45,0.61,0.64,0.36), (0.28,0.23, 0.25, 0.45, 0.68, 0.44, 0.26, 0.34)>

Table 4(b): ONN by decision makers to each criterion to the candidate ϖ.

- Assigning Octagonal Neutrosophic Number ONN, by decision makers to the candidate υ.

Sr # No	Criteria	Octagonal Neutrosophic Number (ONN)
1	Degree	< (0.73,0.83,0.93,0.56,0.95,0.95,0.73,0.88), (0.76,0.95,0.69,0.94,0.94,0.63,0.55,0.61), (0.74,0.73,0.85,0.75,0.48,0.34,0.66,0.74) >
2	Experience	< (0.73,0.65,0.96,0.54,0.63,0.65,0.81,0.59), (0.75,0.45,0.85,0.38,0.78,0.79,0.67,0.13), (0.38,0.59,0.68,0.79,0.97,0.36,0.67,0.85) >
3	Publications	< (0.74,0.73,0.64,0.75,0.96,0.34,0.85,0.89), (0.35,0.44,0.58,0.79,0.75,0.71,0.54,0.96), (0.74,0.63,0.35,0.35,0.98,0.34,0.28,0.64)>

Table 4(c): ONN by decision makers to each criterion to the candidate υ.

6.4 VIKOR Method

Vikor method is best for solve the problem of multi criteria decision making.it is used to drive on ranking and for selection of a set of possibilities and solve consolation solution for a problem with aggressive criteria. Opricovic [12] introduced the idea of Vikor method in 1998. It is related with both positive and the negative ideal solution, it can change the variable into two or more alternative variables to find out the best compromise solution. By the help of Vikor method we can put new ideas for group decision making problem under the certain criteria.

Vikor Method consist of following steps;

Step 1. Normalization of decision matrix and weight assigning.

Step 2. Now we will calculate the group unity value $\breve{H}_i$=[H_i^L, H_i^U] and the individual regard value $\breve{\mathbb{S}}_i$=[$\mathbb{S}_i^L, \mathbb{S}_i^U$], where;

$$H_i^L = \sum_j w_j \frac{\mathbb{S}_i^L - \mathbb{S}_j^+}{\mathbb{S}_i^- - \mathbb{S}_j^+},\ H_i^U = \sum_j w_j \frac{\mathbb{S}_i^U - \mathbb{S}_j^+}{\mathbb{S}_i^- - \mathbb{S}_j^+}$$

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And

$S_i^L = \max_{1\le j\le n} w_j \left\{ \left(\frac{s_{ij}^L - s_j^+}{s_j^- - s_j^+} \right) \right\}$, $\mathbb{S}_i^U = \max_{1\le j\le n} w_j \left\{ \left(\frac{\mathbb{S}_{ij}^U - \mathbb{S}_j^+}{\mathbb{S}_j^- - \mathbb{S}_j^+} \right) \right\}$

Step 3. Here we will Calculate the comprehensive sorting index $\widetilde{W}_i=[W_i^L, W_i^U]$, where

$\widetilde{W}_i = \sigma \frac{\widetilde{H}_i - H^*}{H^- - H^*} + (1-\sigma) \frac{\mathbb{S}_i - \mathbb{S}^*}{\mathbb{S}^- - \mathbb{S}^*}$

Now by using algorithm of interval fuzzy number:

$W_i^L = \sigma \frac{H_i^L - H^*}{H^- - H^*} + (1-\sigma) \frac{\mathbb{S}_i^L - \mathbb{S}^*}{\mathbb{S}^- - \mathbb{S}^*}$

and

$W_i^U = \sigma \frac{H_i^U - H^*}{H^- - H^*} + (1-\sigma) \frac{\mathbb{S}_i^L - \mathbb{S}^*}{\mathbb{S}^- - \mathbb{S}^*}$

Here $H^* = \min_i H_i^L$, $H^- = \max_i H_i^U$, $\mathbb{S}^* = \min_i \mathbb{S}_i^L$, $\mathbb{S}^* = \max_i \mathbb{S}_i^U$. Parameter σ is called decision mechanism index, and it lies between [0,1]. If σ >0.5, it is the decision making in the light of maximum group benefit (i.e., if σ is big, group utility is emphasized); if σ=0.5, here decision making in accordance with compromise. If σ <0.5, it is the decision making in the light of minimum individual regret value. In VIKOR, we take σ =0.5 generally, that is called compromise makes maximum group benefit and minimum individual regret value.

Step 4. The rank of fuzzy numbers is $\mathbb{S}_i$, $\widetilde{W}_i$ *and* $\widetilde{H}_i$.

Since $\mathbb{S}_i$, $\widetilde{W}_i$ *and* $\widetilde{H}_i$ are all still individual numbers, now to compare the two-interval value we use the possible degree theory.

Here number of interval number $\breve{A}_i = [A_i^L , A_i^U]$, (i=1,2, 3,…,m), the comparison steps are given of these interval numbers;

(a) For any two intervals numbers $\breve{A}_i=[A_i^L , A_i^U]$ and $\breve{A}_j=[A_j^L , A_j^U]$, now we will calculate the possible degree $\rho_{ij} = \rho(\breve{A}_i \ge \breve{A}_j)$ and now we will construct the possible degree matrix $\rho = (\rho_{ij})_{m\times m}$, and the product by comparison of any two interval numbers $\breve{A}_i=[A_i^L , A_i^U]$ and $\breve{A}_j=[A_j^L , A_j^U]$, where i,j=1,2,3,….,m. Xu [18] proved that matrix $\rho = (\rho_{ij})_{m\times m}$ satisfies $(\rho_{ij} \ge 0, \rho_{ij} + (\rho_{ji}$=1, $\rho_{ii} = 0.5$ (i,j=1,2,3,…,m)

The matrix $\rho = (\rho_{ij})_{m\times m}$ is called the fuzzy complementary judgement matrix, and we can rank the alternatives as follow.

(b) The rank of interval numbers $\breve{A}_i = [A_i^L , A_i^U]$, (i=1,2,3,,m)
Ranking formula is given below
$\mathcal{U}_i = \frac{1}{m(m-1)} \left(\sum_{j=1}^{m} \rho_{ij} + \frac{m}{2} - 1 \right)$,i=1,2,3,…,m
The smaller $\mathcal{U}_i$, is the smaller $\breve{A}_i = [A_i^L , A_i^U]$ is.

Step 5. Now we will rank the alternatives based on $\mathbb{S}_i$, $\widetilde{W}_i$ *and* $\widetilde{H}_i$(i=1,2,3,…,m).here the smaller of interval number $\mathbb{S}_i$ is, and the better alternative x_i is. propose as a min $\{\mathbb{S}_i \mid$ i=1,2,3,…,m$\}$ if these two condition are satisfied[16]:

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(i) $\mathbb{S}\,(A^{(2)}) - \mathbb{S}\,(A^{(1)}) \geq 1/(m-1)$, where $A^{(2)}$ called the second alternative with second position in the ranking list by $\mathcal{R}$; m is the number of alternatives.

(ii) $A^{(1)}$alternative also must be best ranked by $\{\breve{\mathbb{S}}_i or/and\, \mathcal{R}_i \mid I = 1,2, 3\ldots m\}$.

Figure 6: Flowchart of VIKOR algorithm

6.5 Numerical Analysis

Suppose that U is the universal set. Let HR which is responsible for recruiting and interviewing, and wants to hire a new candidate in company. Three candidates $\check{S} = <\zeta, \varpi, \upsilon>$ apply for this opportunity, which have different degrees, experiences and publications. On the base of choice parameters $\{\mathbb{C}_1 = \text{Dergre}, \mathbb{C}_2 = \text{Experience}, \mathbb{C}_3 = \text{Publication}\}$ we apply the algorithm to find the potential candidate.

Step 1. Associated Decision Matrix

$$
\begin{array}{ccc}
\text{Candidate}= \zeta & \text{Candidate}= \varpi & \text{Candidate}= \upsilon
\end{array}
$$

$$
\begin{pmatrix}
\{\mathbb{C}_1(0.72,0.35,0.71,0.77,0.41,0.73,0.77,0.81) & \{\mathbb{C}_1(0.73,0.73,0.94,0.85,0.96,0.74,0.95,0.89) & \{\mathbb{C}_1(0.73,0.83,0.93,0.56,0.95,0.95,0.73,0.88) \\
(0.93,0.83,0.93,0.88\ ,0.94,0.99,0.96,0.90) & (0.33,0.46,0.59,0.79,0.85,0.79,0.74,0.86) & (0.76,0.95,0.69,0.94,0.94,0.63,0.55,0.61)\} \\
(0.86,0.95,0.99,0.97,0.94,0.93,0.95,0.91)\} & (0.48,0.33,0.55,0.75,0.68,0.64,0.36,0.70)\} & (0.74,0.73,0.85,0.75,0.48,0.34,0.66,0.74)\} \\
\{\mathbb{C}_2(0.75,0.65,0.96,0.54,0.73,0.65,0.83,0.56) & \{\mathbb{C}_2(0.75,0.55,0.96,0.54,0.93,0.65,0.73,0.56) & \{\mathbb{C}_2(0.73,0.65,0.96,0.54,0.63,0.65,0.81,0.59) \\
(0.75,0.45,0.95,0.38,0.68,0.79,0.57,0.13) & (0.93,0.83,0.83,0.58\ ,0.84,0.69,0.76,0.80) & (0.75,0.45,0.85,0.38,0.78,0.79,0.67,0.13) \\
(0.36,0.59,0.68,0.79,0.47,0.36,0.47,0.95)\} & (0.66,0.59,0.68,0.99,0.47,0.46,0.87,0.95)\} & (0.38,0.59,0.68,0.79,0.97,0.36,0.67,0.85)\} \\
\{\mathbb{C}_3(0.74,0.73,0.64,0.75,0.96,0.34,0.85,0.89) & \{\mathbb{C}_3(0.94,0.93,0.74,0.95,0.96,0.94,0.85,0.99) & \{\mathbb{C}_3(0.74,0.73,0.64,0.75,0.96,0.34,0.85,0.89) \\
(0..35,0.46,0.58,0.79,0.85,0.71,0.64,0.96) & (0.28,0.26,0.58,0.35,0.45,0.61,0.64,0.36) & (0.35,0.44,0.58,0.79,0.75,0.71,0.54,0.96) \\
(0.84,0.73,0.85,0.75,0.98,0.84,0.66,0.94)\} & (0.28,0.23,0.25,0.45,0.68,0.44,0.26,0.34)\} & (0.74,0.63,0.35,0.35,0.98,0.34,0.28,0.64)\}
\end{pmatrix}
$$

De-Neutrosophication of Octagonal Neutrosophic number by,

$$
\boldsymbol{D}^{\boldsymbol{T}_{\boldsymbol{NO}_N}} = \left(\frac{\Omega+\square+\text{ɛ̧}+\text{ȼ}+\varepsilon+\square+\acute{o}+3}{\mathbf{8}}\right),\ \boldsymbol{D}^{\boldsymbol{I}_{\boldsymbol{NO}_N}} = \left(\frac{\Omega^1+\square^1+\text{ɛ̧}^1+\text{ȼ}^1+\varepsilon^1+\square^1+\acute{o}^1+3^1}{\mathbf{8}}\right),\ \boldsymbol{D}^{\boldsymbol{F}_{\boldsymbol{NO}_N}} = \left(\frac{\Omega^2+\square^2+\text{ɛ̧}^2+\text{ȼ}^2+\varepsilon^2+\square^2+\acute{o}^2+3^2}{\mathbf{8}}\right)
$$

The associated neutrosophic matrix is,

$$
X = \begin{pmatrix}
(0.65,0.92,0.93) & (0.84,0.67,0.56) & (0.82,0.88,0.66) \\
(0.70,0.59,0.58) & (0.70,0.78,0.70) & (0.69,0.60,0.66) \\
(0.86,0.66,0.82\ ) & (0.91,0.44,0.36) & (0.73,0.64,0.49)
\end{pmatrix}
$$

The associated fuzzy matrix is,

$$X = \begin{pmatrix} (0.8333) & (0.6900) & (0.7866) \\ (0.6233) & (0.7266) & (0.6500) \\ (0.7800\,) & (0.5700) & (0.6200) \end{pmatrix}$$

After calculating normalized decision matrix, we determine the positive ideal solution as well as negative ideal solution

$\mathbb{r}^{+}$={(0.65,0.92,0.93)} $\mathbb{r}^{-}$={(0.91,0.44,0.36)}

Step 2. Calculate the group utility value as $\breve{H}_i = [H_i^L, H_i^U]$ and $\breve{\mathbb{S}}_i = [\mathbb{S}_i^L, \mathbb{S}_i^U]$

$\breve{H}_1$= [0.2769,0.2000] $\breve{H}_2$ =[0.1076,0.3846] $\breve{H}_3$ =[0.4230,0.2230]

And $\breve{\mathbb{S}}_1$ =[0.1461,0.1615] $\breve{\mathbb{S}}_2$ =[0.0384,0.2000] $\breve{\mathbb{S}}_3$= [0.2000,0.1307]

Step 3. Now we will calculate the comprehensive sorting index $\widetilde{W}_i = [W_i^L, W_i^U]$

W1 = 0.0506

W2 = 0.0275

W3 = 0.0163

Step 4. Calculation of $\boldsymbol{H_i}$,$\boldsymbol{W_i}$ and $\boldsymbol{S_i}$

S1 = 0.2767 H1 = 0.1088 W1 = 0.0506

S2 = 0.2394 H2 = 0.1165 W2 = 0.0275

S3 = 0.2530 H3 = 0.1066 W3 = 0.0163

Step 5. Ordering of $\boldsymbol{H_i}$,$\boldsymbol{W_i}$ and $\boldsymbol{S_i}$

Order the alternatives, listed by the values Si; Hi and Wi:

S2 = 0.2394 H3 = 0.1066 W3 = 0.0163

S3 = 0.2530 H1 = 0.1088 W2 = 0.0275

S1 = 0.2767 H2 = 0.1165 W1 = 0.0506

According to the ranking S3 is the potential candidate for the company.

7. Conclusion

The concept of octagonal neutrosophic number has sufficient scope of utilization in different studies in various domain. In this paper, we proposed a new concept of octagonal neutrosophic number ONN, notion and graphical representation. The de-neutrosophication technique is carried out by implementing accuracy function and following points were concluded.

- The octagonal neutrosophic number, function and graph add a new tool for modeling different aspects of daily life issues, science and environment.
- Since this study has not yet been studied yet, the comparative study cannot be done with the existing methods.

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- Detailed illustrations of truthiness, indeterminacy, falsity and de-neutrosophication techniques will provide all the required information in one platform to model any real-world problem.

In forthcoming work, authors will define the types Symmetric, Asymmetric, along with their α-cuts. Proposed work can be used to model different dynamics, of applied sciences, such as MCDM and networking problems, etc.

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